

MINNESOTA POLLUTION CONTROL AGENCY SITE RESPONSE SECTION

DRAFT SITE SCREENING EVALUATION GUIDELINES

(WORKING DRAFT)

NOTICE

THIS DOCUMENT IS A WORKING DRAFT. The Site Response Section of Minnesota Pollution Control Agency (MPCA) is developing guidelines for evaluating risks to human health and the environment at sites that may require investigation or response actions pursuant to the Minnesota Environmental Response and Liability Act, Minn. Stat. § 115B.01 to 115.24 (MERLA).

DEVELOPMENT OF A SITE RESPONSE SECTION SITE EVALUATION MANUAL. The attached document and other documents not yet developed will be incorporated into a Site Response Risk-Based Site Evaluation Manual which will contain guidelines for conducting MERLA-related evaluations, including risk evaluations under the State Superfund program and the MPCA Voluntary Investigation and Cleanup (VIC) Program.

MPCA staff intend to use the policies and procedures in the proposed manual as guidelines to evaluate the need for investigation or remedial actions to address releases and threatened releases of hazardous substances or pollutants or contaminants under MERLA, and the scope and nature of such actions. These policies and procedures are not exclusive and do not have the force and effect of law. MPCA staff may use other policies or procedures to evaluate the need for or adequacy of response actions under MERLA, including procedures set forth in outstanding MPCA Requests for Response Action and Consent Orders. The final standard for all such evaluations is the MERLA statutory requirement that such actions must be reasonable and necessary to protect the public health and welfare and the environment.

APPLICATION TO SITES MUST BE PRE-APPROVED. At this time, Site Response Section staff shall accept only written comments regarding this draft document (see comment period and address below). During guideline development, application of these guidelines or procedures shall be site-specific, conducted in consultation with and upon approval of MPCA Site Response Section staff assigned to the specific site.

EXPLANATION:

This draft document presents only a portion of a Risk-Based Site Evaluation process currently under development by the MPCA Site Response Section staff. MPCA staff involved in your Site should be consulted for pre-screening procedures, including determination of the need for ecological assessment, to be conducted prior to implementing the screening procedures outlined in the current document.

Users of this document are responsible for confirming with the MPCA Site staff the version of the working draft to be used.

The technical rationale for the procedures outlined in the Site Screening Evaluation Guidelines will be provided in separate support documents available in the future.

References in this document to electronic storage locations apply to MPCA staff access only. Excel spreadsheets of the Screening Criteria Tables are available for Site-specific application upon request to the MPCA Site staff. The requester shall provide MPCA Site staff with a formatted disk with a return self-addressed, stamped disk envelope for duplication of the spreadsheets by the mailing list administrator, Julianne Mossak. Until further notice, there will be no charge for the spreadsheets.

SITE SCREENING EVALUATION

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LIST OF SCREENING CRITERIA TABLES

Soil Criteria

A) Human-Health Based Criteria

- Residential (Unrestricted Land Use Soil Reference Values
[Used for Screening Evaluations])
- July 6, 1994, Lead Clean-up Goals for Superfund Sites Site Response Memorandum

B) Ecological Soil Screening Criteria

- EcoSoil Table 1. Direct Soil Contact Criteria
- EcoSoil Table 2. Bioaccumulation Screening Criteria

C) Soil-to-Ground Water Screening Criteria

- Revised February 26, 1996, Soil Screening Values for the Soil-to-Ground Water Exposure Pathway Site Response Memorandum
- Soil-to-Ground Water Soil Screening Value Additivity Evaluation Table

Ground Water Criteria

- Health Risk Limit (HRL) Additivity Table
- Drinking Water Criteria Summary Table

Surface Water Criteria

- Surface Water Toxics Impact Assessment Form
- Use Classification Descriptions
- Surface Water Screening Criteria Summary Table

Sediment Criteria

- Sediment Screening Criteria Table

Air Criteria

- Air Quality's Air Concentration Limits

Biota Criteria

- Biota Table 1. Food and Drug Administration (FDA) Action Levels and Tolerance Levels [To be developed]
- Biota Table 2. Fish Flesh Criteria — Minnesota Department of Health and New York Department of Environmental Conservation [To Be Developed]

EXECUTIVE SUMMARY

In order to rationalize and streamline its Superfund and Voluntary Investigation and Cleanup Programs, the Minnesota Pollution Control Agency (MPCA) has adopted a risk-based decision making approach. Risk-based decision making provides a means for making technically defensible decisions which allocate resources to sites and conditions posing the greatest long-term risks to humans and the environment.

The screening evaluation comprises the second major step of the Site Response Section's hazardous waste site investigation and clean-up process. It follows the site evaluation phase, during which contaminant conditions at a site are characterized, providing information and data for the screening evaluation.

The screening evaluation then helps determine whether conditions at a site require further investigation and possible cleanup due to potential risks to human health and the environment. To do this, the evaluation employs a media-based approach. Appropriate exposure concentrations in each environmental medium are compared to screening criteria for that medium.

The screening criteria represent contaminant levels in the media above which unacceptable risks could occur under the general exposure conditions used in developing the criteria. During the screening evaluation, it is assumed that the site will be developed for residential purposes, and thus, that exposures related to residential uses may occur. This relatively conservative land use assumption helps to ensure that protective decisions result from the screening evaluation, because the evaluation depends on information from site characterizations that may not be comprehensive at this early stage of the investigation and clean-up process.

Section I, Introduction, of the "Site Screening Evaluation" guidance document explains the purpose of the screening evaluation, its context in the overall site investigation process, and the possible outcomes of the evaluation. The introduction also provides a brief overview of the evaluation and of its applicability outside the traditional Superfund program.

Section II of the "Site Screening Evaluation" briefly reviews the types of site information needed to conduct the screening. Future guidance on site evaluation will explain these information needs. Future guidance on sampling will explain options for planning and conducting sampling to ensure collection of accurate and representative quantitative data for use in the Screening Evaluation.

Section III explains how to identify chemicals of potential concern at a site. This step is necessary to determine which chemicals may pose risks, and, therefore, whether the site requires further evaluation. Identification of chemicals of potential concern depends on the adequacy of sampling data from the site evaluation. The main factors which affect

identification of chemicals of potential concern are: the chemicals detected at the site, data quality, and comparison of site concentrations to background levels.

Section IV contains the central elements of the screening evaluation, comparison of media concentrations to media-based screening criteria. The section is therefore divided into six media-specific subsections: soil, ground water, surface water, sediment, air, and biota.

These subsections for each medium include the following main screening steps:

- determine representative exposure concentrations;
- calculate hazards quotients and excess cancer risks;
- for ecological receptors, compare concentrations to toxicological benchmarks;
- sum individual values to derive cumulative risks when appropriate or feasible; and
- evaluate results of calculations and make final determination on further investigation.

Section V contains a discussion of short-term hazard evaluations. It also provides examples of site conditions or circumstances which might constitute short-term hazards, as well as examples of response actions which can be used to address these hazards.

The document concludes with a brief review of the possible outcomes of the screening evaluation. If a site does not “pass” the screening for one or more of the media, because screening levels are exceeded, conditions at the site must be evaluated further. Finally, definitions and references are attached to assist the reader.

Criteria tables referenced in the guidance will be available on the *P:drive* of the Ground Water and Solid Waste Division computer system. The “Technical Support Document,” also referenced in the guidance, is under development and, upon completion, will be made available. Copies of the documents will be made available to the public on a unit cost basis.

SITE SCREENING EVALUATION

I. INTRODUCTION

General Comments:

This document explains how to conduct a site screening evaluation. The objective of the screening evaluation is to identify sites most likely to need cleanup and to eliminate sites or portions of sites not needing cleanup. It does this by focusing on risks early in the site investigation process. This is important for three reasons:

- 1) because the site evaluation process (formerly site assessment) must provide information for the screening evaluation, the requirements of the screening evaluation help to focus the site evaluation on collection of information needed for evaluating site risks;
- 2) the screening evaluation contributes to better informed, more defensible, and more consistent decisions regarding whether further investigation or cleanup is needed; and
- 3) it contributes to a better focused, and thus more cost-effective, remedial investigation.

The site screening evaluation comprises one phase of the site investigation and clean-up process. It follows the site evaluation portion of the site investigation process, and it precedes remedial investigation activities and the setting of clean-up goals. Each step of the investigation and clean-up process should support the following step. For example, the effectiveness of the screening evaluation depends upon the quantity and quality of information available from site evaluation activities. The screening evaluation in turn should help to focus use of resources during the remedial investigation by indicating where additional information is needed, what parts of a site pose the greatest risks, and whether a formal risk assessment is also needed. Focused investigations help to ensure that staff, responsible parties, or voluntary parties collect only data and other information necessary to determine impacts on public health and the environment. Sites may enter the process with varying amounts of information and predetermined factors which will require flexibility and may not require completing every step.

The following brief outline illustrates where the site screening evaluation fits in the overall site investigation process.

- site discovery, reporting, or referral;
- site evaluation activities, including a "Phase I" historical investigation and preliminary sampling;
- **Site Screening Evaluation**;
- remedial investigation (RI);
- setting preliminary clean-up goals;

- feasibility study;
- setting clean-up goals;
- selecting the remedy;
- setting *final* clean-up levels;
- implementing the remedy;
- monitoring remedy effectiveness; and
- issuing liability assurances, certificate of completion, or de-listing the site.

The Site Response Section (SRS) staff will continue to develop a site evaluation process designed to provide appropriate information for the site screening evaluation. A document on site evaluation will describe the process. The site evaluation guidance will explain how to identify data requirements for different phases of site investigation, and how to fulfill them. The SRS staff will also continue to develop guidance on setting clean-up goals and selecting remedies, incorporating the risk-based decision making process initiated during the screening evaluation.

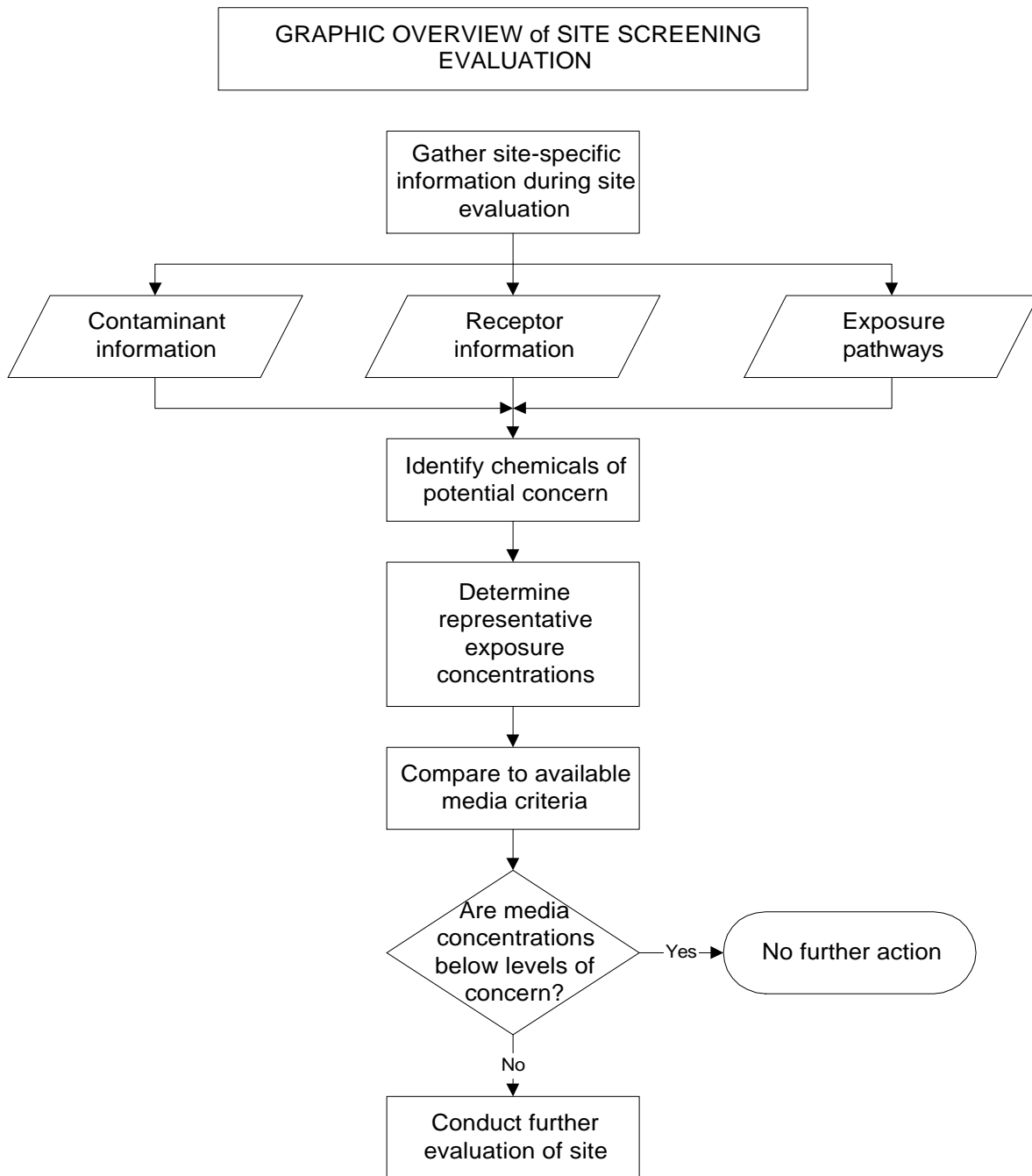
Overview of the Screening Evaluation:

The main steps of the screening evaluation are:

- to evaluate sampling data in the context of site background information;
- to determine chemicals of potential concern (COPCs);
- to determine representative exposure concentrations for the different media;
- to calculate Hazard Quotients (HQs) and Excess Cancer Risks (ECRs) for human receptors (for ecological receptors, compare data with toxicological benchmarks);
- to sum individual values to derive cumulative risks when appropriate or feasible; and
- to evaluate results of calculations and make final determinations regarding further investigation.

The screening evaluation consists of more than simply comparing a sample result to a generic number. The purpose of the evaluation is to estimate risks posed by contaminants at the site. Therefore, a risk estimate must be calculated for each contaminant of concern, and cumulative risks must be estimated. This process varies for the different media, as explained by the sections of this document.

The following flowchart summarizes the main steps of the site screening evaluation.



Possible Outcomes of the Screening Process:

In conducting the screening evaluation, evaluate all media, and consider the context of the site. At some sites, the screening process may indicate that contaminants in only one or two of the media pose risks to human or ecological receptors. If this is the case, it is not necessary to investigate other media further. On the other hand, investigate further any medium which poses potential risks for any receptor of concern.

Briefly, the possible outcomes of the screening evaluation are:

- 1) the site clearly “fails” the screening—concentrations in one or more media clearly exceed screening criteria for one or more contaminants;
- 2) the site barely “fails”— concentrations in one or more media barely exceed screening criteria;
- 3) the site barely “passes”— concentrations in one or more media are barely below screening criteria;
- 4) the site clearly “passes”— concentrations in all media are clearly below screening criteria.

Future guidance on setting preliminary clean-up goals will discuss how to make decisions in situation 1. In situations 2 and 3 and before a decision is finalized, the basis of the screening criteria (e.g., default assumptions, exposure pathways, etc.) and the quality of the data need to be reviewed. The site team will then use professional judgment to determine whether confirmation sampling is recommended or if the screening criteria were appropriate for the site conditions. Situation 4 requires no further action to ensure protection of human health and the environment, assuming that sampling was adequate and that additivity was evaluated.

Application of the Screening Evaluation Beyond Superfund:

The SRS staff are designing a comprehensive, integrated investigation and clean-up process to determine whether a site poses risks to either humans or other organisms; therefore, requiring remediation. The site screening evaluation is an integral part of the process. The screening evaluation uses a media-based risk evaluation and decision making approach because sampling data is collected and analyzed by media.

To the greatest extent possible, the SRS staff will use this approach at all contaminated sites, regardless of the types of contamination present or the authorities under which sites are investigated. From an environmental perspective, either contamination exists and poses risks at the site or it does not—on this level, legal and administrative distinctions should be subordinate to the nature of the problem and appropriate solutions. The programs or funding sources which the

Minnesota Pollution Control Agency (MPCA) or other parties use to address the risks are secondary, albeit important and practical factors.

Applicable laws, authorities, or funding sources may direct the extent of the investigation and full use of the screening evaluation. For example, a non-responsible, voluntary party may request liability assurances concerning contamination of only a portion of a site or of only one environmental medium. In these cases, apply the screening evaluation to the relevant medium or area of the site. However, if background research or data suggest that other media or other areas may pose unacceptable risks to humans or ecological receptors, refer the site (or that aspect of it) to another appropriate program, so that it may evaluate these potential risks and determine whether response actions are necessary to address them.

II. IDENTIFYING APPLICABLE SITE INFORMATION

Implementing the screening process requires three types of information:

- 1) contaminant concentrations at the site;
- 2) potential human and/or ecological receptors on or near the site, and
- 3) potential exposure pathways.

Estimation of potential risks from site contaminants is possible only if this information is summarized as carefully as possible, given the relatively limited quantitative data which will be available at this point.

Gather this information during the site evaluation. Then determine whether any critical data gaps exist, and whether appropriate media-specific comparison criteria are available for use in the screening process.

The following paragraphs summarize these types of information and briefly explain why they are needed.

1) Contaminant Information --

Necessary contaminant information includes location (e.g., "hot spots," discrete areas with substantially higher contamination relative to the surrounding area), chemical form or speciation, media impacted, and magnitude and extent of contamination. Selecting contaminants of concern and appropriate exposure concentrations requires this information.

2) Receptor Information --

Identify potential human and/or ecological receptors using the checklists developed by the risk assessors. Consider both current and foreseeable uses of the site *and the surrounding environment* in developing a comprehensive list of potential receptors.

Use an unrestricted land use scenario for the screening evaluation. The evaluation intentionally employs this conservative approach because the evaluation will often occur following a relatively limited investigation. At the site screening phase, it is more important to avoid false negatives than false positives.

3) Exposure Information --

When identifying potential exposure pathways resulting from site activities, consider both current and foreseeable uses of the site and the surrounding environment. Determine uses of ground water independent of uses of the land itself. In other words, because uses of (and thus, exposures to) one medium are independent from uses of another medium, consider the media separately when estimating risks. Table 1 ("Media-specific Exposure Pathways," on the following page) presents the potential exposure pathways resulting from site activities and uses.

Future guidance on site evaluation will provide more detail on how to identify data requirements and how to fulfill them.

TABLE 1. MEDIA SPECIFIC EXPOSURE PATHWAYS.

ROUTE				
	AIR (Gases and Particulate)	SOIL (Surface and root-zone soil)	WATER (Surface and Ground)	SEDIMENT
INHALATION	* Gases and particulate in outdoor air.	* Soil vapors migrating indoors.	* Contaminants volatilized from tap water (e.g. showering, drying laundry, etc.).	
	* Gases and particulate transferred from outdoor air to indoor air.	* Soil particulate transferred indoors.		
INGESTION	* Plants (e.g., fruits, vegetables, and grains) contaminated by transfer of atmospheric chemicals to	* Incidental ingestion of contaminated particulate.	* Consumption of tap water during domestic use (e.g. cooking, beverages made using tap water, etc.)	* Incidental ingestion of contaminated particulate during
	* Meat, dairy products, and poultry products contaminated through inhalation by animals.	* Plants (e.g., fruits, vegetables, and grains) contaminated by transfer from soil.	* Plants (e.g., fruit, vegetables, and grain) irrigated with contaminated water.	* Fish and seafood contaminated by uptake from sediment and from transfer from
	* Meat, dairy products, and poultry products contaminated by transfer of contaminants from air to	* Meat, dairy products, and poultry products contaminated through soil ingestion by animals.	* Meat, dairy products, and poultry products from animals consuming contaminated water.	
	* Meat, dairy products, and poultry products contaminated by transfer of contaminants from air to		* Incidental ingestion of contaminated surface water during recreational activity (e.g. swimming)	
	* Mother's milk contaminated by maternal ingestion of food (e.g. plant and animal products) contaminated through transfer from air.	* Meat, dairy products, and poultry products contaminated by transfer from soil to plants to animals.	* Fish and seafood contaminated by uptake from water and from transfer from water to plants to aquatic	
		* Mother's milk contaminated by maternal ingestion of food (e.g. plant and animal products) contaminated through transfer from soil.	* Mother's milk contaminated by maternal ingestion of food (e.g. plant and animal products) contaminated through	
DERMAL		* Contact with contaminated soil.	* Contact with contaminated tap water (e.g. showering, bathing)	* Contact with contaminated sediment during
			* Contact with contaminated water during recreational activity (e.g.	

III. DETERMINING CHEMICALS OF POTENTIAL CONCERN (COPCs)

General Comments:

The purposes of determining COPCs are:

- to identify for further evaluation chemicals which may pose risks; and
- to eliminate from consideration those which do not.

Further investigation and clean-up activities can then be focused on the COPCs.

To determine COPCs, **first** identify the following information during the site assessment (as discussed in the previous section):

- 1) contaminant information:
 - contaminants at the site,
 - the extent and magnitude of contamination;
- 2) potential receptors; and
- 3) potential exposure pathways.

Identify and produce a complete list of COPCs only after analytical data have been collected and evaluated. This list of analytes becomes the focus of the risk-based evaluation. The following section explains how to determine which data are acceptable for use in the screening evaluation.

A. Data Quality and Usability:

1. Evaluate Data Sources:

It is not appropriate to use all data collected during the field investigation for the screening evaluation. Site data which do not apply to a specific compound (e.g., diesel range organics (DRO)), or which result from insensitive analytical methods (e.g., portable field instruments) may be useful when locating sources of contamination or estimating potential fate and transport of contaminants. Such analytical results usually are not appropriate for human risk-based evaluation, but DRO results can sometimes be used in an ecological risk assessment. If an ecological assessment is needed at a site, the assessment should be discussed with the SRS staff and the Ecological Risk Assessor. Also eliminate from further quantitative use data resulting from analytical methods associated with few, unknown, or no quality assurance/quality control (QA/QC) procedures. However, these data may be useful for qualitative discussions of risk or in planning additional investigation.

2. Evaluate Detection Limits:

Before eliminating chemicals because they were not detected (or conducting any other manipulation of the data), apply the following criteria:

- a) If the sample quantitation limit (SQL) for a chemical is greater than corresponding standards, criteria, or health-based levels of concern, the data are not useful. The SQL is the method detection limit (MDL) adjusted to reflect a sample-specific action taken by the laboratory, such as dilution or use of a smaller sample aliquot for analysis;
- b) Due to sample-specific problems, SQLs for a particular chemical in some samples may be unusually high, sometimes greatly exceeding the positive results reported in other samples in the same data set. If the SQLs cannot be reduced by re-analyzing the sample, and if they cause the calculated exposure concentration to exceed the maximum detected concentration for a particular sample set, exclude the sample from the screening evaluation;
- c) For some sites, data summaries may not provide the SQLs. Instead, the laboratory may have substituted MDLs, contract required quantitation limits (CRQLs), or even instrument detection limits (IDLs) whenever a chemical was not detected. Sometimes, the laboratory provides no detection or QLs with the data. As a first step in these situations, always attempt to obtain the SQLs, because these are the most appropriate limits to consider when evaluating NDs (i.e., they account for sample characteristics, sample preparation, or analytical adjustments which may differ from sample to sample); and
- d) For contract laboratory program (CLP) sample analyses, use the CRQL as the quantitation limit (QL) for each ND chemical. These limits may over-estimate or under-estimate the actual SQL. For samples analyzed by methods different from CLP methods, use the MDL as the QL. In most cases, the MDL will underestimate the SQL. Do not use the IDL as an SQL.

3. Evaluate Values Below Detection Limits:

Treat non-detect (ND) results in one of the following ways:

- a) If you do not detect a particular chemical in any samples from a particular medium, and there is no history of a release of that chemical, drop the chemical from the screening evaluation for that medium. This approach requires that the detection limit does not exceed a level of concern;

- b) If you do not detect a chemical in any samples from a particular medium, and there is reason to believe that the chemical may be present, re-analyze selected samples using a different analysis and/or a different laboratory, or re-sample (however, for naturally occurring inorganics, if the detection limit is below background, re-analysis may not be necessary); or
- c) If laboratory analysis shows chemical concentrations ranging from ND to some site maximum, then the reported NDs actually represent a distribution of concentrations between zero and the DL. Typically, incorporate these ND results into the quantitative risk assessment by assuming one-half the DL. There are other methods available—see the section on sampling.

If the DLs are unusually high (i.e., they cause the calculated exposure concentration to exceed the maximum detected concentration for a particular sample set), exclude the ND samples from the quantitative risk assessment.

After considering the above points, and any other logical reasons why contaminants may not have been detected, generally eliminate those chemicals that have not been detected in any medium. If information exists to indicate that the chemicals are present (e.g., historic information on releases, manufacturing processes, etc.), do not eliminate them.

4. Evaluate Qualified Data:

Evaluate all qualifiers before determining the chemical concentration for the screening evaluation. **Either laboratories conducting data analysis or persons validating sample data attach qualifiers to the data, and analytical results exhibit these qualifiers.** Because the purpose of validating data is to assess the effect of QC issues on data usability, the data validator attaches validation qualifiers to the data after the laboratory has attached qualifiers, and they supersede the laboratory qualifiers.

The U.S. Environmental Protection Agency's (EPA's) "Risk Assessment Guidance for Superfund" (RAGS) presents a list of qualifiers which the CLP permits laboratories to use, as well as a discussion of their potential uses in risk assessments (EPA 1989, pages 5-12 through 5-14). Ensure that the laboratory has provided current definitions for the data qualifiers used in the data set for the site, and that they are current.

The "J" qualifier (i.e., the chemical identity is certain, but the concentration is an estimated quantity) is the most commonly encountered data qualifier. Use J-qualified data in the same way as positive data that do not have this qualifier. If possible, note potential uncertainties associated with the qualifier, so that, if data qualified with a "J"

appear to contribute significantly to risk, the risk screening or other evaluation can include appropriate precautionary notes.

5. Frequency of Detection:

Treat data sets from individual source areas separately, whether they are from hot spots or diffuse areas of contamination. However, often at this point in the site investigation process, the number of available samples may be insufficient for application of this criterion.

Note that the number of samples can severely limit the usefulness of the frequency of detection evaluation.

For example, use of a 5 percent frequency-of-detection limit requires at least 20 samples (i.e., 1 detect in 20 equals 5 percent). If only 5 samples were taken, the lowest frequency of detection possible is 20 percent (i.e., 1 detect in 5 samples).

Infrequently detected chemicals may be *artifacts* in the data due to sampling, analytical, or other problems. Therefore, if there is no other reason to believe that the chemical is present, assume that the *detection* is not related to site operations or disposal practices and consider removing them from further consideration. However, do not eliminate chemicals known to have existed at the site.

6. Presence in Multiple Media:

Detection of a particular chemical in more than one sampled medium may indicate that some media are sources of contamination of other media. For example, do not eliminate as a site soil contaminant a chemical infrequently detected in soil (a potential source of ground water contamination), if the same chemical has been frequently detected in ground water. Also, remember to consider the differences in detection limits for different media.

7. Blanks:

Blank samples can help determine whether contamination has been introduced into a sample set either; 1) in the field, when the samples were collected or transported to the laboratory; or 2) in the laboratory during sample preparation and analysis. To avoid including non-site-related contaminants in the screening evaluation, compare the concentrations of chemicals detected in blanks to concentrations of the same chemicals detected in site samples. Chapter 5 of RAGS provides detailed definitions of different types of blanks (EPA 1989).

a. Lab Contaminants:

The EPA considers acetone, 2-butanone (methyl-ethyl ketone), methylene chloride, toluene, and the phthalate esters to be common laboratory contaminants (EPA 1989). In accordance with EPA guidance, if the laboratory blank contains detectable levels of common laboratory contaminants, consider the sample results to be positive results only if the concentration in the sample exceeds 10 times the maximum amount detected in any blank. If the concentration of a common laboratory contaminant is less than 10 times the concentration detected in the blank, assume the chemical was not detected, and consider the blank-related concentration of the chemical to be the QL for the chemical in that sample. If all samples contain levels of a common laboratory contaminant that are less than 10 times the level of contamination noted in the blank, eliminate that chemical from further evaluation.

b. Field Contamination:

If the blank contains detectable levels of 1 or more organic or inorganic chemicals that EPA does not consider to be common laboratory contaminants, consider site sample results as positive only if the concentration of the chemical in the site sample exceeds 5 times the maximum amount detected in any blank. Treat samples containing less than 5 times the amount in any blank as *NDs*, and consider the blank-related chemical concentrations to be the QLs for the chemicals in that sample. Again, note that, if all samples contain levels of a chemical that are less than 5 times the level of contamination noted in the blank, eliminate that chemical completely from further evaluation.

B. Compare Site Data to Background Levels:

1. Background Risk:

A risk evaluation estimates potential excess risk (i.e., above background) posed by a site. Obtaining background samples is recommended—it helps determine whether contaminants are site-related. The point at which background sampling is conducted (e.g., before or after the screening evaluation) is up to SRS staff. If appropriate pre-existing background data exists (e.g., ground water monitoring data), site-specific background data are not needed.

To determine what is above background, identify representative background concentrations. Comparing sample concentrations to background concentrations helps identify non-site-related chemicals found at or near a site. Do not use samples as background samples, if they were obtained from areas influenced or potentially influenced by the site, or by contaminant producing activities similar to those associated with the site. Take background samples from areas with similar soil type, from similar depths, and where exposure to the general population and ecological receptors would be typical.

The medium sampled determines which kinds of comparisons to background data are appropriate. For example, air monitoring stations and ground water wells are normally positioned to detect contaminant releases according to onsite factors and gradient considerations. Because of biased placement, compare data from each well or air monitor individually to background levels. It may also be useful to make other types of comparisons, in addition to onsite versus background levels. For example, compare contaminant concentrations from upgradient wells to concentrations in downgradient wells.

Many factors can affect background concentrations in soil. For example, the geologic origin (e.g., the "parent" rock) of glacial drift may have been high in copper, lead, or other metals which can also be contaminants. Hydrogeologic conditions can also alter the quantity of these elements (Michigan Department of Natural Resources, April 1994). Other conditions, such as precipitation and atmospheric fallout from widely dispersed human and natural activities, also affect soil concentrations.

For some commonly occurring chemicals, ambient background levels may exceed levels of health concern. **If background risk is a concern, calculate it separately from site-related risk. If the calculation suggests significant risk, notify the Minnesota Department of Health.**

2. Locations and Numbers of Samples:

Determine the appropriate numbers and locations of samples. The particular medium affects the appropriate number and locations of samples. For potentially mobile media such as ground water, surface water, and air, utilize upgradient or upwind locations as background locations. For more stationary media such as soil and sediment, utilize a variety of sampling locations to estimate background levels. For example, the number of background air and water (both surface and ground water) sample locations is often limited, but because contamination in these media exhibit extensive variability over time, take several samples at each location, and at different times. Sampling over time can also help estimate long-term exposure.

Collect background samples in an area which has not been impacted by environmental contamination from the site and which is representative of natural background conditions. Based on waste type, contaminant mobility, operation practices, and soil type (e.g., sand, silty sand, clay), make an estimate of contamination depth, and take background samples at comparable depths for the particular soil type.

Future guidance on sampling will present methods for determining background soil concentrations.

C. Identify COPCs:

Evaluate further all chemicals not eliminated by any of the above evaluations. The MPCA will determine whether sampling was satisfactory—seek input from SRS staff before completely eliminating these chemicals from further consideration. Also, do not eliminate chemicals reliably associated with site activities based on historical information (e.g., where releases are known to have occurred), with the possible exception of background comparisons for common contaminants.

After identifying COPCs, determine which chemical concentrations to screen. To do this, consider again exposure-pathway-related factors, such as:

- 1) location of likely exposure areas;
- 2) location and magnitude of hot spots of contamination; and
- 3) type of contaminated media.

In other words, consider carefully the potential relationships between receptors and each of the contaminated media. The following sections discuss this process for each of the media.

IV. ESTIMATING SITE CONCENTRATIONS AND COMPARING TO SCREENING CRITERIA

A. Estimate Site Concentrations:

1. Data v. Models:

Estimate exposure concentrations using:

- 1) monitoring data; or
- 2) a combination of monitoring data and environmental fate and transport models.

Representative monitoring data are always preferred over modeled estimates. To illustrate:

1. It is appropriate to use monitoring data to estimate exposure concentrations where exposure involves direct contact with the monitored medium, or where monitoring has occurred at an exposure point (e.g., a drinking water well).
2. In some instances, it may not be appropriate or possible to utilize monitoring data alone, and fate and transport models may be required. When exposure points are

remote from sources of contamination, or when are above levels which cause toxic effects, models (e.g., ground water transport) may be required to predict future exposure concentrations.

Because contaminant release, transport, and fate models are often needed to supplement monitoring data when estimating exposure concentrations, planning for the site investigation should incorporate required model input data in overall site data collection requirements. Future guidance on site evaluation and sampling will provide more information on this topic.

2. Data Sources and Sampling Periods:

If site data is available from multiple sampling events, decide whether to combine data. It may be appropriate to compare or combine data from a variety of sources (e.g., data from several different sampling periods, and which may have been analyzed using several different analytical methods). It also may be appropriate to combine data, if the methods used to analyze samples from different time periods are similar in terms of the types of analyses conducted and the QA/QC procedures followed, and if concentrations between sampling periods are similar.

First, sort data by medium, and evaluate data from different time periods to determine whether concentrations are similar, or whether changes have occurred between sampling periods. If concentrations of chemicals change significantly between sampling periods, it is desirable to keep the data separate and to evaluate risks separately. Significant fluctuations in concentrations may indicate the need for additional sampling to resolve the inconsistency. For example, changes in concentrations over time may indicate either trends (e.g., natural biodegradation) or analytical problems, and additional sampling may be required to determine the cause of change.

3. Sampling Strategies and Number of Samples:

(Sample collection strategies will be discussed in future guidance on sampling.)

Resource constraints often restrict the number of samples available for site contaminant characterization, particularly during the early phases of site evaluation, therefore potentially increasing the variability associated with the results. When resource or other constraints restrict the number of samples one can take, biased sampling may identify the COPC. However, do not use biased sampling to estimate maximum values, or to estimate the uncertainty of contaminant concentrations.

Incorporate biased samples into a statistical design only if the sampling areas were selected in a biased manner, but the sample locations within this area were selected in an unbiased manner (e.g., randomly, or selected using a grid design).

The quality of data generated by different stages of site sampling will affect accuracy and quality of evaluations. For example, limited sampling information on hot spots may be adequate for a screening assessment (i.e., is there a potential problem?) of the site, whereas more extensive sampling would be necessary to adequately characterize exposure and risks at the site. A screening evaluation will help determine whether additional investigation is warranted. Before developing site clean-up goals, conduct sampling adequate enough to characterize the potential exposure and risk from the site.

4. Averaging Data:

Ideally, the concentration term used in the exposure equation represents the average concentration contacted at the exposure point(s) over the exposure period. The objective in estimating exposure concentrations is to provide a conservative estimate of this average concentration. At the screening phase; however, exposure areas (particularly for future use) typically are not known, so averaging of data across exposure areas is not possible. Because of the uncertainty associated with estimating the true average exposure concentration at a site, use the 95 percent upper confidence limit (UCL) of the arithmetic mean for the exposure concentration.

Hot spots should be evaluated as individual exposure areas for comparison to screening criteria. Consider hot spots to be distinct exposure areas, and evaluate them separately from non-hot spot areas. Separating hot spots from other areas of the site should decrease the degree or range of variability in chemical concentrations, improve statistical performance, and result in more accurate assessments. The separation of non-hot spots from hot spots may allow the project team to eliminate the less contaminated areas of the site from further investigation, provided that sampling has been adequate.

The 95 percent UCL mean provides reasonable confidence that the true average will not be underestimated. Although the 95 percent UCL mean provides a conservative estimate of the mean, do not confuse it with a 95th percentile concentration. When a limited amount of data (e.g., at the screening phase) is available, or when extreme variability in measured or modeled data exists, the 95 percent UCL mean can be greater than the maximum measured or modeled concentration. In these cases, the 95 percent UCL mean indicates that, given the variability in the available data, the true mean may be higher than the maximum value in the data set.

5. Grouping Data by Sampling Location:

It may be necessary to divide chemical data from a particular medium into subgroups based on locations of sample points and the potential exposure pathways. When an individual sampling point is a potential exposure point (e.g., a drinking water well), it is not

appropriate to group samples across sampling points (i.e., across different locations). Instead, treat the sample data from each sampling point separately when estimating intakes.

When it is appropriate to group sampling data from a particular medium (remember, assess hot spots separately), calculate for each exposure medium and each chemical the 95 percent UCL mean chemical concentration for each exposure area or area of concern. See the "Exposure Point Concentration Calculation Appendix" in the "Technical Support Document" (under development) for recommended methodology for calculating the 95 percent UCL mean, EPA (1992).

B. Available Media Criteria for Comparison:

Comparison of site concentrations to risk-based criteria helps determine potential risks to human health and the environment and the need for further investigation and remedial action. Make this comparison for all media potentially impacted by contaminants, as identified during the site evaluation (e.g., soil, ground water, surface water, sediment, air, or biota).

The MPCA employs a phased approach to screening and identifying clean-up goals for a contaminated site. The first evaluation phase uses generic health-based criteria (such as soil reference values (SRVs) for soil and Health Risk Limits (HRLs)/Maximum Contaminant Levels (MCLs) for ground water) which are based on a "standard" exposure scenario for contaminated sites throughout Minnesota. Risk-based criteria are used early in the process to determine whether additional investigation is warranted and whether remediation may be necessary.

The criteria are based on a reasonable maximum, limited exposure scenario, actual effect levels, and/or regulatory standards. The criteria need to be conservative at this phase, because the level of certainty possible in estimating risk is dependent upon the amount of contaminant and exposure information available for the site. At this point in the investigation process, such information may be relatively limited.

At the screening phase, estimate site contaminant levels as explained above, and compare them to appropriate available criteria. The following sections present the media-based components of the screening evaluation.

C. Soil

1. Estimate Site Soil Concentration(s) for Comparison to Risk-Based Criteria:

Base estimates of current exposure concentrations in soil directly on summarized monitoring data, assuming that concentrations remain constant over time. The spatial distribution of soil contamination (vertically as well as horizontally) is also a critical factor. Contamination

may be unevenly distributed across a site, resulting in hot spots. Assess hot spots separately. Similarly, consider the depth of the sample (evaluate surface soil samples separately from subsurface samples).

In general, assess potentially accessible soil for potential direct human contact, and where appropriate, for ecological endpoints. Also evaluate deeper soils as sources of contamination for ground water and, as appropriate, for special risk-posing circumstances on a site-specific basis (e.g., proposed future use may access deeper soils).

For the screening evaluation, evaluate both the maximum and the 95 percent UCL mean, based on a minimum of 3 to 5 samples in an area of suspected contamination and/or exposure (e.g., a suspected hot spot). If a sufficient number of samples is not available, use the maximum concentration. Future guidance on sampling will provide more information on this issue. A 95 percent mean much higher than the maximum indicates high variability in sample concentrations, and that the true mean may be higher than the maximum value. Conduct additional sampling and/or re-evaluate the data (e.g., to determine whether hot spot data were mixed with non-hot-spot data).

The “Exposure Point Concentration Calculation Appendix” in the “Technical Support Document” presents **an example of an *exposure point concentration calculation table* format and the methodology for calculating the 95 percent UCL mean (EPA 1992).**

2. Available Risk-Based Soil Criteria - Direct Exposure:

Contaminated soil can be a source of direct and indirect exposure. The soil criteria developed and presented in this section address direct routes of exposure. Various sections below discuss indirect routes of exposure resulting from transfer of contaminants from soil to other media (e.g., ground water, subsurface gas, and surface water).

a. Human Receptors:

Exposure of humans to contaminants in soil may occur primarily through inhalation of soil vapors/particles, incidental ingestion of soil particles, dermal contact with soil, and ingestion of food (e.g., produce, meat, milk) contaminated by transfer from soil to plants and/or animals.

The SRS staff developed unrestricted land use SRVs reflecting the most common direct exposure pathways to help determine when additional investigation and/or remediation is necessary. Unrestricted land use SRVs allow for both adult and child receptors and combined direct exposure pathways (i.e., incidental soil/dust ingestion, dermal contact, and inhalation of vapors and suspended particulates), and are used in the screening

evaluation. The SRS staff assumes that an unrestricted land use scenario incorporating the three most common direct exposure pathways will provide a reasonably conservative, protective exposure scenario for most sites.

SRVs are risk-based soil concentrations based on a standard land use scenario, and they correspond to a specific target risk level. If multiple contaminants are present, the cumulative risk must be evaluated on a site-specific basis.

The “Unrestricted Land Use SRV Documentation Appendix” in the “Technical Support Document” explains the specific exposure assumptions. The unrestricted land use SRVs are available on the *p: drive (p:\siteguid\soil\unrsrv96.xls)*. Each chemical-specific SRV corresponds to an individual target risk limit (i.e., 10^{-5} for carcinogens, and a 0.2 HQ for noncarcinogens). The SRS staff assumes risks to be additive for carcinogens and for noncarcinogens with similar toxic endpoints. Therefore, when multiple contaminants with similar endpoints occur, evaluate the cumulative risk, in order to ensure that total site risk remains at or below the acceptable risk limits. The acceptable risk limits are:

- 1) total (i.e., cumulative risk from the site) ECR is not to exceed 1 in 100,000 (i.e., 10^{-5}); and
- 2) non-cancer risk is not to exceed a HQ of 0.2 per contaminant and a total hazard index (HI) of 1 for contaminants with similar target endpoints (e.g., liver, kidney, etc.).

For some relatively non-toxic chemicals (e.g., benzoic acid), the SRS staff fixed a maximum SRV at 10 percent (or 100,000 mg/kg) in soil.

The SRS staff based the unrestricted land use exposures on standard EPA methodology. However, the SRS staff believe that certain modifications are appropriate for Minnesota sites, such as use of reasonably conservative values, rather than upper-bound (i.e., high-end) values. The SRS staff intends the SRVs to be protective without being unduly stringent (i.e., avoiding “cascading conservatism”). The combination of exposure factors utilized represents a reasonable maximum exposure scenario. However, the SRS staff did not include all potential exposure pathways (e.g., ingestion of contaminated plants and animals). Therefore, the risk estimates calculated are not worst-case estimates. The SRVs should be adequately protective for most sites. Sites which potentially include additional exposure pathways, particularly pathways involving food production and consumption, require site-specific evaluations.

The SRV calculations include inhalation exposure to vapors and/or to particulates directly from soil. The “Unrestricted Land Use SRV Documentation Appendix” in the “Technical Support Document” presents the methodology for calculation of vapor and particulate levels. The SRS staff assessed inhalation of contaminants adsorbed to respirable particulate (PM10) using a default particulate

emission factor (1/PEF) that relates the contaminant concentration in soil to the concentration of respirable particles in the air due to fugitive dust emissions from contaminated soils (RAGS, Part B). The 1/PEF value does not account for particulate emissions resulting from vehicle disturbance of soil, which could lead to higher levels of airborne particles than estimated using this default PEF. If frequent vehicle traffic is common and large areas of contaminated bare soil occur on a site, the generic SRV may not be adequately protective.

The SRS staff used a volatilization factor (VF) model to estimate air concentrations of volatiles from contaminated soil. The calculated SRV assumed a soil-organic-carbon content of 0.001 grams/gram, a soil moisture of 0.2 cubic centimeters/cubic centimeter and a 5 acre source area. If the site-specific soil organic carbon content, soil moisture and/or source area are inconsistent with these default values, make a site-specific adjustment. For native or non-disturbed soils, use organic carbon and/or soil moisture values from the county soil survey.

The basic principle of the VF model is applicable only if the soil is not saturated with the contaminant. Saturation conditions also affect the bioavailability and mobility of a contaminant. Conduct site field evaluations and/or model soil saturation levels to determine whether the SRV is appropriate. Compare the SRV to the site-specific C_{sat} value. Use the lower of the two values as the site-specific SRV. The "Unrestricted Land Use SRV Documentation Appendix" also includes a model for estimating C_{sat} .

The equation for VF is not applicable where municipal or sanitary wastes have been disposed with the hazardous substances, because decomposition of the solid waste would generate landfill gases which can greatly enhance volatile emission rates. Nor is the equation applicable when shallow ground water is contaminated with VOCs. Inhalation exposure resulting from migration of soil gases may be a concern at some sites and can be a pathway which drives further evaluation. Evaluate the indoor vapor pathway using in-home vapor concentration measurements. Adequate models do not yet exist for this pathway.

Applying SRVs:

The primary condition for use of SRVs is that the exposure pathways of concern and site conditions match the assumptions underlying the SRV calculations. At all sites it is necessary to identify likely source areas, exposure pathways, potential receptors, and soil characteristics to determine the extent to which the SRVs can be applied to the site.

Before applying the SRVs, consider whether the exposure pathways at the site are fully accounted for in the SRV calculations. The protective effects of short-term or interim measures (e.g., fences, soil cover, filtration systems) are temporary in nature—during the screening evaluation do **not** evaluate exposure conditions based on the effects of these measures. These measures may become part of the remedy, but in order to estimate potential chronic risks based on a sound understanding of actual site conditions, do not consider interim measures during the screening phase.

To determine the appropriateness of the SRVs, ask the following questions:

- are there other likely human exposure pathways at the site which were not considered in developing the SRVs (e.g., fish consumption, swimming, etc.) (review Table 1, “Media-specific Exposure Pathways”)?;
- are there unusual site conditions which are likely to result in exposures exceeding the SRV exposure scenario and/or to invalidate model results (e.g., large areas of contamination, high fugitive dust levels, contaminant saturated soil, etc.)?; and
- are there contaminants of concern for which SRVs are not available?

If any of these conditions exist, consider modifying the SRVs. The “Unrestricted Land Use SRV Documentation Appendix” presents the specific exposure assumptions and methodologies and the chemical-specific information (e.g., chemical properties, bioavailability factors) utilized in calculating the SRVs. Contact the SRS staff and the Health Risk Assessor if a contaminant does not have an SRV. If toxicity values exist for a contaminant, an SRV can be derived by SRS staff. The number of contaminants with SRVs will be expanded over time, and will be updated as necessary.

Because SRVs address only human direct soil exposure pathways under a standardized unrestricted land use scenario, other human exposure pathways must be incorporated, as appropriate, into a site-specific evaluation.

As stated above, each chemical-specific SRV corresponds to an individual target risk limit (i.e., 10^{-5} for carcinogens and 0.2 for noncarcinogens).

The following equations provide a contaminant-specific HQ and/or ECR for each site contaminant:

$$[1] \quad HQ_s = HQ_{srv} (C/SRV); \text{ and}$$

$$[2] \quad ECR_s = ECR_{srv} (C/SRV).$$

where:

HQ_s	=	site contaminant HQ;
C	=	site exposure concentration (mg/kg);
HQ_{srv}	=	HQ associated with the SRV;
SRV	=	soil reference value (mg/kg);
ECR_s	=	site contaminant ECR; and
ECR_{srv}	=	ECR associated with the SRV.

Compare the calculated chemical-specific HQ and the ECR to the acceptable target risk values of 0.2 and 10^{-5} , respectively.

When multiple contaminants exist at a site, it is necessary to determine whether the cumulative target risk levels (i.e., 10^{-5} for carcinogens and an HI of 1 per target endpoint) are exceeded. Derive a cumulative hazard/risk by summing the HQ or ECR for individual contaminants and for each target endpoint.

The SRS staff has developed a spreadsheet which will make the appropriate calculations for assessing site-specific mixtures. The unrestricted land use SRV spreadsheet tables are located on the *p:drive (p:\siteguid\soil\unrsrv96.xls)*.

If the screening assessment indicates that further evaluation is not necessary, evaluate the model assumptions. In particular, if *Csat* is exceeded, the bioavailability and/or volatilization factor model will not produce accurate results. For some VOCs, if *Csat* is exceeded, the soil-to-ground-water pathway will determine the need for further investigation. Remediate saturated soil to remove *free product*.

If a site is a candidate for release from further investigation based on health risk analysis for direct exposure, and if you are not highly confident in the existing sampling data, conduct confirmation sampling. If the confirmation sampling supports the original conclusions, no further action is required based on potential risk associated with direct human exposure. Remember, evaluate potential ecological, surface water, and/or ground water impacts before releasing the site completely from further investigation.

The screening evaluation process will provide information indicating the contaminated areas of greatest concern, and can serve as an indicator of priority for further investigation or remediation. Because the SRS staff has developed a standardized approach to site screening, the results can be quantitatively and qualitatively compared to determine which sites pose the highest potential risks. This facilitates focusing more quickly on those sites of greatest concern, and using limited resources (e.g., staff, money, time, etc.) more efficiently. Evaluation of *short-term hazards* illustrate one example of utilizing the results of the screening process. For further information on this, see Section V, "Evaluating Short-term Hazards," near the end of this document.

b. Ecological Receptors:

Ecological receptors may be exposed to soil contaminants through dermal (or root) contact, by incidental ingestion of soil particles, by eating plants or soil invertebrates contaminated via bioaccumulation from soil, or by inhalation of soil vapors/particles.

Ecological soil screening values for direct soil exposure (direct contact and ingestion) are toxicological benchmarks developed by Oak Ridge National Laboratory (Will and Suter 1994 a, b). The benchmark values were derived for terrestrial plants, soil invertebrates, and

soil microorganisms (soil microbial processes), because these organisms represent important components of terrestrial ecosystems. They have intimate contact with soil and are relatively immobile. Therefore, they are potentially highly exposed to soil contaminants, and are good indicators for potential direct toxic effects. If soil contaminant concentrations are below effects levels for these receptors, it is reasonable to expect that impacts from direct soil exposure will be minimal for other receptors.

The direct soil contact benchmarks (in the “Ecological Soil Screening Criteria Table 1”) are based on concentrations (Lowest Observed Effects Concentrations (LOECs)) exhibiting greater than 20 percent reduction in ecologically significant responses such as growth, yield, reproduction, or activity in laboratory or field studies. The benchmark values were derived by rank ordering LOEC values for a chemical (based on the available literature) and selecting the 10th percentile when 10 or more LOEC values are available. Otherwise, the lowest LOEC is used as the benchmark (Will and Suter 1994 a, b).

Soil contaminants can also bioaccumulate in plants and soil invertebrates, and be passed to higher animals which feed on them (food chain exposure). Because this can be important exposure route for certain chemicals, such as mercury and PCBs, screening criteria were also derived for bioaccumulative contaminants for the food chain pathway.

The bioaccumulation screening criteria (in the “Ecological Soil Screening Criteria Table 2”) were derived using the methodology of Opresko et al. (1995). Chemical-specific soil-to-plant and soil-to-earthworm uptake factors obtained from the literature are used to estimate concentrations in above-ground plant parts and soil invertebrates resulting from exposure to site soil contaminants. These factors are combined with typical soil and food ingestion rates in a simple model to calculate estimated exposure to terrestrial vertebrates (selected small mammal and bird species with various feeding strategies which are likely to have high exposures via the food chain pathway and to occur on many sites). The exposure concentration is compared with a wildlife dietary No Observed Adverse Effect Level (NOAEL) obtained or derived from Opresko et al. (1995) for ecologically relevant endpoints (primarily reproduction, mortality, or body weight), and a hazard quotient (HQ) is calculated for each species. The bioaccumulation screening criteria is the soil concentration at which the HQ for the most sensitive species is equal to 1.0. Details of the modeling procedure and input variable values are provided in the “Ecological Soil Screening Criteria Appendix” of the “Technical Support Document”.

Note that the ecological soil screening values do not address inhalation exposure, so in some cases they may not be adequately protective for exposure to volatile contaminants. If inhalation exposure is likely to be an important pathway, consult the Ecological Risk Assessor.

Applying the screening criteria:

Apply the direct soil contact benchmarks to all areas of soil contamination for which the ecological flowchart indicates the need for screening. Compare surface soil concentration data (generally for the upper 3 feet only) with criteria values in the “Ecological Soil Screening Criteria, Table 1” (*p:\siteguid\soil\ecoscrn1.xls*). If exposure areas can be defined and soil contaminant data has been collected randomly, use the 95 percent UCL mean as the exposure concentration. Otherwise, use the maximum concentration or compare sample concentration data on a point-by-point basis and note values which exceed criteria. The latter option allows mapping and visual inspection of data for patterns of exceedances, and is often preferable. To facilitate screening, the soil concentration can be entered in the “Soil Conc.” column of the table and the ratio of the soil concentration to the screening criteria (HQ) is calculated. If the $HQ > 1$ and the concentration also exceeds background (for metals), potential risk to soil organisms, and to other organisms with extensive soil contact, is indicated.

For bioaccumulative contaminants (see the lists of “Contaminants of Concern for Plant and Animal Uptake” in Subsection H., 2., b. of this document), compare the 95 percent UCL mean or maximum soil concentration for an exposure area to the bioaccumulation screening criteria in “Ecological Soil Screening Criteria Table 2” (*p:\siteguid\soil\ecoscrn2.xls*). To examine the HQs for individual species, enter the soil concentration in the “Soil Conc.” column of the table. The HQ for soil ingestion and dietary intake will be calculated for each species. An $HQ > 1$ indicates potential risk to that species. The more species for which the $HQ > 1$, the greater the likelihood of impacts.

If contaminants are present for which there are no soil screening values, contact the Ecological Risk Assessor. If appropriate toxicity data exist for a contaminant, a screening value can be derived. The number of contaminants with soil screening values will be expanded over time, and existing values may be revised as more information becomes available.

3. Available Risk-Based Soil Criteria—Indirect Exposure:

Soil criteria discussed in this section address contaminated soil as a source for ground water contamination due to contaminant leaching.

a. Human Receptors:

Exposure of humans to contaminants in soil may occur from ingestion of ground water contaminants by leaching of contaminants from soil. There are no generic soil criteria established for protection of ground water, primarily due to the complexity of soil and

of contaminant behavior in soil. The SRS staff has developed soil screening values which are protective of ground water as a drinking water source. The "Soil to Ground Water Methodology Appendix" in the "Technical Support Document" outlines procedures for deriving soil screening values. The screening values are contained in the "Soil to Ground Water Screening Criteria" (p:\siteguid/soil/.soil_add.xls).

Compare the mean concentration for a contaminant in soil, or the maximum concentration from a hot spot, to the screening value. For sites where ground water liability assurances are requested, and where soil concentrations do not exceed screening values, both the soil leaching and ground water pathways may proceed to the next phase of investigation.

For sites where liability assurances are not sought, and where soil concentrations do not exceed screening values, further soil investigation is not required. However, the ground water pathway must be screened using ground water data.

b. Ecological Receptors:

Ecological receptors may be exposed indirectly to soil contamination, if contaminants leach to ground water and then flow to a surface water body (e.g., a stream, lake, or wetland). Screening values similar to those for human receptors have not yet been developed. If surface water criteria for a particular contaminant are less than the Health Risk Limit (HRL) for a contaminant of concern, surface water criteria may be used in the Tier 1 equations to derive a screening value.

D. Ground Water

General Comments:

This section describes the decision framework used to determine whether further ground water investigation is warranted at a site based upon an assessment of the preliminary site data. This decision framework applies to the screening, or preliminary, phase of a site investigation and is not intended to be guidance on how to conduct a comprehensive ground water investigation. It assumes that preliminary ground water data have already been collected, and that the sampling scheme was based upon a thorough historic, or Phase I, review.

This decision process also assumes that, during this preliminary phase of the ground water investigation, ground water at all sites may be used as drinking water, regardless of aquifer capacity or current or proposed use of ground water. This assumption will result in a conservative review of ground water quality. It may be appropriate in future phases of the site investigation or in making clean-up decisions to adjust this assumption to account for

limited capacity aquifers, proposed ground water use, technical impracticability, or background contamination in the aquifer.

1. Applicable Risk-Based Ground Water Quality Criteria:

In general, compare site ground water data to established human-health-based ground water quality criteria to determine whether further ground water investigation is warranted.

a. Human Receptors:

For humans, the primary route of exposure to ground water contaminants is the ingestion pathway. Minnesota Department of Health (MDH) HRLs are health-risk-based values predicated on a long-term drinking water consumption scenario. If an HRL is exceeded in a drinking water supply, the MDH recommends against continued use of that water for untreated drinking water. Use the HRL as a reference point for comparison to site ground water quality to determine whether further investigation is warranted. When public water supplies are affected, it may also be appropriate to consider the EPA's MCLs as reference points. MCLs are based on both human health risk assessment and *best available technology*. The "Drinking Water Criteria Summary Table" summarizes the HRLs and MCLs. The "Drinking Water Criteria Summary Table" is also located on the *p: drive (p:\siteguid\grdwater\drin0196.xls)*.

Although the ingestion exposure pathway usually drives the health-risk-based decision process, for certain chemicals under certain exposure scenarios, dermal contact and inhalation of volatilized vapors may be significant exposure pathways to ground water contaminants. The MDH has stated in its "Statement of Need and Reasonableness (SONAR) for HRLs" (MDH 1993) that HRLs are adequately conservative to account for multiple routes of exposure from domestic use, such as cooking, showering, and drinking. The SONAR also notes that the EPA has stated that MCLs are sufficiently conservative to account for multiple routes of exposure in the absence of more accurate and directly applicable models.

The individual HRL values have been derived to correspond to the target risk levels. To determine whether chemical-specific HRLs have been exceeded, simply divide the site concentration by the HRL value. When multiple contaminants exist at a site, a mixtures evaluation is required to determine whether the target risk limit for the mixture is exceeded (Minn. R., ch. 4717, pt. 4717.7800).

The following equation should be used to determine whether the health risk from multiple contaminants with similar toxic endpoints exceeds the target risk level for that endpoint (e.g., cancer, liver toxicity, etc.):

$$\text{Hazard Index}_{\text{TE}} = C_1 / \text{HRL}_1 + C_2 / \text{HRL}_2 + \dots + C_n / \text{HRL}_n$$

where:

Hazard Index_{TE} = the HI of the specific toxic endpoint under evaluation;
C_n = the concentration of the first, second, ... , nth contaminant detected; and
HRL_n = the health risk limit of the first, second, ... , nth contaminant detected.

An HI greater than 1 exceeds the acceptable risk level. The MPCA has developed a spreadsheet which will make the appropriate calculations and which identifies chemical-specific target endpoints for assessing site-specific mixtures. A print-out of the spreadsheet is included in the "Health Risk Limit (HRL) Additivity Table." The spreadsheet is located on the *p: drive* (*p:\siteguid\grdwater\hrl0296.xls*).

b. Ecological Receptors:

In general, there is no direct route of exposure to ground water contaminants for ecological receptors. As a result, if ground water is the sole media contaminated at a site, an ecological risk assessment is unnecessary. Ecological receptors may be exposed to ground water contaminants when they are in contact with surface water which has been contaminated by ground water discharge; this includes wetlands or seeps fed by contaminated ground water discharge. In these cases, compare contaminant concentrations at the ground water/surface water interface. Further information on the application of surface water quality criteria is provided in Subsection IV., E.

2. Comparing Site Ground Water Data to Risk-Based Ground Water Quality Standards:

To decide whether a site requires further ground water investigation, compare site ground water data to available health risk-based ground water quality standards. For this purpose, actual ground water data should be available and should represent known or suspected source areas at the site.

The following outline describes how to decide whether to expand site ground water investigations based upon the type and quality of data available for a given site.

3. Scenarios:

- a. Ground water data from permanent monitoring wells are available for the site and appear to be representative of known or potential source areas. Compare data matching this description directly to health-risk-based ground water quality standards. If ground water samples contain one or more contaminants at mean concentrations equal to or exceeding their respective HRLs, further ground water investigation is warranted. If HRLs (individual, as well as the mixture HRL) are not exceeded, then further ground water investigation is not warranted.

To ensure that ground water data are representative of known or suspected source areas, consider the following elements:

- i. Identify known or suspected source areas through a review of current and historical site activities (Phase I information). Collect ground water samples from monitoring wells or *drive-point samplers* installed within or immediately downgradient of known or potential source areas. Address each source area using one monitoring well or drive-point sample point, although one monitoring well or drive-point sample point may address several source areas, if the source areas are in close proximity to each other.
- ii. Screen monitoring wells, and collect drive-point samples, at appropriate depths. For most sites, screen initial monitoring wells across the water table, and collect drive-point samples at the water table. Note that, if initial ground water quality results indicate the possible presence of a dense non-aqueous phase liquid, it may be necessary to install additional wells screened at the base of the upper aquifer unit during the screening phase.
- iii. Collect ground water samples in accordance with the Site Response Section "Ground Water Sampling Protocol." Employ appropriate laboratory methods and QA/QC for laboratory analysis of the ground water samples—MDLs should be below HRLs for individual compounds.

NOTE: Drive-point samplers may be used to determine the best location for permanent monitoring wells or to further define the extent of ground water contamination at the site. However, some Land Recycling Act ground water liability assurances may not be issued based solely on drive-point sampler results.

NOTE: Ground water data may not be representative of known or potential source areas if any one of items 4, a, i through 4, a, iii are violated. In such cases, take one or more of the actions described below, as appropriate.

b. Ground water data from monitoring wells or drive-point samplers are available for the site but are not necessarily representative of known or potential source areas.

i. If wells are appropriately located (the conditions in 4, a, i and 4, a, ii are met), but the validity of the analytical results is questionable (the conditions in 4, a, iii are violated), then collect an additional round of ground water samples in accordance with appropriate sampling protocol, and analyze the results using appropriate analytical and laboratory QA/QC methods.

ii. If wells are not appropriately located (the conditions in 4, a, i or 4, a, ii are not met), AND:

- One or more contaminants in ground water exceed their respective HRLs (evaluate mixture HRL as well as individual):

Further ground water investigation is warranted. This generally requires installation of additional permanent monitoring wells in appropriate location. Drive-point samplers may aid in determining appropriate well locations.

- Ground water is contaminated, but contaminant concentrations are below HRLs (evaluate mixture as well as individual HRLs), or ground water (from inappropriately located wells) is not contaminated, but soil concentrations in known source areas are sufficiently high to indicate that ground water downgradient of the source areas may be contaminated at levels exceeding HRLs (evaluate mixture as well as individual HRLs):

Conduct additional ground water investigation using drive-point samplers or permanent monitoring wells to address ground water quality in, and downgradient of, the known or suspected source areas.

4. Notes on Land Recycling Act Liability Assurances:

For sites in the Voluntary Investigation and Cleanup (VIC) Program, the screening phase of the investigation is generally either conducted before the site enters the program, or combined with the remedial investigation. The VIC Program does not issue Land Recycling Act liability assurances regarding ground water contamination in the absence of ground water data. Collect a minimum of two rounds of ground water samples from permanent monitoring wells, and analyze them for an approved parameter list, before issuing any Land Recycling Act liability assurances for ground water contamination.

For sites where non-responsible parties are seeking soil assurances only, and only soil data are available, soil data may be used to estimate the potential for ground water contamination. When data indicate that ground water may be contaminated above health risk-based criteria, based upon modeled estimates or by comparison to conservative table values of *acceptable* soil concentrations, either: a) the VIC Program *invites* potentially responsible parties to voluntarily investigate ground water; or b) it refers the site to the Site Assessment Unit or a Superfund Response Unit, recommending ground water investigation.

E. Surface Water

1. Estimate Site Concentration(s) for Comparison to Risk-Based Criteria:

Use data from surface water sampling and analysis alone or in conjunction with fate and transport models to estimate exposure concentrations. Where the sampling points correspond to exposure points (for example, in locations where fishing or recreational activities take place), or at the intake to a drinking water supply, use the sampling data alone to estimate exposure concentrations.

Use fate and transport models to predict the impact of contaminated ground water and/or runoff on surface water. See the preceding section on ground water.

Consider the following factors when screening monitoring data:

- 1) temporal effects — seasonal changes in flow, chemistry, temperature, and depth affect surface water bodies, and may significantly affect the fate and transport of contaminants;
- 2) spatial effect — considerable variation in concentration occurs vertically and laterally within surface water bodies;
- 3) QL limitations — the quantitative detection limit should be evaluated in light of the toxic effects level; and
- 4) contributions from other sources — contamination from many sources may affect surface water bodies; it may therefore, be difficult to distinguish among contaminant sources — background samples may help identify sources. For example, upstream samples from inflowing systems may be utilized as background.

2. Available Risk-Based Surface Water Criteria:

All of Minnesota's surface waters are protected as fisheries and for aquatic recreation, except a relatively small group of waters specifically designated as *limited resource value* waters. Minnesota protects all ground water and certain surface waters as actual or potential sources of

drinking water. Protecting aquatic life includes protecting Minnesota's fish and other aquatic organisms from the harmful effects of toxic substances, and protecting human and wildlife consumers of those organisms.

Each chemical-specific standard (and criterion), with few exceptions, consists of three components:

- 1) the "chronic standard" (CS), protective of organisms from harmful sub-acute effects of long-term or indefinite exposure to the pollutant;
- 2) the "maximum standard" (MS), protective of organisms from brief excursions of the chronic standard to prevent mortality; and
- 3) the "final acute value" (FAV), protective of organisms from acute toxicity (mortality) at the point of discharge from a point or nonpoint source.

Both the CS and MS apply outside mixing zones. The FAV applies as an effluent limitation and mixing zone requirement to prevent acutely toxic discharges. For further information regarding how these criteria are developed, please refer to "Guidelines for the Development of Water Quality Criteria for Toxic Substances," (MPCA July, 1993).

The Water Quality Division has developed a surface water toxics impact assessment form. A copy of the form is included with the "Surface Water Criteria" section of the Criteria Tables. This form should be used to evaluate potential impacts from site contaminants to surface waters near contaminated sites.

The surface water classification should first be determined according to Minn. R., ch. 7050. A complete copy of Minn. R., ch. 7050 is included as an Appendix in the Technical Support Document. Then compare the site-specific contaminant concentrations to the appropriate standard or site-specific criteria for that water class. If the water classification is not known, the standards for Class 2 waters will be adequate for screening in most instances. The chronic surface water standards and site-specific criteria have been summarized in a single table in the "Surface Water Screening Criteria Summary Table." This table is also located on the p: drive (*p:\siteguid\srfwater\surwat96.xls*). The Class 2 water classification covers fisheries and recreation for all waters of the state, except *limited resource value waters*, which are or may be used for fishing, aqua-culture, swimming, or any other recreational purposes. The assessment of recreational use includes incidental water ingestion during recreation.

For ecological receptors, if no Minnesota Water Quality Standard or site-specific criterion exists for a contaminant, but there is an EPA Ambient Water Quality Criterion, Tier II chronic value, or chronic LOEL available, the federal criterion is used as a screening value. For easy reference, the federal criteria have been included in the "Surface Water Screening Criteria Summary Table." If no aquatic life standard or criterion is listed for a specific chemical, a

screening value may be derived using appropriate toxicity data from EPA's Aquatic Toxicity Information Retrieval database or from the scientific literature. For assistance with deriving these screening values, please consult SRS staff or the Ecological Risk Assessor.

Also compare the site-specific concentration for bioaccumulative chemicals to wildlife-based criteria designed to be protective of wildlife which consume aquatic organisms. The MPCA has not yet developed wildlife criteria for Minnesota. In the interim, use the wildlife criteria which the Great Lakes Water Quality Initiative has developed for dichlorodiphenyl-trichloroethane (DDT), mercury, tetrachlorodibenzo-p-dioxin (2,3,7,8-TCDD), and polychlorinated biphenyls (PCBs) (EPA 1995). For easy reference, the Great Lakes Water Quality Initiative criteria are included in the "Surface Water Screening Criteria Summary Table."

3. Comparison of Site Concentrations to Available Criteria:

After obtaining monitoring data on the potential discharge (e.g., plume or seep) concentration or receiving water concentration, determine the potential for exceeding the risk-based surface water criteria. EPA has developed methodology for evaluating effluent impact on receiving waters in order to assess the *reasonable potential* for exceeding criteria (EPA 1991). Utilize this methodology at the screening level to determine the potential impact of site-related discharges to surface water (per personal communication with Gary Kimball, Water Quality Division, MPCA). The "Surface Water—Reasonable Potential for Exceeding Criteria Appendix" in the "Technical Support Document" presents this methodology.

Note: The complexity of the site situation will determine whether help from Water Quality Division staff is needed (e.g., for determination of dilution and/or mixing zones).

Water bodies may receive discharges from only a single point source or from several discharges in close proximity. It is possible that an individual discharge alone does not cause, have the reasonable potential to cause, or contribute to, an exceedence of water criteria. However, the cumulative impact of the discharges may cause, have a reasonable potential to cause, or contribute to, an exceedence of the criteria. Therefore, consider the impacts of multiple discharge points when performing the screening evaluation.

To prevent acutely toxic conditions, concentrations of toxic pollutants from point or nonpoint sources must not exceed the FAV as a 1-day average at the point of discharge or in the surface water. If a discharge is composed of a mixture of more than 1 chemical, and the chemicals have the same mode of toxic action, apply an additivity model to determine the toxicity of the mixture using the following formula (Minn. R., ch. 7050, pt. 7050.0222, subp. 7):

$$\frac{C_1}{FAV_1} + \frac{C_2}{FAV_2} + \dots + \frac{C_n}{FAV_n}$$

where:

$C_1 \dots C_n$ is the concentration of the 1st to the n th toxicant.

$FAV_1 \dots FAV_n$ is the FAV for the 1st to the n th toxicant.

A value of 1 or more indicates an acutely toxic condition.

To prevent chronically toxic conditions, concentrations of toxic pollutants must not exceed the applicable CS or MS in surface waters outside allowable mixing zones (see Minn. R., chapter 7050, pt. 7050.0210, subp. 5). Average the CS and the MS over the following durations: the MS will be a 1-day average; the CS, based on toxicity to aquatic life, will be a 4-day average; and the CS, based on human health or wildlife toxicity, will be a 30-day average.

Concentrations of carcinogenic chemicals from point or nonpoint sources, singly or in mixtures, should not exceed levels representing an ECR of 1 chance in 100,000 in surface waters. Consider carcinogenic chemicals additive in their effects. The additive formula applies to chemicals that have a human-health-based standard calculated with a cancer potency factor.

$$\frac{C_1}{CC_1} + \frac{C_2}{CC_2} + \dots + \frac{C_n}{CC_n}$$

where:

$C_1 \dots C_n$ is the concentration of the 1st to the n th carcinogen

$CC_1 \dots CC_n$ is the drinking water plus fish consumption criterion (dfCC) or fish consumption criterion (fCC) for the 1st to the n th carcinogenic chemical.

A value of 1 or more indicates a risk level greater than 10^{-5} .

For carcinogenic or highly bioaccumulative chemicals with bioaccumulative factors greater than 5,000, or log Kow values greater than 5.19, the human-health-based CS may be 2 or more orders of magnitude smaller than the acute-toxicity-based MS. If the ratio of the MS to the CS is greater than 100, substitute (CS X 100) for the applicable MS, and (CS X 200) for the applicable FAV.

F. Sediment

1. Estimate Site Concentration(s) for Comparison to Risk-Based Criteria:

Sediment sampling data are used in estimating exposure concentrations for both humans and ecological receptors. Sediment sampling data provides better temporal representativeness of exposure potential (i.e., concentrations indicative of exposure potential over time) than do surface water concentrations. This is particularly true for strongly bound contaminants (e.g., PCBs, polycyclic aromatic hydrocarbons, and some metals).

Use data from surficial, near-shore sediments (upper 10 cm) in likely exposure areas to evaluate current ecological exposures. Data from deeper cores are used primarily to determine contaminant deposition history and vertical extent. (Note: If you know that polar organics are the primary sediment contaminants of concern at a site, collect sediment pore water samples.)

2. Available Risk-Based Sediment Criteria:

a. Human Receptors:

Sediment screening criteria based on direct contact with contaminated sediments do not currently exist. Exposure to contaminated sediments may occur by incidental ingestion and by dermal contact during recreational activities (e.g., swimming), as well as indirectly through ingestion of fish contaminated by uptake from sediment. A spreadsheet for assessing site-specific, sediment-related exposure pathways is being developed by the SRS staff. Assistance with site specific evaluations is available from SRS staff or the Health Risk Assessor.

b. Ecological Receptors:

Sediment screening criteria are presented in the "Sediment Screening Criteria Table" (*p:\siteguid\sediment\sedcrit.xls*). Sediment screening values in the table come from several sources:

- 1) Ontario Ministry of the Environment Lowest Effect Levels (LELs) from Persaud et al. (1993);
- 2) Effects Range Low (ERL) values from Long et al. (1995);
- 3) Sediment Quality Benchmarks (SQBs) from EPA (1996);
- 4) Sediment Quality Criteria (SQC) derived by Site Response Staff.

Criteria values from the first 2 sources were derived from sediment chemical concentrations that were associated with biological effects on benthic organisms in field and laboratory studies, and include values for inorganic as well as organic chemicals. These criteria are expressed on a bulk sediment dry weight basis (ug/g or ug/kg).

Criteria values from the latter 2 sources were derived using the equilibrium partitioning (EqP) method, as described in EPA (1993). This method applies only to non-ionic organic chemicals with $\log K_{ow}$ between 2.0 and 5.5. It calculates a sediment concentration that will result in a pore water concentration equal to a chronic toxicity-based water quality criterion, based on the hydrophobicity of the chemical (K_{ow}) and the sorption capacity of the sediment (i.e. organic carbon content). Minnesota chronic aquatic toxicity criteria were used to calculate EqP-based criteria when possible. For chemicals for which Minnesota criteria were not available, Federal chronic ambient water quality criteria or Tier II chronic criteria were used. The EqP-based criteria are expressed on a per unit of organic carbon basis (ug/g OC), and therefore require that bulk sediment concentrations of non-ionic organic chemicals be normalized to the total organic carbon (TOC) content in the sediment sample. (Because TOC data are not always available at the screening phase, EqP-based criteria are also presented on a dry weight bulk sediment basis normalized to 1 percent TOC, a conservative organic carbon content estimate).

Sediment screening criteria are not available for many organic compounds with $\log K_{ow} < 2$. For these compounds, it is best to measure pore water concentrations and compare them with surface water screening criteria. If other contaminants are present for which screening criteria do not exist, consult the Ecological Risk Assessor. Details on the derivation of sediment screening criteria are presented in the "Sediment Criteria Development Appendix" of the "Technical Support Document".

Limitations of sediment screening criteria:

- a. Sediment criteria may not be protective of all species under all circumstances due to site-specific physical and chemical conditions which may influence bioavailability of contaminants (e.g. pH, organic carbon, grain size, redox potential, acid volatile sulfide).
- b. Screening criteria represent a measure of direct toxicity to exposed benthic organisms only; they don't address indirect adverse effects to fish or wildlife through bioaccumulation and food chain exposure (except for criteria for DDT, PCBs and TCDD which were derived using Great Lakes Water Quality Initiative water quality criteria for the protection of wildlife (EPA 1995a); additional criteria to protect fish and wildlife from bioaccumulation will be developed in the future).
- c. Naturally occurring background concentrations of some contaminants (e.g. metals) may exceed sediment screening criteria at some sites; in these cases, background concentrations should be used as the screening criteria.

3. Application of Sediment Screening Criteria:

- a. Compare sediment contaminant concentrations for individual samples (not composites) with sediment criteria:
 - i. For chemicals with LEL or ERL values, compare the individual bulk sediment dry weight concentrations directly to the values in the "Sediment Screening Criteria Table.";
 - ii. For non-ionic organics (chemicals with SQC or SQB values with units of ug/g OC): If a TOC value is available, normalize the sediment dry weight concentrations to the TOC concentration (divide the dry weight concentration in ug/kg by the percent TOC expressed as a decimal and multiply by 0.001 to convert to ug/g OC), and compare the normalized values to the criteria values with units of ug/g OC. Note that TOC normalization applies only up to a maximum of 12 percent TOC; if actual TOC > 12 percent, use 12 percent to normalize. (If desired, the dry weight concentration in ug/kg can be entered in the "Sed. Conc." column, and the TOC value as a decimal percent in the "Site-specific TOC" cell at the bottom of the table, and the normalized data will appear in the "Norm. Sed. Conc." column. Be sure to use the proper units). If TOC data are not available, compare the sediment dry weight concentrations to the criteria values with units of ug/kg dry wt. (these values have been normalized to one percent TOC for a conservative screen in the absence of site-specific data).
 - iii. For polar organics, compare pore water concentrations directly to the Surface Water Screening Criteria;
- b. For naturally occurring substances such as metals, also compare sediment concentrations in the area of interest with local background concentrations from areas known to be unaffected by anthropogenic sources of contamination, or at depths below anthropogenic deposits in deep cores. If background concentrations exceed the screening criteria, use the background concentrations as the screening criteria.
- c. If sediment concentrations of a chemical are all less than the sediment criteria for that substance, consider the risk/impact on aquatic resources posed by that individual substance to be acceptable. If the concentrations of numerous contaminants are near the criteria thresholds, however, consider conducting additional sampling.

If the sediment criteria are below the detection limits and there is other evidence that the contaminant is present, additional investigation may be warranted.

G. Air

(NOTE: Air generally is not sampled during the Site Evaluation, so data will not typically be available for screening. If volatile organic chemicals are present at levels which pose a short-term hazard (See Section V), and human receptors are potentially exposed under current site conditions, air monitoring is recommended. Contact the Section Health Risk Assessor for more information.)

1. Estimate Site Concentration(s) for Comparison to Risk-Based Criteria:

Estimate exposure concentrations in air using air monitoring. Any air monitoring data collected at the site should be representative of actual long-term average air concentrations. If short-term exposures are a concern, evaluate the measured peak concentrations.

In the absence of representative monitoring data, an exposure concentration can be estimated using models. Models exist for estimating outdoor air concentrations and indoor air concentrations. However, these models require information which may not be readily available.

Outdoor air modeling — emissions may result as chemicals volatilize from contaminated media or from suspension of onsite soils. The SRV methodology incorporates volatilization and/or suspended particulates.

Indoor air modeling — few models are available for estimating indoor air concentrations from outside sources. The EPA document “Air/Superfund National Technical Guidance Study Series: Assessing Potential Indoor Air Impacts for Superfund Sites” (1992) outlines detailed methodology for assessing potential impacts from soil vapors.

2. Available Risk-Based Air Criteria:

a. Human Receptors:

The “Air Concentration Limits (ACL) Table” summarizes the available air criteria developed by Air Quality staff. Remember that the SRV criteria also incorporate the soil-to-air pathway via utilization of models (See the discussion in the “Soil” subs., C., 1., a.).

Each chemical-specific ACL corresponds to an individual target risk limit (i.e., 10^{-5}) for carcinogens and an HQ of 1 for non-carcinogens). Risks are presumed to be additive for carcinogens, and for noncarcinogens, with similar toxic endpoints. Therefore, when multiple contaminants occur, prorate the chemical specific ACL downward in order to keep

the total site risk at or below acceptable risk limits. As stated above, the acceptable risk limits are:

- 1) total (i.e., cumulative risk from the site) ECR is not to exceed 1 in 100,000 (10^{-5}), and
- 2) noncancer risk is not to exceed an HQ of 0.2 for each contaminant, and a total HI of 1 for contaminants with similar target endpoints.

When the Inhalation Health Risk Values (HRVs) become available in rules, the additivity spreadsheet will be revised to include target endpoint information. In the interim, if the inhalation exposure pathway is of concern, contact SRS staff or the Health Risk Assessor.

b. Ecological Receptors:

To date, the MPCA has not developed air criteria for ecological receptors. Evaluate ecological concerns due to air exposure on a case-by-case basis, in consultation with the assigned SRS staff or the Ecological Risk Assessor.

H. Biota

1. Estimate Site Concentration(s) for Comparison to Risk-Based Criteria:

Sampling biota at the screening level is recommended if bioaccumulative contaminants are present (see the lists below), and if ingestion of contaminants is likely to occur.

Obtain site-specific, measured concentrations of contaminants in biota (e.g., tissue samples from site biota such as fish or game), instead of estimated or modeled values, whenever possible. The sampling plan should adequately characterize the population and species of concern. Analytical QLs should be sufficiently low to detect the lowest concentration potentially harmful to the receptor of interest.

In the absence of adequate tissue measurements, use partition coefficients (e.g., organism/water partition coefficients, or bioconcentration factors) or transfer coefficients (e.g., plant uptake factors) to generate contaminant concentrations for contaminants that bioconcentrate or bioaccumulate. However, model input parameter values may introduce substantial uncertainty into the exposure assessment, because they are often based on very limited data.

2. Available Risk-Based Biota Criteria:

a. Human Receptors:

Exposure through the food chain is potentially significant. For example, according to EPA, approximately 50 percent of households in the Midwest maintain vegetable gardens (EPA 1995). The SRV calculations do not incorporate food chain exposure pathways, because these routes do not exist for every site, and they vary greatly from site to site. Nor have generic biota criteria which account for exposure of human receptors to food chain contamination been developed. The "Biota Criteria Table 1" summarizes Food and Drug Administration action levels for informational purposes. In general, chemicals with log K_{ow} values greater than 4 are considered potentially bioaccumulative in food chains.

If food production (livestock production as well as produce) and consumption are likely to occur at a site containing contaminants known to bioaccumulate in the food chain, include these pathways in a site-specific evaluation. Also include ingestion of contaminated fish as a food chain pathway when evaluating surface water and/or sediments.

"Sensitive populations," which consume large percentages of their diets from local food sources, present particular concerns. The Hmong people, who consume large numbers of bottom-feeding fish, and subsistence farmers are examples of sensitive populations.

b. Ecological Receptors:

Generic biota criteria which account for exposure of ecological receptors to food chain contamination have not been developed. If consumption of contaminated biota by wildlife at a site containing contaminants known to bioaccumulate is likely to occur, include the food chain exposure pathway in the site-specific evaluation.

The New York Department of Environmental Conservation has developed fish flesh criteria for 16 organochlorine chemicals or chemical groups, for the protection of fish-eating wildlife (Newell, et al. 1987). These are contained in the "Biota Criteria Table 2."

Contaminants of concern (COCs) for plant uptake include:

arsenic	cadmium	mercury	nickel
silver	selenium	thallium	zinc

[This list will be modified in future versions]

COCs for animal uptake include:

Aldrin	Bis (2-ethyl hexyl) phthalate	4-Bromophenyl phenyl ether
Butyl benzyl phthalate	Chlordane	Dibutyl phthalate
Di-n-octyl phthalate	4,4-DDD	4,4-DDE
DDT	Dieldrin	Dioxins/Furans
Endrin	Gamma-Hexachlorocyclohexane	Heptachlor
Heptachlor epoxide	Hexachlorobenzene	Hexachlorobutadiene
Hexachloroethane	Lindane	Mercury
Methoxychlor	Mirex	Octachlorostyrene
PBBs	PCBs	Pentachlorobenzene
Pentachlorobutadiene	Pentachlorocyclopentane	Pentachlorophenol
Photomirex		1,2,3,4-Tetrachlorobenzene
Tetrachloroquaiacol		
Toxaphene	Trichlorobutadiene	

[This list will be modified in future versions of this document.]

V. EVALUATING SHORT-TERM HAZARDS

General Comments:

Make a qualitative judgment at any point during the site evaluation concerning whether a short-term hazard exists. Make a quantitative judgment during the site screening, after comparing site data to risk-based screening criteria and evaluating site conditions.

A short-term hazard evaluation shall focus on actual or likely exposures to human and environmental receptors under current site conditions, considering current use(s) of the site and the surrounding environment, and considering an appropriately short period of time. The evaluation shall focus primarily, but not exclusively, on hot spots. If a short-term hazard exists, take steps to minimize exposure or remove the material.

In general, a short period of time shall be any duration of time from the beginning of an exposure up to five years. Select the time period after considering the nature of the contaminant under investigation (e.g., a carcinogen or acute toxin), current potential for exposure, type of individual(s) exposed (e.g., a child, pregnant woman or adult worker), and the time between the present date and the expected implementation date of the "Remedy Implementation Plan." To the extent that they are known to have occurred, also consider past and ongoing exposures in the evaluation.

A. Conditions Which Pose Short-Term Hazards:

Conditions which pose or could pose a short-term hazard may include, but are not limited to:

- 1) the presence of rusted or corroded drums or containers, open pits, lagoons, or dangerous structures;
- 2) any uncontained materials which exhibit the characteristics of corrosivity, reactivity, or flammability referenced in Resource Conservation and Recovery Act (RCRA) rules;
- 3) a release to the environment resulting in the presence of vapors within buildings, structures, or underground utility conduits at a concentration equal to, or greater than, 10 percent of the lower explosive limit;
- 4) a release to the environment of reactive or explosive hazardous material threatening human health or safety;
- 5) a release to a roadway which endangers public safety;
- 6) a release to the environment that poses a significant risk to human health when present for even a short period of time;
- 7) a release to the environment that produces immediate or acute adverse impacts on fish or wildlife populations;
- 8) a release to the environment indicated by measurement of a contaminant in a private drinking water supply well at a concentration greater than the HRL or MCL, whichever is the most appropriate health-risk based criteria; if this occurs, inform the Section risk assessor and contact the Minnesota Department of Health, as required by the March 1995, Memorandum of Agreement (MDH/MPCA MOA 1995);
- 9) a release to the environment indicated by the measurement of any of the following concentrations of hazardous materials at the ground surface or within a depth of 6 inches below the ground surface, at any location within 500 feet of a residential dwelling, school, playground, recreation area (this includes areas where children play, even if the area is not zoned specifically for such use), or park, unless human access is controlled or prevented by bituminous pavement, concrete, a fence, or some other physical barrier:

<u>Hazardous Material</u>	<u>CAS number</u>	<u>Concentration (mg/kg dry weight)</u>
Arsenic	7440382	40
Cadmium (total)	7440439	60
Cyanide (available)	57125	100
Lead	7439-92-1	100
Mercury (total)	7439976	300
Methyl mercury	22967926	10
PCB (total)	1336363	10;

- 10) conditions at the site posing a short-term hazard based upon potential for carcinogenic health effects if, for each contaminant evaluated, the estimated ECR, calculated for even a short period of time, results in a cancer risk $\geq 10^{-5}$; this would be indicated in the screening evaluation, if the cancer risk exceeded 10^{-5} by a factor of greater than or equal to 10, and if potential exposure was occurring under the current land use;
- 11) conditions at the site posing a short-term hazard based upon the potential for non-cancer health effects, if, for each contaminant evaluated, the calculated chemical-specific HQ is greater than 1, (unless the Uncertainty and Modifying Factors incorporated into the Reference Dose for the contaminant total ≥ 100 , in which case the cumulative non-cancer risk limit shall be an HI equal to 10); or
- 12) conditions at the site posing a short-term hazard to environmental receptors based on visible evidence of stressed biota attributable to the site, or significant adverse ecological impacts being likely under current site conditions, and those impacts being likely to persist, if current conditions remain unremediated for up to 5 years.

B. Interim Response Actions:

Interim response actions to address a potential short-term hazard must be developed in conjunction with SRS staff, and must be approved prior to implementation. Involve Site Response Section risk assessment staff in this evaluation. Potential interim response actions include:

- 1) preparation of documentation justifying accelerated removal or containment actions;
- 2) re-assessment of the validity of sample data results;
- 3) a site-specific assessment of whether a short-term hazard to health, safety, public welfare, or the environment exists;

- 4) collection of additional site data (e.g., additional soil samples to determine the extent of the area containing levels exceeding the short-term hazard concentration);
- 5) installation of fences, warning signs (including, where appropriate, multi-lingual or symbolic signs), and/or implementation of other security or site-control measures;
- 6) installation of drainage controls and/or berms, dikes, or impoundments;
- 7) removal or temporary covering of areas of concern to prevent exposure;
- 8) installation of waste or product recovery systems;
- 9) provision of alternative water supply;
- 10) relocation of residents from the site or surrounding area of concern; and/or
- 11) any other assessment, containment, or removal action consistent with the purpose and scope of an emergency response action, or otherwise deemed necessary by the SRS.

VI. CONCLUSION

Review:

The Screening Evaluation helps determine whether a site warrants further investigation and possible remediation due to potential risks to humans and/or the environment. It does this by screening representative contaminant concentrations in each environmental medium at the site against appropriate screening criteria. If concentrations in any of the media exceed screening criteria for either humans or ecological receptors, further evaluation of the site (or, at a minimum, further consideration of the assumptions underlying screening criteria) is required.

Results:

Again, the possible general outcomes of the screening are:

- 1) the site clearly “fails” the screening — concentrations in one or more media clearly exceed screening criteria;
- 2) the site barely “fails”— concentrations in one or more media barely exceed screening criteria;
- 3) the site barely “passes” — concentrations in one or more media are barely below screening criteria;
- 4) the site clearly “passes”— concentrations in all media are below screening criteria.

Actions:

Situation 1 requires that site conditions be further evaluated. In situations 2 and 3, before a decision is finalized, the basis of the screening criteria (e.g., default assumptions, exposure pathways, etc.) and the quality of the data need to be reviewed. The site team will then use professional judgement to determine whether confirmation sampling is recommended or if the screening criteria were appropriate for the site conditions. Situation 4 requires no further action to ensure protection of human health and the environment, assuming that sampling was adequate and that additivity was evaluated.

For sites requiring further evaluation, a more thorough characterization of site conditions is required. This helps to more fully define contaminant locations, contaminant levels, contaminant volumes, exposure pathways, etc. This information is needed in order to determine what clean-up goals are appropriate and the feasibility of cleanup. In some cases, consideration of screening assumptions in light of site-specific conditions may also be warranted.

Next, preliminary clean-up goals must be established—the generic screening criteria are not clean-up levels. However, because the generic criteria are not *worst-case* or overly conservative, they may be evaluated on a site-by-site basis for appropriateness as preliminary clean-up goals. A future guidance document will present additional discussion of focused site investigation and development of preliminary clean-up goals.

DEFINITIONS

Aquifer - A geologic formation, group of formations or part of a formation capable of yielding a significant amount of ground water to wells or springs.

Background - Environmental contaminant conditions representative of an area which has not been impacted by contamination from the site, and which represent natural, ambient conditions.

Benthic Organism - One of a wide range of organisms dwelling at the bottom of a river, lake, or ocean.

Bioavailability - The degree to which a material in environmental media is assimilable by an organism.

Bioconcentration - A process by which there is a net accumulation of a chemical directly from an exposure medium into an organism.

Biota - The animal and plant life (including microbes and invertebrates) of a particular region or area considered as a total ecological entity.

Contaminant of Concern - A material detected at a hazardous waste site which has the potential to adversely affect receptors due to its concentration, distribution, and/or mode of toxicity.

Cumulative Receptor Cancer Risk - The sum of the estimated excess lifetime cancer risks resulting from exposure to all contaminants at or from a site, at all exposure points, for a given receptor.

Cumulative Receptor Non-Cancer Risk - A calculation of the possibility of non-cancer health effects associated with exposure to all contaminants at or from a disposal site at all exposure points identified for a given receptor. The HI is a measure of the Cumulative Receptor Non-cancer Risk.

Ecological Receptor - A non-human organism (or population, community, or ecosystem) potentially experiencing adverse effects from direct or indirect exposure to contaminated media.

Excess Lifetime Cancer Risk(ELCR) - The product of exposure and carcinogenic potency. The resulting risk estimate is an upper-bound probability that an individual's exposure during a lifetime to a contaminant could result in cancer.

Exposure Pathway - The course a chemical or physical agent takes from a source to an exposed organism. Each exposure pathway includes a source or release from a source, an exposure point, and an exposure route. If the exposure point differs from the source, transport/exposure media (i.e., air, water) are also included.

Exposure Point - Location of potential contact between a human or environmental receptor and a release of contaminants. An Exposure Point may describe an area or zone of potential exposure, as well as a single discrete point.

Exposure Point Concentration - The concentration of contaminants in a specific medium which a human or environmental receptor may contact at an exposure point.

False Negative - The conclusion that an event is false when in fact it is true.

False Positive - The conclusion that an event is true when in fact it is false.

Fate - Disposition of a material in various environmental compartments (e.g., soil or sediment, water, air, or biota) as a result of transport, transformation, and degradation.

Ground Water - Ground water consists of all waters below the surface of the earth, including, but not limited to, aquifers.

Hazard Index (HI) - The sum of more than one HQ for multiple substances with the same or similar modes of toxic action or toxic endpoints. (MA - a calculation of the possibility of non-cancer health effects as the result of exposure to one or more oil or contaminants with the same or similar modes of toxic action or toxic endpoints. The $HI = HQ1 + HQ2 + \dots + HQn$).

Hazard Quotient (HQ) - The ratio of a single substance exposure level to a reference dose for that substance derived from a similar exposure period (e.g., $D1/RfD1$, where D is the daily intake/dose (or air concentration) for a particular contaminant, and the RfD is the reference dose (or air reference concentration, RfC)).

Hot Spot - A discrete area of a hazardous waste site characterized by contaminant levels substantially higher than those of the surrounding area of the site.

Lowest Observed Effect Concentration (LOEC) - The lowest concentration of a chemical in a toxicity test that causes an effect that is statistically significantly different from the controls.

No Observed Effect Concentration (NOEC) - The highest concentration of a chemical in a toxicity test that causes effects that are not statistically significantly different from the controls.

Permanence - An implemented remedy is considered permanent when it allows for the unrestricted use of all land and natural resources impacted by contaminants and, except for the purpose of treatment, does not involve removal of the contaminants to another site, and minimizes exchanges of the contaminant.

Permanent Solution - A measure or combination of measures which will, when completed, attain a level of each identified substance of concern at a disposal site or in the surrounding environment such that no substance of concern will present a significant risk to public health, safety, public welfare, or the environment.

Potentially Productive Aquifer - Any high or medium yield *overburden* aquifer, as defined by US Geological Survey Hydrogeologic Atlas, except those aquifers located in heavily developed communities where development of the aquifer as a public water supply is not reasonably foreseeable.

Receptor - A human or non-human organism (or population, community, or ecosystem) potentially experiencing adverse effects from direct or indirect exposure to contaminated media.

Reference Concentration (RfC) - The daily concentration in air of a contaminant which would not result in any adverse non-cancer health effects, as published by EPA.

Reference Dose (RfD) - An estimate (with uncertainty of perhaps an order of magnitude or greater) of a daily exposure level for the human population, including sensitive sub-populations, that is likely not to result in appreciable risk of deleterious effects during a lifetime. Chronic RfDs are specifically developed to be protective for long-term exposure to a compound.

Residual Contamination - The concentration of a contaminant remaining at a site at which further remedial response actions are not required under this guidance.

Risk - The expected frequency or probability of undesirable effects resulting from exposure to known or expected stressors.

Site Assessment - The early phases of the site investigation process which occur prior to the Remedial Investigation, including the Phase I and most of the Phase II under voluntary investigation programs, and the Integrated Assessment under the federal Superfund program.

Slope Factor - A plausible upper-bound estimate of the probability of an adverse health-related response per unit intake of a chemical over a lifetime. The slope factor is used to estimate probability of an individual developing cancer as a result of a lifetime of exposure to a particular level of a potential carcinogen.

Uncertainty Factors - One or more factors, each generally an order of magnitude, used to divide a no-observed-adverse-effect level, following EPA-approved methodology, to reflect uncertainty in the various types of data used to estimate a Reference Dose.

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