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NOTE: Because of new developments in toxicology and human health risk assessment, many numeric values in this 1997 guidance document are outdated. This document should be used for general background information and reference purposes only. For current risk assessment approaches and risk-based concentrations, please consult current DEQ guidance documents and/or contact a DEQ project manager.

Generic Remedies For Soils Contaminated With Polychlorinated Biphenyls (PCBs)

Oregon Department of Environmental Quality
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This generic remedy guidance was prepared in accordance with OAR 340-122-047,
and has been approved by the Department of Environmental Quality,
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This document provides information and technical assistance to the public and DEQ employees about DEQ's cleanup program. This information should be interpreted and used in a manner fully consistent with the state's environmental cleanup laws and implementing rules. This document does not constitute rulemaking by the Oregon Environmental Quality Commission and may not be relied on to create a right or benefit, substantive or procedural, enforceable at law or in equity, by any person, including DEQ employees. DEQ may take action at variance with this guidance.

NOTE:

Because of new developments in toxicology and human health risk assessment, many of the numeric values in this document are outdated. Therefore, this guidance is provided for general background information and reference purposes only. For current risk assessment approaches and risk-based concentrations, please consult current DEQ guidance documents and/or contact your DEQ Project Manager.

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1. INTRODUCTION

Oregon Revised Statute (ORS) 465.315(1)(f) directs the Department of Environmental Quality (DEQ) to develop or identify generic remedies for common categories of facilities taking into account balancing factors specified in the statute. Requirements for the development and application of generic remedies are given in Oregon Administrative Rule (OAR) 340-122-047. The generic remedies in this document were developed pursuant to that rule.

1.1 Purpose

This document provides generic remedies to facilitate remedy selection for sites with soils contaminated with polychlorinated biphenyls (PCBs). Assumptions made in the development of this guidance were based on experience with typical PCB-contaminated sites and the best currently available data on the physical, chemical and toxicological properties of PCBs. Supporting documentation which summarizes the information reviewed and the conclusions reached by the DEQ is included in the appendices. This information was used to calculate protective risk-based concentrations (RBCs) and to identify and evaluate remedial alternatives in accordance with OAR 340-122-047, 084, 085 and 090.

1.2 Benefits

This guidance provides a streamlined approach to site characterization and remediation by prescribing generic RBCs and generic remedial technologies for sites that meet the qualifying criteria outlined in Section 1.3. Application of these remedies should result in more efficient remediation of PCB-contaminated sites because:

- The remedial investigation can be focused on collecting data necessary to define the extent of the contamination and confirm that the site is appropriate for applying the generic remedy.
- The risk assessment can be limited to identifying the appropriate site category and, if necessary, any factors pertinent to modifying the cleanup level.
- The feasibility study can be limited to confirming that site-specific conditions are consistent with the generic conditions used for this remedy, or modifying the analysis, as needed, based on considerations of site size, contaminant depth and concentrations, and amount of contaminated soil.

1.3 Applicability

This guidance applies to facilities or sites that have been contaminated by the release of PCB-containing materials and which meet all of the conditions described in Sections 1.3.1 through 1.3.4. Sites being remediated within the framework of this generic remedy must comply with all applicable sections of OAR 340-122.

1.3.1 Contaminants

This guidance applies to sites, or to well-defined units within a site, for which PCBs are the primary contaminants of concern. Other contaminants, such as volatile organic compounds, polynuclear aromatic hydrocarbons, and/or metals may be present if it can be clearly demonstrated that they are not significant contributors to the risk at the site (or cleanup unit).

PCBs were produced and have been released into the environment as complex mixtures of PCB congeners usually referred to as Aroclors (see Appendix A). Although the physical and toxicological properties of different Aroclors were taken into account when carrying out the generic risk assessment used in this document, the resulting RBCs must be applied to total PCB concentrations, not to concentrations of specific Aroclor mixtures (e.g., Aroclor 1242 or Aroclor 1260) or specific congeners (e.g., 2, 2', 5, 5'-tetrachlorobiphenyl).

1.3.2 Media and Receptors

This generic remedy guidance pertains only to soils contaminated with PCBs. Remediation of oils, sediments, surface water, or groundwater containing PCBs is not covered by this guidance and must be managed under other relevant sections of OAR 340-122.

The generic risk assessment and resulting remedial action levels found in this document are based solely upon consideration of potential risk to humans. Implementation of this guidance is contingent upon demonstrating that there are no unacceptable ecological risks from the PCBs found at the site.

1.3.3 Amount of Contaminated Soil

Due to uncertainties in the generic feasibility study resulting in part from variations in per-unit remediation costs as the amount of treated soil increases, the Department believes that the conclusions reached in this document may need to be reevaluated on a site-specific basis in cases where large amounts of contaminated soil exceed the generic hot spot level. Therefore, sites requiring treatment of more than 500 tons of soil contaminated with PCBs must be discussed with the Department and may require a focused feasibility study to determine the appropriate remedy.

1.3.4 Categories of Sites

This guidance document includes risk-based concentrations and remedies for sites which, upon completion of the remedial action, will fit one of the following three categories:

- Residential - Sites suitable for residential (unrestricted) use.
- Industrial - Sites used for industrial purposes. These sites must continue to be used for industrial purposes in the foreseeable future since those exposure conditions were used in the generic risk assessment for this category.

- Operating Electrical Substations - Sites that contain equipment used to transform and distribute electricity and which will continue to be used as operating substations in the foreseeable future. These sites must meet industry design and operating standards for substations since those standards were incorporated into the generic risk assessment for this category.

For industrial and operating substation sites consideration must also be given to the property use or zoning immediately adjacent to the site. Sites immediately adjacent (i.e., within 100 m) to residential properties may need additional evaluation to ensure adequate protection and should be discussed with the Department.

As discussed in Appendix B, the RBCs in this document are based on a specific set of exposure routes and receptors, *not on arbitrary land-use designations*. Therefore, before the remedies in this document can be applied, sites being considered for remediation must fit the defining exposure routes listed in Table B-1.

PCB-contaminated sites or facilities which are not being remediated to one of the generic categories listed above, or sites which do not meet conditions outlined in Section 1.3.1 or 1.3.2, are not eligible for the generic remedies in this document and should follow the site characterization and remedial action requirements outlined in OAR 340-122.

1.4 Other Standards

This document does not supersede other applicable federal, state or local regulations, including but not limited to those specified in:

- 40 CFR 761 (Toxic Substance Control Act (TSCA) PCB manufacturing, processing, distribution in commerce and use prohibitions);
- OAR 340-110 (Oregon PCB rules); and
- OAR 340-108 (Oregon spill response rules).

Parties using the PCB generic remedy guidance are responsible for ensuring that they are also in compliance with all other applicable regulations.

More specifically, this document does not apply to nor prevent the remediation of PCB spills carried out under 40 CFR 761.120 through 135 (TSCA PCB Spill Cleanup Policy). The TSCA PCB Spill Cleanup Policy establishes criteria EPA will use to determine the adequacy of the cleanup of spills resulting from releases of materials containing PCBs at concentrations of 50 mg/kg or greater. The policy applies only to PCB spills occurring after May 4, 1987 (the effective date of the policy). Older spills must be evaluated on a site-by-site basis. The TSCA PCB Spill Cleanup Policy provides numerical cleanup levels for various scenarios including: low concentration, low volume spills; non-restricted access areas; industrial areas; outdoor electrical substations and specific situations. Additional information on the TSCA PCB Spill Cleanup Policy is provided in Appendix G.

In addition to the regulations mentioned above, the DEQ's environmental cleanup rules provide numerical soil cleanup levels for PCBs and other hazardous substances at "simple sites" (OAR 340-122-045). These rules provide a streamlined, albeit conservative, approach as an option to conducting a remedial investigation, risk assessment and feasibility study. For eligible PCB sites (as described in Section 1.3), the Department recommends using this PCB generic remedy guidance in place of OAR 340-122-045.

1.5 Limitations

This document has been developed to provide specific guidance on site investigation and remedial action activities *as they are related to implementing the PCB generic remedies*. It is not intended to be general guidance on site investigations, risk assessments, compliance sampling, or other related activities. Additional guidance may be needed to ensure that all phases of the project have been completed in a manner acceptable to the Department.

The Department may modify this guidance document as new information becomes available.

2. Steps for Employing a PCB Generic Remedy

OAR 340-122-047(4) specifies that the Department may select or approve the use of a generic remedy at a given facility if:

- Site-specific information demonstrates that the remedy is consistent with the Department's generic remedy guidance, and
- The remedy is in compliance with OAR 340-122-090(1).

This section summarizes the required steps for the selection, approval and implementation of generic remedies for soils contaminated by PCBs. Prior to applying this guidance the responsible party should meet with the Department to ensure that the requirements of this document can be met and discuss any site-specific issues that may need to be resolved.

2.1 Site Investigation

In addition to the usual goals of determining the source(s) of the release and the nature, magnitude and extent of the resulting contamination, an investigation carried out for the purpose of applying a PCB generic remedy must gather sufficient information to demonstrate that the site meets the eligibility requirements outlined in Section 1.3. For this purpose the investigation must specifically address the following:

2.1.1 Contaminants of Concern

Before a PCB generic remedy can be employed, it must be demonstrated that PCBs are the only significant contaminants of concern at the site. Other contaminants may be present as long as they do not exceed the acceptable risk level. Demonstrating that this requirement has been met will generally require information such as:

- Site history, including all known past and current property uses, and materials or chemicals used by those businesses that may have resulted in contamination;
- The known or suspected source(s) of the release being investigated;
- A list of potential contaminants of concern based on the site history; and
- Sampling results addressing all potential contaminants of concern and all potentially contaminated areas and media at the site.

Showing that the non-PCB contaminants are below a level of concern may require comparison of maximum soil concentrations to values listed in the current release of EPA Region 9 Preliminary Remediation Goals (available at *http://www.epa.gov/region09/waste/sfund/prg/* or from DEQ); evaluating their potential to create a significant adverse impact to groundwater; and determining if they result in an unacceptable ecological risk.

2.1.2 Contaminated Media

These generic remedies apply to sites where the PCB contamination is found only in soil. The site investigation must confirm that media other than soil have not been impacted. Data to substantiate this may typically include:

- The vertical and horizontal extent of the PCB contamination;
- The depth to groundwater and distance to surface water;
- Analytical data from groundwater samples;
- Surface soil permeability and slope of the terrain; and
- Proximity to flood plain(s).

In addition, data from the site should indicate that the concentration and location of the contaminants which will remain after remediation are unlikely to present a potential future threat of contaminating the groundwater. The risk-based protective concentrations in Table 2-1 should not present an unacceptable threat when left in the vadose zone. However, the hot spot concentrations in Table 2-2 could pose a threat, especially if such concentrations are left in the vicinity of the water table. In these circumstances the Department may require additional proof that the proposed remedial action will protect groundwater. This may include:

- Leaching tests on samples representative of the concentrations that are proposed to remain on site;
- Site-specific measurements of permeability and fraction of organic carbon; and/or
- Computer modeling studies of the leachate pathway.

2.1.3 Ecological Risks

A PCB generic remedy can be used only if there are no unacceptable ecological risks at the site. In many cases this can be demonstrated by a scoping level assessment and will not require a full ecological risk assessment. A scoping level assessment will generally include:

- An evaluation of land use, water use, type and extent of vegetation, presence of wildlife, presence of threatened and endangered species, topography and drainage features, presence of wetlands or other sensitive environments, etc.;
- Identification of contaminants of interest (COIs) for ecological receptors (this list may differ from the list of contaminants that are considered a threat to human health); and
- An evaluation of whether pathways exist between the COIs and any ecologically important receptors found at the site.

For additional information on performing a scoping level ecological risk assessment, see *Guidance for Ecological Risk Assessment: Level I - Scoping* (DEQ, 1997a).

2.1.4 Land Use

Generic remedies have been developed for three categories of sites: residential use, industrial use and operating electrical substations. Sites being proposed for generic remediation under the residential use category will generally not require any detailed land use information; routine site information will usually be sufficient. Sites being considered under the industrial use or operating substation categories must submit information to substantiate the current and reasonably likely future use of the property. Such documentation will usually include information about:

- Historical and current land use or zoning designations;
- Anticipated future land uses based on local comprehensive plans;
- Community and nearby property owners' concerns regarding future uses of the contaminated site;
- Regional and local development patterns; and
- Regional and local population projections.

2.2 Risk Assessment

It will not be necessary to perform a baseline human health risk assessment as long as the site meets the generic conditions set forth in this document. The exposure routes and factors used by the Department to develop the risk-based concentrations and remedies in this document are discussed in Appendix B. This information should be reviewed to ensure that the generic conditions are appropriate for the site in question. A PCB generic remedial action plan (as discussed in Section 2.6) submitted to the Department *must include* a discussion of how the site in question meets the assumptions used in Appendix B. Site-specific variations that may require additional risk analysis, such as additional potential exposure pathways, should be discussed with the Department.

If contaminants other than PCBs are present, some assessment will be required to demonstrate that the risk from those contaminants does not exceed the acceptable risk level. The level of assessment needed will depend on site-specific conditions and should be discussed with the Department when sufficient data are available on the non-PCB contamination.

2.3 Remedial Action Objectives

OAR 340-122-040(2)(a) requires that remedial actions achieve acceptable risk levels as a means of protecting public health, safety, and welfare and the environment. The objectives of the PCB generic remedies are to prevent unacceptable levels of exposure to:

- Current and reasonably likely future site residents (children and adults) through contact (i.e., ingestion, dermal, inhalation) with surface or near-surface soils contaminated with PCBs;

- Current and reasonably likely future site residents (children and adults) through consumption of homegrown produce contaminated with PCBs through uptake by plants;
- Current and reasonably likely future site workers (adults) through contact (i.e., ingestion, dermal, inhalation) with surface or near-surface soils contaminated with PCBs; and
- Current and reasonably likely future substation workers (adults) through contact (i.e., ingestion, dermal, inhalation) with surface or near-surface soils contaminated with PCBs.

The residential site generic remedy is designed to meet the first two remedial action objectives (RAOs) listed above, and the industrial and operating substation remedies are designed to meet the third and fourth RAOs, respectively. It will generally not be necessary for site-specific RAOs to be developed for PCB generic remedies. A generic remedial action plan should simply confirm that the RAOs developed in this guidance document are appropriate for the site. However, if any site-specific information indicates that additional exposures may need to be evaluated, then additional RAOs may need to be developed. This should be discussed with the Department.

As described in Appendix B, the Department has evaluated the concentrations of PCBs in soil which will provide adequate protection to meet the generic remedial action objectives listed above. The results of this evaluation are listed in Table 2-1. These protective soil concentrations correspond to human-health risk-based concentrations derived for a lifetime excess cancer risk of one in 1,000,000 (i.e., $1x10^{-6}$). This is the acceptable risk level required by OAR 340-122. Residential sites that are eligible for the remedies in this document and which meet the residential risk-based protective level in Table 2-1 will require no additional action. Eligible industrial and operating substation sites that meet the protective levels in Table 2-1 may require a deed restriction or other institutional control to ensure that the exposure assumptions on which the generic risk assessment is based do not change. Sites with PCB concentrations in soil exceeding the levels in Table 2-1 will require additional action to meet the RAOs.

Table 2-1: Generic Protective PCB Concentrations in Soil

Land-Use Scenario	**Risk-Based Protective Level (mg/kg)**
Residential	1.2
Industrial	7.5
Operating Substation	25

2.4 Identification of Hot Spots

Depending on site conditions, the remedial action objectives may be achieved by treatment, excavation and off-site disposal, engineering controls and/or institutional controls. OAR 340-122-090(4), however, requires *treatment* of hot spots of contamination to the extent that treatment is feasible based on specified balancing factors. Therefore, at sites with soil PCB concentrations exceeding the levels in Table 2-1, it will be necessary to determine whether any part of the site may be classified as a hot spot. Hot spots will require treatment if feasible.

For soils, ORS 465.315 defines hot spots as areas of contamination which:

- Have high concentrations,
- Are highly mobile, or
- Are not reliably containable.

High concentrations are defined in OAR 340-122-115(31)(b)(A)(i - ii) as risk-based concentrations corresponding to 100 times the acceptable risk level for human exposure to each individual carcinogen or 10 times the acceptable risk level for human exposure to each individual noncarcinogen. Due to the low water solubility and low volatility of PCBs, soils contaminated with PCBs will typically not constitute a hot spot as a result of high mobility or inability to be reliably contained. Shallow soil contamination located in a flood plain may be an exception and should be discussed with the Department.

Table 2-2 lists the hot spot levels for soils contaminated with PCBs based on the definition of high concentration. After completing the site investigation, the portion of contamination exceeding the hot spot concentration for a given site's land-use scenario should be identified and estimates should be made of the hot spot's areal extent, depth, volume, soil mass and range of concentrations; and the fraction of total mass of contaminated soil that is considered a hot spot. Note that although values are listed for all three categories of sites, the residential value is of limited use since the only generic alternative presented in this document is excavation to the protective level (see Table 2-3). Residential sites for which other alternatives are being considered (e.g., excavation to the hot spot level plus institutional controls) will be considered on a case-by-case basis (see Section 2.5.5).

Table 2-2: Soil Hot Spot Levels Based on High Concentration

Land-Use Scenario	Soil Hot Spot Levels (mg/kg)
Residential	22
Industrial	100
Operating Substation	250

2.5 Feasibility Study

OAR 340-122-047(1)(b) permits the DEQ to develop generic remedies which incorporate generic feasibility studies. A remedial action plan may be developed based on the results of the generic feasibility study (FS). This section summarizes the Department's generic feasibility study for soils contaminated with PCBs. Additional information can be found in Appendices C, D and E.

It will generally not be necessary to perform a feasibility study for sites which meet the requirements of the generic remedies in this document. However, proposed modifications to any of the generic remedies should be discussed with the Department and may require additional site-specific information to be submitted in support of the proposed remedial action (see Section 2.5.5). Also, as explained in Section 1.3.3, sites with more than 500 tons of soil exceeding the generic remedy hot spot levels in Table 2-2 may require a focused feasibility study to determine the appropriate remedy.

2.5.1 Identification and Screening of Remedial Alternatives

The Department identified 11 possible technologies (Appendix C) and selected five screening criteria consistent with the goals of the generic remedy process. First, in order to increase the likelihood of success, only demonstrated technologies were chosen. Second, to expedite generic remedial actions, the technologies must be commercially available at a TSCA-permitted facility. Third, at least one technology was retained for evaluation of treatment of hot spots at a higher cost threshold. Fourth, the technologies must be cost-effective for the amounts of soil that may require generic treatment under this guidance document (<500 tons). Finally, institutional controls were retained to allow options for management of non-hot spots.

The technologies that were retained are:

- Excavation and off-site incineration;
- Excavation and off-site disposal;
- Engineering controls (capping, erosion control, runoff collection, etc.); and
- Institutional controls (site use restrictions, etc.).

2.5.2 Development of Remedial Action Alternatives

Using the technologies that were retained in the screening step, the Department developed a range of potential remedial action alternatives (Appendix D). The remedial action alternatives potentially applicable to generic PCB sites are:

Alternative 1: No action;

Alternative 2: On-site management through engineering and institutional controls;

Alternative 3: Excavation to protective level and off-site disposal in an approved landfill;

Alternative 4: Excavation to hot spot level and off-site disposal in an approved landfill plus additional controls; and

Alternative 5: Excavation to hot spot level and off-site incineration plus additional controls.

2.5.3 Evaluation of Alternatives

The five alternatives were evaluated to ensure that they would be protective of public health, safety, and welfare and the environment; would balance the remedy selection factors; and would treat hot spots to the extent feasible (Appendix E).

In the final evaluation the no-action alternative was not selected because it does not achieve protective levels. Due to a significant cost differential, excavation/incineration is not likely to be selected when compared to excavation/off-site disposal. However, it is the only commercially permitted treatment technology that is cost-effective for less than 500 tons of soil. Since cost is the only factor against incineration, the Department has elected to retain it to provide responsible parties an additional option in cases where changing costs, reduced long-term liability, or transportation or business reasons make it reasonable. When the amount of soil requiring treatment exceeds 500 tons, other treatment technologies may become competitive and should be evaluated on a site-specific basis (see Appendix C). Table 2-3 summarizes which alternatives are applicable to each of the eligible land-use scenarios.

Table 2-3: Generic Remedies

Land Use Scenario	**Generic Remedy**	
	Hot Spots	**Non-Hot Spots**
Residential	Alternative 3* - Excavation to the protective level and off-site disposal in an approved landfill	Alternative 3*
Industrial	Alternative 4* - Excavation to the hot-spot level and off-site disposal in an approved landfill plus additional controls OR Alternative 3*	Alternative 2 - On-site management through engineering and institutional controls OR Alternative 3*
Operating Substation	Alternative 4* OR Alternative 3*	Alternative 2 OR Alternative 3*

*Off-site incineration may be substituted for off-site disposal at the discretion of the responsible party.

2.5.4 Selection of a Remedy

The responsible party may propose any of the applicable remedies in Table 2-3 as long as the remedy is consistent with current and reasonably likely future land use and all requirements of this guidance. The responsible party also should understand that land-use restrictions and long-term monitoring requirements might affect the value of the site.

2.5.5 Modifications to a Remedy

The Department is willing to consider limited modifications to the generic remedies in this document on a case-by-case basis. Situations where modifications may be appropriate are:

- Industrial or operating substation sites where contaminated soils with concentrations in excess of the generic cleanup levels are determined to be inaccessible. For example, it may not be feasible to remove pockets of contaminated soil beneath active transformers, under buildings, or in utility corridors. Such contamination may be left in place as long as the responsible party can confirm that treatment to the generic level is not feasible, and can demonstrate that migration and unacceptable levels of exposure are not reasonably likely to occur. Additional engineering or institutional controls may be necessary to ensure that acceptable levels of risk are maintained.
- Residential sites for which institutional and/or engineering controls can be shown to be adequately reliable. For example, apartment construction may be planned over areas of contaminated soil and reduce the likelihood of exposure to those soils. At such sites it may be feasible to excavate to the hot spot level and apply additional controls to achieve an acceptable level of protection.
- Sites where technologies not included in this generic remedy guidance may achieve an acceptable level of protection. Changing technologies, costs and unique factors that can not be considered in a generic remedy may lead to other remedies that are more appropriate for a specific site. In such cases pilot studies may provide sufficient additional information to recommend other remedies.

Proposed modifications should be discussed with the Department and will require additional site-specific information to be submitted in support of the remedial action. The remedial action plan should contain a description of the modifications to the selected alternative and include a focused feasibility study which documents the site-specific circumstances that require modifications to that alternative. In all cases where such modifications are proposed, the site must still meet the eligibility requirements outlined in Section 1.3. Although it is the Department's intent to provide flexibility by allowing such modifications, the generic remedies are still based on those assumed conditions. More complex sites must be handled by other relevant sections of OAR 340-122.

2.6 Proposal Submittal and Public Comment

The results of the work completed under Sections 2.1 through 2.4 and a discussion of the remedy proposed under Section 2.5 of this guidance must be submitted to the Department in the form of a written remedial action plan. The Department will review the written proposal and, if the information submitted is complete and meets the requirements specified in this document, the proposal will be made available to the public for a minimum of 30 days for review and comment as required by ORS 465.320. After the comment period ends, the DEQ will decide whether to approve, approve with modifications, or deny the proposal.

2.7 Remedy Implementation

Upon the DEQ's approval, the generic remedy must be implemented as outlined in the proposal. DEQ may require an agreement or order at some sites for the implementation of the remedy. During implementation, the responsible party should document that the remedial action objectives of the generic remedy have been achieved. This documentation must include, but is not limited to, data from post-remediation samples verifying that the remedial action objectives have been met. The number of samples required and how the data are analyzed to determine compliance will depend on the complexity of the site and should be discussed with the Department. Where institutional controls are part of the remedy, such controls must be both approved by and enforceable by DEQ.

If the responsible party has adequately characterized the site and achieved the appropriate remedial action objectives, the Department will issue a written determination (No Further Action letter, NFA) that the remedial action is complete. This determination is applicable unless new or previously undisclosed facts show that the remedial action does not comply with the rules. Under those conditions, the site may be subject to additional investigation and/or remediation.

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APPENDIX A: BASIS FOR GENERIC REMEDY DEVELOPMENT

The decision to develop a generic remedy for PCB-contaminated facilities was based in part on the information about the history, use and properties of PCBs summarized in this section.

A.1 History of PCB Manufacture and Use

Chlorination of biphenyl can theoretically produce 209 congeners containing from one to ten chlorine atoms per molecule (Hutzinger *et al*., 1974). Commercial production of PCBs generated complex mixtures of congeners for which the dominant congeners were determined by the amount of chlorine used in the process. In the United States, PCBs were produced by Monsanto and sold under the registered trademark of Aroclor. Aroclors were generally assigned a number based on the weight percentage of chlorine used in the production of the mixture. Aroclor 1242, for instance, has an overall chlorine content of 42 weight-percent and consists primarily of a mixture of mono- through hexachlorobiphenyl congeners, with tri- and tetra-congeners dominating the mixture. Aroclor 1260, on the other hand, has a chlorine content of 60 weight-percent and consists primarily of penta- through octachlorobiphenyl congeners with hexa- and hepta- congeners dominating the mixture (Table A-1). The most common Aroclors of this type used in the U.S. were 1221, 1232, 1242, 1248, 1254 and 1260. Aroclor 1016, which contains 41% chlorine by weight, was a later formulation produced by Monsanto to limit the amount of the degradation-resistant higher chlorinated congeners.

Table A-1: Distribution of Congeners in Various Aroclor Mixtures

Number of Chlorines	Number of Congeners			
	Aroclor 1242	Aroclor 1248	Aroclor 1254	Aroclor 1260
1	3			
2	13	2		
3	28	18		
4	30	40	11	
5	22	36	49	12
6	4	4	34	38
7			6	41
8				8
9				1

PCB production in the United States began about 1930 and peaked in 1970 when 85 million pounds of PCBs were produced (National Academy of Sciences (NAS), 1979). Due to their thermal stability, chemical stability, and dielectric properties, PCBs have been widely used as coolants and lubricants in transformers, capacitors and other electrical equipment; high-pressure hydraulic fluids; machine-tool cutting oils; protective coatings for wood, metal and concrete; adhesives; and carbonless reproduction paper. Although the manufacture of PCBs in the United States ceased in 1977 following the implementation of regulatory controls in TSCA, many of the transformers and capacitors which contain or once contained PCBs are still in use.

For almost fifty years, releases into the environment occurred as a result of spills and leaks during the manufacture and use of PCBs and PCB-containing products, as well as through the disposal of liquids and solids containing PCBs. Since they are no longer produced or used in the production of new products in the United States, the primary sources of contemporary PCB contamination include outdated or illegal landfills and scrapyards which accepted or continue to accept electrical equipment, and leaks or explosions of operating electrical equipment. The National Academy of Sciences estimates that out of approximately 1.25 billion pounds of PCBs sold in the U.S. through 1975, about 150 million pounds (12%) are mobile in the environment and 290 million pounds (23%) are in landfills or equipment dumps (NAS, 1979).

A.2 Sources of PCB Contamination

Because of their widespread manufacture and use, PCBs have been found at large numbers of sites contaminated with hazardous substances. The majority of sites fall into one of the following categories:

- Electrical Transmission and Distribution Facilities: These facilities are used to transform and distribute electricity, and include substations, pad-mounted transformers, and pole-mounted transformers. Releases at these sites tend to occur above ground, although releases from underground vaults may also occur. The releases are generally small and localized. Depending on the size of the facility and amount of equipment present, however, numerous releases may have occurred since the facility started operation.
- Electrical Equipment Maintenance Facilities and Salvage Yards: These are sites where electrical equipment such as transformers and capacitors are repaired or salvaged. PCBs may be released to the environment during the scrapping of such equipment. Releases are exclusively above ground although site grading operations at salvage yards may result in subsurface soil contamination. At salvage yards, the PCB contamination tends to be commingled with other types of contamination such as metals, asbestos and petroleum products. If PCB-containing petroleum products were burned, chlorinated dibenzofurans and/or dioxins may be present.
- Manufacturing Facilities: These facilities fall into two categories: sites where PCBs were manufactured or used in the manufacturing processes; and sites where products containing PCBs were used. The magnitude and extent of PCB contamination at these sites can be quite variable. In addition to soil contamination, both types of facilities commonly have PCB contamination on the surfaces of buildings and other structures.
- Oil Recycling Facilities: These are facilities that handle, store, treat and recycle transformer oils, waste oils and other petroleum products. Oil recycling facilities may have accepted PCB-contaminated oil for recycling. Therefore, PCB contamination will

likely be commingled with petroleum contamination. If PCB-containing petroleum products were burned, chlorinated dibenzofurans and/or dioxins may be present.

- Waste Disposal Facilities: These include outdated or illegal municipal landfills and other facilities that handled, stored, treated and disposed of solid and liquid wastes prior to the promulgation of TSCA. Such facilities may have accepted PCB-containing materials for disposal. Because of the manner in which these facilities operated, PCBs are likely to be commingled with other types of contamination and present in the subsurface.

Although the list above covers the most common sources of PCB contamination, it is not necessary to demonstrate that a site belongs to one of these five categories in order to apply the generic remedy guidance. The prerequisites for its use are simply that the site meet the conditions outlined in Section 1.3 and that the work be carried out under DEQ supervision as covered in OAR 340-122-047.

A.3 Environmental Fate and Transport

Once released into the environment, the fate of PCBs is a function of their physical and chemical properties, which are in part a function of the degree of chlorination. Since PCBs have been produced and released as mixtures (Monsanto's Aroclors, for example) and not as pure compounds, the properties of the mixtures are also critical factors. Key properties affecting the environmental fate of PCBs are their low aqueous solubility, relatively low vapor pressure, and extreme resistance to chemical reaction. Each of these properties contributes to the tendency for PCBs to be relatively long-lived and immobile in the environment.

The low solubility of PCB mixtures inhibits the migration of PCBs from soil to groundwater. Aroclor 1254, for example, has a reported aqueous solubility of approximately 56 ppb (Haque *et al*., 1974) and the solubility of Aroclor 1242 is approximately 97 ppb (Luthy *et al*., 1997). Also, dissolution of PCB congeners is skewed towards the less chlorinated compounds (Luthy *et al*., 1997). Once PCBs are released to the environment, they tend to adsorb strongly to soils and resist dissolution. The tendency to adsorb increases with decreasing solubility (which corresponds to the increasing degree of chlorination and toxicity). Transport of PCBs to nearby surface water bodies, however, can occur as a result of the entrainment of contaminated soil particulates into surface water run-off.

PCBs have a moderate to low volatility (Shiu and Mackay, 1986) which is strongly affected by the way in which the PCBs are exposed. Losses from the surface of free liquid Aroclors are significantly greater than losses from PCBs which have moved into and are adsorbed onto soil particles. In general, volatilization is not a major factor in the transport of PCBs from a contaminated site. Despite their low volatility, however, it is important to note that the widespread distribution of PCB contamination coupled with their stability in the environment has resulted in a significant flux of PCBs to the Great Lakes from atmospheric deposition.

The chemical stability of PCBs is reflected in the fact that they are highly resistant to both oxidation and to acidic or basic hydrolysis. The more highly chlorinated PCBs may undergo photolysis, but this is probably not a significant process affecting their fate. Congeners with fewer than four chlorine atoms are susceptible to biodegradation, whereas those with more than four chlorine atoms are resistant to biodegradation.

Finally, though individual PCB congeners are generally solids under normal conditions, Aroclor mixtures are dense, very viscous liquids. With a density greater than 1 g/mL, Aroclors would be expected to easily move downward through porous media. However, the high viscosity of these liquids significantly inhibits movement of the fluid into fine-grained media and helps restrict smaller surface releases to shallow soils.

In summary, due to their low mobility and persistence, most PCB contamination tends to be confined to soils and aquatic sediments found in close proximity to the point of release. For surface releases from electrical equipment, the majority of PCB contamination will be found in shallow soils or obvious surface water drainage areas.

APPENDIX B: GENERIC PCB RISK ASSESSMENT

OAR 340-122-047(1)(c) permits the Department to include numeric cleanup standards in a generic remedy as long as a generic risk assessment is performed showing that the standards achieve the acceptable risk levels, and the risk assessment is consistent with the requirements of OAR 340-122-084 through 090. This section describes the calculation of the risk-based concentrations (RBCs), for both carcinogenic and noncarcinogenic effects, to support the PCB generic remedies. Because ORS 465.315(2)(a) allows for the conduct of probabilistic risk assessments, RBCs for these generic remedies were established using probabilistic exposure factors and equations.

B.1 Generic Receptor

For a probabilistic assessment, the risk assessor models the exposures to a population of exposed (and non-exposed) human receptors. Each iteration of the model represents a statistical model of one person drawn from this population, using the following process:

1. Drawing the body weight (from a distribution of body weights) for one random person in the population;
2. Calculating the skin area, daily inhalation rate, and other exposure factors for that person;
3. Estimating the doses received by that person for each pathway and lifestage;
4. Summing the doses received by that person for each pathway over all lifestages;
5. Estimating the risk posed to that person by the dose received from each pathway;
6. Returning to Step 1 and repeating the process for the next person in the population.

For this generic risk assessment, the exposure models were sampled 10,000 times using a commercial software package (Crystal Ball™ v 4.0a, Decisioneering, Inc., Denver, CO) and Latin Hypercube sampling. This represents a sample of 10,000 individuals (each with different, randomly selected, characteristics) from the population of individuals defined by the chosen probability distributions. The number of model iterations (10,000) was selected somewhat arbitrarily; no tests were performed to ascertain whether this number resulted in stability of the mean or percentile values. Furthermore, no effort was made to test the adequacy of the pseudo-random number generator employed by Crystal Ball™. Seed values for the various simulations were generated randomly within the software package.

Note that in the above process, we are drawing body weights for 10,000 different randomly selected individuals in the population and not different body weights for the same individual. In a multi-media or multi-pathway assessment, the simulation must be designed to preserve the correlations and dependencies among body weight, skin area, daily inhalation rate, and other factors. Several of the exposure factors (skin surface area, inhalation rate) are allometrically calculated on the basis of body weight in order to more easily maintain these dependencies.

For the purposes of establishing an exposure duration, it is assumed that each exposed individual is continuously exposed at a site from birth to a maximum of 75 years. Because contact and intake rates can vary with age, the population of potential receptors was separated into three distinct life stages on the basis of age. The child life stage extends from 0.0 to 6.0 years of age, the juvenile life stage extends from > 6.0 to < 18.0 years of age, and the adult life stage from ≥ 18 to ≤ 75 years of age.

B.2 Exposure Routes

Estimation of exposure begins with the identification of exposure pathways, routes, and points. An exposure pathway is the course a chemical or physical agent takes from a source to an exposed organism (EPA 1989, 1992a). An exposure route is the way a chemical or physical agent comes in contact with a receptor (i.e., by ingestion, inhalation, dermal contact, etc.). The fundamental premise in establishing risk-based concentrations is that *risk at a given site is a function of the receptors and exposure routes present and not of some arbitrary land-use designation* such as “residential” or “industrial.” The land and water uses that are allowable at a site are thus determined by showing that a set of exposure routes specific to each use does not produce unacceptable risks in human and/or ecological receptors.

The Department expects that all risk assessments will include an initial consideration of a broad range of exposure routes, the goal of which is to select a set of reasonable routes for the site of interest. For the purpose of the PCB generic remedies the Department considered the exposure routes listed in Table B-1. For each of the three scenarios (residential, industrial, operating substation) the Department then selected the exposure routes thought to be reasonably likely for that scenario. The selected routes are marked with a (4) in Table B-1 and summarized below. These are the routes used to calculate the generic risk-based concentrations in this document.

The exposure routes included in the generic residential scenario (Scenario A) are:

- INGESTION / CONSUMPTION
    - Incidental ingestion of contaminated soil by all age groups
    - Consumption of homegrown vegetables by all age groups
- DERMAL CONTACT
    - Dermal contact with contaminated soil by all age groups
- INHALATION
    - Inhalation of particulates (fugitive dust) by all age groups
    - Inhalation of soil vapors (outdoors) by all age groups

Table B-1: Exposure Routes Considered in the Calculation of Risk-Based Concentrations for the PCB Generic Remedies

EXPOSURE ROUTE	OPTION A [1]	OPTION B [2]	OPTION C [3]
INGESTION / CONSUMPTION			
Incidental ingestion of soil - adults	4	4	4
Incidental ingestion of soil - juveniles, children	4	;	;
Consumption of homegrown produce - adults	4	;	;
Consumption of homegrown produce - juveniles, children	4	;	;
Consumption of homegrown meat/milk/eggs - adults	m	;	;
Consumption of homegrown meat/milk/eggs - juveniles, children	m	;	;
Consumption of water - adults	;	;	;
Consumption of water - juveniles, children	;	;	;
Consumption of home caught fish - adults	;	;	;
Consumption of home caught fish - juveniles, children	;	;	;
DERMAL CONTACT			
Dermal contact with soil - adults	4	4	4
Dermal contact with soil - juveniles, children	4	;	;
Dermal contact with water - adults	;	;	;
Dermal contact with water - juveniles, children	;	;	;
INHALATION			
Inhalation of fugitive dust - adults	m	m	m
Inhalation of fugitive dust - juveniles, children	m	;	;
Inhalation of volatiles - adults	4	4	4
Inhalation of volatiles - juveniles, children	4	;	;
ECOLOGICAL			
Chronically exposed ecological receptors	;	;	;
Any threatened or endangered species and/or their habitat	;	;	;

4 Exposure route must be included in calculation of the RBC
m Exposure route judged to make minor contribution to total exposure, excluded from calculation of RBCs
; Exposure route not allowed, receptor must be absent and/or actively excluded from site if generic remedy is to apply, otherwise a site-specific evaluation of risk is required.
1) Equivalent to “residential” or “unrestricted” land use; 5000 square foot (residential lot) exposure unit
2) Equivalent to general industrial land use
3) Industry-specific land use, applies to operating electrical substations only

The exposure routes included in the generic industrial scenario (Scenario B) and the generic operating substation scenario (Scenario C) are:

- INGESTION / CONSUMPTION
  - Incidental ingestion of contaminated soil by adults
- DERMAL CONTACT
  - Dermal contact with contaminated soil by adults
- INHALATION
  - Inhalation of particulates (fugitive dust) by adults
  - Inhalation of soil vapors (outdoors) by adults

Note that these two scenarios by definition exclude juveniles and children.

EPA (1996a) suggests that consideration of the ingestion exposure route is adequately protective for inhalation exposures to fugitive dusts for organic compounds and that the fugitive dust exposure route need not therefore be routinely considered. For these reasons, a RBC was not calculated for the inhalation of fugitive dust (carcinogenic and noncarcinogenic contaminants on soil particles) exposure route for any of the exposure scenarios.

Before the generic remedies in this document can be applied to any site, the exposure pathways listed in Table B-1 must be reviewed. Pathways marked with a (;) are not allowed and must therefore be absent and/or actively excluded from the site if the generic remedy is to apply. If any excluded exposure routes are present, particularly those involving ecological receptors, a site-specific evaluation of risk may be required.

B.3 Exposure Estimation Equations

The following individual equations are used to estimate the average daily exposure associated with each contaminant within each medium (soil, water, air) for each of the three (*k*th) lifestages (child, k = 1; juvenile, k = 2; adult, k = 3) for each exposure scenario listed above. Lifestage exposures are combined to estimate exposure averaged over a lifetime. Note that these equations treat exposure frequency and duration differently and more explicitly than the typical U.S. EPA default equations (EPA 1991a). These models also include a combination of parameters expressed as either point estimates or distributions.

B.3.1 Absorbed Daily Dose (One Day Exposure)

B.3.1.1 Incidental Ingestion of Soil

$$ADD_{Ik} = \frac{Cs \times IRS_k \times CF_{km} \times Fs \times RAF_g \times Fcon}{BW_k} \qquad \textbf{Equation B.1}$$

Where:

ADD_{Ik} = Absorbed daily dose to *k*th lifestage from soil ingestion (mg/kg·d)

Cs	=	Contaminant concentration in soil (mg/kg)
IRS_k	=	Incidental soil ingestion rate of *k*th lifestage (mg/d)
CF_{km}	=	Conversion factor (10^{-6} kg/mg)
Fs	=	Fraction of soil contaminated (unitless)
RAF_g	=	Relative gastrointestinal absorption factor (unitless)
Fcon	=	Fraction of time spent in contact with soil (unitless); Scenario C only
BW_k	=	Body weight of *k*th lifestage (kg)

B.3.1.2 Consumption of Homegrown Vegetables

$$ADD_{Zk} = Cr \times IRV_k \times HP \times RAF_g \times Fv$$ **Equation B.2**

$$Cr = \left(\frac{Cs}{PEF} \times K_{ap}^{pt}\right) + \left(\frac{Cs}{VFs} \times K_{ap}^{gs}\right) + \left(Cs \times K_{ps}\right) + \left(Cs \times K_{ps(roots)}\right)$$ **Equation B.3**

$$K_{ps(roots)} = \frac{10^{\left(0.77 \times \log K_{ow}\right) - 1.52}}{K_{oc} \times f_{oc}}$$ **Equation B.4**

$$K_{ap}^{gs} = \left[f_{pa} + \left(f_{pw} + f_{pl} \times K_{ow}\right) \times \frac{RT}{H}\right] \times 10^{-3}$$ **Equation B.5**

$$K_{ps} = \left\langle 0.784 \times \left\{\exp - \left[\frac{\left(\log K_{ow} - 1.78\right)^2}{2.44}\right]\right\}\right\rangle \times \frac{1}{K_{oc} \times f_{oc}}$$ **Equation B.6**

Where:

ADD_{Zk}	=	Absorbed daily dose to *k*th lifestage from ingestion of homegrown produce (mg/kg·d)
Cr	=	Contaminant concentration in homegrown vegetables (mg/kg)
IRV_k	=	Total vegetable ingestion rate of *k*th lifestage (g/[kg·d])
HP	=	Probability of home vegetable production (unitless)
RAF_g	=	Relative gastrointestinal absorption factor (unitless)
Cs	=	Concentration of contaminant in soil (mg/kg)
PEF	=	Particulate emission factor (m^3/kg)
K_{ap}^{pt}	=	Plant-air partition coefficient for particle-bound contaminant (m^3/kg)
K_{ap}^{gs}	=	Plant-air partition coefficient for gas-phase contaminant (m^3/kg)
VFs	=	Volatilization factor for soil (m^3/kg)
f_{pa}	=	Volume fraction of plant tissue in air (unitless)
f_{pw}	=	Volume fraction of plant tissue in water (unitless)
f_{pl}	=	Volume fraction of plant tissue lipid (unitless)

R	=	Universal gas constant (Pa·m^3/mol·K)
T	=	Temperature (K)
H	=	Henry's law constant (Pa·m^3/mol)
K_{ps}	=	Plant-soil partition coefficient from root-zone soil to above-ground plant parts (unitless)
$K_{ps(roots)}$	=	Plant-soil partition coefficient from root-zone soil to roots (unitless)
K_{ow}	=	*n*-Octanol-water partition coefficient (unitless)
K_{oc}	=	Organic carbon partition coefficient (L/kg)
f_{oc}	=	Fraction of organic carbon in soil (unitless)
K_{ow}	=	*n*-Octanol-water partition coefficient (unitless)
Fv	=	Fraction of homegrown vegetables from site (unitless)

B.3.1.3 Dermal Contact with Soil

$$ADD_{Sk} = \frac{Cs \times SA_k \times AR \times Fb \times CF_{km} \times CF_{cm} \times Fs \times DAF \times Fcon}{BW_k}$$

Equation B.7

Where:

ADD_{Sk}	=	Absorbed daily dose to *k*th lifestage from contact with soil (mg/kg·d)
Cs	=	Contaminant concentration in soil (mg/kg)
SA_k	=	Total skin surface area of *k*th lifestage (m^2)
AR	=	Soil-to-skin adherence rate (mg/cm^2·d)
Fb	=	Fraction of total skin area exposed (unitless)
CF_{km}	=	Conversion factor (10^{-6} kg/mg)
CF_{cm}	=	Conversion factor (10^4 cm^2/m^2)
Fs	=	Fraction of soil contaminated (unitless)
DAF	=	Dermal absorption factor (unitless)
Fcon	=	Fraction of time spent in contact with soil (unitless); Scenario C only
BW_k	=	Body weight of *k*th lifestage (kg)

B.3.1.4 Inhalation of Soil Vapors (Outdoors)

$$ADD_{Vk} = \frac{(Cs/VFs) \times IRA_k \times Fs \times RAF_h \times Fcon}{BW_k}$$

Equation B.8

Where:

ADD_{Vk}	=	Absorbed daily dose to *k*th lifestage from inhalation of soil vapors (mg/kg·d)
Cs	=	Contaminant concentration in soil (mg/kg)
VFs	=	Volatilization factor for soil (m^3/kg)

IRA_k	=	Inhalation rate of *k*th lifestage (m^3/day)
Fs	=	Fraction of soil contaminated (unitless)
RAF_h	=	Relative inhalation absorption factor (unitless)
Fcon	=	Fraction of time spent in contact with soil (unitless); Scenario C only (see Section B.4)
BW_k	=	Body weight of *k*th lifestage (kg)

B.3.2 Absorbed Daily Dose (Averaged Over One Year)

Exposure frequency considers the amount of time that a given lifestage is exposed to a contaminant via a given exposure route while engaged in a given exposure scenario (Table B-2). When dealing with exposure frequency distributions for various individual mutually exclusive exposure scenarios, it is important to ensure that the sum of the parts is not greater than the whole. For example, the sum of the time spent at home, at work, and elsewhere (commuting, shopping, etc.) cannot exceed 24 h/d, 7 d/wk, or 52 wk/y for an exposed individual. A computationally pragmatic method for ensuring this outcome during a probabilistic analysis is through normalization of the individual exposure scenario exposure frequency values (EFka) relative to their sum using Equation B.11.

$$ADD(y)_{ik} = ADD_{ik} \times EF_k^a$$ **Equation B.9**

$$\hat{E}F_k^a = \frac{h_k^a}{24\,h/d} \times \frac{d_k^a}{7\,d/wk} \times \frac{wk_k^a}{52\,wk/y}$$ **Equation B.10**

$$EF_k^a = \frac{\hat{E}F_k^a}{\sum_{a=1}^{m} \hat{E}F_k^a}$$ **Equation B.11**

Where:

$ADD(y)_{ik}$	=	Absorbed daily dose to *k*th lifestage averaged over one year of exposure via *i*th exposure route (mg/kg·d)
ADD_{ik}	=	Absorbed daily dose to *k*th lifestage via *i*th exposure route (mg/kg·d)
EF_k^a	=	Normalized exposure frequency for the *a*th exposure scenario of *k*th lifestage (unitless)
$\hat{E}F_k^a$	=	Exposure frequency for the *a*th exposure scenario of *k*th lifestage (unitless)
h_k^a	=	Hourly exposure frequency for *a*th exposure scenario of *k*th lifestage (h/d)
d_k^a	=	Daily exposure frequency for *a*th exposure scenario of *k*th lifestage (d/wk)
wk_k^a	=	Weekly exposure frequency for *a*th exposure scenario of *k*th lifestage (wk/y)
m	=	Number of *a*th scenarios considered (unitless)

B.3.3 Absorbed Daily Dose (Averaged Over a Lifetime)

The generic receptor is assumed to be an individual resident onsite from birth, who, depending on the exposure duration, could experience different doses during up to three different lifestages. To account for the different doses received by that individual during each lifestage averaged over a year, as well as for the number of lifestages experienced, instantiations of the EDr distribution are sorted, and lifestage doses summed using Equation B.12, which is a conditional logic expression and not an algebraic equation. Because an individual receptor is being modeled, if that receptor also experiences occupational exposures (which have parameters different than those for "at home" exposures), doses received at work must be added to the total dose received by that individual, as shown in Equation B.13.

{start one instantiation of EDr} **Equation B.12**

if EDr ≤ 6
 then $ADD(y)_{it} = ADD(y)_{i1} \times Edr$
  else if EDr > 6 **and** EDr < 18
   then $ADD(y)_{it} = (ADD(y)_{i1} \times 6) + (ADD(y)_{i2} \times (EDr - 6))$
    else if EDr ≥ 18
     then $ADD(y)_{it} = (ADD(y)_{i1} \times 6) + (ADD(y)_{i2} \times 12) + (ADD(y)_{i3} \times (EDr - 18))$
      else $ADD(y)_{it} = 0$
    end
  end
end

{end one instantiation of EDr}

$$LADD_i = \frac{ADD(y)_{it} + \left(ADD(y)_{i3}^{work} \times EDo\right)}{AT}$$ **Equation B.13**

Where:

$LADD_i$	=	Absorbed daily dose for all lifestages averaged over a lifetime of exposure via *i*th exposure route (mg/kg·d)
$ADD(y)_{it}$	=	Absorbed daily dose for all lifestages averaged over one year of exposure via ith exposure route (mg/kg·d) - from Equation B.12
$ADD(y)_{i1}$	=	Absorbed daily dose for the child lifestage averaged over one year of exposure via *i*th exposure route (mg/kg·d)
$ADD(y)_{i2}$	=	Absorbed daily dose for the juvenile lifestage averaged over one year of exposure via *i*th exposure route (mg/kg·d)

$ADD(y)_{i3}$ = Absorbed daily dose for the adult lifestage averaged over one year of exposure via *i*th exposure route (mg/kg·d)

$ADD(y)_{i3}^{work}$ = Absorbed daily dose for occupational exposures averaged over one year of exposure via *i*th exposure route (mg/kg·d)

EDr = Exposure duration, residential occupancy (y)

EDo = Exposure duration, occupational tenure (y)

AT = Averaging time (y)

Equations B.12 and B.13 are used together to estimate exposure. A conditional logic statement (Equation B.12) is required to properly apportion the doses received by a randomly selected individual receptor during their various lifestages as a function of exposure duration. In Equation B.12, if the exposure duration is ≤ 6 years, then $ADD(y)_{it}$ is only the dose received as a child, averaged over a lifetime, i.e., $ADD(y)_{it} = ADD(y)_{i1} \times EDr / AT$. If the exposure duration is > 6 years but < 18 years, then $ADD(y)_{it}$ is the dose received as a child plus the dose received as a juvenile. And if the exposure duration is ≥ 18 years, then $ADD(y)_{it}$ is the dose received as a child and as a juvenile and as an adult (from 18 to 75 years). The dose received only by adults while at work is represented by $ADD(y)_{i3}^{work} \times EDo$.

B.3.4 Risk Calculations

B.3.4.1 Hazard Quotient

Note that the acceptable risk level for noncarcinogens is based on a Hazard Index (HI) ≤ 1 per OAR 340-122-115(4). However, with only one contaminant under consideration, the Hazard Quotient (HQ) is synonymous with the HI, so that HQ = HI.

$$HQ_{ij} = \frac{\sum_{k=1}^{3} ADD(y)_{ik}}{RfD_j}$$

Equation B.14

Where:

HQ_{ij} = Hazard quotient for *j*th contaminant via *i*th exposure route for all lifestages (unitless)

$ADD(y)_{ik}$ = Absorbed daily dose for the *k*th lifestage averaged over one year of exposure via *i*th exposure route (mg/kg·d)

RfD_j = Reference dose for *j*th noncarcinogenic contaminant (mg/kg·d)

For this generic remedy, the doses received by each lifestage were summed to represent a maximum possible exposure for purposes of comparison with the HQ.

B.3.4.2 Incremental Lifetime Cancer Risk

$$ILCR_{ij} = LADD_i \times CSF_j$$ **Equation B.15**

Where:

$ILCR_{ij}$	=	Incremental lifetime cancer risk for *j*th contaminant via *i*th exposure route during a lifetime (unitless)
$LADD_i$	=	Absorbed daily dose averaged over a lifetime of exposure from *i*th exposure route (mg/kg·d)
CSF_j	=	Cancer slope factor for the *j*th carcinogenic contaminant (kg·d/mg)

B.4 Operating Substation Worker Scenario

Due to the location-specific characteristics that uniquely dictate potential exposures at operating electrical substations and the specific potentially exposed populations and their behaviors, the Department considers substations to be a class of sites distinctly different from the standard residential (unrestricted) and industrial scenarios. The substation worker scenario merits attention in a generic remedy because of the large number of substations within the state of Oregon.

This section describes the information used to develop the operating substation worker scenario and calculate the RBC for the resulting exposure conditions. The information is taken from CH2M Hill (1997a). The risk-based concentration developed for this scenario is *only applicable to properties that are reasonably anticipated to remain in use as a substation, and retain the characteristics assumed for the derivation of the RBC.*

B.4.1 Typical Substation Description

The general physical characteristics of operating electrical substations that are covered by this guidance are listed below:

- Vary in size from a few hundred square feet to several acres
- Surrounded by a wall or fence on all sides, generally topped with barbed wire
- Covered with 3 inches of course heavily-compacted rock, extending 2 to 3 feet beyond the fence
- Constructed by leveling a site, installing an electrical grounding grid 18-24 inches below grade, compacting the subgrade fill material to 95%, then covering with rock compacted to 90%
- Equipment typically consists of transformers, regulators, circuit breakers, and a capacitor bank
- The electrical equipment is usually mounted on concrete pads or piers

B.4.2 Potentially Exposed Populations

Populations potentially exposed to PCBs in soils at substations include workers that frequent substations on a relatively regular basis. Two general worker populations are of concern:

- Workers who are regularly involved with subsurface soil activities, but at multiple substations (i.e., construction workers), and
- Workers who frequent the same substation, but do not participate in subsurface activities (i.e., office workers).

These populations are described below.

B.4.2.1 Construction Workers

As used in the operating substation scenario, the term “construction workers” includes the following types of electrical substation workers:

- Riggers;
- Splicers;
- Equipment operators;
- Electricians; and
- Laborers.

These workers collectively constitute the most likely population to contact subgrade soils within a substation and are considered the limiting population type for derivation of the cleanup goal. Potential routes of exposure include incidental ingestion, dermal contact, and inhalation of dusts and vapors. These workers do not work exclusively at a single substation, but at multiple substations over a wide geographic area. As a consequence, potential PCB exposures from multiple substations need to be accounted for in the generic cleanup goal for this population. It is therefore important to know what factors influence the frequency, duration, and magnitude of exposure to construction workers, as described in Section B.4.3.

B.4.2.2 Office Workers

Substation office workers are a potential population of concern because of the frequency with which they may work at a single substation. However, due to the compacted gravel pad covering the substation, these workers are not exposed via direct contact with soil, but may be exposed by inhalation of PCB vapors originating from site soils. For the purposes of the generic remedy for substations, inhalation exposures to substation office workers are assumed the same as described above for typical occupational workers. Due to the relatively low exposure rate for this route, it is not expected that substation office workers are the critical population of concern. Rather, construction workers are of greater concern due to their direct involvement with subsurface soil activities.

B.4.3 Factors Influencing Construction Worker Exposure

Characterization of the potential for exposure by construction crew workers must include all factors that significantly influence and contribute to the total amount of PCB exposure from substation soils. The primary factors considered for this scenario are:

- Total number of construction workdays per year (EF_c)
- Fraction of constructions conducted at substations ($Const_{sub}$)
- Fraction of substation construction time spent potentially in contact with soil ($Frac_{dig}$)
- Fraction of substations potentially contaminated ($Subs_{cont}$)
- Fraction of typical substation surface area potentially contaminated ($Frac_{area}$)

The generic equation for calculating a risk-based concentration for a construction worker is:

$$RBC = (TCR \times BW \times AT \times 365\ d/yr)/(CSF \times EF_c \times Fcon \times ED \times IR) \qquad \textbf{Equation B.17}$$

where:

C	=	Risk-based concentration (mg/kg)
TCR	=	Target excess cancer risk (1×10^{-6})
BW	=	Body weight (70 kg)
AT	=	Time over which exposure is averaged, in days
CSF	=	Cancer slope factor ($(mg/kg\text{-}day)^{-1}$)
EFc	=	Exposure frequency (construction workdays/year)
Fcon	=	Fraction of time spent in contact with soil (unitless, see below)
ED	=	Exposure duration (years)
IR	=	Daily medium contact rate (e.g., kg soil/day)

The fraction of time spent in contact with soil is defined as:

$$Fcon = Const_{sub} \times Frac_{dig} \times Subs_{cont} \times Frac_{area} \qquad \textbf{Equation B.18}$$

where:

$Const_{sub}$	=	Fraction of constructions conducted at substations
$Frac_{dig}$	=	Fraction of substation construction time spent potentially in contact with soil
$Subs_{cont}$	=	Fraction of substations potentially contaminated
$Frac_{area}$	=	Fraction of typical substation surface area potentially contaminated

The total number of construction workdays per year is not expected to be different from the number of workdays assumed for a typical worker under the industrial scenario. To be conservative it was assumed that the fraction of constructions conducted at substations, the fraction of total substations potentially contaminated, and the fraction of typical substation surface area potentially contaminated all equaled unity.

The fraction of total substation construction time spent potentially in contact with soil ($Frac_{dig}$) has been quantified by evaluating construction records provided by Bonneville Power Administration (BPA, 1997). These data are expected to be representative of substations from any utility company in Oregon. The records were evaluated to identify the distribution surrounding the mean time spent potentially in contact with soil by a substation construction worker, as described below.

B.4.3.1 Fraction of Substation Construction Time Spent in Contact with Soil

The fraction of substation construction time spent on activities involving potential contact with soils beneath the substation (Fcon) was estimated using data obtained from BPA's 1994 and 1995 construction work order estimates. All construction work orders on record during this period were queried. This included work at substations, on transmission lines, at radio towers, in shops/maintenance headquarters and at compensation stations. PCB-contaminated soil was assumed to potentially occur only at substations and compensation stations. Projects taking place in these areas were sorted out and their labor estimates reviewed for activities involving excavation or subsurface work (BPA, 1997).

The following assumptions were used to select labor estimates and derive the exposure scenario:

- Underground storage tank (UST) removal may or may not involve soil PCB exposure. If tanks were located within substations, exposure may occur; if not, exposure would be highly unlikely. Tank location was not noted in work orders. However, very few of BPA's underground tanks are actually located inside substations. BPA uses USTs for different purposes; tanks used to power emergency generators are at times located within substations, while tanks used for vehicle fueling are always placed away from the energized substation. Because of this uncertainty, all tank removals were included as a health-conservative assumption.
- No spill containment or cap yard replacement projects were recorded as being completed in 1995. However; several records were closed in early 1996. None of these were included in the exposure assessment because they fell outside of the selection criteria. Most of the construction associated with these projects was actually completed in 1995, but closure was held up by late delivery of valves necessary to finish the projects and energize the yards.
- Foundation demolition, but not foundation construction was included in the exposure estimate. Foundation construction was not included because soils are tested for PCBs prior to construction and no exposure for these events is assumed.
- All excavation time was included. This is conservative because most of the time spent on excavation involves backhoe operation, and soil exposure is not likely during backhoe operation.

- All ground mat work is included. This is conservative because most ground mat installation projects at existing substations occur after PCB soil testing, (similar to foundation construction). However, PCB testing may not be conducted on small ground mat repair/modification jobs. These situations prompted inclusion of all ground mat work.
- In a small number of cases, labor was not included where it could not be broken out (that is, where ‘material and labor’ were combined in the estimate). This was an infrequent occurrence and usually was associated with small dollar amounts, indicating short labor times. Thus ignoring these occurrences is not expected to significantly affect the final estimate.
- All manhole and tunnel work was included (under miscellaneous).
- New substation construction was not included, since it is unlikely that PCBs would be present on undeveloped property.
- PCB remediation was not included since special training and protective clothing worn during remediation prevents exposure.
- No exposure to PCBs is assumed to occur during resurfacing. Resurfacing in substations involves compaction of existing rock and the subsequent application of new rock.

Since the BPA dataset (BPA, 1996) included 77 data points collected over a 2-year period, the data were considered to be representative of long-term averages. The results of the database search were statistically evaluated to determine whether the percent time potentially exposed to soil was normally or lognormally distributed. The Anderson-Darling, chi-square, and Kolmogorov-Smirnov tests all indicated that the hypothesis of normality was rejected, and the hypothesis of lognormality could not be rejected.

The results of the statistical analysis are summarized in Table B-3. The percentiles for the distribution are provided in Table B-4. The lognormal distribution for the fraction of total substation construction time spent potentially in contact with soil is shown in Figure B-1. These results provide the basis for incorporation of this exposure parameter (Fcon) into the probabilistic analysis used to derive the risk-based concentration for the operating electrical substation scenario.

B.5 Risk-Based Concentration Estimation

In deterministic assessments, the risk-based concentration is determined by setting the total risk for carcinogenic or noncarcinogenic effects at an acceptable risk level of ILCR = 1×10^{-6} or HI = 1, respectively, then solving a simple algebraic expression for the concentration term. This method is not applicable to this probabilistic assessment because of: (a) the presence of conditional logic statements in the computations, (b) acceptable risk levels defined (per OAR 340-122-115(2) and -115(4)) in terms of distributions rather than as single points, and (c) the likelihood of generating distributions with undefined moments. Thus determination of a soil concentration (Cs) value that resulted in $ILCR_{ij}$ values within acceptable risk limits was accomplished by iteration of each model.

B.5.1 Incidental Ingestion of Soil

Parameters and calculations related to determination of the HI_I and $ILCR_I$ for PCBs (as Aroclor-1254) are listed in Table B-5. With the exception for certain contaminant-dependent distributions discussed below, the selection rationale and references for all exposure factor distributions shown in Table B-5 are provided in DEQ (1997).

The fraction of soil contaminated parameter ($0 \leq Fs \leq 1$) is a site-specific estimate of how much of the soil within a site (exposure unit) is potentially contaminated. For this generic risk assessment, it was assumed that soil containing PCBs covers the entire site, so that Fs = 1.

The distribution for the relative gastrointestinal absorption factor (RAF_g) is the range of values (0.9 - 0.99) reported by Owen (1990); a uniform distribution was assumed.

The fraction of total substation construction time spent potentially in contact with soil (Fcon) is an industry specific value that was quantified and distributed by evaluating construction records provided by the Bonneville Power Administration (see Section B.4). These data are expected to be representative of substations operated by any utility company in Oregon.

The averaging time (AT) is the period over which exposure is averaged and is dependent upon the type of toxic effect being assessed (EPA 1989). For carcinogens, intakes are calculated by prorating the total cumulative dose over a lifetime. The default value for the duration of a lifetime is 75 years; therefore, the averaging time is 75 years (EPA 1996b). For chronic exposure to noncarcinogens, intakes are calculated by averaging intakes over one year.

The cancer slope factor (CSF) for PCBs has been recently revised (EPA 1996c; IRIS 1996). For applications involving food chain exposure, soil ingestion, dust or aerosol inhalation, or dermal exposure (with absorption factors applied), the new upper-bound slope factor is 2.0 $(mg/g\cdot d)^{-1}$ and the central-estimate slope factor is 1.0 $(mg/g\cdot d)^{-1}$. The reference dose (RfD) for PCBs (as Aroclor-1254) is 2×10^{-5} mg/kg-d (EPA 1996d).

B.5.2 Ingestion of Homegrown Vegetables

Parameters and calculations related to determination of the HI_Z and $ILCR_Z$ for PCBs (as Aroclor-1254) are listed in Table B-6. With the exception for certain contaminant-dependent distributions discussed below, the selection rationale and references for all exposure factor distributions shown in Table B-6 are provided in DEQ (1997).

The Cr term accounts for the potential for contaminants to reach vegetables through any or all of the following routes: (a) from soil to roots, (b) from soil to aboveground plant parts via root uptake (translocation), (c) from air as particulate deposition onto foliar surfaces, and (d) from air as vapors to aboveground plant parts.

The value for the particulate emission factor is the default value recommended by EPA (EPA 1996d). The log K_{ow} for Aroclor-1260 ranges between 6.3 and 7.5 (McKay *et al*. 1992; pg 600, Table 4-4); a uniform distribution was assumed. The Henry's Law constant (H) for Aroclor-1260 ranges between 20 and 60 Pa m^3/mol (McKay *et al*. 1992; pg 600, Table 4-4). The value for the PCB organic carbon partition coefficient (Koc) is from EPA (1996a), while the organic carbon content of soil is a default value recommended by EPA (1996d).

The volatilization factor for soils (VFs) relates soil contaminant concentrations to air contaminant concentrations that may be inhaled on-site. Using the soil vaporization model described in EPA (1996a), a value of 2.03×10^9 m^3/kg was estimated as the VFs for Aroclor-1254. The derivation of the VFs term and associated equations can be found in EPA (1996a), Equation 8, page 26.

Briggs *et al*. (1982) have developed a regression equation based on the octanol-water partition coefficient (K_{ow}) for translocation of contaminants from roots to shoots. This represents the ratio of contaminant concentration in the plant tissue to contaminant concentration in soil solution. They noted that there appears to be an optimum lipophilicity for maximum translocation of contaminants to roots ($K_{ps(roots)}$) and stems (K_{ps}) in the range of $\log_{10}(K_{ow})$ -0.5 to 3.5. This represents the difficulty more highly lipophilic compounds ($\log K_{ow} > 6$) have in crossing root membranes and being translocated in plant tissues. Values for f_{pa}, f_{pw}, and f_{pl} are given in McKone (1993). The derivation of K_{ap}^{pt}, and K_{ap}^{gs} are further described in McKone (1993); those for K_{ps}, $K_{ps(roots)}$ are in Briggs *et al.* (1982).

The values for IRV_k are indexed to the actual body weights of survey respondents and are expressed in units of grams of food consumed per kg body weight per day. Consequently, use of these data in estimating potential dose does not require the body weight factor in the denominator of the ADD calculation (EPA 1996b).

Whether or not a person grows or produces food at home was based on the Nationwide Food Consumption Survey (USDA 1988) estimate that 6% of households consume home grown vegetables.

The fraction of homegrown vegetables from site parameter ($0 \leq Fv \leq 1$) is a site-specific estimate of that fraction of the total homegrown vegetable intake which originates within the contaminated site (exposure unit). For this generic risk assessment, it was assumed that all homegrown vegetables are grown onsite in contaminated soils, so that Fv = 1.

B.5.3 Dermal Contact with Soil

EPA (1996a) indicates that absorption via the dermal route must be >10% to equal or exceed the ingestion exposure. Data presented in EPA (1992b) suggest that the percent of PCB (as 3,3',4,4'-tetrachlorobiphenyl) absorbed from soil ranges from 0.6% to 6.0%. This would suggest that dermal absorption could be overshadowed by ingestion exposures. However, at 6% absorption, the dermal exposure route could approach ≈60% of the oral dose (EPA 1992b). Because of this uncertainty, the dermal contact exposure route was evaluated.

Parameters and calculations related to determination of the HI_S and $ILCR_S$ for PCBs (as Aroclor-1254) are listed in Table B-7. With the exception for certain contaminant-dependent distributions discussed below, the selection rationale and references for all exposure factor distributions shown in Table B-7 are provided in DEQ (1997). A uniform distribution from 0.6% to 6.0% was assumed based on the EPA (1992b) data.

B.5.4 Inhalation of Soil Vapors (Outdoors)

EPA (1996d) has defined a volatile contaminant as one with a Henry's Law constant (H) of $>10^{-5}$ atm-m^3/mol and a molecular weight of <200 g/mol. Under these criteria, PCBs, particularly the higher Aroclor mixtures, do not qualify as volatiles. However, others (Rice & O'Keefe 1995) have suggested that volatilization can be a significant environmental transport process for PCBs; i.e., because of H values of 2.9×10^{-4} for Aroclor 1016 to 4.6×10^{-3} for Aroclor 1260. Because of this uncertainty, the inhalation of volatiles exposure route was evaluated. The parameters and equations used for this evaluation are listed in Table B-8.

The relative inhalation absorption factor (RAF_h) parameter, as used here, is a numerical descriptor characterizing that fractional uptake by the blood from the lungs and represents an approximation of the biological dose ultimately responsible for toxicity. This is a contaminant-specific parameter, values for which may, in some cases, be obtained from the literature (Owen 1990). In the absence of contaminant-specific information, the default value for RAF_h is 1.

The cancer slope factor (CSF) for PCBs has been recently revised (EPA 1996c; IRIS 1996). For applications involving ingestion of water-soluble congeners, inhalation of evaporated congeners, or dermal exposure (no absorption factors applied), the new upper-bound slope factor is of 0.4 $(mg/g\cdot d)^{-1}$ and the central-estimate slope factor is 0.3 $(mg/g\cdot d)^{-1}$.

B.5.5 Conclusions

Each individual receptor can be exposed to PCBs in soils at home, at work, at both locations, or elsewhere. The total exposure received by that individual from all locations cannot result in an exceedence of the acceptable risk levels. This analysis focused on exposures received from two locations in two ways: (1) Scenario A ("at home") + Scenario B ("at work") and (2) Scenario A ("at home") + Scenario C ("at work at an operating substation"). Key assumptions are that these represent the total sources of exposure to PCBs in soils and that no exposures are occurring via a scenario excluded from the exposure model.

Because PCBs are known to induce both carcinogenic and noncarcinogenic effects, the exposure modeling considered both of these processes. For an individual exposed to PCBs as carcinogens, recommended concentrations in soils via a combination of Scenario A + Scenario B are 1.2 mg/kg for Scenario A and 7.5 mg/kg for Scenario B. For an individual exposed to PCBs as carcinogens under the more restrictive circumstances engendered by a combination of Scenario A + Scenario C, recommended concentrations in soils are 1.2 mg/kg for Scenario A and 25 mg/kg for Scenario C. Percentiles and distributions of ILCR values resulting from these calculations, for combinations A+B and A+C, are shown in Tables B-9 and B-10 and Figures B-2 and B-3, respectively.

For an individual exposed to PCBs as noncarcinogens, recommended concentrations in soils via a combination of Scenario A + Scenario B are 2.2 mg/kg for Scenario A and 10 mg/kg for Scenario B. For an individual exposed to PCBs as noncarcinogens under the more restrictive circumstances engendered by a combination of Scenario A + Scenario C, recommended concentrations in soils are 2.2 mg/kg for Scenario A and 25 mg/kg for Scenario C. Percentiles and distributions of HQ values resulting from these calculations, for combinations A+B and A+C, are shown in Tables B-11 and B-12 and Figures B-4 and B-5, respectively.

Per OAR 340-122-115(31)(b)(A)(i - ii), hot spots of contamination are defined as risk-based concentrations corresponding to 100 times the acceptable risk level for human exposure to each individual carcinogen or 10 times the acceptable risk level for human exposure to each individual noncarcinogen. Hot spots would therefore be defined by the noncarcinogenic RBC values as these are the lower of the two values. Recommended hot spot concentrations in soils via a combination of Scenario A + Scenario B are 22 mg/kg for Scenario A and 100 mg/kg for Scenario B. For the more restrictive circumstances engendered by a combination of Scenario A + Scenario C, recommended concentrations in soils are 22 mg/kg for Scenario A and 250 mg/kg for Scenario C.

Table B-2: Exposure Frequencies for Various Activities

Activity	Exposure Frequency Elements			Raw Exposure Frequency	Normalized Exposure Frequency
	h_k	d_k	wk_k	$\hat{EF}_k$[a]	EF_k[a]
Child at residence, indoors	triangular(8, 16, 18)	7	50	Equation B.10	Equation B.11
Child at residence, outdoors	triangular(2, 4, 6)	7	50	Equation B.10	Equation B.11
Child away from residence at work	0	0	0	Equation B.10	Equation B.11
Child away from residence on vacation	24	7	2	Equation B.10	Equation B.11
Child away from residence (other) ‡	triangular(0, 4, 14	7	50	Equation B.10	Equation B.11
Adult / Juvenile at residence, indoors	triangular(7, 13, 20)	7	50	Equation B.10	Equation B.11
Adult / Juvenile at residence, outdoors	triangular(1, 2, 4)	7	50	Equation B.10	Equation B.11
Adult / Juvenile away from residence at work	triangular(0, 9, 16)	5	50	Equation B.10	Equation B.11
Adult / Juvenile away from residence on vacation	24	7	2	Equation B.10	Equation B.11
Adult / Juvenile away from residence (other)	triangular(0, 2.6, 4.5)	7	50	Equation B.10	Equation B.11

Table B-3: Fraction of Substation Construction Time Spent Digging[a]

Number of Observations	77
Mean	0.149
Mode	0.021
Median	0.078
Standard Deviation	0.244

a. Values listed are for logtransformed data.

Table B-4: Distribution for Fraction of Time Spent on Subsurface Activities
(Tlognorm(0.1492,0.2443,0,1))

Percentile	Fraction of Time Spent
5	0.01180154
10	0.0178468
15	0.02358222
20	0.02943102
25	0.03557764
30	0.04219035
35	0.0493814
40	0.05734282
45	0.06624756
50	0.07636108
55	0.08793668
60	0.1015036
65	0.117689
70	0.137408
75	0.1623278
80	0.1950828
85	0.240993
90	0.3127757
95	0.4498521

Table B-5: Incidental Ingestion of Soil

Parameter	Symbol	Scenario A			Scenario B	Scenario C
		Child (k = 1)	**Juvenile (k = 2)**	**Adult (k = 3)**	**Adult (k = 3)**	**Adult (k = 3)**
Contaminant concentration in soil (mg/kg)	Cs	*X*	*X*	*X*	*Y*	*Z*
Incidental soil ingestion rate (mg/d)	IRS_k	Lognormal(3.98, 1.03)	Lognormal(3.28, 1.03)	Lognormal(3.28, 1.03)	Lognormal(3.28, 1.03)	Lognormal(3.28, 1.03)
Conversion factor (10^{-6} kg/mg)	CFkm	1×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}
Fraction of soil contaminated (unitless)	Fs	1	1	1	1	1
Relative gastrointestinal absorption factor (unitless)	RAF_g	Uniform(0.9, 0.99)	Uniform(0.9, 0.99)	Uniform(0.9, 0.99)	Uniform(0.9, 0.99)	Uniform(0.9, 0.99)
Body weight (kg)	BW_k	Lognormal(2.75, 0.13)	Lognormal(3.76, 0.23)	Lognormal(4.34, 0.17)	Lognormal(4.34, 0.17)	Lognormal(4.34, 0.17)
Absorbed daily dose (mg/kg·d)	ADD_{Ik}	Equation B.1	Equation B.1	Equation B.1	Equation B.1	Equation B.1
Normalized exposure frequency (unitless)	EF_k[a]	$EF_1^{indoors} + EF_1^{outdoors}$ from Table B-3	$EF_2^{indoors} + EF_2^{outdoors}$ from Table B-3	$EF_3^{indoors} + EF_3^{outdoors}$ from Table B-3	EF_3^{work} from Table B-3	EF_3^{work} from Table B-3
Absorbed daily dose averaged over one year of exposure (mg/kg·d)	$ADD(y)_{Ik}$	Equation B.9	Equation B.9	Equation B.9	Equation B.9	Equation B.9
Fraction of time spent in contact with soil (unitless) - industry specific	Fcon					Lognormal(-2.65, 1.17)
Exposure duration (y)	EDr EDo	Exponential(0.23)			Exponential(0.33)	Exponential(0.33)
Absorbed daily dose for all lifestages averaged over one year of exposure (mg/kg·d)	$ADD(y)_{It}$	Equation B.12			Equation B.12	Equation B.12
Averaging time (y)	AT	75				
Absorbed daily dose for all lifestages averaged over a lifetime of exposure (mg/kg·d)	$LADD_I$	Equation B.12				

Parameter	Symbol	Scenario A			Scenario B	Scenario C
		Child (*k* = 1)	Juvenile (*k* = 2)	Adult (*k* = 3)	Adult (*k* = 3)	Adult (*k* = 3)
Cancer slope factor (oral) (kg·d/mg)	CSF	2				
Incremental lifetime cancer risk during a lifetime (unitless)	$ILCR_I$	Equation B.15				
Reference Dose (mg/kg·d)	RfD	2×10^{-5}				
Hazard Quotient	HQ_I	Equation B.14				

Table B-6: Consumption of Homegrown Vegetables

Parameter	Symbol	Scenario A			Scenario B	Scenario C
		Child (k = 1)	**Juvenile (k = 2)**	**Adult (k = 3)**	**Adult (k = 3)**	**Adult (k = 3)**
Contaminant concentration in soil (mg/kg)	Cs	*X*	*X*	*X*	---	---
Contaminant concentration in plant tissue (mg/kg)	Cr	Equation B.3	Equation B.3	Equation B.3	---	---
Particulate emission factor (m^3/kg)	PEF	1.32×10^9	1.32×10^9	1.32×10^9	---	---
Plant-air partition coefficient for particle-bound contaminant (m^3/kg)	K_{ap}^{pt}	3300	3300	3300	---	---
Volatilization factor for soil (m^3/kg)	VFs	2.03×10^9	2.03×10^9	2.03×10^9	---	---
Plant-air partition coefficient for gas-phase contaminant (m^3/kg)	K_{ap}^{gs}	Equation B.5	Equation B.5	Equation B.5	---	---
Plant-soil partition coefficient from root-zone soil to above-ground plant parts (unitless)	K_{ps}	Equation B.6	Equation B.6	Equation B.6	---	---
Plant-soil partition coefficient from root-zone soil to roots (unitless)	$K_{ps(roots)}$	Equation B.4	Equation B.4	Equation B.4	---	---
n-Octanol-water partition coefficient (unitless)	K_{ow}	Uniform(6.3, 7.5)	Uniform(6.3, 7.5)	Uniform(6.3, 7.5)	---	---
Organic carbon partition coefficient (unitless)	K_{oc}	3.09×10^5	3.09×10^5	3.09×10^5	---	---
Fraction of organic carbon in soil (unitless)	f_{oc}	0.006	0.006	0.006	---	---
Volume fraction of plant tissue in air (unitless)	f_{pa}	0.5	0.5	0.5	---	---
Volume fraction of plant tissue in water (unitless)	f_{pw}	0.4	0.4	0.4	---	---
Volume fraction of plant tissue lipid (unitless)	f_{pl}	0.01	0.01	0.01	---	---

Parameter	Symbol	Scenario A			Scenario B	Scenario C
		Child (k = 1)	**Juvenile (k = 2)**	**Adult (k = 3)**	**Adult (k = 3)**	**Adult (k = 3)**
Universal gas constant ($Pa \cdot m^3/mol \cdot K$)	R	8.31	8.31	8.31	---	---
Temperature (K)	T	290	290	290	---	---
Henry's law constant ($Pa \cdot m^3/mol$)	H	Uniform(20,60)	Uniform(20,60)	Uniform(20,60)	---	---
Homegrown vegetable ingestion rate (g/[kg·d])	IRV_k	Lognormal(-0.40, 1.71)	Lognormal(-0.81, 1.65)	Lognormal(-0.26, 1.49)	---	---
Engage in home production of vegetables	HP	Equation B.16	Equation B.16	Equation B.16	---	---
Fraction of homegrown vegetables from contaminated soil (unitless)	Fv	1	1	1	---	---
Relative gastrointestinal absorption factor (unitless)	RAF_g	Uniform(0.9, 0.99)	Uniform(0.9, 0.99)	Uniform(0.9, 0.99)	---	---
Absorbed daily dose (mg/kg·d)	ADD_{Zk}	Equation B.2	Equation B.2	Equation B.2	---	---
Normalized exposure frequency (unitless)	EF_k[a]	$EF_1^{indoors} + EF_1^{outdoors}$ from Table B-3	$EF_2^{indoors} + EF_2^{outdoors}$ from Table B-3	$EF_3^{indoors} + EF_3^{outdoors}$ from Table B-3	---	---
Absorbed daily dose averaged over one year of exposure (mg/kg·d)	$ADD(y)_{Zk}$	Equation B.9	Equation B.9	Equation B.9	---	---
Fraction of time spent in contact with soil (unitless) - industry specific	Fcon					---
Exposure duration (y)	EDr	Exponential(0.23)			---	---
Absorbed daily dose for all lifestages averaged over one year of exposure (mg/kg·d)	$ADD(y)_{Zt}$	Equation B.12			---	---
Averaging time (y)	AT	75				
Absorbed daily dose for all lifestages averaged over a lifetime of exposure (mg/kg·d)	$LADD_Z$	Equation B.12				
Cancer slope factor (oral) (kg·d/mg)	CSF	2				

Parameter	Symbol	Scenario A			Scenario B	Scenario C
		Child (k = 1)	**Juvenile (k = 2)**	**Adult (k = 3)**	**Adult (k = 3)**	**Adult (k = 3)**
Incremental lifetime cancer risk during a lifetime (unitless)	$ILCR_Z$	Equation B.15				
Reference Dose (mg/kg·d)	RfD	2×10^{-5}				
Hazard Quotient	HQ_Z	Equation B.14				

Table B-7: Dermal Contact With Soil

Parameter	Symbol	Scenario A			Scenario B	Scenario C
		Child (k = 1)	**Juvenile (k = 2)**	**Adult (k = 3)**	**Adult (k = 3)**	**Adult (k = 3)**
Contaminant concentration in soil (mg/kg)	Cs	*X*	*X*	*X*	*Y*	*Z*
Total skin surface area of *k*th lifestage (m^2)	SA_k	$0.102 \times BW_k^{0.682}$	$0.102 \times BW_k^{0.682}$	$0.102 \times BW_k^{0.682}$	$0.102 \times BW_k^{0.682}$	$0.102 \times BW_k^{0.682}$
Soil-to-skin adherence rate ($mg/cm^2 \cdot d$)	AR	Lognormal(-3.98, 1.79)	Lognormal(-3.98, 1.79)	Lognormal(-3.98, 1.79)	Lognormal(-3.98, 1.79)	Lognormal(-3.98, 1.79)
Fraction of total skin area exposed (unitless)	Fb	Triangular(0.05, 0.1, 0.25)	Triangular(0.05, 0.1, 0.25)	Triangular(0.05, 0.1, 0.25)	Triangular(0.05, 0.1, 0.25)	Triangular(0.05, 0.1, 0.25)
Conversion factor (10^{-6} kg/mg)	CFkm	1×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}	1×10^{-6}
Conversion factor (10^4 cm^2/m^2)	CFcm	1×10^4	1×10^4	1×10^4	1×10^4	1×10^4
Fraction of soil contaminated (unitless)	Fs	1	1	1	1	1
Dermal absorption factor (unitless)	DAF	Uniform(0.006, 0.06)	Uniform(0.006, 0.06)	Uniform(0.006, 0.06)	Uniform(0.006, 0.06)	Uniform(0.006, 0.06)
Body weight (kg)	BW_k	Lognormal(2.75, 0.13)	Lognormal(3.76, 0.23)	Lognormal(4.34, 0.17)	Lognormal(4.34, 0.17)	Lognormal(4.34, 0.17)
Absorbed daily dose ($mg/kg \cdot d$)	ADD_{Sk}	Equation B.1	Equation B.1	Equation B.1	Equation B.1	Equation B.1
Normalized exposure frequency (unitless)	EF_k[a]	$EF_1^{indoors} + EF_1^{outdoors}$ from Table B-3	$EF_2^{indoors} + EF_2^{outdoors}$ from Table B-3	$EF_3^{indoors} + EF_3^{outdoors}$ from Table B-3	EF_3^{work} from Table B-3	EF_3^{work} from Table B-3
Absorbed daily dose averaged over one year of exposure ($mg/kg \cdot d$)	$ADD(y)_{Sk}$	Equation B.9	Equation B.9	Equation B.9	Equation B.9	Equation B.9
Fraction of time spent in contact with soil (unitless) - industry specific	Fcon					Lognormal(-2.65, 1.17)
Exposure duration (y)	EDr EDo	Exponential(0.23)			Exponential(0.33)	Exponential(0.33)
Absorbed daily dose for all lifestages	$ADD(y)_{St}$	Equation B.12			Equation B.12	Equation B.12

Parameter	Symbol	Scenario A			Scenario B	Scenario C
		Child (k = 1)	Juvenile (k = 2)	Adult (k = 3)	Adult (k = 3)	Adult (k = 3)
averaged over one year of exposure (mg/kg·d)						
Averaging time (y)	AT	75				
Absorbed daily dose for all lifestages averaged over a lifetime of exposure (mg/kg·d)	$LADD_S$	Equation B.12				
Cancer slope factor (oral) (kg·d/mg)	CSF	2				
Incremental lifetime cancer risk during a lifetime (unitless)	$ILCR_S$	Equation B.15				
Reference Dose (mg/kg·d)	RfD	2×10^{-5}				
Hazard Quotient	HQ_S	Equation B.14				

Table B-8: Inhalation of Soil Vapors (Outdoors)

Parameter	Symbol	Scenario A			Scenario B	Scenario C
		Child (k = 1)	Juvenile (k = 2)	Adult (k = 3)	Adult (k = 3)	Adult (k = 3)
Contaminant concentration in soil (mg/kg)	Cs	*X*	*X*	*X*	*Y*	*Z*
Volatilization factor for soil (m^3/kg)	VFs	2.03×10^9	2.03×10^9	2.03×10^9	---	---
Inhalation rate of *k*th lifestage (m^3/day)	IRA_k	$0.5458 \times BW_k^{0.8}$	$0.5458 \times BW_k^{0.8}$	$0.5458 \times BW_k^{0.8}$	$0.5458 \times BW_k^{0.8}$	$0.5458 \times BW_k^{0.8}$
Fraction of soil contaminated (unitless)	Fs	1	1	1	1	1
Relative inhalation absorption factor (unitless)	RAF_h	1	1	1	1	1
Body weight (kg)	BW_k	Lognormal(2.75, 0.13)	Lognormal(3.76, 0.23)	Lognormal(4.34, 0.17)	Lognormal(4.34, 0.17)	Lognormal(4.34, 0.17)
Absorbed daily dose (mg/kg·d)	ADD_{Vk}	Equation B.8	Equation B.8	Equation B.8	Equation B.8	Equation B.8
Normalized exposure frequency (unitless)	EF_k[a]	$EF_1^{outdoors}$ from Table B-3	$EF_2^{outdoors}$ from Table B-3	$EF_3^{outdoors}$ from Table B-3	EF_3^{work} from Table B-3	EF_3^{work} from Table B-3
Absorbed daily dose averaged over one year of exposure (mg/kg·d)	$ADD(y)_{Vk}$	Equation B.9	Equation B.9	Equation B.9	Equation B.9	Equation B.9
Fraction of time spent in contact with soil (unitless) - industry specific	Fcon					Lognormal(-2.65, 1.17)
Exposure duration (y)	Edr Edo	Exponential(0.23)			Exponential(0.33)	Exponential(0.33)
Absorbed daily dose for all lifestages averaged over one year of exposure (mg/kg·d)	$ADD(y)_{Vt}$	Equation B.12			Equation B.12	Equation B.12
Averaging time (y)	AT	75				
Absorbed daily dose for all lifestages averaged over a lifetime of exposure (mg/kg·d)	$LADD_V$	Equation B.12				

Parameter	Symbol	Scenario A			Scenario B	Scenario C
		Child (*k* = 1)	Juvenile (*k* = 2)	Adult (*k* = 3)	Adult (*k* = 3)	Adult (*k* = 3)
Cancer slope factor (oral) (kg·d/mg)	CSF	2				
Incremental lifetime cancer risk during a lifetime (unitless)	$ILCR_V$	Equation B.15				
Reference Dose (mg/kg·d)	RfD	2×10^{-5}				
Hazard Quotient	HQ_V	Equation B.14				

Table B-9:

Percentiles of Incremental Lifetime Cancer Risk
Simulated Distributions
(Combination of Scenario A @ 1.2 mg/kg + Scenario B @ 7.5 mg/kg)

Percentiles	**$ILCR_I$ (ingestion)**	**$ILCR_Z$ (vegetables)**	**$ILCR_S$ (dermal contact)**	**$ILCR_V$ (soil vapor)**
minimum	1.8E-10	0.0E+00	8.7E-12	1.6E-14
0.05	2.9E-08	1.4E-18	4.8E-10	5.9E-13
0.10	4.9E-08	4.2E-18	9.1E-10	9.1E-13
0.15	6.9E-08	8.5E-18	1.4E-09	1.2E-12
0.20	8.9E-08	1.4E-17	2.0E-09	1.5E-12
0.25	1.1E-07	2.1E-17	2.6E-09	1.8E-12
0.30	1.4E-07	3.1E-17	3.4E-09	2.1E-12
0.35	1.6E-07	4.2E-17	4.2E-09	2.4E-12
0.40	1.9E-07	5.8E-17	5.2E-09	2.7E-12
0.45	2.2E-07	7.9E-17	6.4E-09	3.1E-12
0.50	2.6E-07	1.0E-16	7.9E-09	3.6E-12
0.55	3.1E-07	1.4E-16	9.6E-09	4.1E-12
0.60	3.5E-07	1.9E-16	1.2E-08	4.7E-12
0.65	4.1E-07	2.6E-16	1.5E-08	5.3E-12
0.70	4.8E-07	3.5E-16	1.8E-08	6.1E-12
0.75	5.6E-07	4.9E-16	2.3E-08	6.9E-12
0.80	6.7E-07	7.3E-16	3.0E-08	7.9E-12
0.85	8.1E-07	1.2E-15	3.9E-08	9.4E-12
0.90	**1.0E-06**	**2.7E-15**	**5.5E-08**	**1.1E-11**
0.95	**1.5E-06**	**2.6E-07**	**9.4E-08**	**1.6E-11**
maximum	4.7E-06	1.3E-04	9.9E-07	5.2E-11

Table B-10:

Percentiles of Incremental Lifetime Cancer Risk
Simulated Distributions
(Combination of Scenario A @ 1.2 mg/kg + Scenario C @ 25 mg/kg)

Percentiles	**$ILCR_I$ (ingestion)**	**$ILCR_S$ (dermal contact)**	**$ILCR_V$ (soil vapor)**
minimum	3.6E-12	6.4E-13	4.8E-15
0.05	1.6E-08	2.2E-10	2.2E-13
0.10	3.0E-08	4.4E-10	3.5E-13
0.15	4.7E-08	6.8E-10	4.7E-13
0.20	6.6E-08	9.9E-10	5.8E-13
0.25	8.5E-08	1.3E-09	7.0E-13
0.30	1.1E-07	1.8E-09	8.1E-13
0.35	1.3E-07	2.3E-09	9.4E-13
0.40	1.6E-07	2.9E-09	1.1E-12
0.45	1.8E-07	3.6E-09	1.2E-12
0.50	2.2E-07	4.5E-09	1.4E-12
0.55	2.6E-07	5.6E-09	1.5E-12
0.60	3.0E-07	7.0E-09	1.7E-12
0.65	3.6E-07	8.8E-09	1.9E-12
0.70	4.2E-07	1.1E-08	2.2E-12
0.75	5.0E-07	1.4E-08	2.6E-12
0.80	6.0E-07	1.9E-08	3.1E-12
0.85	7.6E-07	2.6E-08	4.0E-12
0.90	**9.9E-07**	**3.7E-08**	**5.5E-12**
0.95	**1.4E-06**	**6.5E-08**	**8.6E-12**
maximum	4.7E-06	1.3E-06	9.3E-11

Table B-11:

Percentiles of Hazard Quotient
Simulated Distributions
(Combination of Scenario A @ 2.2 mg/kg + Scenario B @ 10 mg/kg)

Percentiles	HQ (ingestion)	HQ (vegetables)	HQ (dermal contact)	HQ (soil vapor)
minimum	3.3E-02	7.4E-12	4.7E-04	4.5E-06
0.05	1.5E-01	5.9E-11	3.3E-03	7.9E-06
0.10	1.8E-01	8.9E-11	4.5E-03	1.1E-05
0.15	2.1E-01	1.2E-10	5.6E-03	1.3E-05
0.20	2.3E-01	1.5E-10	6.9E-03	1.6E-05
0.25	2.5E-01	1.8E-10	8.0E-03	2.0E-05
0.30	2.8E-01	2.1E-10	9.6E-03	2.4E-05
0.35	3.0E-01	2.5E-10	1.1E-02	2.8E-05
0.40	3.3E-01	2.9E-10	1.3E-02	3.2E-05
0.45	3.7E-01	3.4E-10	1.5E-02	3.6E-05
0.50	4.0E-01	3.8E-10	1.7E-02	4.2E-05
0.55	4.3E-01	4.5E-10	1.9E-02	4.8E-05
0.60	4.7E-01	5.5E-10	2.2E-02	5.5E-05
0.65	5.1E-01	6.3E-10	2.5E-02	6.4E-05
0.70	5.8E-01	7.5E-10	2.9E-02	7.3E-05
0.75	6.4E-01	9.3E-10	3.4E-02	8.4E-05
0.80	7.3E-01	1.2E-09	3.9E-02	9.8E-05
0.85	8.4E-01	1.7E-09	4.5E-02	1.2E-04
0.90	**1.0E+00**	**2.8E-09**	**5.8E-02**	**1.4E-04**
0.95	**1.3E+00**	**2.0E+00**	**7.8E-02**	**1.9E-04**
maximum	2.9E+00	7.6E+01	3.0E-01	5.9E-04

Table B-12:

Percentiles of Hazard Quotient
Simulated Distributions
(Combination of Scenario A @ 2.2 mg/kg + Scenario C @ 25 mg/kg)

Percentiles	HQ (ingestion)	HQ (dermal contact)	HQ (soil vapor)
minimum	3.8E-02	5.1E-04	3.6E-06
0.05	1.1E-01	2.2E-03	5.3E-06
0.10	1.4E-01	3.0E-03	5.8E-06
0.15	1.7E-01	4.0E-03	6.4E-06
0.20	1.9E-01	5.1E-03	6.8E-06
0.25	2.2E-01	6.1E-03	7.3E-06
0.30	2.4E-01	7.0E-03	7.8E-06
0.35	2.6E-01	7.9E-03	8.4E-06
0.40	2.9E-01	9.1E-03	9.1E-06
0.45	3.2E-01	1.1E-02	1.0E-05
0.50	3.5E-01	1.2E-02	1.1E-05
0.55	3.9E-01	1.4E-02	1.2E-05
0.60	4.3E-01	1.6E-02	1.4E-05
0.65	4.8E-01	1.9E-02	1.6E-05
0.70	5.3E-01	2.3E-02	1.9E-05
0.75	6.0E-01	2.7E-02	2.2E-05
0.80	6.9E-01	3.3E-02	2.8E-05
0.85	8.1E-01	3.9E-02	3.5E-05
0.90	**9.9E-01**	**5.0E-02**	**4.9E-05**
0.95	**1.3E+00**	**7.0E-02**	**8.2E-05**
maximum	2.8E+00	2.3E-01	6.4E-04

Figure B-1: Fraction of Time in Contact With Soil (Fcon) for Electrical Substation Construction Worker

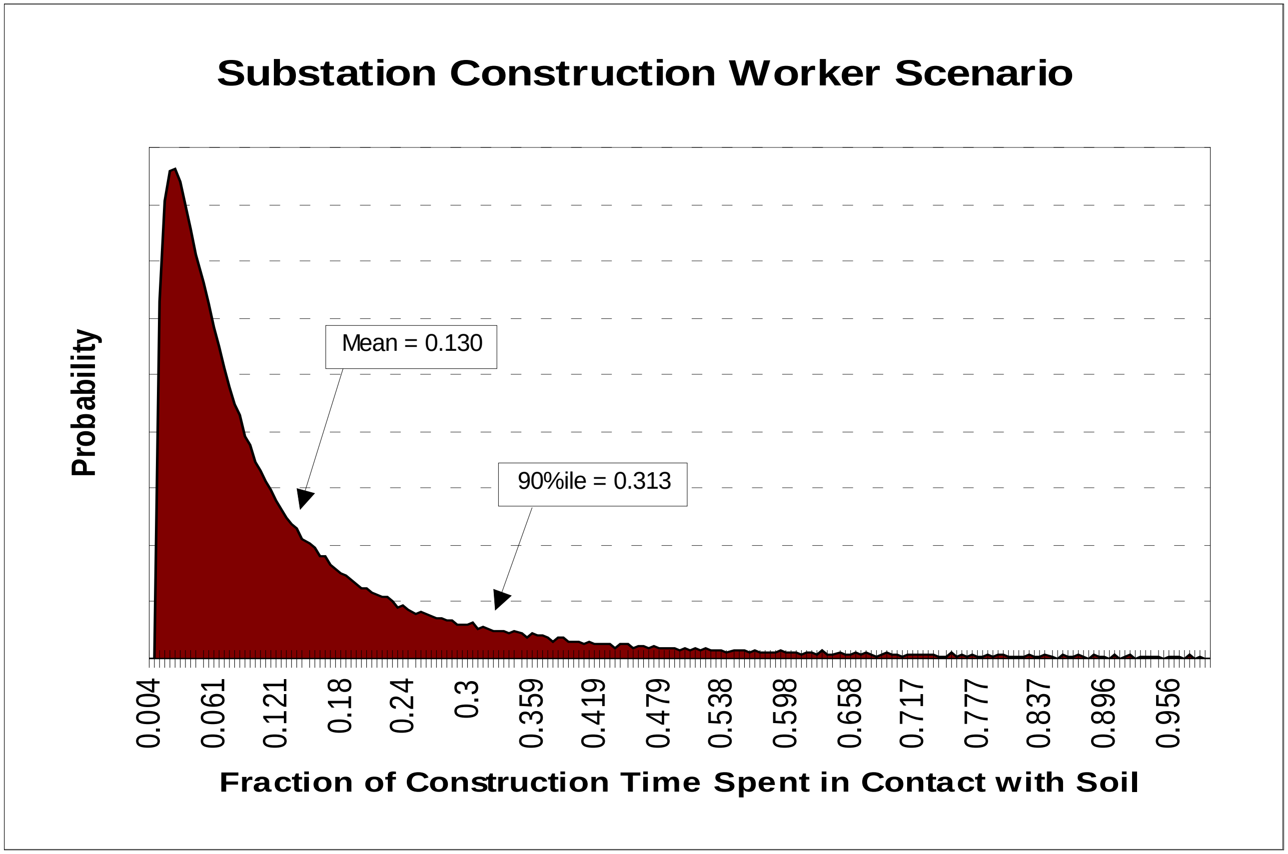


Figure B-2: Incremental Lifetime Cancer Risk Simulated Distributions (Combination of Scenario A + Scenario B)

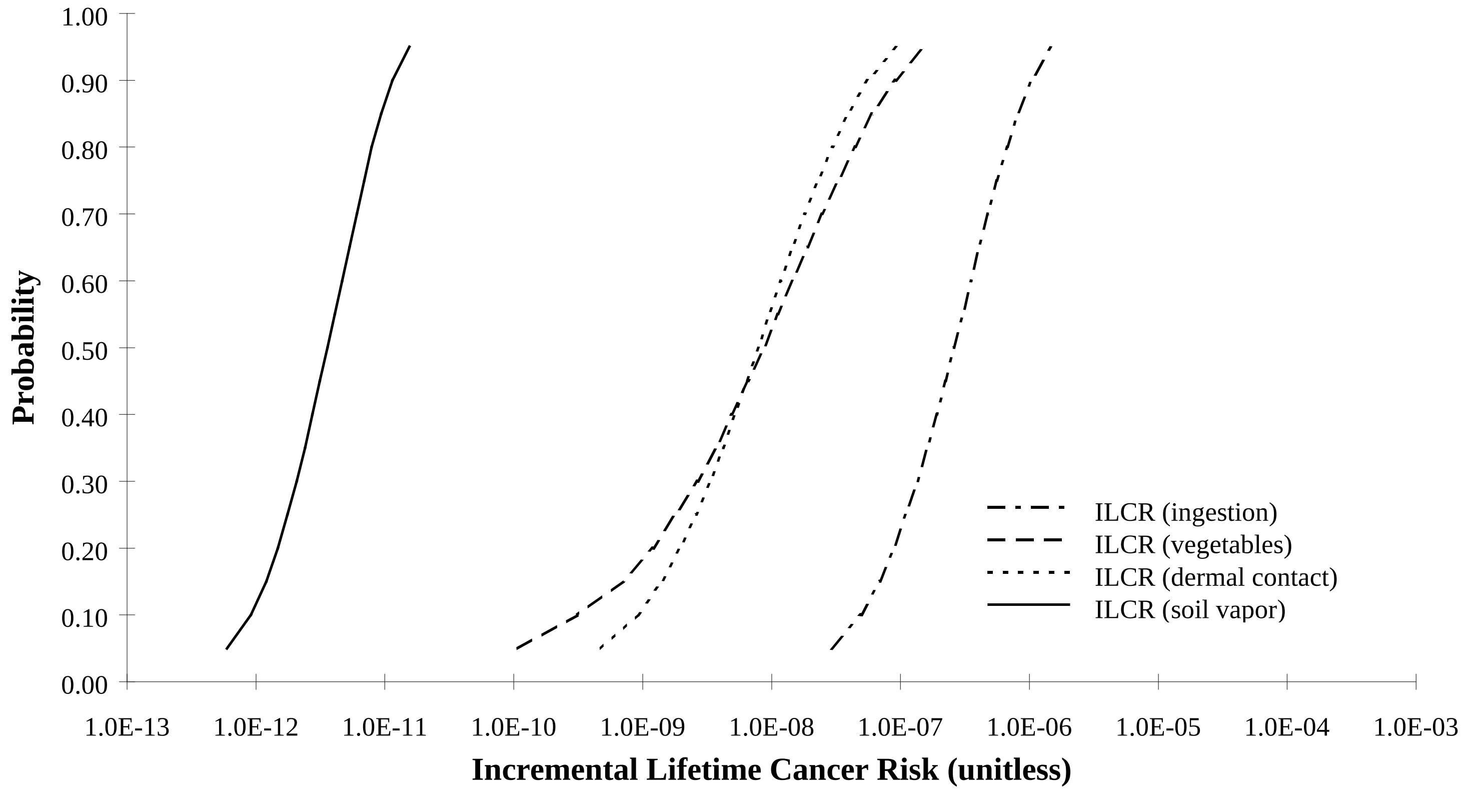


Figure B-3: Incremental Lifetime Cancer Risk Simulated Distributions
(Combination of Scenario A + Scenario C)

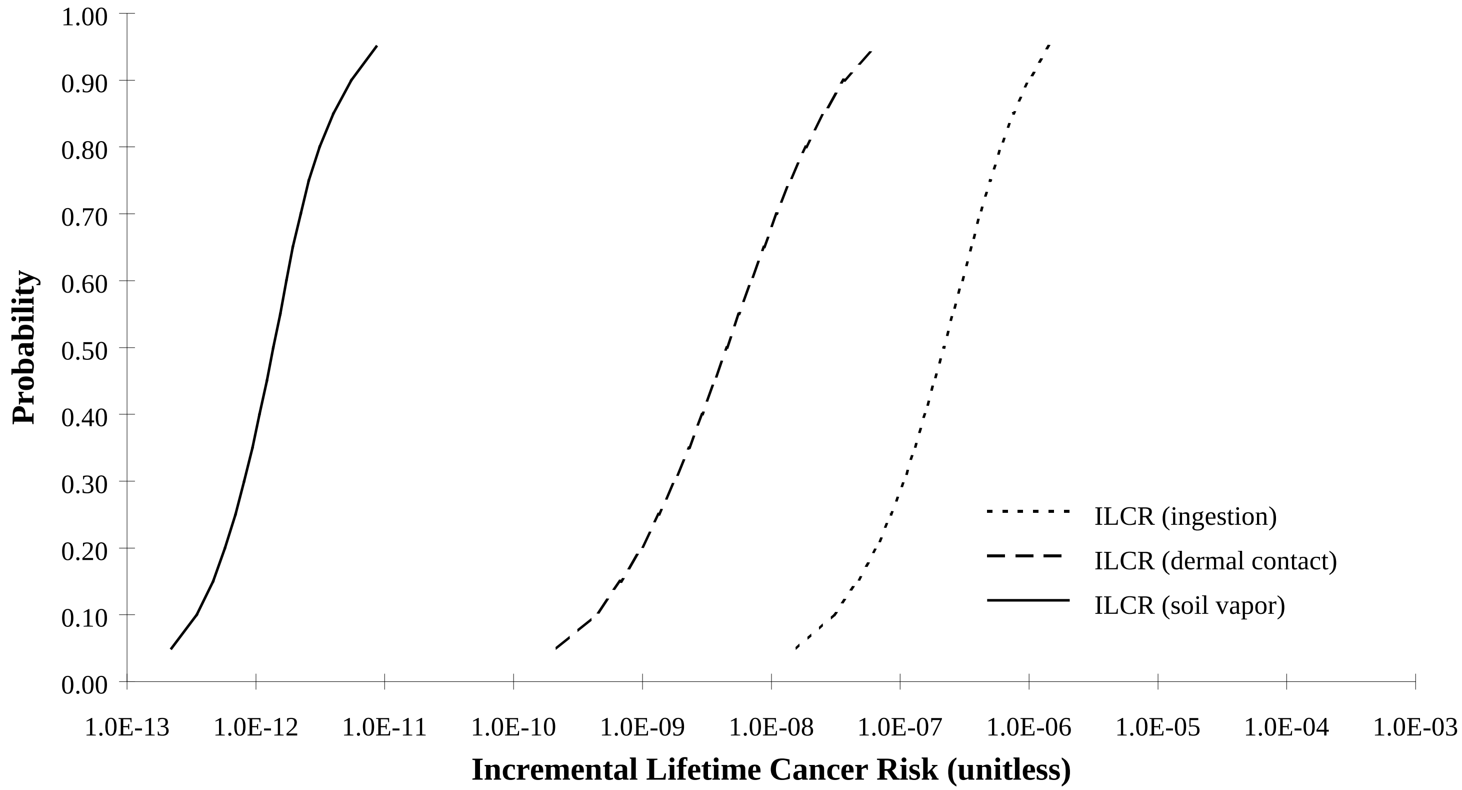


Figure B-4: Hazard Quotient Simulated Distributions (Combination of Scenario A + Scenario B)

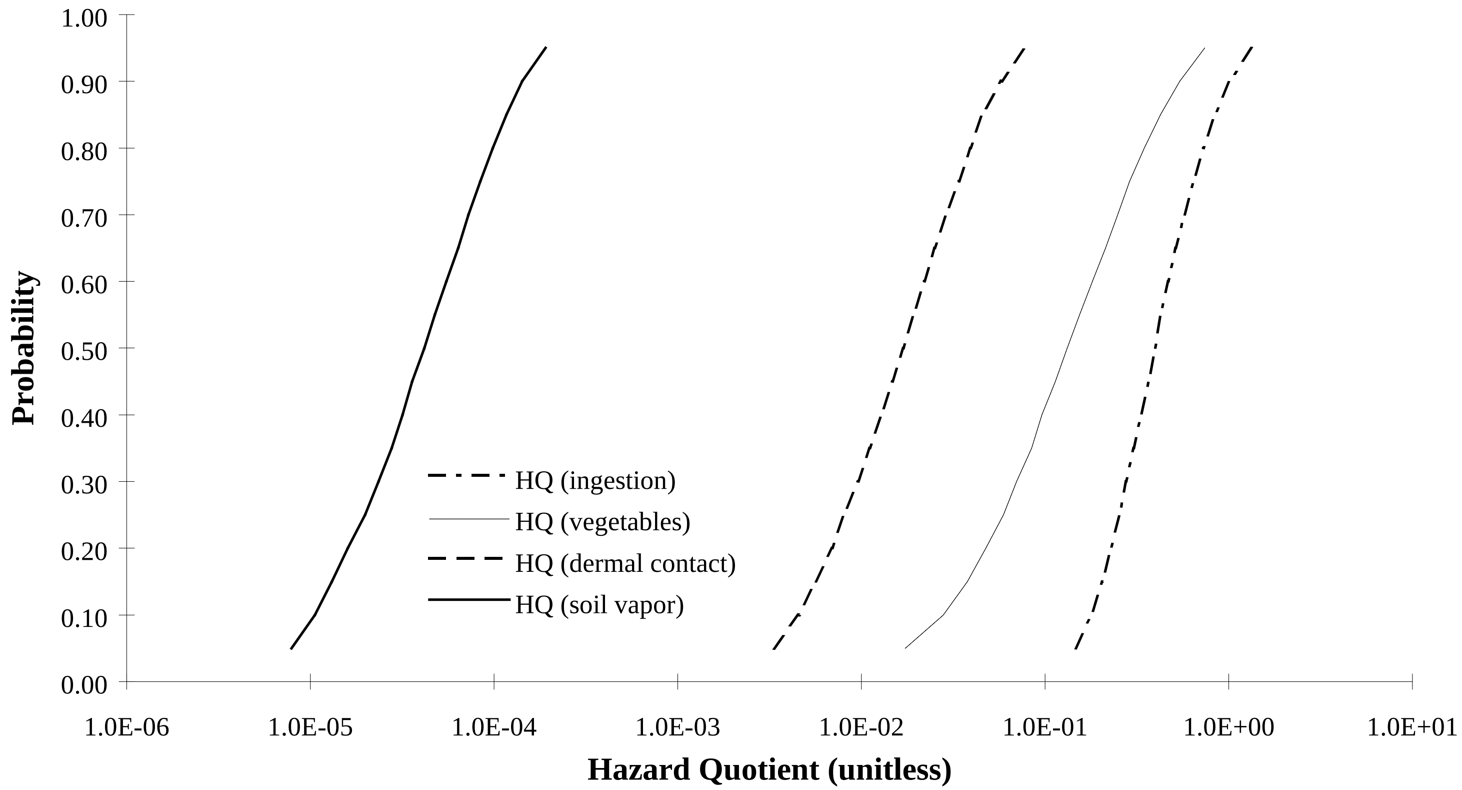
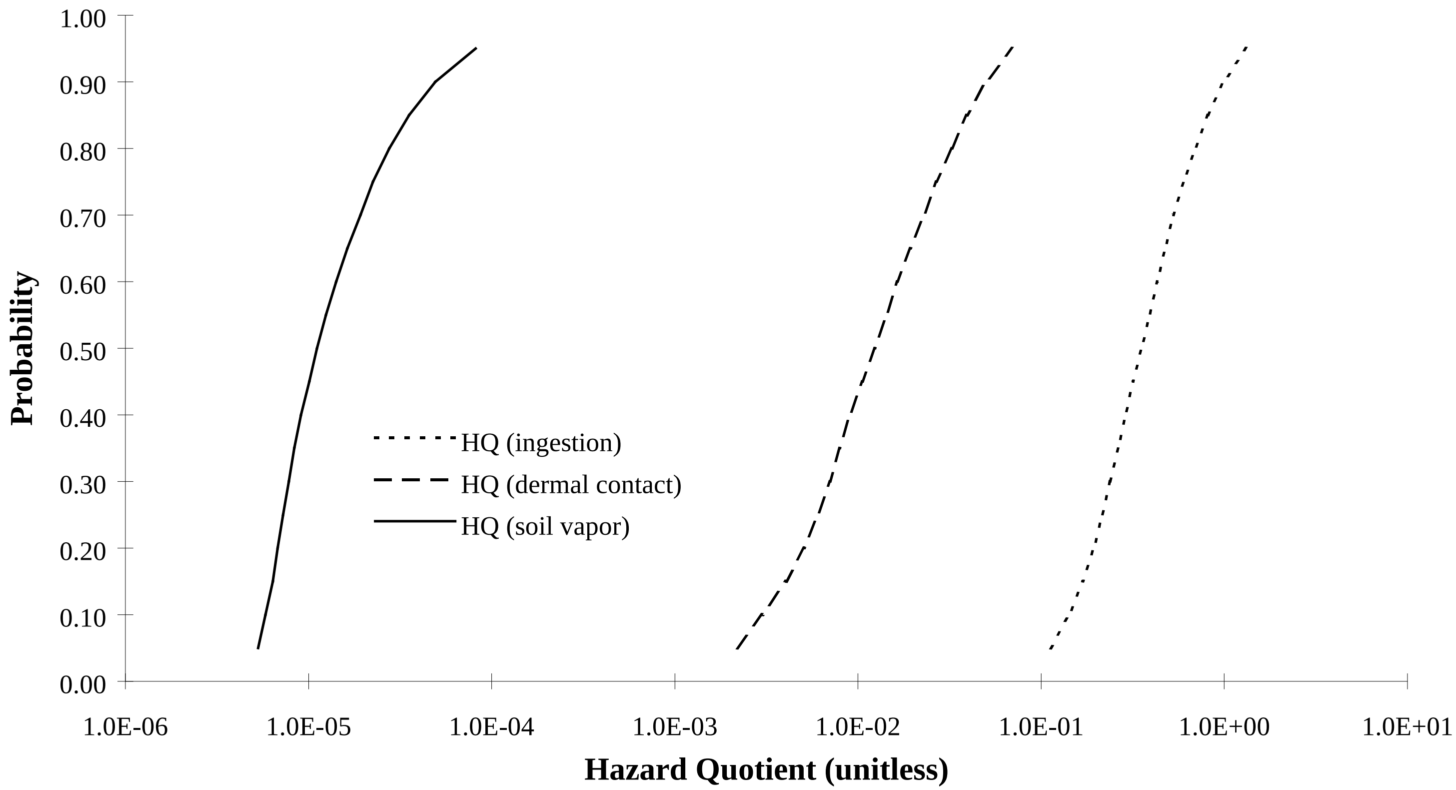


Figure B-5: Hazard Quotient Simulated Distributions
(Combination of Scenario A + Scenario C)



APPENDIX C: IDENTIFICATION AND SCREENING OF REMEDIAL TECHNOLOGIES

In this appendix, technologies that are potentially applicable for remediation of soils contaminated with PCBs are identified and screened. The technologies retained after screening are used to develop remedial action alternatives in Appendix D.

C.1 Technology Identification

Appropriate technologies for any remedial action depend primarily on the physical and chemical properties of the contaminants, and on the properties and location of the contaminated media. The chemical stability that made PCBs well-suited for the industrial uses discussed in Appendix A also contributes to difficulties in their remediation. A recent National Academy of Sciences/National Research Council study (NAS, 1997) discusses remediation technologies for various classes of soil and groundwater contaminants, including PCBs. The technologies that NAS considers to be the current "state of the practice" for PCBs are listed in Table C-1.

Table C-1: State-of-the-Practice Technologies Applicable to the Remediation of Soils and Groundwater Contaminated by PCBs (NAS, 1997).

Technology Types	Technologies
Containment and Stabilization Techniques	Cementing agents; pozzolanic materials Slurry walls; sheet pilings, etc. In situ vitrification
Separation Techniques	Thermal Desorption Soil Washing and Soil Flushing Solvent Extraction
Reaction Techniques	Incineration Chemical Reactions Biological Reactions

In addition to looking for remedial methods that, from a purely technical perspective, *can* treat soils contaminated with PCBs, the Department reviewed records of decision (RODs) for sites with PCB contamination in order to evaluate what technologies *are* typically being selected when other balancing factors are also considered. Since the purpose of this document is to present generic remedies, and since generic remedies should be both broadly applicable and readily available, the information from RODs was used to help identify those remedies which may apply to a wide range of site conditions. Both EPA and DEQ RODs were reviewed.

Finally, the Department contacted EPA Region 10 and obtained a list of companies that are permitted to treat and dispose of PCB-contaminated soil, groundwater and other materials (see

Appendix F). Representative vendors were contacted to obtain current cost information as well as to discuss the application of their technologies to the types and amounts of soils likely to be treated under this generic remedy guidance.

C.1.1 EPA Records of Decision and Technology Information

In *Guidance on Remedial Actions for Superfund Sites with PCB Contamination* (EPA, 1990), EPA describes treatment technologies commonly selected for sites where PCBs were a key contaminant of concern. For the 72 sites included in this summary, incineration was the most frequently selected technology, being used at approximately 38 percent of the sites (see Table C-2). Excavation and land disposal was the second most frequently selected, being employed at 24 percent of the sites. Stabilization/solidification and containment/capping were both selected 13 percent of the time. Chemical dechlorination, thermal desorption, bioremediation, solvent extraction, and in-situ vitrification were all selected relatively infrequently when compared to other remedial technologies.

Table C-2: Selected Remedial Technologies for PCB Sites

Selected Technology	No. of Sites	Percent
Incineration	27	38
Land Disposal	17	24
Stabilization/Solidification	9	13
Containment/Capping	9	13
Chemical Dechlorination	3	4
Thermal Desorption	3	4
Bioremediation	2	3
Solvent Extraction	1	1
In-Situ Vitrification	1	1
Total	72	100

A recent GAO study found that even though EPA selected innovative technologies for 20% of its remedy decisions at Superfund sites in 1994, such technologies were only selected at 10% of PCB sites (American Chemical Society, 1996).

The bias towards incineration and land disposal has been driven by the regulatory requirements in the Toxic Substances Control Act (TSCA). Specifically, 40 CFR 761.60(a)(4) requires soils and debris contaminated as a result of a spill involving 50 mg/kg PCB or greater to be managed as follows:

- Treated through incineration per 40 CFR 760.70;
- Treated by an equivalent method per 40 CFR 761.60(e); or

- Disposed in a TSCA landfill per 40 CFR 761.75.

Note, however, that TSCA requirements do not apply to all soils contaminated with PCBs (see Appendix G). Parties using this generic remedy guidance are responsible for ensuring that they are in compliance with TSCA and all other applicable regulations.

In another publication, EPA identifies remedial technologies for soil and sediments contaminated with PCBs at Superfund sites (EPA, 1993b). This publication provides a process description for each remedial technology, site requirements, technology performance information, process residuals, and innovative applications of each technology. The list of potentially applicable remedial technologies is similar to those listed above and includes incineration, thermal desorption, chemical dehalogenation (i.e., dechlorination), solvent extraction, soil washing, solidification/stabilization, bioremediation, and vitrification. EPA also identified a number of applicable long-term management controls, including: caps, liners, leak detection, groundwater monitoring, surface water monitoring, surface water management, and fencing.

C.1.2 DEQ Records of Decision

A summary of Department of Environmental Quality records of decision for five PCB-contaminated sites is presented in Table C-3. The most frequently selected remedial technology was excavation and off-site disposal. Since the lowest feasible cleanup level[1] for each of these sites was less stringent than the protective level, supplemental measures such as engineering controls (capping) and institutional controls (deed restrictions and monitoring) were utilized to ensure that the selected remedy provides adequate protection. For commingled contaminants such as were encountered at the Schnitzer Unit C and Portable Equipment Salvage sites, stabilization was required prior to off-site disposal. Incineration was not selected at any of the DEQ sites.

C.1.3 Technology Summary

The remedial technologies identified above are presented in Table C-4 and summarized based on their technology status, attainable residual concentrations, process residuals, availability of TSCA-permitted facilities and cost. This table categorizes these technologies as demonstrated or emerging. Demonstrated technologies are defined as those which have been employed at the full-scale level to successfully meet PCB cleanup goals at multiple sites. Emerging technologies are those which have been shown to effectively or consistently treat PCB-contaminated soils at the pilot-scale level.

[1] The rules in effect when these RODs were approved required remedies to achieve background or the lowest feasible concentrations.

Table C-3: Remediation Technologies for Selected Oregon PCB Sites

Site Name (Type)	Remedial Technology
Balteau Standard (Manufacturer)	Excavation and off-site disposal; soil cover.
John Battin (Scrapyard)	Excavation and off-site disposal; asphalt cap; institutional controls.
Portable Equipment Salvage (Scrapyard)	Excavation and off-site disposal with stabilization; soil cover; institutional controls.
PGE Substation L (Substation)	Low volume dredging, dewatering and off-site disposal; sediment cap; monitoring.
Schnitzer Unit C (Scrapyard)	Excavation and off-site disposal; soil, concrete and asphalt cap; institutional controls.

In addition to treatment technologies, Table C-4 provides comparable information, when applicable, for other remedial technologies applicable to soils contaminated with PCBs. These remedial technologies include excavation and land disposal in accordance with 40 CFR 761.75; long-term management controls and institutional controls. The first two remedial technologies were identified in both the 1990 and the 1993 EPA documents. Institutional controls were not identified in these publications, but have been used by EPA and DEQ on a number of sites. For this reason, institutional controls are included as a potentially applicable remedial technology.

C.2 Technology Screening

The purpose of technology screening is to reduce the number of identified technologies prior to development of remedial action alternatives. The criteria used for screening should be consistent with the remedial action objectives as well as any other criteria that will logically reduce the number of technologies.

Five criteria were used for screening the remedial technologies and management controls listed in Table C-4. These criteria are specific to this generic feasibility study and may not be appropriate outside of this context.

- The technology must be demonstrated. The Department has chosen this criterion in order to maximize the likelihood that the retained technologies will meet the remedial action goals for as many sites as possible.
- Commercial availability of TSCA-permitted facilities. These technologies are currently available through companies permitted by EPA to treat or dispose of PCB contaminated soils.
- At least one treatment technology must be retained in order to evaluate the feasibility of treating hot spots of contamination while applying a higher cost threshold.

Table C-4: Technology Identification Summary

Technology	Technology Description	Technology Status[1]	Attainable Residual Conc.	Process Residuals	Availability of TSCA-Permitted Facilities[2]	Cost/ton	Reference for Cost Information
Chemical Dechlorination (*ex-situ*)	Employs chemical reagents that remove chlorine atoms from PCBs and in some cases mineralize parent molecule. The reagents are primarily alkali metal-organic reducing agents.	Demonstrated[3]	< 1 mg/kg	Treated water and condensate, and decontaminated sludge	Columbus, OH	\$400 to \$600[4] (1000 ton minimum)	Valeri, 1997
Incineration (Off-site)	Subjects contaminated soil to high temperature in the presence of oxygen, which causes volatilization, combustion and destruction of PCBs.	Demonstrated	<<1 mg/kg	On site: None Off site: Ash and wastewater	Coffeyville, KS Aragonite, UT Port Arthur, TX Deer Park, TX West Chester, PA	\$700 to \$1000[4,5]	King, 1997 Raglund, 1997
Solvent Extraction (*ex-situ*)	Takes advantage of the low solubility of PCB in water by contacting contaminated soil with a solvent into which the PCB's preferentially partition. Another technology is used to destroy PCBs in the extract.	Demonstrated[3]	< 1 mg/kg	Extract containing concentrated PCBs and separated water	San Diego, CA	\$200 to \$300[4] (500 ton minimum)	Cash, 1997
Vitrification (*in-situ*)	Vitrification uses heat to melt the contaminated soil to a glassy, rigid product. PCBs are destroyed at the high temperatures used.	Demonstrated	<< 1 mg/kg	Off-gases, scrubber wastewater, and spent carbon or diatomaceous earth	Richland, WA	\$700 to \$900[4] (500 ton minimum)	Haass, 1997

Technology	Technology Description	Technology Status[1]	Attainable Residual Conc.	Process Residuals	Availability of TSCA-Permitted Facilities[2]	Cost/ton	Reference for Cost Information
Soil Washing (*ex-situ*)	Mechanically mixes, washes and rinses soil to segregate the PCB laden silt and clay fractions from the relatively uncontaminated larger soil particles. Another technology is used to destroy PCBs in the extract.	Demonstrated	< 2 mg/kg	Contaminated fines and humic materials; wastewater; and sludges	None	\$40 to \$250 (several hundred ton minimum)	Elsevier Science, 1995
Solidification / Stabilization (*ex-situ*)	Binders are added to the soil to reduce the mobility of the PCBs. Solidification is a similar process, but sufficient binder is used to encapsulate the contaminants. Treated soils must be disposed of pursuant to TSCA regulations.	Demonstrated	Not Applicable	None	None	\$200 to \$300[6] (several hundred ton minimum)	EPA, 1993 Bates, 1997
Thermal Desorption (*ex-situ*)	Heats contaminated soil to a temperature high enough to volatilize PCBs. The product gas stream must then be treated to remove PCB's.	Demonstrated	< 2 mg/kg	On site: None Off site: Condensed off-gases and particulate control system dusts; and spent carbon	None	\$100 to \$200 (several hundred ton minimum)	DePercin, 1997 CH2M Hill, 1997b
Bioremediation (*ex-situ*)	Employs indigenous or exogenous microorganisms to degrade PCBs.	Emerging	Not demonstrated	Wastewater and off-gases	None	unknown	

Technology	Technology Description	Technology Status[1]	Attainable Residual Conc.	Process Residuals	Availability of TSCA-Permitted Facilities[2]	Cost/ton	Reference for Cost Information
Off-site Disposal	Contaminated soil is excavated and transported to a licensed chemical landfill or solid waste landfill, depending on the regulatory status of the contaminated soil.	Demonstrated	Not Applicable	None	Emelle, AL Kettleman City, CA Arlington, OR Model City, NY Boise, ID Salt Lake City, UT Beatty, NV Pasadena, TX Belleville, MI	$135 to 190[4,7]	Johnson, 1997
Institutional Controls	Deed restrictions and notices used to notify future owners of the presence of PCBs.	Demonstrated	Not Applicable	None	Not Applicable	Not applicable	
Engineering Controls	Use of caps, liners, surface water management, and/or fencing to prevent exposure to PCB concentrations above remedial action objectives and to prevent migration.	Demonstrated	Not Applicable	None	Not Applicable	$1 to $3/sq. foot (capping)	CH2M Hill, 1995 Geraghty & Miller, 1995

[1] See Section C.1.2 for a description of these categories of technology status.

[2] Availability of commercially permitted PCB disposal companies (i.e., treatment or disposal facility) which currently accept PCB-contaminated soil (see Appendix F for vendor information).

[3] A laboratory treatability study is required in order to determine treatment conditions and refine cost estimate.

[4] The cost estimates provided in this table are general in nature. For many of these technologies, costs are highly dependent on site-specific conditions (e.g., PCB concentration and soil structure). As such, more precise estimates should be obtained prior to a site specific evaluation of remedial technologies. The cost estimates are based on a mass of contaminated soil ranging from 1000 tons to 15 tons, respectively. Where the technology is not applicable to small amounts of contamination (e.g., due to high mobilization costs) the cost estimates are based on a mass ranging from 1000 tons to the minimum mass indicated. Estimates also include the cost of transportation to an off-site treatment or disposal facility and the cost of mobilization for on-site treatment. For *ex-situ* treatment or off-site disposal, the cost estimates do not include excavation which typically is less than $5 to $10 per ton.

[5] The cost of transportation of excavated soil to the incinerator is based on a distance of 800 miles (e.g., Portland to Aragonite, Utah).

[6] Including cost for disposal of solidified or stabilized soils in a chemical landfill.

[7] The cost of transportation of excavated soil to the disposal facility is based on a distance of 150 miles (e.g., Portland to Arlington, Oregon).

- The treatment technology must be cost effective for the amount of contaminated soil that may require treatment under this generic remedy guidance (<500 tons).
- Institutional controls must be retained so remedial action alternatives can be developed that manage non-hot spots of contamination on-site and presumably would be less costly than remedial action alternatives employing treatment or excavation and off-site disposal.

C.2.1 Retained Technologies

Described below are the remedial technologies and management controls which meet the screening criteria listed above. These technologies were used to develop remedial action alternatives.

- Incineration (off-site): Excavation and off-site incineration consists of removing the contaminated soil through standard construction techniques and transporting the material off-site for incineration. Incineration is the only treatment technology which meets the screening criteria. Five incineration facilities are commercially permitted by EPA to treat TSCA wastes. The closest facilities are located in Texas and Utah. Incineration is the only commercially permitted treatment technology which is cost-effective for less than 500 tons of PCB-contaminated soil.
- Off-Site Disposal: Excavation and off-site disposal consists of removing the contaminated soil through standard construction techniques and transporting the material to an off-site disposal facility. Excavation and off-site disposal is a demonstrated technology. Numerous chemical landfills are commercially permitted to accept TSCA wastes. The closest facility is located in Arlington, Oregon.
- Engineering Controls: Engineering controls consist of physical controls utilized to manage contamination on-site. Typical engineering controls include capping, erosion control and runoff collection. Engineering controls are a demonstrated technology.
- Institutional Controls: Institutional controls consist of legal or administrative controls which are utilized to reduce the potential for exposure to contaminated material. Institutional controls include site use restrictions, monitoring and worker safety programs. Institutional controls are a demonstrated tool for managing potential exposure to contaminated soils.

C.2.2 Excluded Technologies

Described below are the remedial technologies which do not meet the screening criteria. These technologies were not used to develop remedial action alternatives included in this guidance document.

- Chemical Dechlorination: Chemical dechlorination utilizes chemical reagents and processes to remove the chlorine from PCBs and in some cases mineralize the parent molecule. The reagents are primarily alkali metal-organic reducing agents. Chemical dechlorination is a demonstrated technology which is commercially permitted by EPA to treat TSCA wastes. However, chemical dechlorination is not cost-effective for amounts of soil less than about 1000 tons.

- Solvent Extraction: Solvent extraction uses solvents to preferentially dissolve PCBs from contaminated soils. The PCBs are subsequently extracted from the solvent and concentrated to reduce the volume of contaminated materials requiring disposal or incineration. Solvent extraction is a demonstrated technology which is commercially permitted by EPA to treat TSCA wastes. However, solvent extraction is not cost-effective for amounts of soil less than about 500 tons.
- Vitrification: Vitrification utilizes heat to melt the contaminated soil to a glassy, rigid product. PCBs are destroyed at the high temperatures used. Vitrification is a demonstrated technology which is commercially permitted by EPA to treat TSCA wastes. However, vitrification is not cost-effective for amounts of soil less than about 500 tons.
- Soil Washing: Soil washing is a water-based technology that mechanically mixes, washes and rinses soil to segregate the PCB laden silt and clay fractions from relatively uncontaminated larger soil particles. Soil washing is a demonstrated technology. However, no facilities currently are commercially permitted by EPA to treat TSCA wastes by soil washing. Also, soil washing is not cost-effective for amounts of soil less than at least several hundred tons.
- Solidification/Stabilization: Stabilization consists of mixing the contaminated soil with cement or other binders to render the contamination immobile. Solidification is a similar process, but sufficient binder is used to encapsulate the contaminants. The solidified or stabilized soil must be treated or disposed of pursuant to TSCA regulations. Solidification/stabilization is a demonstrated technology. Solidification/stabilization is not cost-effective for amounts of soil less than at least several hundred tons.
- Thermal Desorption: Thermal desorption consists of heating contaminated soil to a temperature sufficient to volatilize the PCBs from the contaminated soil. The PCBs are treated or captured and then disposed off site. Thermal desorption is a demonstrated technology. However, no facilities currently are commercially permitted by EPA to treat TSCA wastes by thermal desorption. Also, thermal desorption is not cost-effective for amounts of soil less than at least several hundred tons.
- Bioremediation: Bioremediation consists of utilizing microorganisms to convert PCBs into less toxic compounds. Nutrients, air and water are typically added to the soil to enhance the rate of biodegradation. Bioremediation is an emerging technology for PCB-contaminated soils. No facilities currently are commercially permitted by EPA to treat TSCA wastes by bioremediation.

It should be noted that although these technologies have been screened out in this generic review, there still may be specific sites at which they are appropriate. The Department is willing to consider these technologies and others, as they become available, for use within the PCB generic remedy process. Pilot studies and focused site-specific feasibility studies may provide sufficient additional information to recommend another remedy. This option should be discussed with the Department (see Section 2.5.5). At sites where more than 500 tons of contaminated soil exceeds the generic hot spot levels, a site-specific evaluation should be made to determine the appropriate remedial technology (see Section 1.3.3).

APPENDIX D: DEVELOPMENT OF REMEDIAL ACTION ALTERNATIVES

In this appendix, remedial action alternatives are assembled from the technologies retained after screening in Appendix C. The alternatives are then developed, which includes defining preliminary design assumptions for each alternative, and evaluated in detail.

D.1 Identification and Evaluation of Remedial Action Alternatives

Oregon Administrative Rules require feasibility studies to develop and evaluate a range of remedial action alternatives including any or all of the following (OAR 340-122-085):

- No action
- Remedial actions utilizing engineering and/or institutional controls
- Remedial actions utilizing treatment
- Remedial actions utilizing excavation and off-site disposal
- Any combination of the above

Remedial alternatives were developed from technologies retained in Appendix C in a manner compatible with the design elements discussed in Section D.3. Ultimately, all remedial actions must be protective of present and future public health, safety, and welfare and the environment; balance the remedy selection factors; and treat hot spots of contamination to the extent feasible. Protective levels may be achieved exclusively through treatment or off-site disposal to the protective concentration, or to a higher concentration as long as it can be demonstrated that engineering and/or institutional controls are adequate to manage the risk at the site at the protective level. Protective levels are developed in Appendix B.

D.2 Federal, State and Local Requirements

Federal, state and local requirements affect the development of remedial alternatives. Remedial action alternatives which are not consistent with such requirements likely would not be implementable and, therefore, not feasible.

The remediation of soil contaminated with PCBs is governed by the regulatory requirements specified in the Toxic Substances Control Act (TSCA). TSCA requires all soils and debris contaminated from releases of materials containing PCBs at concentrations of 50 mg/kg or greater to be managed as follows:

- Treated through incineration per 40 CFR 760.70;
- Treated by an equivalent method per 40 CFR 761.60(e); or
- Disposed in a TSCA landfill per 40 CFR 761.75.

Although treatment technologies other than incineration would be acceptable under the requirements of TSCA, only incineration has been carried forward for developing generic remedial action alternatives. Consequently, the only alternatives available for soil contaminated from releases of materials containing PCBs at concentrations of 50 mg/kg or greater are incineration or disposal in a TSCA-approved landfill. Soils contaminated from releases of materials containing PCBs at concentrations less than 50 mg/kg can be disposed of at a RCRA subtitle D landfill. Parties using the PCB generic remedy guidance are responsible for ensuring that all soil disposal meets the requirements of TSCA. See Appendix G for more information on TSCA soil disposal requirements.

D.3 Design Elements

For the purpose of these generic remedies, the Department has assumed that it is generally not reliable to use engineering or institutional controls at residential sites. Therefore, for residential sites the goal of remediation is to treat or remove from the site all soils with PCB concentrations exceeding the residential *protective* level (Table 2-1). Any PCB-contaminated material excavated and removed from the site must be treated through incineration or permanent disposal in an approved landfill.

For industrial or operating substation sites, the goal of remediation is to treat or remove from the site all soils with PCB concentrations exceeding the *hot spot* levels (Table 2-2). As with residential sites, PCB-contaminated material excavated and removed from the site must be treated through incineration or permanent disposal in an approved landfill. Engineering and/or institutional controls must then be used to provide the additional protection necessary to ensure that the acceptable risk level is met for the site.

The design elements necessary to achieve these identified goals are each discussed below. A summary is given in Table D-1. These elements have been used to assemble the remedial action alternatives discussed in Section D.4.

D.3.1 Soil Excavation, Handling and Transport

Excavation is common to all land use scenarios. Soil excavation would be conducted using conventional construction equipment such as backhoes and bulldozers. Excavated soil will likely be stockpiled on-site prior to off-site disposal or treatment. Excavated soil will be transported off-site for disposal or incineration using dump trucks fitted with tarps to prevent loss of contaminated soil during transport. Material remaining on-site above the protective level must be managed with engineering and/or institutional controls.

D.3.2 Off-Site Disposal

Off-site disposal is common to all land use scenarios. As described in Section D.2, soils contaminated with PCBs may have to be disposed of in a TSCA-approved landfill. The responsible party must make that determination. The closest disposal facility capable of accepting both RCRA and TSCA wastes is located in Arlington, Oregon, and is operated by Chemical Waste Management, Inc (see Appendix F). All appropriate disposal requirements must be met prior to off-site disposal in an approved landfill.

Table D-1: Design Elements for the Remedial Action Alternatives

PCB Concentration	Management Options*	Treatment/Disposal Options
Greater than protective concentration, but less than hot spot level	Cap with concrete or asphalt to prevent worker exposure; Deed restrictions to maintain land use; Restrictions on excavation activities; Worker health & safety programs; Periodic site reviews	Excavation and off-site disposal in an approved landfill
Greater than hot spot level	Not Applicable*	Excavation and off-site incineration to the extent feasible; Excavation and off-site disposal of remaining material in an approved landfill

* Management options are not considered part of the generic remedy for residential sites, or for soils exceeding the hot spot level at industrial or operating substation sites. However, for these situations the Department will consider site-specific proposals for the management of contamination that exceeds the generic cleanup levels.

D.3.3 Incineration

Incineration is common to all land use scenarios. PCB-contaminated material requiring incineration will be transported to a TSCA-approved incineration facility. The closest such incinerators are located in Aragonite, Utah (operated by Laidlaw Environmental Services) and Port Arthur, Texas (operated by Chemical Waste Management, Inc.) (see Appendix F).

D.3.4 Engineering Controls

Engineering controls may consist of fencing and/or soil, concrete or asphalt caps. Capping is common to the industrial and the operating substation scenarios. Capping would also be required in a residential scenario if a site-specific modification was proposed to allow soils in excess of the protective level to remain on site. The purpose of capping at most PCB sites will be to limit direct contact with contaminated soil. However, at sites where high concentrations in the vicinity of the water table may pose a threat to groundwater, cap design must also specifically address control of infiltration and contaminant leaching.

Capping material shall consist of concrete or asphalt for contamination left in place at depths less than four feet. For material at depths of greater than four feet, soil caps are acceptable. In addition, structures such as buildings and pad mounted electrical equipment may also be placed over contaminated material. In general, all material at industrial and operating substation sites which exceeds the protective levels but does not exceed the hot spot level may be capped on-site.

Caps will be constructed such that the potential for erosion and/or ponding is minimized. Fencing may also be used to limit access to and protect capped areas.

D.3.5 Institutional Controls

Institutional controls are common to the industrial and operating substation scenarios. They would also be required in a residential scenario if a site-specific modification was proposed to allow soils in excess of the protective level to remain on site. In general, whenever engineering controls are utilized to manage contaminated soils in excess of the relevant generic protective levels, institutional controls will be required to ensure that the engineering controls are maintained. This may be accomplished by limiting site access (e.g., deed restrictions), limiting exposure to contaminated material (e.g., worker safety programs or restrictions on excavation activities) and ensuring the effectiveness of the engineering controls (e.g., monitoring programs and periodic reviews).

D.3.6 Additional Considerations

As covered in Section 2.5.5, the Department expects that there may be cases where it is not feasible to treat or remove and dispose of all soil exceeding the generic cleanup levels (i.e., the protective level at residential sites or the hot spot level at industrial and operating substation sites). Material exceeding generic cleanup levels which is inaccessible due to the presence of underground utility lines, buildings or other structures may also be managed in place through engineering and institutional controls. However, this will be considered a modification to the generic remedies and will require additional site-specific information. Such sites should be discussed with the Department.

It should be noted that on-site management of contamination carries long-term liability. In the event of an unanticipated change in land use, unexpected failure of the management controls, or changing environmental conditions, additional action may be necessary.

D.4 Remedial Action Alternatives

The following remedial action alternatives were identified as potentially applicable to soils contaminated with PCBs:

- No action;
- On-site management through engineering and institutional controls;
- Excavation to protective level and off-site disposal in an approved landfill;
- Excavation to hot spot level and off-site disposal in an approved landfill plus additional controls; and
- Excavation to hot spot level and off-site incineration plus additional controls.

The major elements of each remedial action alternative are presented below:

<u>Alternative 1: No Action</u>

The no-action alternative is required as a baseline for comparison to other alternatives (OAR 340-122-085(2)(a)). Under the no-action alternative, no remediation activities to address the contaminated soil are performed.

Alternative 2: On-Site Management through Engineering and Institutional Controls

- Capping of all PCB contamination above the protective level with a soil, asphalt or concrete cover; and
- Institutional controls to ensure maintenance of cap, including restrictions on site activities (e.g., excavation); deed restrictions to prevent changes in land use; worker safety programs; DEQ notification of property use changes, proposed excavation activities or changes in property ownership; and periodic reviews.

Alternative 3: Excavation to Protective Level and Off-Site Disposal in an Approved Landfill

- Excavation of all PCB-contaminated material above protective level; and
- Disposal of all PCB-contaminated material in a landfill that meets the TSCA requirements for that material.

Alternative 4: Excavation to Hot Spot Level and Off-Site Disposal in an Approved Landfill plus Additional Controls

- Excavation of all PCB-contaminated material above hot spot level;
- Disposal of all PCB-contaminated material in a landfill that meets the TSCA requirements for that material;
- Capping of all remaining PCB-contaminated material above protective level with a soil, asphalt or concrete cover; and
- Institutional controls to ensure maintenance of cap, including restrictions on site activities (e.g., excavation); deed restrictions to prevent changes in land use; worker safety programs; DEQ notification of property use changes, proposed excavation activities or changes in property ownership; and periodic reviews.

Alternative 5: Excavation to Hot Spot Level and Off-Site Incineration plus Additional Controls

- Excavation of all PCB-contaminated material above hot spot level;
- Incineration of all PCB-contaminated material greater than hot spot level;
- Capping of all remaining PCB-contaminated material above protective level with a soil, asphalt or concrete cover; and
- Institutional controls to ensure maintenance of cap, including restrictions on site activities (e.g., excavation); deed restrictions to prevent changes in land use; worker safety programs; DEQ notification of property use changes, proposed excavation activities or changes in property ownership; and periodic reviews.

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APPENDIX E: DETAILED EVALUATION OF ALTERNATIVES

The Oregon Administrative Rules require that remedial actions:

- Protect public health, safety and welfare, and the environment (OAR 340-122-040);
- Balance specified remedy selection factors (OAR 340-122-090(3)); and
- Treat hot spots of contamination to the extent feasible (OAR 340-122-090(4)).

In this appendix the remedial action alternatives developed in Appendix D are evaluated with respect to these requirements.

E.1 General Discussion of Requirements

E.1.1 Protectiveness

This generic remedy policy is applicable to sites which only present risks to human health. Therefore, the evaluation of protectiveness determines whether, as a whole, the particular remedial action alternative would achieve and maintain protection of human health. The eligibility requirements identified in Section 1.3 are intended to exclude sites which may pose an unacceptable risk to the environment. Sites posing threats beyond those relating to human health may require a site-specific risk assessment and feasibility study.

In order for remedial alternatives to be protective of human health, the remedial actions must achieve the acceptable risk levels under both present *and* reasonably likely future land use scenarios. These acceptable risk levels are defined in OAR 340-122-115(1) and are discussed in Appendix B.

E.1.2 Remedy Selection Balancing Factors

OAR 340-122-090 describes five balancing factors to be used in the evaluation of remedial action alternatives. All alternatives must be evaluated against these criteria. These factors are:

- Effectiveness
- Long-Term Reliability
- Implementability
- Implementation Risk
- Reasonableness of Cost

E.1.3 Hot Spot Treatment Criteria

The rules distinguish between hot spots and non-hot spots for the purpose of evaluating cost reasonableness. For hot spots of contamination, a higher threshold must be applied in evaluating the reasonableness of treatment costs. For non-hot spots, there is a preference for the least expensive remedial alternative unless the additional cost of a more expensive remedial alternative is justified by proportionately greater benefits within one or more of the remedy selection balancing factors. This higher cost threshold only applies as long as the hot spot criteria are met.

For the purpose of this generic remedy, the only hot spot criterion which is expected to apply is the high concentration threshold (see Section 2.4). If the material is highly mobile (e.g., may migrate and impact groundwater) the generic remedy is not applicable since effects on ground or surface water or sensitive environments have not been taken into consideration in the development of protective concentrations given in this guidance. Due to the low intrinsic mobility of PCBs, soils contaminated with PCBs are generally considered reliably containable. If other factors are present which adversely affect the reliability of containment alternatives (e.g., contaminated soils in a flood plain), then this generic remedy may not be applicable.

E.2 Detailed Analysis of Alternatives

E.2.1 Alternative 1

Alternative 1 is the “No Action” alternative.

Protectiveness: Alternative 1 fails to achieve the protective level. Exposure may occur through direct contact (e.g., ingestion, dermal absorption or inhalation) of contaminants present in soil.

Effectiveness: Alternative 1 is not effective. No reduction in risk occurs. The risk remaining at the site is unchanged from baseline conditions.

Long-Term Reliability: Alternative 1 is not reliable. Exposure to contaminated material will continue to occur.

Implementability: Alternative 1 is implementable; no remedial activities are anticipated under this alternative.

Implementation Risk: There is no additional implementation risk beyond the baseline risk to human health and the environment.

Reasonableness of Cost: Although there is no cost associated with Alternative 1, there also is no benefit to human health or the environment.

Treatment of Hot Spots: Alternative 1 does not treat hot spots of contamination.

E.2.2 Alternative 2

Alternative 2 manages all soils contaminated with PCBs on site.

Protectiveness: Alternative 2 is protective. Engineering controls such as capping and fencing will be utilized to manage contaminated material exceeding the protective concentration. Protectiveness will be enhanced through the use of institutional controls.

Effectiveness: Alternative 2 is effective. All contaminated material will be managed on-site through engineering and institutional controls. Engineering controls such as capping are effective if maintained. Institutional controls will be used to ensure that the engineering controls are properly maintained. However, if engineering controls were to fail in areas containing highly concentrated PCB-contaminated materials, significant risk could result. Therefore, Alternative 2 is considered to be less effective for hot spots. The time to achieve protection is limited only by the time required to develop and implement the appropriate engineering and institutional controls.

Long-Term Reliability: Alternative 2 achieves long-term reliability through the use of engineering and institutional controls. Engineering controls such as capping are reliable if properly maintained. Institutional controls will be required to ensure that engineering controls are properly maintained. Since PCBs tend to degrade slowly in the environment, these controls are expected to be applied indefinitely

Implementability: Alternative 2 is implementable. Engineering controls such as capping and fencing, and institutional controls such as deed restrictions are easily implemented if the owner consents and contamination has not or is not likely to migrate off site to adjoining properties. If contamination has migrated or has the potential to migrate off-site, this generic remedy is not applicable

Implementation Risk: The short-term risk presented to on-site workers, the community or the environment during implementation of the remedy is expected to be low. Capping and fencing activities are not expected to result in significant exposures to the environment or the community. Although some exposure to on-site workers may occur, this exposure can be managed through appropriate worker health and safety programs. These include restrictions on activities which may occur in the contaminated area (e.g., eating, drinking and smoking) and appropriate protective clothing (e.g., tyvek, rubber steel-toed boots).

Reasonableness of Cost: For sites which have large volumes of soil contaminated with PCBs but for which the risk is relatively low (i.e., not exceeding the hot spot level), the costs of Alternative 2 are low compared to the benefits to human health and the environment. However, as the concentration of the PCB contamination increases (i.e., as with hot spots), the potential for significant risk if the engineering and institutional controls were to fail also increases.

Treatment of Hot Spots: Alternative 2 does not treat hot spots of contamination.

E.2.3 Alternative 3

Alternative 3 requires excavation of all PCB-contaminated material exceeding the protective concentration and off-site disposal in an approved landfill.

Protectiveness: Alternative 3 is protective. All PCB-contaminated material exceeding the protective concentration is removed for disposal in a RCRA or TSCA approved landfill.

Effectiveness: Alternative 3 is effective. All PCB-contaminated material will be managed in either a RCRA subtitle D or TSCA landfill. The time to achieve protection is limited by the time required to excavate the PCB-contaminated material and transport it to the appropriate disposal facility.

Long-Term Reliability: Alternative 3 achieves long-term reliability through the long-term management of PCBs in permitted waste disposal facilities. Landfilling is considered a reliable waste disposal technology when operated properly. Landfills which may accept PCB containing material are subject to RCRA subtitle D or TSCA permit requirements which are designed to ensure long-term reliability.

Implementability: Excavation and off-site disposal at either a RCRA subtitle D landfill or TSCA approved landfill is easily implementable. Contractors are readily available to excavate and transport the contaminated material to an appropriate landfill. Numerous RCRA subtitle D landfills are available and a TSCA facility is located in Arlington, OR which has adequate space available. Institutional controls are unnecessary since all contamination posing an unacceptable risk is removed from the site.

Implementation Risk: No material will be treated on-site. The greatest threat to the surrounding community during implementation of the remedy is the result of contaminated dust emissions generated during excavation activities. However, emission controls, such as applying water as a dust suppressant, greatly reduce the potential for dust emissions and are easily implementable. In addition, protective clothing (e.g., tyvek) and health and safety procedures (e.g., decontamination procedures) are standard operating practice for workers involved in construction activities at hazardous waste sites. These safeguards will be implemented when appropriate. Risks to the environment are expected to be minimal due to the absence of sensitive environments or significant ecological risk as a prerequisite for application of the generic remedy. If any sensitive environments are expected to be impacted by site activities, this generic remedy is not applicable.

Reasonableness of Cost: Although the costs of implementing Alternative 3 in the short term are expected to be high, there likely will be no long-term costs associated with site use restrictions and periodic reviews. For sites which have small volumes of PCB-contaminated material, the costs of Alternative 3 are expected to be low compared to the benefits to human health and the environment.

Treatment of Hot Spots: Alternative 3 does not treat hot spots of contamination.

E.2.4 Alternative 4

Alternative 4 includes excavation and off-site disposal in an appropriate landfill of all PCB-contaminated material above the hot spot level. Contamination exceeding the protective level (i.e., non-hot spots) will be managed on site through a combination of engineering and institutional controls.

Protectiveness: Alternative 4 is protective. All PCB-contaminated material exceeding the hot spot level will be removed for disposal in a RCRA or TSCA approved landfill. The remaining contaminated material exceeding the protective level will be capped in place to prevent exposure to on-site workers, site visitors or trespassers. The protectiveness of the engineering controls will be enhanced through the use of institutional controls.

Effectiveness: Alternative 4 is effective. All contaminated material exceeding protective levels will be transported to an appropriate RCRA or TSCA landfill, and/or managed on-site through capping and institutional controls. On-site management controls, such as capping, are effective if maintained. Institutional controls will be used to ensure that the engineering controls are properly maintained. The time to achieve protection is limited by the time required to excavate the PCB-contaminated material and transport it to the appropriate disposal facility and the time to implement the appropriate engineering and institutional controls.

Long-Term Reliability: Alternative 4 achieves long-term reliability through the long term management of PCBs in permitted waste disposal facilities and the on-site management of low concentration contamination. Landfilling is considered to be a reliable waste disposal technology when operated properly. Landfills which may accept PCB containing material are subject to RCRA subtitle D or TSCA permit requirements which are designed to ensure long-term reliability. Engineering controls such as capping are reliable as long as they are properly maintained. Institutional controls such as restrictions on excavation activities; appropriate health and safety training programs; periodic reviews and Department notification of proposed changes in site conditions (e.g., removal of structures) or change in property ownership will be required to ensure that engineering controls are properly maintained. Since PCBs tend to degrade slowly in the environment, these controls are expected to be applied indefinitely.

Implementability: Alternative 4 is implementable. Contractors are readily available to excavate and transport the contaminated material to an appropriate landfill. Oregon has one TSCA facility, located in Arlington, which has adequate space available. Engineering and institutional controls are easily implemented if the owner consents and contamination has not or is not likely to migrate off site to adjoining properties. If contamination in excess of protective levels has migrated or has the potential to migrate off-site, this generic remedy is not applicable.

Implementation Risk: The implementation risk of Alternative 4 is low. No material will be treated on-site. The greatest threat to the surrounding community and site workers during implementation of the remedy is the result of contaminated dust emissions generated during excavation activities. However, emission controls, such as applying water as a dust suppressant, greatly reduce the potential for dust emissions and are easily implementable. In addition, protective clothing (e.g., tyvek) and health and safety procedures (e.g., decontamination procedures) are standard operating practice for workers involved in construction activities at hazardous waste sites. These safeguards will be implemented when appropriate. The installation of engineering controls is not expected to result in significant exposures to the environment or the community. Risks to the environment are expected to be minimal due to the absence of sensitive environments or significant ecological risk as a prerequisite for application of the generic remedy. If any sensitive environments are expected to be impacted by site activities, this generic remedy is not applicable. Institutional controls do not present any implementation risk.

Reasonableness of Cost: The costs of Alternative 4 are low compared to the benefits to human health and the environment. Alternative 4 attempts to balance the short-term costs of on-site risk reduction (i.e., hot spot removal) and long-term costs of on-site risk management (i.e., engineering and institutional controls for non-hot spots). Furthermore, off-site disposal in a highly engineered and permitted landfill is a cost-effective approach to permanently reducing on-site risks. With this balance of on-site risk reduction and risk management coupled with the high reliability of RCRA/TSCA permitted landfills, the costs of Alternative 4 are expected to be proportionate to the benefits created to human health and the environment.

Treatment of Hot Spots: Alternative 4 does not treat hot spots of contamination. However, Alternative 4 does result in on-site risk reduction (as compared to risk management) by transferring the risk posed by hot spots to a secure landfill.

E.2.5 Alternative 5

Alternative 5 includes excavation and off-site incineration of all PCB-contaminated material above the hot spot level. Contamination exceeding the protective level and below the hot spot level (i.e., non-hot spots) will be managed on site through a combination of engineering and institutional controls.

Protectiveness: Alternative 5 is protective. All contaminated material exceeding the hot spot level will be removed for incineration. The remaining contaminated material exceeding the protective level will be capped in place to prevent exposure to on-site workers, site visitors or trespassers. The protectiveness of the engineering controls will be enhanced through the use of institutional controls.

Effectiveness: Alternative 5 is effective. All contaminated material exceeding the protective level will be either managed on-site through capping and institutional controls or incinerated at a facility permitted to accept TSCA PCB waste. On-site management controls are effective if properly maintained. Institutional controls will be used to ensure that the engineering controls are properly maintained. Incineration as a treatment technology is proven to destroy PCBs. Fixed incinerators have the controls necessary to ensure effective operation. The time to achieve protection is limited by the time required to excavate the PCB-contaminated material and transport it to the incinerator and the time to implement the appropriate engineering and institutional controls.

Long-Term Reliability: Alternative 5 achieves long-term reliability through the permanent destruction of PCBs by incineration and the on-site management of low concentration contamination. Incineration is considered to be a reliable waste disposal technology when operated properly. Incinerators which accept PCB waste have the appropriate permits and other controls necessary to ensure long-term reliability. Engineering controls such as capping are reliable as long as they are property maintained. Institutional controls such as restrictions on excavation activities; appropriate health and safety training programs; periodic reviews and

Department notification of proposed changes in site conditions (e.g., removal of structures) or change in property ownership will be required to ensure that engineering controls are properly maintained. Since PCBs tend to degrade slowly in the environment, these controls are expected to be applied indefinitely.

Implementability: Alternative 5 is implementable. Contractors are readily available to excavate and transport the contaminated material for incineration. Although there are relatively few incineration facilities nationwide which accept TSCA PCB waste, adequate capacity is available. The two nearest TSCA incinerators are the Chemical Waste Management Inc. facility located in Port Arthur, Texas, and the Laidlaw Environmental Services facility located in Aragonite, Utah. Engineering and institutional controls are easily implemented if the owner consents and contamination has not or is not likely to migrate off site to adjoining properties. If contamination in excess of protective levels has migrated or has the potential to migrate off-site, this generic remedy is not applicable.

Implementation Risk: The implementation risk of Alternative 5 is low. No material will be treated on-site. The greatest threat to the surrounding community and site workers during implementation of the remedy is the result of contaminated dust emissions generated during excavation activities. However, emission controls, such as applying water as a dust suppressant, greatly reduce the potential for dust emissions and are easily implementable. In addition, protective clothing (e.g., tyvek) and health and safety procedures (e.g., decontamination procedures) are standard operating practice for workers involved in construction activities at hazardous waste sites. These safeguards will be implemented when appropriate. The installation of engineering controls is not expected to result in significant exposures to the environment or community. Risks to the environment are expected to be minimal due to the absence of sensitive environments or significant ecological risk as a prerequisite for application of the generic remedy. If any sensitive environments are expected to be impacted by site activities, this generic remedy is not applicable. Institutional controls do not present any implementation risk.

Reasonableness of Cost: Incineration is a costly technology, therefore the costs of Alternative 5 are relatively high. Alternative 5 attempts to balance the short-term costs of risk reduction (i.e., hot spot incineration) and the long-term costs of on-site risk management (i.e., engineering and institutional controls for non-hot spots). Incineration has the added benefit of reducing the long-term liability for the contaminated materials.

Treatment of Hot Spots: Alternative 5 treats hot spots of contamination.

E.3 Comparative Evaluation of Remedial Action Alternatives

In this section, the alternatives evaluated in E.2 are compared to one another based on the protectiveness standard, the five remedy selection balancing factors and the requirement for hot spot treatment, subject to feasibility.

E.3.1 Protectiveness

All of the remedial action alternatives except Alternative 1 are protective of human health. Alternative 2 achieves protection solely through the use of engineering and institutional controls. Alternative 3 achieves protection by removing all soil exceeding the protective level and transporting it to a secure off-site disposal facility. Alternative 4 achieves protection through a combination of excavation and off-site disposal, and engineering and institutional controls. Alternative 5 achieves protection through a combination of excavation and incineration, and engineering and institutional controls.

E.3.2 Effectiveness

All of the remedial action alternatives except Alternative 1 are effective. Alternative 2 achieves effectiveness exclusively through the use of engineering and institutional controls. However, if engineering controls were to fail, significant risk could result from exposure to highly concentrated PCB-contaminated materials. Therefore, Alternative 2 is considered to be less effective for hot spots. Alternative 3 achieves effectiveness through excavation and off-site disposal. Alternative 4 achieves effectiveness through a combination of off-site disposal and engineering and institutional controls. Alternative 5 achieves effectiveness through a combination of incineration and engineering and institutional controls.

In general, remedies which achieve a lower risk level through treatment or excavation and off-site disposal, employ more robust engineering and institutional controls, or achieve the remedial action objectives faster are considered more effective. Since the time to achieve protectiveness and the nature of the institutional and engineering controls are similar for all alternatives with the exception of Alternative 1, effectiveness is largely controlled by the amount of contamination remaining on-site at the completion of remedial activities. Consequently, Alternative 3, which achieves the protective level solely through off-site disposal, is considered more effective than Alternatives 2, 4 and 5 which employ a combination of engineering and institutional controls to manage contamination below the hot spot threshold.

E.3.3 Long-Term Reliability

All of the remedial action alternatives except Alternative 1 are reliable. Contamination which exceeds the protective level is either removed for off-site disposal or incineration, or managed through a combination of engineering and institutional controls. Off-site disposal or incineration are both considered reliable in the long term. Incineration is considered more reliable than landfilling due to the permanent destruction of contamination. Engineering controls are only considered reliable if properly maintained. Consequently, institutional controls are used in combination with engineering controls to ensure long-term reliability. Alternative 3 is considered the most reliable alternative. Alternative 5 is slightly more reliable than Alternative 4. Alternative 2 is considered less reliable than Alternatives 4 and 5.

The reliability of the alternatives also depends on the land-use scenario. The Department does not consider engineering and institutional controls to be reliable for generic remedies at residential sites. Such controls are, however, considered reliable for industrial and operating substation sites. Therefore, Alternative 3 is the only reliable alternative for residential sites.

E.3.4 Implementability

All of the remedial action alternatives are implementable. Alternatives 3, 4 and 5 utilize standard construction procedures to excavate and transport contaminated material. Adequate landfill space in either a RCRA subtitle D or TSCA approved landfill is currently available. The incineration capacity is also considered adequate. Engineering and institutional controls necessary to manage contamination are easily implementable for on-site contamination.

E.3.5 Implementation Risk

The short-term risk during implementation of each remedial alternative is considered low. Alternatives 3, 4 and 5 which require the excavation of contaminated material will require controls to reduce the risk of exposure to on-site workers, the community or the environment. Alternative 2 may require worker safety procedures to reduce the risk to on-site workers during implementation.

E.3.6 Reasonableness of Cost

The no-action alternative is, of course, the least costly of the 5 alternatives reviewed in this document. Of the remaining 4, Alternative 2 is the least costly followed by Alternative 4 and then Alternative 3. Alternative 5 is the most costly. Since Alternatives 4 and 5 apply only to hot spots, sites without hot spots will have Alternative 2 as the least costly followed by Alternative 3. However, assuming the presence of both hot spots and non-hot spots, the benefits of Alternative 2 are low since the potential for exposure to highly concentrated PCBs will continue to exist for a very long time.

The costs of Alternative 3 are high when compared to the benefits to human health and the environment. These high costs are mostly short-term costs. The long-term costs associated with maintaining the engineering and institutional controls will continue to approach those for off-site disposal or incineration. The costs of Alternative 3 may be more reasonable for small volumes of PCB-contaminated materials.

As with Alternative 3, the costs of Alternative 5 are high when compared to the benefits to human health and the environment. However, in the case of Alternative 5, these high costs are mostly attributed to the high cost of incineration which ranges from $700 to $1000 per ton. In contrast, the cost for disposal in a TSCA permitted facility ranges from $135 to $190 per ton.

E.3.7 Treatment of Hot Spots

Only Alternative 5 treats hot spots of contamination. Although Alternatives 3 and 4 do not treat hot spots, these alternatives reduce the concentration of PCBs at the site thereby reducing the amount of on-site risk which must be managed by engineering and institutional controls. Due to the high cost of incineration of PCB-contaminated material relative to disposal in a TSCA or

RCRA landfill and the high reliability of such landfills, treatment via incineration is not considered feasible. Alternative 2 neither treats hot spots of contamination nor reduces their concentration at the site.

E.4 Summary

A total of 5 remedial action alternatives were evaluated for this generic remedy policy. They are summarized in Table E-1. The no-action alternative (Alternative 1) does not meet the protectiveness standard. Alternative 2 utilizes only engineering and institutional controls and is not appropriate for hot spots of contamination. Alternative 3, which utilizes excavation and off-site disposal for concentrations of PCBs above the protective level, does not result in the least costly remedy for non-hot spots of contamination. However, Alternative 3 is the only alternative which does not require use of engineering and institutional controls. Since treatment of hot spots is not feasible (subject to the low cost and high reliability of TSCA and RCRA permitted landfills), Alternative 4 reduces the on-site risk posed by the hot spots by transferring it to a highly engineered and regulated disposal facility consistent with TSCA and RCRA. Alternative 4 also provides the least costly remedy for non-hot spots of contamination. Considering the high reliability of TSCA and RCRA permitted landfills, the cost of Alternative 5, which utilizes incineration to treat hot spots, is not reasonable even when the higher threshold is applied.

Table E-1: Remedial Alternative Summary

Alternative	Protectiveness	Effectiveness	Long-Term Reliability	Implementable	Implementation Risk	Reasonableness of Cost	Treats Hot Spots of Contamination
Alternative 1 (No Action)	Does not achieve protective levels.	Is not effective at reducing or managing risk.	Does not achieve long-term reliability.	Yes	Low	Both costs and benefits are low.	Does not treat hot spots of contamination.
Alternative 2 (Engineering and Institutional (E&I) Controls)	Achieves protectiveness through engineering and institutional controls.	Achieves effectiveness through engineering and institutional controls.	Engineering and institutional controls are reliable if properly maintained.	Yes	Low	For non-hot spots, costs are low compared to the benefits. For hot spots both costs & benefits are low.	Does not treat hot spots of contamination.
Alternative 3 (Excavation to Protective Level and Off-Site Disposal)	Achieves protectiveness through off-site disposal.	Achieves effectiveness through removal to protective level and off-site landfill management.	Off-site disposal in an approved landfill is reliable.	Yes	Low with proper controls	For non-hot spots, costs are high compared to the benefits. For hot spots, costs are low compared to benefits.	Does not treat hot spots of contamination. Applies higher cost threshold to off-site disposal of hot spots.
Alternative 4 (Excavation to Hot Spot Level, Off-site Disposal and E&I Controls)	Achieves protectiveness through off site disposal and engineering and institutional controls.	Achieves effectiveness through removal to hot spot level, off-site disposal and on-site management.	Off-site disposal in an approved landfill is reliable; engineering and institutional controls are reliable if properly maintained.	Yes	Low with proper controls	Costs are low compared to the benefits.	Does not treat hot spots of contamination. Applies higher cost threshold to off-site disposal of hot spots.
Alternative 5 (Excavation to Hot Spot Level, Off-site Incineration and E&I Controls)	Achieves protectiveness through off-site incineration and engineering and institutional controls.	Achieves effectiveness through removal to hot spot level, off-site incineration and on-site management.	Off-site incineration is reliable; engineering and institutional controls are reliable if properly maintained.	Yes	Low with proper controls	Costs are high compared to the benefits.	Treats hot spots of contamination.

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APPENDIX F: COMMERCIALLY PERMITTED PCB DISPOSAL COMPANIES*

	Company	Address	Phone No.
		INCINERATORS	
	Chemical Waste Management	PO Box 2563 Port Arthur, TX 77643	(409) 736-2821
	Laidlaw Environmental Services, Inc.	PO Box 1328 Coffeyville, KS 67337	(316) 251-6380
	Laidlaw Environmental Services, Inc.	PO Box 27448 (Office) Salt Lake City, UT 84127-0448	(801) 531-4200
		1600 N. Aptus Road (Site) Aragonite, UT 84029	(801) 531-4200 (801) 531-4394 (fax)
	Laidlaw Environmental Services, Inc.	PO Box 609 Deer Park, TX	(713) 930-2300
1	WESTON	One Weston Way West Chester, PA 19380	(610) 692-3030
		ALTERNATE THERMAL DESTRUCTION	
1	Geosafe Corporation	2950 George Washington Way	(509) 375-0710
		CHEMICAL DECHLORINATION	
2	Aptus, Inc.	PO Box 1328 Coffeyville, KS 67337	(316) 252-6380
1	Commodore Remediation Technologies, Inc.	1487 Delashmut Avenue Columbus, OH 43212	(614) 297-0365
1,2	Laidlaw Environmental Systems (PPM, Inc.)	1875 Forge Street Tucker, GA 30084	(770) 934-0902
1,2	Sunohio	1515 Bank Street, SW Canton, OH 44706	(330) 452-0837 (330) 430-4486 (fax)
1,2	Transformer Consultants Div. of S. D. Meyers, Inc.	180 South Avenue Tallmadge, OH 44278	(800) 444-9580
		PHYSICAL SEPARATION	
2	Laidlaw Environmental Services	PO Box 1328 Coffeyville, KS 67337	(316) 251-6380
2	S. D. Meyers, Inc.	180 South Avenue Tallmadge, OH 44278	(800) 444-9580
2	Sunohio	1515 Bank Street, SW Canton, OH 44706	(330) 452-0837 (330) 430-4486 (fax)
1	Terra-Kleen Response Group, Inc.	3970-B Sorrento Valley Blvd San Diego, CA 92130	(619) 558-8762

	Company	Address	Phone No.
2	Unison Transformer Services, Inc.	5801 Riverport Road Henderson, KY 43420	(502) 827-0541
	CHEMICAL WASTE LANDFILLS		
	Chemical Waste Management	Alabama Inc. Box 55 Emelle, AL 35459	(205) 652-9721
		Box 451 Kettleman City, CA 93239	(209) 386-9711
	Chemical Waste Management of the Northwest	Star Route, Box 9 Arlington, OR 98712	(503) 454-2643
	CWM Chemical Services Control, Inc.	1550 Balmer Road Model City, NY 14107	(716) 754-8231
	Envirosafe Services Inc. of Idaho	PO Box 16217 Boise, ID 83715-6217	(800) 274-1516
	Laidlaw Environmental Services	Grayback Mountain PO Box 22750 Salt Lake City, UT 84122	(801) 323-8900 (801) 323-8990 (fax)
	US Ecology, Inc.	Box 578 Beatty, NV 89003	(702) 553-2203
	Waste Control Specialists, LLC	PO Box 1937 Pasadena, TX 77501	(713) 944-5900 (713) 944-5252
	Wayne Disposal, Inc.	1349 Huron Street South Belleville, MI 48197	(313) 480-8085

***** The information in this table is from the October 1, 1997 EPA Region 10 list of Commercially Permitted PCB Disposal Companies. The complete Region 10 list also includes companies that perform pipeline removal, transformer decommissioning and other PCB-related services outside of the scope of this generic remedy guidance. For a complete up-to-date list, contact EPA Region 10 at 1-800-424-4EPA.

1 These companies are permitted to operate in all ten EPA regions.

2 These companies currently do not accept soil.

APPENDIX G: SUMMARY OF PCB DISPOSAL REQUIREMENTS UNDER TSCA

The following is a summary of federal PCB disposal requirements for PCB-contaminated soil pursuant to the Toxic Substances Control Act (TSCA). This summary is taken from Hedgebeth (1994) and is provided by the Department to assist parties in making the proper decisions regarding disposal of PCB-contaminated soils. Parties using the PCB generic remedy guidance are responsible for ensuring that they are in compliance with TSCA and all other applicable regulations.

1. PCB-contaminated soil in which the original PCB concentration was less than 50 parts per million (ppm) PCBs, and in which the actual concentration of PCBs in the soil is less than 50 ppm, and regardless of when the spill occurred, is not regulated for disposal under 40 C.F.R. Part 761.

2. PCB-contaminated soil in which the original PCB concentration was 50 ppm or greater, and in which the actual PCB concentration in the soil is 10 ppm or less, and regardless of when the spill occurred, is not regulated for disposal under 40 C.F.R. Part 761.

    NOTE: However, some initial removal and disposal as a result of a spill which occurred after the effective date of the PCB Spill Cleanup Policy would be required.

3. PCB-contaminated soil in which the original PCB concentration is unknown, and in which the actual PCB concentration in the soil is less than 50 ppm, and the spill occurred prior to April 18, 1978, is not regulated for disposal under 40 C.F.R. Part 761.

4. PCB-contaminated soil in which the original PCB concentration is unknown, and in which the actual PCB concentration in the soil is less than 10 ppm, and the spill occurred after April 18, 1978, is not regulated for disposal under 40 C.F.R. Part 761.

    NOTE: However, some initial removal and disposal as a result of a spill which occurred after the effective date of the PCB Spill Cleanup Policy (and the source of the spill was untested oil from electrical equipment other than circuit breakers, reclosers, and cable) would be required.

Questions about the information in this Appendix should be directed to EPA Region 10 at 1-800-424-4EPA.

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APPENDIX H: REFERENCES

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