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APR 25 2019

Mr. Brian Begley
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PPPO-02-5360343-19

Ms. Julie Corkran
Federal Facility Agreement Manager
U.S. Environmental Protection Agency, Region 4
61 Forsyth Street
Atlanta, Georgia 30303

Dear Mr. Begley and Ms. Corkran:

TRANSMITTAL OF THE UPDATED METHODS FOR CONDUCTING RISK ASSESSMENTS AND RISK EVALUATIONS AT THE PADUCAH GASEOUS DIFFUSION PLANT, PADUCAH, KENTUCKY, VOLUME 2, ECOLOGICAL (DOE/LX/07-0107&D2/R3/V2)

Enclosed please find the revised *Methods for Conducting Risk Assessments and Risk Evaluations at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky, Volume 2. Ecological,* DOE/LX/07-0107&D2/R3/V2. This revision updates the previously issued document. Updates have been coordinated through the Risk Assessment Working Group.

With these revisions, the Risk Methods Document has been updated to promote development of ecological risk assessments in accordance with the most current state and federal guidance.

The U.S. Department of Energy requests acknowledgement of receipt of the subject document no later than May 28, 2019.

If you have any questions or require additional information, please contact Rich Bonczek at (859) 219-4051.

Sincerely,

Tracey Duncan
Federal Facility Agreement Manager
Portsmouth/Paducah Project Office

Enclosures:

1. Methods for Conducting Risk Assessments and Risk Evaluations, Volume 2. Ecological, DOE/LX/07-0107&D2/R3/V2—Clean
2. Methods for Conducting Risk Assessments and Risk Evaluations, Volume 2. Ecological, DOE/LX/07-0107&D2/R3/V2—Redline

General Reference Compendium

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DOE/LX/07-0107&D2/R3/V2

Methods for Conducting Risk Assessments and Risk Evaluations at the Paducah Gaseous Diffusion Plant Paducah, Kentucky

Volume 2. Ecological

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DOE/LX/07-0107&D2/R3/V2

Methods for Conducting Risk Assessments and Risk Evaluations at the Paducah Gaseous Diffusion Plant Paducah, Kentucky

Volume 2. Ecological

Date Issued—April 2019

U.S. DEPARTMENT OF ENERGY
Office of Environmental Management

Prepared by
FOUR RIVERS NUCLEAR PARTNERSHIP, LLC,
managing the
Deactivation and Remediation Project at the
Paducah Gaseous Diffusion Plant
under Contract DE-EM0004895

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ACRONYMS

ADD	average daily dose
ASTM	American Society for Testing and Materials
AUF	area use factor
BAF	bioaccumulation factor
BCF	bioconcentration factor
BRA	baseline risk assessment
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
COC	contaminant of concern
COPEC	chemical or radionuclide of potential ecological concern
COPC	chemical or radionculide of potential concern
CSM	conceptual site model
DOE	U.S. Department of Energy
DQO	data quality objective
EPA	U.S. Environmental Protection Agency
EPC	exposure point concentration
ERA	ecological risk assessment
ERAWG	Ecological Risk Assessment Working Group
ERED	Environmental Residue-Effects Database
FS	feasibility study
GLWQI	Great Lakes Water Quality Initiative
HQ	hazard quotient
KDEP	Kentucky Department for Environmental Protection
LANL	Los Alamos National Laboratory
LOAEL	lowest observed adverse effect level
MED	Mid-Continent Ecology Division
MDC	minimum detectable concentration
MQC	minimum quantification concentration
NFA	no further action
NRWQC	National Recommended Water Quality Criteria
NOAEL	no observed adverse effect level
OREIS	Oak Ridge Environmental Information System
PAH	polycyclic aromatic hydrocarbon
PCBRes	PCB Residue Effects Level Database
PCOPEC	preliminary chemical or radionuclide of potential ecological concern
PEGASIS	Portsmouth/Paducah Project Office Environmental Geographic Analytical Spatial Information System
PGDP	Paducah Gaseous Diffusion Plant
RAIS	Risk Assessment Information System
RAWG	Risk Assessment Working Group
RCRA	Resource Conservation and Recovery Act
RI	remedial investigation
ROD	record of decision
SAP	sampling and analysis plan
SLERA	screening-level ecological risk assessment
SMDP	scientific/management decision point
T&E	threatened and endangered
TCL	target cleanup level
TRV	toxicity reference value

UCL	upper confidence limit
WWAH	Warm Water Aquatic Habitat
XRF	X-ray fluorescence

EXECUTIVE SUMMARY

An Ecological Risk Assessment Working Group (ERAWG) was chartered in April 2000 to develop effects-based threshold concentrations for no-action and action decisions and to develop risk assessment and analysis methods to support decision making for sites requiring further evaluation and to support verification that cleanup goals have been reached following implementation of a response action. In 2008, another ERAWG comprised of representatives from the Kentucky Department for Environmental Protection (KDEP), U.S. Environmental Protection Agency (EPA), and U.S. Department of Energy was assembled to update the document in accordance with new guidance. In 2014, the Paducah Risk Assessment Working Group (RAWG) included ecological evaluations in their discussions and provided updates to this document. In 2018, the RAWG agreed to perform another update to incorporate recent information, such as updated EPA Region 4 guidance.

In April 2000, in subsequent updates in 2008 and 2014, and in this update, the ERAWG agreed that the overall process of designing and conducting ecological risk assessments (ERAs) would continue to follow an eight-step process concordant with current EPA Superfund guidance, *Ecological Risk Assessment Guidance for Superfund: Process for Designing and Conducting Ecological Risk Assessments*, *Interim Final* (EPA 1997a). Additionally, for this update, the ERAWG agreed to incorporate *Region 4 Ecological Risk Assessment Supplemental Guidance* (EPA 2018).

This document is not intended to be prescriptive, rather it is meant to be a guidance document describing the ERA process for Paducah Gaseous Diffusion Plant (PGDP). The ERAWG agreed upon sources and types of published data, model parameters, and methods for obtaining site-specific data that are required in various steps of the ERA process, and these are described. The revision of this document incorporates updates to the no-action levels and guidance from EPA and KDEP issued after the development of the initial version of this document.

This ERA guidance document describes the input from ecological risk assessors that is required for PGDP decision documents. Ecological risk input to decision documents includes summaries of ERA and screening results, evaluations of the adverse effects on ecological receptors of the proposed remedial actions and the effectiveness of proposed exposure controls, and the requirements of monitoring plans.

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1. INTRODUCTION

This document presents guidance for designing and conducting ecological risk assessments (ERAs) and related ecological risk analyses at the Paducah Gaseous Diffusion Plant (PGDP) in Paducah, Kentucky. This ecological risk guidance reflects the consensus of the PGDP Ecological Risk Assessment Working Group (ERAWG). The original ERAWG chartered in April 2000, was comprised of representatives of the Kentucky Department for Environmental Protection (KDEP), Kentucky Department of Fish and Wildlife Resources, U.S. Environmental Protection Agency (EPA), U.S. Fish and Wildlife Service, and U.S. Department of Energy (DOE). The charter directed the ERAWG to reach consensus on (1) criteria to support no-action and remedial action decisions and (2) risk assessment and analysis methods for sites requiring evaluation and verification. The ERAWG assembled to update this document in accordance with new guidance in 2008 was comprised of representatives of KDEP, EPA, and DOE. By documenting ERAWG consensus on decision criteria, guidelines, and methods, this guidance incorporates the requirements of the Commonwealth of Kentucky and EPA and promotes prompt approval of ecological risk plans and reports for PGDP sites. In 2014, the Paducah Risk Assessment Working Group (RAWG) included ecological evaluations in their discussions and provided updates to this document. In 2018, the RAWG agreed to perform another update to incorporate recent information, such as updated Region 4 guidance.

This document is not intended to be prescriptive, rather it is meant to be a guidance document describing the ERA process for PGDP. This consensus guidance supplements existing guidance for conducting risk assessment activities at PGDP. For ERAs at PGDP sites, this ERAWG consensus guidance is similar in many areas to previous documents but takes precedence over these previous documents when they differ. The PGDP ERA method document supplements and is concordant with existing state and federal guidance documents. The methods in this PGDP ERA methods document apply to both source and integrator[1] units at PGDP and remedial activities being conducted under the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA) and the Resource Conservation and Recovery Act of 1976 (RCRA) regulations. ERAs for PGDP source or integrator units that were or are currently being conducted according to earlier guidance are expected to be consistent with the initial steps of the ERA process as described in this PGDP ERA methods document. If additional evaluation is required for these sites to support risk-management decisions, those evaluations are expected to conform to this guidance.

This document presents the updated ERAWG-consensus criteria values as well as guidance for designing and conducting risk assessments and related ecological risk analysis activities supporting risk management decisions at PGDP. The eight-step process to be followed by ERAs for all PGDP sites is described in Chapter 2. Screening benchmarks for soil, surface water, and sediment are provided. These benchmarks are for use in all ERAs conducted in accordance with this guidance. Chapter 2 includes model receptors and values of exposure parameters for use at all PGDP sites and guidance on selecting toxicity reference values (TRVs). Guidance is also provided for the conduct, use, and reporting of each of the eight steps of PGDP ERAs. Chapter 3 describes the data, results, and information about ecological risk that should be included in CERCLA and RCRA decision documents for PGDP sites. The following appendices support this document.

- Appendix A—PGDP No Further Action Levels
- Appendix B—Exposure Parameters for PGDP Model Ecological Receptors

[1] Integrator units are those units or areas that accumulate contaminants from source units or areas.

- Appendix C—Calculating Preliminary Hazard Quotients
- Appendix D—Examples of EPA Streamlined Risk Summary Tables
- Appendix E—Checklist for Ecological Assessment/Sampling
- Appendix F—Kentucky Ecological Screening Values

2. DESIGNING AND CONDUCTING ECOLOGICAL RISK ASSESSMENTS AT PGDP

The 2001 ERAWG reached consensus on specific elements potentially required for all ERAs at PGDP, including specific decision criteria, such as screening benchmarks; model receptors, exposure assumptions, and parameters for preliminary risk calculations; and formats for assessment endpoints and ERA reports. PGDP ERA rules are consensus statements clarifying potentially important guidelines. The ERAWG also agreed that ERAs at PGDP must follow an eight-step process concordant with the EPA eight-step process for designing and conducting ERAs at Superfund sites (EPA 1997a). The review by the 2008 ERAWG confirmed the use of the eight-step process and updated some aspects of this guidance with new ecological risk information and screening levels. The EPA eight-step ERA process leading to scientific/management decision points (SMDPs) is illustrated in Figure 1.

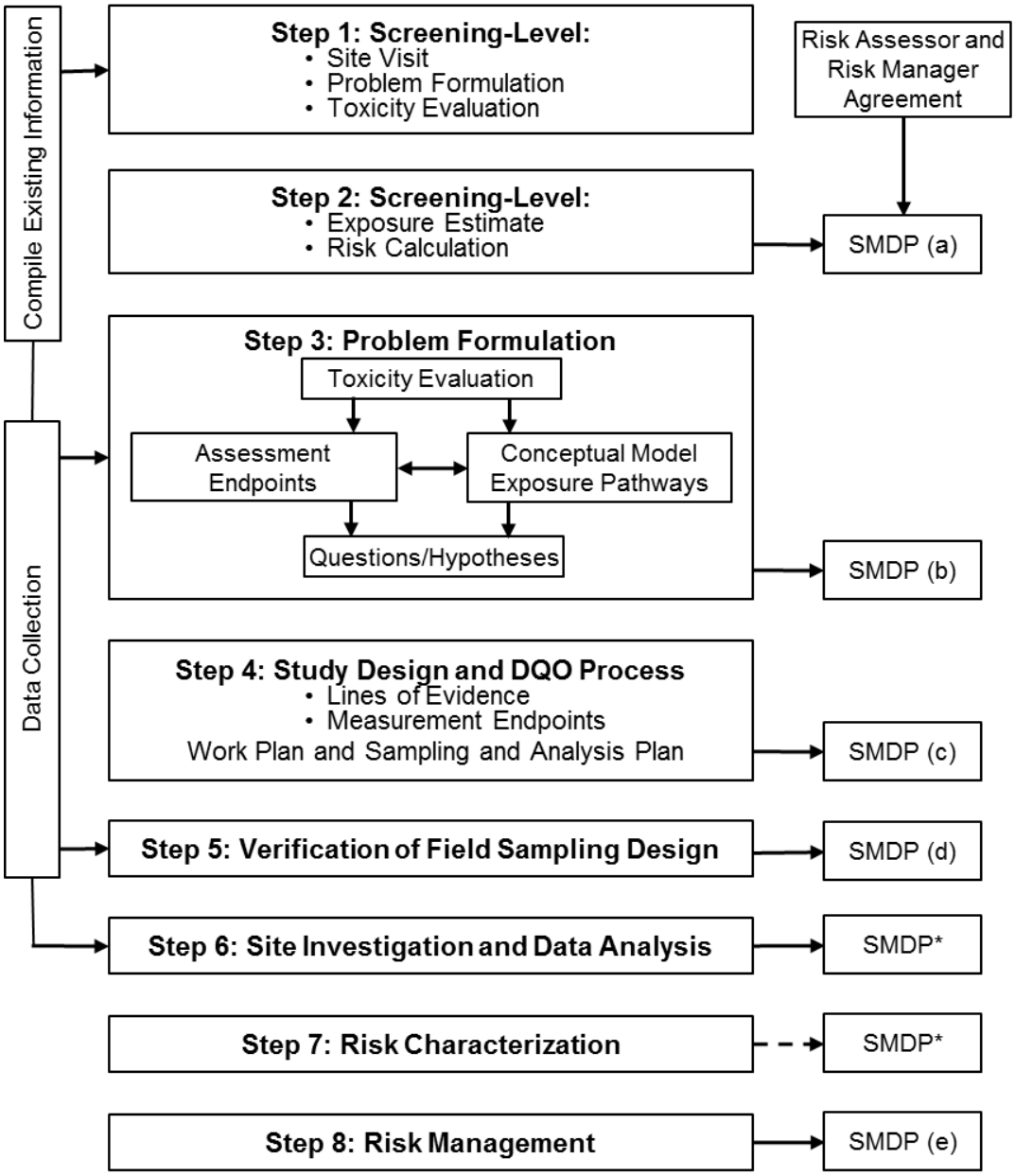
The eight-step process for ERAs at PGDP agreed upon by the ERAWG supplements the EPA's ERA process (EPA 1997a). Although the names of the eight steps are identical, some of the activities within the steps are different. This site-specific consensus document specifies where the PGDP process differs slightly from the EPA process in the sequencing of activities. Where this document is silent, EPA governs (EPA 1997a). A description of the eight-step process, including implementation of Data Quality Objectives (DQOs), and directions for applying the process to ERAs at PGDP are given below.

The PGDP ERA process should be complete to justify a decision to remediate a site based on ecological risks alone. If a decision is made to remediate a site before the PGDP ERA process is complete, such as when high risk to human health has been established during scoping activities (DOE 2018), then evaluations of the protectiveness of proposed remedial actions for ecological receptors will be more uncertain. Given the greater uncertainty when proceeding with remediation before the PGDP ERA process is complete, remedial goal options will be based on more default and effect assumptions, and site-specific target cleanup levels (TCLs) likely will be lower and more costly to achieve than would result following completion of the PGDP ERA process. A decision that no further action is necessary to protect ecological receptors, on the other hand, may be justified following the early steps of the PGDP ERA process (Steps 1, 2, and 3).

2.1 SCOPING FOR ECOLOGICAL EVALUATION

Prior to ecological evaluation of a site, a scoping meeting should be conducted with ecological risk assessors from the regulatory agencies. Some aspects of ecological evaluation, even at a screening level, are site-specific, and discussions regarding the site held prior to the evaluation will focus resources and efforts in the appropriate direction. The scoping meeting should include discussion of the presentation of the dataset for the ERA and the format for any requested electronic copies of the data to be included with the ERA. A checklist for ecological assessment/sampling is provided in Appendix E to assist in beginning to characterize the site for problem formulation.

The consensus of the ERAWG is that PGDP sites with any amount of vegetation are potential nesting or feeding habitat for ecological receptors and, thus, require at least a screening-level ecological risk assessment (SLERA). Some sites may not require a screening for ecological risk from soil because no habitat and no exposure pathways for ecological receptors currently exist at the site. Sites meeting the general guidelines here can be considered for exclusion from the screening process. Each site meeting the



SMDP Explanation

(a) Decision about whether a full ecological risk assessment is necessary.

(b) Agreement among the risk assessors, risk manager, and other involved parties on the conceptual model, including assessment endpoints, exposure pathways, and questions or risk hypotheses.

(c) Agreement among the risk assessors and risk manager on the measurement endpoints, study design, and data interpretation and analysis.

(d) Signing approval of the work plan and sampling and analysis plan for the ecological risk assessment.

(e) Signing the Record of Decision.

* SMDP is required only if change to the sampling and analysis plan is necessary.

Source: Adapted from EPA 1997a. *Ecological Risk Assessment Guidance for Superfund: Process for Designing and Conducting Ecological Risk Assessments, Interim Final*.

Figure 1. EPA Eight-Step Process for Designing and Conducting ERAs

criteria still needs to be discussed with risk managers and regulators, as these criteria are not prescriptive and some sites meeting them still may need to undergo evaluation.

Sites considered for exclusion should have all of the following characteristics:

- All areas of soil contamination shallower than five ft are covered with concrete, pavement, or a building.

- Routes for off-site migration of soil also are incomplete due to the presence of concrete, pavement, or a building.

- Features and structures preventing the existence of complete pathways are reasonably expected to remain in place.

Groundwater at these sites still should undergo screening for ecological risk, as described in Section 2.3.

2.2 SCREENING-LEVEL ECOLOGICAL RISK ASSESSMENT (STEPS 1 AND 2)

Steps 1 and 2 of the ERA process at PGDP constitute a SLERA. The purpose of the SLERA is to evaluate whether existing data justify a decision that site contaminants do not pose a risk to ecological receptors, or whether additional evaluation is necessary. Because the consequences of incorrectly deciding that there is risk (further evaluation) when there is no risk are less severe than the consequences of incorrectly concluding there is no risk (not reducing or eliminating risk) when there is risk, the SLERA is designed to minimize the likelihood of the latter, false negative error. That is, the SLERA is intentionally conservative (i.e., protective) (EPA 1997a). If no potential for risk is identified in a conservative (or protective) SLERA, then risk managers can confidently conclude that no further action (i.e., investigation, remediation) is required at the site. A SLERA is an appropriate risk analysis during scoping, prioritization, and work plan development activities prior to the remedial investigation (RI)/feasibility study (FS) or equivalent.

Steps 1 and 2 of the ERA process contain the following elements:

- Site visit (if needed),
- Screening-level problem formulation [preliminary conceptual site model (CSM)],
- Screening-level effects evaluation (toxicity threshold benchmarks),
- Screening-level exposure estimate (site maximum concentration data), and
- Screening-level risk calculation (site concentration data screens).

In Step 1 of SLERAs/ERAs for PGDP sites, ecological risk assessors use available information to develop a preliminary CSM. Available information includes observations made during site reconnaissance, historical documents, existing data, and professional judgment of other technical experts who are familiar with the site (e.g., biologists, hydrogeologists, chemists, and engineers). The preliminary CSM describes the environmental setting of the individual site, the site's immediate surroundings (as opposed to the larger PGDP), and the contaminants known to exist at the site. The preliminary CSM should identify fate and transport mechanisms by which site contaminants potentially move off-site, and briefly discuss the ways that site contaminants act on likely receptors.

Based on the preliminary CSM, the ecological risk assessors identify the potentially complete exposure pathways and endpoints for the screening assessment. The potentially contaminated source media at the site, such as soil, surface water, sediment, and groundwater, are described, and the classes of receptors

potentially exposed to these media are identified. As determined in the scoping described in Section 2.1, all contaminants in those exposure media (e.g., soil, sediment, surface water, or groundwater) associated with a complete ecological receptor exposure pathway need to be screened in Steps 1 and 2. Subsurface soils to a depth of 5 ft should be screened if surface soil at a site likely will be removed and not replaced or if site-specific information indicates that ecological receptors are exposed to potentially significant levels of contamination (e.g., burial grounds and waste piles). For PGDP SLERAs/ERAs, surface soil is defined as no deeper than 0–1 ft below ground surface (bgs). For SLERAs/ERAs, use of samples collected in the 0–6-inch bgs depth is preferred over the 0–1-ft depth when those results are available. This shallower depth range should be considered when additional sampling of a unit is done for the purposes of ecological investigation.

The exposure pathways and endpoints for the site specify which ecological effects data are required. For PGDP SLERAs/ERAs, the screening-level effects data are screening-level benchmarks, which are concentrations of substances in abiotic media that are associated with little to no adverse ecological effect. The screening benchmarks used to make the screening-level risk calculations are the PGDP no further action (NFA) levels. There are NFA levels for substances in soil, sediment, and surface water. Screening benchmarks are also available for some classes of chemicals [e.g., total polycyclic aromatic hydrocarbons (PAHs)]. If groundwater potentially discharges to surface water, groundwater concentrations are compared to surface water screening benchmarks. There are not any NFA levels for constituents in air. PGDP NFA levels for soil, sediment, and surface water are described in Appendix A.

In Step 2 of SLERAs/ERAs at PGDP sites, the maximum site concentrations for substances in a given exposure medium are compared to the screening-level benchmarks for those substances [i.e., PGDP NFA levels (PGDP ERA Rule 2)]. For the NFA screen at PGDP sites, the maximum site concentration for a substance reported as detected in any sample is the larger of the maximum detected concentration and one half of the maximum reported detection limit for the substance in samples reported as nondetect. Therefore, it is highly recommended that there be some existing data with detection limits below the NFA values. If existing data do not have adequate detection limits, new data may be collected to replace them. Existing data should be considered valid until newer data are collected to replace them.

Sample quantification limits will be evaluated, as described in the Human Health Risk Methods Document (DOE 2018). See text box.

Site concentration data for PGDP sites are those data present in the Portsmouth/Paducah Project Office Environmental Geographic Analytical Spatial Information System (PEGASIS). All relevant concentration data for a site should be gathered and entered into Paducah's Oak Ridge Environmental Information System (OREIS) before conducting the screen. Although data on the extent of contamination need not be complete before screening, representative samples are required and the nature of the contamination at the site should be defined. If sampling results are suspected of not being representative of the site or data quality is unsatisfactory (e.g., detection limits routinely exceed NFA values), then additional data may be required for the screening evaluation needed to reach SMDP (a) following Step 2. Data sets that have been evaluated and accepted for use in human health risk assessments for PGDP sites are acceptable for use in ERAs; however, these data should not be screened against background and human health preliminary remediation goals, and essential nutrients should not be eliminated before conducting the ecological NFA screen. If existing data are not used, the reasons for not using the data should be explained. For some samples, duplicate or split-sample analyses may be available. When calculating the representative concentration, the maximum value reported in the duplicate or split-sample analysis will be used. Duplicate and split-sample results will not be averaged when calculating the representative concentration in baseline risk assessments performed for PGDP.

EVALUATION OF SAMPLE QUANTITATION LIMITS

Chemicals. The sample quantitation limits for each analyte and sample will be examined to determine if these limits were below the concentration at which the analyte may pose an unacceptable risk or hazard to human health. If the maximum sample quantitation limit for an analyte (over all samples within a medium) is greater than the concentration that may pose an unacceptable risk or hazard to human health and the analyte is not detected in any sample, then the data for that analyte will be deemed suspect. Data from these analytes will not be used quantitatively in the risk assessment, but the potential risk or hazard from exposure to media potentially containing these analytes will be examined qualitatively. In developing the qualitative assessment for these data, the maximum quantitation limit for the analyte (in all samples from a medium) will be compared to the appropriate no-action residential preliminary remediation goal, if historical or process information indicates that the analyte potentially could be present. One-half the maximum quantitation limit for the analyte (in all samples from a medium) will be used in this comparison if historical or process information indicates that the analyte is not expected to be present.

Radionuclides. The analysis for radionuclides will be performed in two steps. In the first step, the MDC/minimum detectable concentration/minimum quantification concentration (MQC) for each analyte and sample will be examined to determine if these limits were below the concentration or activity concentration at which the analyte may pose an unacceptable risk (or radiological dose). If the maximum MDC/MQC for an analyte over all samples within a medium is greater than the concentration or activity concentration that may pose an unacceptable risk (or radiological dose) to human health and the analyte is less than the minimum detectable activity concentration MDC/MQC in any samples, then the data for that analyte will be deemed suspect.[2] The MDCs used for radionuclides should be the MDCs established in the MARLAP Manual (EPA 2004), which provides guidance for evaluating SQLs for radionuclide data. For radionuclides, all reported values, including negative values,[3] will be used to derive the exposure point concentrations (EPCs) under current conditions.

Survey-type data. When X-ray fluorescence (XRF) data are used in the derivation of EPCs, all XRF values, including negative values, will be used as reported. Other survey-type data (such as PCB field test kits) should be used in accordance with project-specific review of the data and performance of the method.

EXAMPLE OF EVALUATION OF SAMPLE QUANTITATION LIMITS

Chemicals:

Consider the following results for Chemicals W, X, Y, and Z. Assume that Chemicals W and Y are site-related contaminants and that Chemicals X and Z are not site-related. Also, let the data qualifier (U) be defined as not detected at the sample quantitation limit (SQL).

Chemical	Sample 1	Sample 2	Sample 3	Sample 4	Screening Value
W	10U	10U	10U	10U	5
X	10U	10U	10U	10U	5
Y	10U	6	10U	10U	5
Z	1U	1U	1U	1U	5

Then, following the rules in Step 3 of the data evaluation process:

- Results for Chemical W are suspect because the maximum SQL overall results (10) are greater than the screening value (5), and Chemical W was not detected in any sample. Because Chemical W is site-related, the qualitative risk analysis of this chemical's potential effect would use the full SQL.
- Results for Chemical X are suspect because the maximum SQL overall results (10) are greater than the screening value (5), and Chemical X was not detected in any sample. Because Chemical X is not site related, the qualitative risk analysis of this chemical's potential effect would use one-half the SQL.
- Results for Chemical Y are not suspect even though the maximum SQL exceeds the screening value because Chemical Y was detected in one sample.
- Results for Chemical Z are not suspect because the maximum SQL is less than the screening value.

For radionuclides, SQLs should be evaluated in accordance with the guidance in the Multi-Agency Radiological Laboratory Analytical Protocols (MARLAP) Manual (EPA 2004) ….

[2] Radionuclide results reported with an uncertainty that indicates the result could fall below the MDC will be reported as detections or nondetects or otherwise flagged in the data verification/validation and assessment process, indicating the detected result is tentative.

[3] Negative results may be reported due to a statistical determination of the counts seen by a detector, minus a background count.

Source: Adapted from DOE 2018. *Methods for Conducting Risk Assessments and Risk Evaluations at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*, Volume 1. *Human Health*

NFA levels are available for some groups of substances for some media. For Steps 1 and 2 of PGDP SLERAs/ERAs, the maximum concentrations for all members of a group detected at a site and the reported detection limits for all members of the group reported as nondetected are summed to give the group total concentration. The group total concentration is compared to the screening benchmark for the group (e.g., total PAHs) when at least one member of the group is detected. If toxicity equivalency factors for effects on ecological receptors are available for a group of related chemicals, then they should be used to adjust concentrations when calculating group totals or to compare individual chemicals against the standard benchmark.

PGDP ERA Rule 1—Assume shallow groundwater discharges to surface water. Provide justification that groundwater does not discharge to surface water if groundwater data are not screened in Steps 1 and 2.

Screens are conducted for surface soil, sediment, surface water, and groundwater (if groundwater potentially discharges to surface water) at the site if they potentially result in exposure to ecological receptors. The comparison of site concentrations to screening benchmarks for abiotic media assumes that the primary exposure routes for receptors at the site are the same as those for receptors at the test site or in the lab experiments that generated the data used to derive the screening benchmarks. These screens constitute the screening-level risk calculations and should include calculation of the screening hazard quotient (HQ). If the site maximum concentration (the numerator) is greater than the screening benchmark (the denominator), then the substance has an HQ > 1 for that medium. Because the NFA values are meant to be protective of general end points that may not exist at a PGDP site, the HQs generated during the screening step should be referred to as screening HQs to distinguish them from the receptor-specific HQs generated during a baseline ERA. An example table depicting ecological screening for chemicals and radionuclides is presented in Exhibit 1.

PGDP ERA Rule 2—In Step 2, compare the maximum site concentrations for substances in a given exposure medium to the screening-level benchmarks and generate screening HQs. Maximum site concentrations are the larger of the maximum detected concentration and one-half of the maximum reported detection limit for the substance in samples reported as nondetect.

Chemicals with known additive synergistic effects or that bioaccumulate are retained as chemical of potential ecological concern, even if they are detected below NFA levels, and evaluated further in Step 3. These COPECs should be communicated clearly among the risk assessors and risk managers [SMDP (b)]. The list of bioaccumulating compounds is based on the list developed by EPA and is presented in Appendix A.

2.2.1 Steps 1 and 2 Uncertainties

At Steps 1 and 2 of the ERA process, information will not be complete, and some constituents will not have NFA levels. There may not be site chemistry data for all classes of constituents. There may be incomplete information about what animal and plant species actually or potentially occur at the site, including threatened and endangered (T&E) species. The document recording the results of Steps 1 and 2 should discuss these uncertainties.

Exhibit 1. Example Table Depicting Ecological Screening for Chemicals in Soils

Example Table Depicting Ecological Screening for Chemicals in Soils								
CHEMICAL	**Freq. of Detection**	**Range of Detection Limits**	**Range of Detected Conc.**	**Location of Maximum Detected Conc.**	**EPA Region 4 Screening Value**	**Max Hazard Quotient (HQ)**	**Freq. Exceeding ESV**	**PCOPC (Y/N) Basis**
Volatile Organic Compounds, µg/kg								
1,2-Dichlorobenzene	2/10	4.9 – 6.4	3.5 - 100	SS-06	90	1.1	1/10	Yes/E
Tetrachloroethene	10/10	4.8 - 9	10 – 210	SS-06	60	3.5	3/10	Yes/E
1,1,2-Trichloroethene	0/10	4.9 - 12	NA	NA	180	NA	0/10	No/C
Cyclohexane	0/10	4.9 - 12	NA	NA	NA	NA	0/10	No/B
Semi-volatile Organic Compounds, µg/kg								
2-Chlorophenol	0/10	5-20	NA	NA	40	NA	NA	Yes/D
3-Chlorophenol	0/10	5-20	NA	NA	7,000	NA	NA	Yes/D
Pentachlorobenzene	2/10	79-120	40-2,200	SS-03	500	4.4	1/10	Yes/E
Polycyclic Aromatic Hydrocarbons (PAHs), µg/kg								
Low Molecular Weight Polycyclic Aromatic Hydrocarbons (LMW-PAHs)								
Acenaphthene	2/10	220 - 360	24-54	SS-08	F	NA	NA	No/F
Fluorene	2/10	220 - 360	41-91	SS-08	F	NA	NA	No/F
Phenanthrene	3/10	220 - 350	23-120	SS-08	F	NA	NA	No/F
Naphthalene	1/10	220 - 360	ND-73	SS-08	F	NA	NA	No/F
Total LMW-PAHs[1]	4/10	220 - 350	70 - 265	SS-08	29,000	0.009	0/10	No/A
High Molecular Weight PAHs (HMW-PAHs), µg/kg								
Benzo(a)anthracene	4/10	220 - 360	19 - 640	SS-09	F	NA	NA	No/F
Benzo(a)pyrene	2/10	220 - 350	20 - 590	SS-09	F	NA	NA	No/F
Benzo(b)fluoranthene	2/10	220 - 360	28 - 120	SS-09	F	NA	NA	No/F
Chrysene	1/10	220 - 350	21 - 130	SS-09	F	NA	NA	No/F
Dibenz(a,h)anthracene	1/10	220 - 350	ND - 46	SS-09	F	NA	NA	No/F
Indeno(1,2,3-cd)pyrene	5/10	220 - 350	21 - 54	SS-09	F	NA	NA	No/F
Pyrene	3/10	220 - 350	26 - 300	SS-09	F	NA	NA	No/F

Exhibit 1. Example Table Depicting Ecological Screening for Chemicals in Soils (Continued)

Example Table Depicting Ecological Screening for Chemicals in Soils								
CHEMICAL	**Freq. of Detection**	**Range of Detection Limits**	**Range of Detected Conc.**	**Location of Maximum Detected Conc.**	**EPA Region 4 Screening Value**	**Max Hazard Quotient (HQ)**	**Freq. Exceeding ESV**	**PCOPC (Y/N) Basis**
Total HMW-PAHs[2]	5/10	220 - 350	21 – 1,800	SS-09	1,100	1.6	1/10	Yes/E
Pesticides, µg/kg								
4,4'-DDD	7/10	4.9 – 5.2	2.8 - 25	SS-07	6.3	4	0/10	Yes/E
4,4'-DDE	6/10	4.9 – 5.2	2.4 - 49	SS-07	110	0.4	0/10	No/A
4,4'-DDT	6/10	4.9 – 5.2	2.5 - 110	SS-07	1.7	65	1/10	Yes/E
Total DDT	7/10	4.9 – 5.2	18.3 - 184	SS-07	21	8.8	5/10	Yes/E
Heptachlor	1/10	2.7 – 4.7	ND - 140	SS-07	59	2.4	2/10	Yes/E
Inorganic Compounds, mg/kg								
Copper	9/10	1 - 1.3	10.4 - 66	SS-07	28	2.4	3/10	Yes/E
Manganese	10/10	1 - 3	44 - 1,020	SS-06	220	4.6	6/10	Yes/E
Sodium	3/10	61.3 – 70.6	2,550	SS-06	NA	NA	NA	Yes/G
Vanadium	10/10	1 - 3	12.1 - 54	SS-07	7.8	6.9	10/10	Yes/E

Footnotes:

PCOPC = Preliminary Chemical of Potential Concern (yes/no)

1 = Total of low molecular weight PAHs includes acenaphthene, fluorene, phenanthrene, and naphthalene,

2 = Total of high molecular weight PAHs includes benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, chrysene, dibenz(a,h)anthracene, indeno(1,2,3-cd)pyrene, and pyrene

A = Maximum detected concentration is less than the screening value.

B = Chemical lacks a Region 4 screening value and was not detected in any sample.

C = Maximum detection limit is less than screening value for a chemical not detected in any sample.

D = Maximum detection limit exceeds screening value for a chemical not detected in any sample.

E = Maximum detected concentration exceeds screening value.

F = Chemical is a member of a class of compounds and the total concentration is screened against the screening value for the total compound in that class.

G = Chemical was detected and no Region 4 ESV was available.

Note: This exhibit was excerpted in its entirety from *Region 4 Ecological Risk Assessment Supplemental Guidance* (EPA 2018) as an example only, in agreement with discussions by the Risk Assessment Working Group. At Paducah, in addition to chemicals, radionuclides also will be screened in the same manner.

2.2.2 Use of Steps 1 and 2

The screening results and site information for the given unit are used at SMDP (a) to support a decision whether to continue evaluating ecological risk. If any constituent in an abiotic medium to which organisms are potentially exposed is present at a concentration exceeding the PGDP NFA level or if there is not an NFA level for a constituent, then further evaluation of the potential for risk will be required unless the decision to take an action (such as soil or sediment removal) has been made. At SMDP (a), the results of the screening evaluation should be discussed with the regulatory agencies. If constituents exceed NFA levels, there are critical data gaps, or other uncertainties at this point in the process are large enough, then additional data could be required for decision making.

Another important piece of information risk managers need at the first SMDP [SMDP (a)] is the nature of the habitat and ecological setting of the site. At SMDP (a), risk managers may decide that sites do not require additional evaluation, even though one or more substances are identified as chemicals or radionuclides of potential ecological concern (COPECs), if exposure pathways are not complete or actions will be taken to eliminate the exposure pathway. The terms chemicals or radionuclides of potential concern (COPCs) and COPECs are used interchangeably in this document; however, in reporting results of the evaluations described in this document, the term COPECs should be used.

2.2.3 Reporting Steps 1 and 2

The documentation of Steps 1 and 2 for PGDP sites should include the following:

- Brief habitat description, photographs, and map, if appropriate;
- Preliminary CSM;
- Discussion of all changes to the dataset made to refine the raw data to that used in the risk assessment;
- Tables of screening results;
- List of wildlife species actually or potentially occurring at the site, including T&E plant and animal species; and
- Discussion of uncertainties.

The discussion of the uncertainties should identify constituents for which there are not NFA levels or analytical chemistry data. Chemicals without NFA levels are automatically retained as COPECs for further evaluation in the baseline risk assessment (BRA) (Step 3a). The decision whether to collect additional data for screening, proceed with the ERA, or conduct no further evaluation or other action can be documented in the report.

When reporting risks from PGDP sites at which no surface soil samples were collected, the report needs to state the following: "The potential risk from exposure to surface soil was not quantified in this risk assessment and is, therefore, unknown. The risk from exposure to this medium was not quantified because the investigation of this medium falls outside the scope of the current investigation." (Note that a similar caveat also will apply when considering risk from potential exposure to groundwater when data are not available because of the scope of the investigation.) Ecological assessment does not move beyond Step 2, if maximum site concentrations do not exceed their NFA levels.

2.3 ERA PROBLEM FORMULATION (STEP 3)

The purpose of Problem Formulation (Step 3) is to provide sufficient information to support a risk management decision concerning the need for additional evaluation of ecological risk. Important inputs to this decision [SMDP (a)] are the identification of COPECs that warrant further evaluation, an understanding of the effects of COPECs on ecological receptors, identification of complete exposure pathways by which COPECs are brought into contact with ecological receptors, and identification of assessment endpoints. The outputs of the Problem Formulation step are the final list of COPECs, assessment endpoints, and questions and hypotheses potentially requiring further evaluation in an ERA. In support of SMDP (b), the risk assessors provide their conclusions and recommendations based on professional judgment.

2.3.1 Reevaluation of COPECs (Step 3a)

The further evaluation of COPECs identified in Steps 1 and 2 of the EPA eight-step process is called the "Refinement of COPECs," and it occurs after the screen. Some evaluation of COPECs beyond the comparison with screening values appears with the results of the screening, as described in previous sections. Those evaluations should be repeated as part of the Problem Formulation step (Step 3) for the BRA. According to EPA's amended guidance, Step 3a of the process represents an opportunity to present a "reasoned toxicological approach for the elimination of one or more COPCs from future consideration" (EPA 2000a). The purpose of this step is to sharpen the focus of the evaluation on those COPECs that can and should be evaluated because of the potentially significant risk they pose to ecological receptors at the site.

Step 3a of ERAs for PGDP sites include the following activities:

- Compare site and background concentrations;
- Evaluate frequency and distribution of concentrations exceeding benchmarks and/or referenced site values;
- Evaluate site-specific tissue concentrations against benchmarks for direct risk to organism sampled (if available);
- Calculate preliminary HQs for bioaccumulating constituents and for selected PGDP wildlife receptors;
- Evaluate site-specific exposure data and assumptions [e.g., area use factor (AUF), ingestion rates, and diet];
- Consider alternative toxicity data and benchmarks for receptors exposed by direct contact;
- Compare site and reference concentrations; and
- Evaluate site-specific tissue concentrations (if available) to calculate risk from food chain uptake.

In contrast to the eight activities potentially included in Step 3a for PGDP ERAs, EPA explicitly identifies only one activity in this step: review and consideration of "realistic conservative" exposure assumptions (EPA 1997a). **The first four activities listed for Step 3a may be included as part of the uncertainty evaluation of the screening assessment, if this is appropriate based on the site and information available**. The last four of the eight activities generally require input from regulators and

should be completed after regulatory review of the results of the screening. The eight activities potentially included in Step 3a for PGDP ERAs are briefly described here.

Comparison of site and background. Consistent with the Human Health Risk Methods Document (DOE 2018), the maximum detected concentration of inorganic chemicals and naturally occurring radionuclides may be compared to the background dataset for that chemical or radionuclide as presented in Appendix A of the human health document. The most recent revision of the Human Health Risk Methods Document should be used for background values. Constituents with maximum detected concentrations less than background can be eliminated from further consideration as COPECs after the initial screening.

Frequency and distribution. The frequency of occurrences in site samples of concentrations exceeding background criteria may be used to evaluate the extent of contamination. The representativeness of the site data set, including the number and spatial distribution of samples, should be evaluated if the frequency of exceedances is considered in Step 3a of PGDP ERAs.

Site-specific tissue concentrations—Direct Risk to Organism. If data is available on the concentrations in tissues within species found at a site, that data may be compared to available tissue residue benchmarks to provide a refined screen for direct risk to that organism. Tissue residue benchmarks for assessing ecological risk should be based on "no effect" levels to the organism, not based on effects of human consumption. Tissue residue benchmarks available for the bird and mammal PGDP receptor species are presented in Tables A.10 and A.11. Tissue residue benchmarks available for fish and aquatic invertebrates are presented in Table A.12. Additional sources of fish tissue residue levels include the Environmental Residue-Effects Database (ERED) [located at https://ered.el.erdc.dren.mil/] the EPA PCB Residue Effects Level Database (PCBRes) [located at https://archive.epa.gov/med/med_archive_03/web/html/pcbres.html], and the USEPA MED-Duluth Toxicity/Residue Database (located at https://archive.epa.gov/med/med_archive_03/web/html/tox_residue.html). Additional benchmarks may be obtained from scientific literature in which critical tissue residues are developed. Tissues collected for comparison should be matched to the tissue used to generate the benchmark, for example, muscle tissue for large fish or mammals, whole body for small fish, or insects, etc.

Preliminary HQs. Preliminary HQs are calculated for individual wildlife receptors when those receptors are present at PGDP sites. This set of preliminary HQs is based on individual receptors and differs from the screening HQs based on general endpoints that were generated during Steps 1 and 2. For ERAs at PGDP sites, the ERAWG has selected the following model wildlife receptors: arboreal insectivorous mammal, insectivorous bird, ground-dwelling insectivorous/vermivorous mammal, piscivorous mammal, piscivorous bird, granivorous mammal, granivorous bird, predatory mammal, predatory bird, and carnivorous fish. Preliminary HQs are required only for those wildlife receptor groups that occur or potentially occur at a given site. If the preliminary HQs are presented in the same document as screening Steps 1 and 2, the receptors listed in Table 1 must be used for the calculations. If the preliminary HQs are calculated during the beginning of the BRA, the receptors and parameters for the site should be scoped with the regulators prior to performing the HQ calculations to ensure that appropriate receptors are selected for the site under consideration. Preliminary HQs for model wildlife receptors should be calculated for all COPECs for which the screening HQ calculated in step 2 was greater than 1.0 as well as for all bioaccumulative COPECs (regardless of their screening HQ). All those COPECs also should be included in the food chain modeling for wildlife receptors. Food chain modeling is described in Appendix C.

The parameters for the receptor model species used to calculate preliminary HQs are given in Table 1. Parameters for model species [i.e., body weights, specific ingestion rates (kg/kg body weight/day), AUFs, and diets] are meant to protect all species in the group. It is assumed that model receptors spend their

entire lives and obtain 100% of their diet or drinking water at the facility (i.e., AUF equals 1). Ground-dwelling insectivorous/vermivorous mammals and insectivorous/vermivorous birds are assumed to eat only soil-dwelling invertebrates that bioaccumulate contaminants from soil. Predatory mammals and birds are assumed to eat only small mammals such as shrews that bioaccumulate contaminants from ingested soil or biota. Mammalian piscivorous predators and carnivorous fish are assumed to eat only fish. Avian piscivorous predators are assumed to eat only fish for evaluations of surface water and groundwater, and only sediment-dwelling invertebrates for evaluations of sediment. Receptors representing reptiles and amphibians are not included in this table due to the lack of risk assessment parameters for these receptors. Until values for these parameters are available, it is assumed that assessments protecting other receptors are also protective of reptiles and amphibians. The sources of values in Table 1 are provided in Appendix B.

Preliminary HQs for wildlife receptors are calculated using the maximum detected concentrations and the appropriate benchmarks associated with no effect [the no observed adverse effect level (NOAEL)]. For wildlife receptors, these benchmarks are TRVs expressed as a daily dose. TRVs based on NOAELs for wildlife are presented in Table A.8 in Appendix A. Published, observed, or estimated NOAELs for test species are the benchmarks for all model receptors except carnivorous fish (PGDP ERA Rule 3). Benchmarks for carnivorous fish are body burdens (tissue concentrations) associated with no adverse effect (Jarvinen and Ankley 1999). ERAs for PGDP sites will need to explain how all benchmarks are derived and selected, including NOAELs estimated from other benchmarks [e.g., lowest observed adverse effect levels (LOAELs)]. TRVs based on LOAELs for wildlife are presented in Table A.9 in Appendix A. Equations for calculating preliminary HQs are presented in Appendix C.

If site-specific tissue data or appropriate biotransfer factors derived from PGDP data are not available, protective biotransfer factors should be compiled from sources selected in cooperation with KDEP. The ERAWG has not identified preferred biotransfer factors, but a list of bioaccumulating substances and biotransfer factors is available from the KDEP. Other possible sources of bioaccumulation factors (BAFs) are Sample et al. (1997) and the Los Alamos National Laboratory (LANL) ECORISK Database (LANL 2017). EPA has published biotransfer factors (EPA 1999a), and the PGDP ERAWG has used these values, or values derived as specified therein, for use in deriving site-specific cleanup goals for the

Table 1. Model Parameters for Calculating Preliminary Hazard Quotients for PGDP ERAs[1]

PGDP Model Receptor Group (PGDP Species Model)	Model Body Weight (kg)	Model Feeding Rate (kg/kg/day)	Water Ingestion Rate, L/kg BW-d	Soil/Sediment Ingestion Rate, as a % of the Food Ingestion Rate[2]
Arboreal insectivorous mammal (Little Brown Bat)	0.01	0.92	0.16	0
Ground-dwelling insectivorous/vermivorous mammal (Shrew)	0.017	0.81	0.29	3.7
Insectivorous/vermivorous bird (Woodcock)	0.17	1.16	0.10	10.4
Insectivorous/vermivorous bird (American robin)	0.081	1.52	0.14	5
Insectivorous/vermivorous bird (Marsh wren)	0.01	1.41	0.28	18
Piscivorous mammal (Mink)	0.896	0.16	0.079	9.4
Piscivorous bird (Belted kingfisher)	0.147	0.5	0.14	0
Carnivorous bird (Green Heron)	0.2	0.6	0.117	2
Omnivorous bird (Mallard duck)	1.134	0.278	0.057	11
Granivorous mammal (Meadow vole)	0.03	0.35	0.214	2.4
Granivorous bird (Northern Bobwhite quail)	0.14	0.117	0.02	9.3
Predatory mammal (Long-tailed weasel)	0.19	0.6	0.079	2.8
Predatory bird (Screech owl)	0.14	0.385	0.113	2
Carnivorous fish (Smallmouth bass)	0.086	2.0	--	--

[1] Receptors listed may not occur at all PGDP sites. Receptors from this group that are representative of the habitats present at a particular site should be evaluated for that site. The sources of values are provided in Appendix B.
[2] Soil/sediment ingestion rate is calculated from a food ingestion rate in wet weight (i.e., kg WW food/kg BW-d).

PGDP ERA Rule 3—When calculating preliminary HQs, do not scale TRVs for body weight of model receptors.

PGDP North-South Diversion Ditch. Table C.1 lists soil-to-invertebrate BAFs and water-to-fish bioconcentration factors (BCFs) provided by KDEP and other sources. These values should be considered as example only, and not as approved values. Biotransfer factors used in PGDP ERAs should be fully documented.

Site-Specific Exposure Assumptions. Site-specific exposure assumptions also may be considered in Step 3a. Exposure units (i.e., wildlife range) and AUFs [the ratio of the area of contamination (or the site area under investigation) to the area used by the animal (e.g., its home range, breeding range, or feeding/foraging range)] should be discussed during project scoping. Preliminary HQs calculated using default exposure assumptions likely overestimate risk. If site-specific data are available, they can provide a more accurate preliminary risk assessment. Alternative HQs may be calculated using site-specific values for exposure parameters and compared to preliminary HQs. Site-specific exposure data include estimates of central tendency [e.g., mean and 95% upper confidence limit (UCL)].

Alternative Benchmarks. Alternative toxicity data and benchmarks include such values as LOAELs for wildlife receptors, National Oceanic and Atmospheric Administration and Ontario Ministry of Environment effects-based values for sediment, and lowest chronic values for aquatic biota for surface water. The LOAEL-based TRVs are presented in Table A.9.

Reference Site Comparison. The reference site comparison evaluates the relationship between COPEC site and reference site concentrations primarily for aquatic systems. Both the choice of reference site and the types of studies to be conducted should be scoped with regulators prior to collection of any data for toxicity and population studies. The reference site comparison is not a background screen because the reference site is used primarily for collecting media for comparison of toxicity test results between the site and the reference site and as a reference site for field data such as population studies.

The site and reference site data presented for comparison include minimum, maximum, mean, and 95% UCL concentrations; frequency of detect; detection limits; and distribution type. Because the comparison to a reference site or sites is not a strict screen, concentration data for organic compounds detected in reference site samples can be compared to site data.

Site-Specific Tissue Concentrations-bioaccumulation. Site-specific data that are available should be considered in Step 3a. If data are available for the concentration of constituents in plant or animal tissues, then those data may reduce the uncertainties in preliminary HQs calculated using abiotic site concentration data and generic BAFs. Available benchmarks for tissue residues in birds and mammals are presented in Table A.10 and Table A.11, respectively. Benchmarks for tissue residues in fish and aquatic invertebrates are presented in Table A.12.

Site-Specific Effects Data. Other potentially useful data are TRVs derived from *in situ* toxicity and laboratory toxicity test results for site media. Toxicity data for standard laboratory test species are of limited value because these species are not necessarily as sensitive to contaminants as are native species.

For all activities conducted as part of Step 3a of PGDP ERAs, mean and 95% UCL concentrations for detected substances are calculated using ProUCL.[4] Site concentration data for PGDP sites are those data present in Paducah OREIS. All relevant concentration data for a site should be gathered and entered into Paducah OREIS before conducting Step 3a. Site concentration data used in ERAs and other ecological risk activities must be qualified as valid. An important consideration is the relationship between detection limits and benchmarks. Also, the appropriateness of using statistical manipulation of data must be considered in relation to the number of samples. An example table depicting refinement of COPECs is presented in Exhibit 2.

2.3.2 ERA Study Focus and Scope (Step 3b)

If any COPECs are identified at a PGDP site, the ERA process continues with Step 3b, ERA Study Focus and Scope. This is the problem formulation step for the site-specific assessment of ecological risk and should be included with the baseline ERA. Where Step 3a focuses the ERA on the subset of COPECs at a site that more likely poses a risk to ecological receptors, Step 3b narrows and sharpens the focus of the required investigation onto the important exposure pathways and receptors that are potentially exposed to these COPECs. Step 3b of the ERA process includes the following activities:

- Summarizing ecotoxicity of COPECs,
- Identifying assessment endpoints,
- Describing habitat,
- Presenting the CSM, and
- Specifying risk questions and hypotheses for the site.

These elements are common to the EPA eight-step ERA process (EPA 1997a; EPA 2000a).

[4] If results from ten or more samples are available, then the most recent version of EPA's ProUCL software (Version 5.1 or later) will be used to determine the 95% UCL concentration. Nondetect values should be included in exposure metric derivation datasets when using ProUCL. An example of a left-censored data set for input of chemical "Y" and the detection status of the chemical "D_y" into ProUCL containing nondetect observations with one reporting limit of 20 is as follows, where "0" indicates a nondetect value and a "1" indicates a detect.

Y	D_y
20	0
20	0
20	0
7	1
58	1

The value selected as the 95% UCL concentration will be the value recommended by ProUCL, noted as the "Suggested UCL to Use." EPA's ProUCL software (available at www.epa.gov/osp/hstl/tsc/software.htm) incorporates a number of different distributional tests that may be used to perform the distributional tests and calculates the most appropriate 95% UCL (EPA 2015). An exception to use of ProUCL is when a sample contains a small fraction of nondetects (i.e., no more than 10−15%). In this case, simple substitution of half the reporting limit is generally adequate (EPA 2009).

Exhibit 2. Example Table Depicting Refinement of COPECs in Soil

Example Table Depicting Refinement Of Chemicals Of Potential Concern In Soil											
CHEMICAL	**Freq. of Detection**	**Maximum Detected Conc.**	**Background Screening Value (BSV)**	**Freq. Exceeding BSV**	**Refinement Screening Value (RSV)**	**Refinement Screening Value Source**	**Freq. Exceeding RSV**	**Refinement Hazard Quotient (HQ)**	**95% UCL Conc.**	**95% UCL HQ**	**COPC (Y/N) Basis**
Volatile Organic Compounds, µg/kg											
1,2-Dichlorobenzene	2/10	100	NA	NA	920	Mammals	0/10	0.1	60	0.065	No/B
Tetrachloroethene	10/10	210	NA	NA	180	Mammals	3/10	1.2	135	0.75	No/A
Semi-volatile Organic Compounds, µg/kg											
Pentachlorobenzene	2/10	2,200	NA	NA	NA	NA	1/10	0.2	130	NA	Yes/Bioaccu.
Polycyclic Aromatic Hydrocarbons (PAHs) Low Molecular Weight Polycyclic Aromatic Hydrocarbons (LMW-PAHs), µg/kg											
Acenaphthene	2/10	41	NA	NA	See total	NA	NA	NA	40	NA	See total
Fluorene	2/10	47	NA	NA	See total	NA	NA	NA	45	NA	See total
Phenanthrene	3/10	36	NA	NA	See total	NA	NA	NA	30	NA	See total
Naphthalene	1/10	40	NA	NA	See total	NA	NA	NA	39	NA	See total
Total LMW-PAHs	4/10	164	NA	NA	29,000	R4 inverts	0/10	0.006	140	0.005	No/A
High Molecular Weight Polycyclic Aromatic Hydrocarbons (HMW-PAHs), µg/kg											
Benzo(a)anthracene	4/10	46	NA	NA	See total	NA	NA	NA	44	NA	See total
Benzo(a)pyrene	2/10	78	NA	NA	See total	NA	NA	NA	78	NA	See total
Benzo(b)fluoranthene	2/10	139	NA	NA	See total	NA	NA	NA	120	NA	See total
Chrysene	1/10	70	NA	NA	See total	NA	NA	NA	69	NA	See total
Dibenz(a,h)anthracene	1/10	135	NA	NA	See total	NA	NA	NA	125	NA	See total
Indeno(1,2,3-cd)pyrene	5/10	280	NA	NA	See total	NA	NA	NA	227	NA	See total
Pyrene	3/10	25	NA	NA	See total	NA	NA	NA	21	NA	See total
Total HMW-PAHs	5/10	773	NA	NA	1,100	R4	0/10	0.7	674	0.6	No/A

Exhibit 2. Example Table Depicting Refinement of COPECs in Soil (Continued)

Example Table Depicting Refinement Of Chemicals Of Potential Concern In Soil											
CHEMICAL	**Freq. of Detection**	**Maximum Detected Conc.**	**Background Screening Value (BSV)**	**Freq. Exceeding BSV**	**Refinement Screening Value (RSV)**	**Refinement Screening Value Source**	**Freq. Exceeding RSV**	**Refinement Hazard Quotient (HQ)**	**95% UCL Conc.**	**95% UCL HQ**	**COPC (Y/N) Basis**
Pesticides, µg/kg											
4,4'-DDD	7/10	25	NA	NA	NA	NA	NA	NA	16	D	Yes/C
4,4'-DDE	6/10	49	NA	NA	NA	NA	NA	NA	25	D	Yes/C
4,4'-DDT	6/10	110	NA	NA	NA	NA	NA	NA	94	D	Yes/C
Total DDT	7/10	184	NA	NA	NA	NA	NA	NA	135	6.4	Yes/C
Heptachlor	1/10	140	NA	NA	NA	NA	NA	NA	67	NA	Yes/Bioaccu
Inorganic Compounds, mg/kg											
Copper	9/10	66	13	1/10	NA	NA	NA	NA	11.4	0.4	No/E
Manganese	10/10	1,020	1,579	0/10	NA	NA	NA	NA	275	1.4	No/F
Sodium	3/10	2,550	634	2/10	NA	NA	NA	NA	1,670	NA	No/G
Vanadium	10/10	81.3	59	3/10	NA	NA	NA	NA	38.1	4.9	Yes/H

Footnotes:
COPC = Chemical of Potential Concern (yes/no)
A = Chemical was infrequently detected above RSV and 95% UCL HQ is less than 1.
B = Chemical was not detected or infrequently detected and refinement HQ is less than 1.
C = Chemical was frequently detected and 95% UCL HQ was greater than 1.
D = Chemical is a member of a class of compounds. The total concentration is screened against the RSV for the total compound in that class.
E = 95% UCL hazard quotient was less than 1 and concentration was less than background screening value.
F = Chemical was detected below background screening value.
G = Chemical is an essential nutrient.
H = Chemical was frequently detected above background and mean hazard quotient was greater than 1.

Source: EPA 2018. *Region 4 Ecological Risk Assessment Supplemental Guidance*

Ecotoxicity Summaries. Ecotoxicity summaries of COPECs in Step 3b are meant to be brief profiles. These profiles support the selection of assessment endpoints; therefore, they should briefly describe the toxicity of the COPECs to groups of organisms (communities, guilds) and the COPECs' bioaccumulation potential. Toxicity profiles for COPECs should include a discussion of published data on the relative toxicity to various groups of organisms when exposed by the same routes. There are two primary exposure routes of interest for potential receptor groups at PGDP sites:

- Direct contact for plants, soil-dwelling invertebrates, sediment-dwelling invertebrates, and aquatic biota; and

- Ingestion by consumers, such as granivorous (seed-eating) birds, and carnivorous birds and mammals.

Predators include arboreal insectivorous mammals, insectivorous birds, ground-dwelling insectivorous/vermivorous mammals, piscivorous mammals, piscivorous birds, predatory mammals, predatory birds, and carnivorous fish.

Assessment Endpoints. Assessment endpoints are valued ecological resources that are potentially exposed and susceptible to the COPECs at a site. Policy goals are given in Table 2, along with generic assessment endpoints. Assessment endpoints are the species populations or communities at a site that are investigated to evaluate the risk from exposure to the COPECs. Resources that are not at risk because they are not exposed or not susceptible to the adverse effects of the COPECs should not be assessed. Because not all populations or communities at a site can be evaluated in an ERA, care must be taken in selecting assessment endpoints. Assessment endpoints for PGDP sites should be selected after consulting members of the ERAWG and other stakeholders to ensure that the site investigation addresses the important risk questions. This is one of the critical decisions made at SMDP (b) (following Step 3b), and concurrence on the assessment endpoints for PGDP sites should be obtained from natural resources trustees and parties to the Federal Facility Agreement.

Table 2. Generic Assessment Endpoints for PGDP ERAs

Policy Goals	Assessment Endpoints
The conservation of threatened and endangered species and their habitats.	No adverse impact to any federal- or state-designated threatened or endangered species[1] (flora and fauna) and no adverse impacts to their critical habitats.
The protection of terrestrial populations, communities, and ecosystems.	Protection of soil-invertebrate populations from negative impacts on nutrient cycling resulting from exposure to COPECs in surface soil.
	Protection of omnivorous mammal populations from negative impact on survival and reproduction resulting from exposure to COPECs in surface soil.
	Protection of herbivorous mammal populations from negative impact on survival and reproduction resulting from exposure to COPECs in surface soil.
	Protection of carnivorous mammal populations from negative impact on survival and reproduction resulting from exposure to COPECs in exposure media.
	Protection of amphibian and reptile populations from negative impact on survival and reproduction resulting from exposure to COPECs in exposure media.
	Protection of herbivorous bird populations from negative impact on survival and reproduction resulting from exposure to COPECs in exposure media.
	Protection of omnivorous bird populations from negative impact on survival and reproduction resulting from exposure to COPECs in exposure media.
	Protection of carnivorous bird populations from negative impact on survival and reproduction resulting from exposure to COPECs in exposure media.
The protection of aquatic populations, communities, and ecosystems.	Protection of benthic invertebrate populations from negative impact on survival and reproduction resulting from exposure to COPECs in sediment and surface water.
	Protection of amphibian and reptile populations from negative impact on survival and reproduction resulting from exposure to COPECs in sediment and surface water.
	Protection of fish populations from negative impact on survival and reproduction resulting from exposure to COPECs in sediment and surface water.
	Protection of mammal populations that feed on aquatic organisms from negative impact on survival and reproduction resulting from exposure to COPECs in sediment and surface water.
	Protection of bird populations that feed on aquatic organisms from negative impact on survival and reproduction resulting from exposure to COPECs in sediment and surface water.
	Protection of bird populations that feed on aquatic vegetation from negative impact on survival and reproduction resulting from exposure to COPECs in sediment and surface water.

[1] If threatened and endangered species not included on the federal list are listed by the Commonwealth of Kentucky.

The assessment endpoints for PGDP sites are stated in terms of the survival and successful reproduction of guilds or communities at the site. For example,

Protection of carnivorous mammal populations at the site from negative impact on survival and reproduction from exposure to the COPECs in surface soil.

Assessment endpoints can be stated as in terms of adverse effects on populations or on communities. Adverse effects on populations can be inferred from measures related to impaired reproduction, growth, and survival. Adverse effects on communities can be inferred from changes in community structure or function. The measures used in BRAs for wildlife receptors at PGDP are TRVs, laboratory toxicity tests, and tissue residue concentrations related to impaired reproduction, growth, and survival. These measures reflect assessment endpoints for populations. If a T&E or otherwise legally protected species is an assessment endpoint, then the endpoint should be stated in terms of survival and reproduction of receptors.

If an individual COPEC or class of COPECs can be identified as the potential cause of risk to an endpoint receptor, then the COPEC can be explicitly named in the assessment endpoint. The ERAWG recommends that the assessment endpoint explicitly name the source medium or media containing the COPECs so as to link the assessment endpoint to potential remedial action decisions, because remedial actions are applied to source media.

Assessment endpoints for ERAs at PGDP sites must be justified on the basis of the following factors:

- The COPECs that are present and their concentrations,
- Mechanisms of toxicity of the COPECs to different groups of organisms,
- Ecologically relevant receptor groups that are potentially sensitive or highly exposed to the COPECs, and
- Potentially complete exposure pathways from source to receptor.

The assessment endpoint receptors must be present at, or must potentially occur at, the site. Endpoint receptors must be exposed to COPECs, and they must be susceptible to the adverse effects of the COPECs when exposed at low doses relative to other potential endpoints.

Habitat Description. The habitats occurring at, or potentially occurring at, PGDP sites are important factors to consider in selecting assessment endpoints and developing the CSM for the site. The description of the habitats at PGDP sites should include general information about the site and specific information about terrestrial and aquatic habitats at the site. EPA provides a useful form (provided in Appendix E) for recording habitat characteristics during a site visit (EPA 1997a). The use of photographs, as well as maps and written site descriptions, is recommended. Photographs of sites should be taken when feasible and made available in association with ERAs and decision documents for PGDP sites.

Conceptual Site Model. A CSM is a written or pictorial representation of an environmental system and the biological, physical, and chemical processes that determine the transport of contaminants from sources through environmental media to environmental receptors within the system (ASTM 2014). The CSM for PGDP sites must define the potential pathways of exposure from source media to assessment endpoint receptors. The CSM should distinguish potential exposure pathways from those pathways that are evaluated in the ERA for the site. A diagram of the exposure pathways, including source media, fate and transport mechanisms, exposure media, exposure routes and receptors, is an expected element of all PGDP ERAs. Figure 2 is an example of a CSM exposure pathways diagram, and it is not representative of any site at PGDP. Food web diagrams are useful and should be included in the report if wildlife receptors are potentially exposed by ingestion at the site. Figure 3 is an example of a foodweb; however, it is not representative of any site at PGDP.

2.3.3 Step 3 Uncertainties

The uncertainties in Step 3 of the ERA process are primarily associated with the COPECs that remain following the reevaluation (Step 3a). As with Steps 1 and 2, there will not be site concentration data or alternative benchmarks for all constituents. The potential adverse effects of COPECs on some classes of receptors may be unknown. Data gaps must be clearly identified so that the investigation can be designed to collect the data necessary to answer the risk questions.

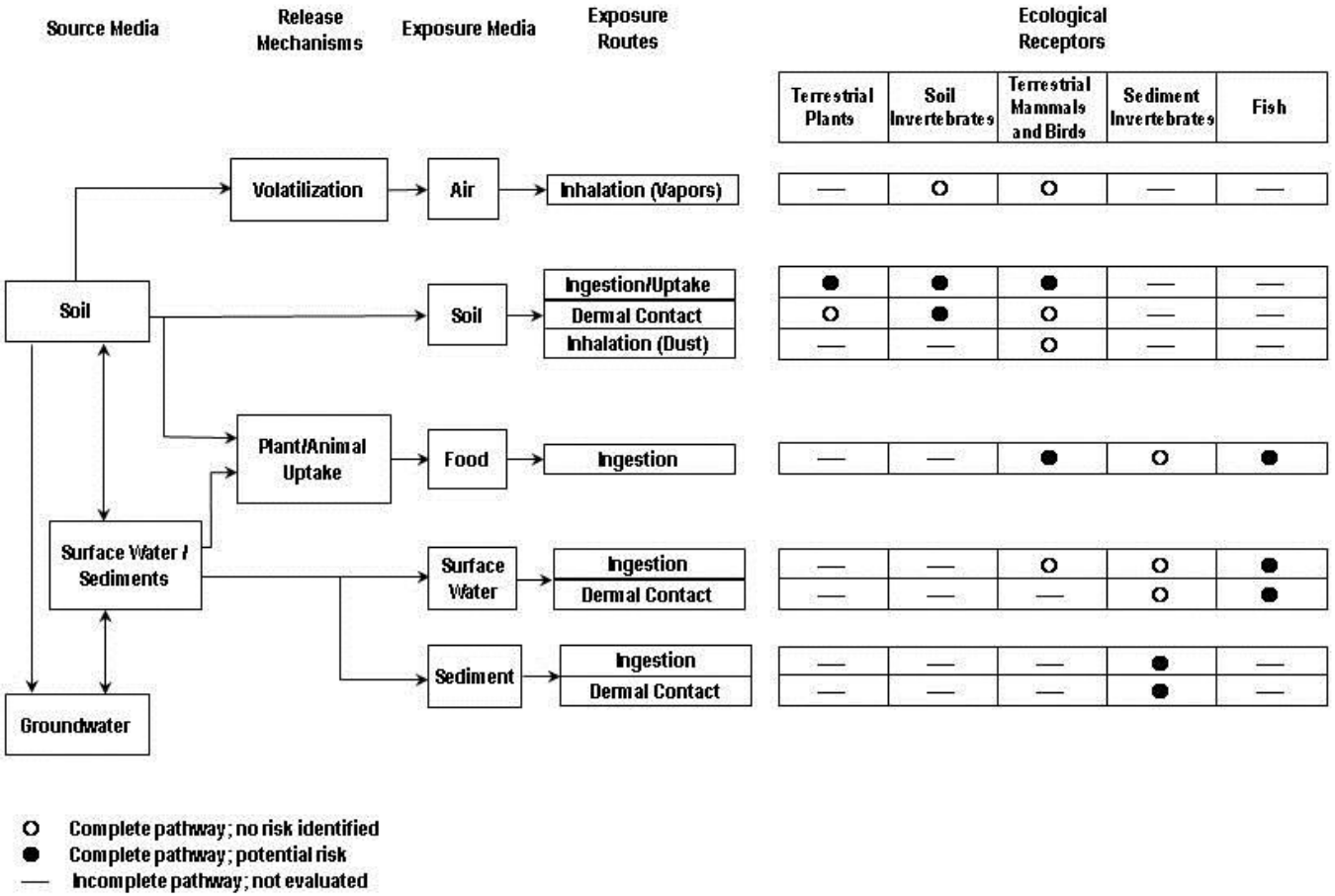


Figure 2. Example of a Conceptual Site Model of Exposure Pathways for Ecological Receptors

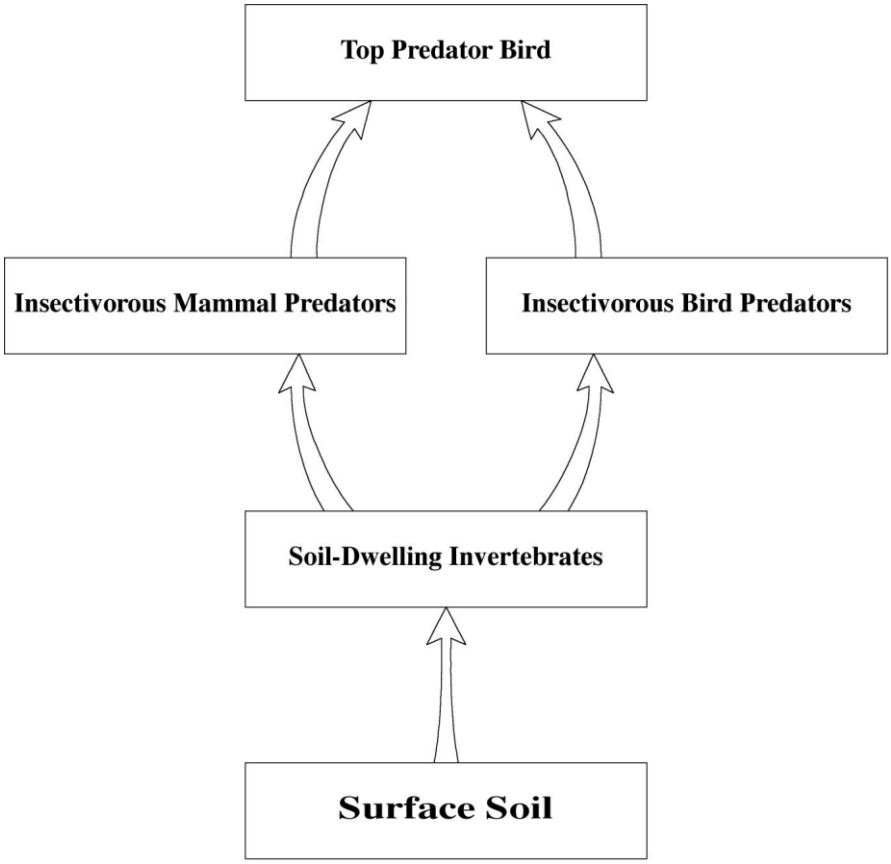


Figure 3. Example of a Foodweb for Wildlife Receptors

Use of Step 3

The results of the refinement of COPECs and the problem formulation (Step 3) for the given site are used to support the decision at SMDP (b) whether to continue evaluating ecological risk. Generally, if any constituent in an abiotic medium to which organisms potentially are exposed is judged to be a COPEC in Step 3a, then further evaluation of the potential for risk to ecological receptors will be required. The results of Step 3a should be communicated in a technical memorandum, and SMDP (b) it triggers should occur before submittal of the work plan for further investigation. Thus, Step 3a supports the decision about what assessment endpoints will be evaluated further in the ERA. Further evaluation means site-specific ecological investigation, which requires a work plan documenting Steps 3b and 4 of the process and describing how the data collected will be used in Step 7 to make a remedial decision for the site.

2.3.4 Reporting Step 3

The documentation of Step 3 for PGDP sites should include the following:

- Site and, if available, reference site concentration data;
- Preliminary HQs, BAFs, and ingestion rates for wildlife receptors;
- Discussion of alternative benchmarks;
- Discussion of site-specific data and exposure assumptions;
- Ecotoxicity profiles for COPECs following reevaluation;

- Assessment endpoints and justification;
- Habitat descriptions;
- Conceptual site model;
- Risk questions and hypotheses; and
- Discussion of uncertainties.

The documentation of Step 3a results should include tables that compare side-by-side site and reference site concentrations, benchmark concentrations, preliminary HQs, and other data used to reevaluate COPECs. The discussion of uncertainties should include the lack of site concentration or toxicity data for COPECs. The results of Step 3a may be provided in the same document as screening Steps 1 and 2. The decision about whether to conduct a site investigation or to conduct no further evaluation or other action can be documented in the same report. If further evaluation is required, the additional elements of Step 3a and the problem formulation (Step 3b) can be incorporated into the work plan for the site investigation. Concurrence on assessment endpoints and risk questions should be obtained and documented before completion of Step 4, ERA Study Design and DQOs.

2.4 ERA STUDY DESIGN AND DATA QUALITY OBJECTIVES (STEP 4)

Step 4 of the ERA process identifies the study design and DQOs for the investigation. For PGDP sites, the ERA work plan and the sampling and analysis plan (SAP) are the primary products of Step 4. The work plan and SAP must specify the study design in sufficient detail for risk managers to evaluate its adequacy for collecting the data necessary to answer the risk questions with sufficient confidence to support remedial action decisions for the site. Final regulatory approval of the work plan and SAP represents the outcome of SMDP (c).

2.4.1 Study Design—Exposure and Effects Measurements

A site-specific study is designed in Step 4 of the ERA process to answer the risk questions defined in Step 3. Investigations for ERAs at PGDP sites are required to measure exposure, effects, or both. The measurements specified in the study design must be directly relevant to evaluating exposure of or effects on the assessment endpoints defined in Step 3. Most of the lines of evidence described below assume consideration of contaminant levels present at the site.

For ERAs at PGDP sites with wildlife receptors that are potentially exposed through ingestion of contaminated media, measurements should be made of the concentrations of COPECs in the tissues of organisms that those receptors potentially eat (PGDP ERA Rule 4) whenever feasible. Contaminant body burdens in prey are expected to be the primary and most typical exposure measurements used in ERAs at PGDP sites. Particular attention should be given to detection limits when establishing the DQOs for tissue analysis. Abiotic media sample collocated with tissue samples should be collected because they may be helpful in developing remedial goals, if required later in the remedial process. If tissue samples cannot be collected, then the estimation of dose ingested through media will be done using the information in Appendix C.

Concentration measurements for endpoint-receptor tissues (e.g., organ, muscle, bone, feather, eggshell, or hair) may be used to confirm or monitor exposure to specific COPECs. If appropriate concentration-effects data are available for the COPEC and the endpoint receptor from the ongoing monitoring programs at PGDP, then exposure measurements should include concentrations in appropriate receptor tissues. Receptor-tissue sampling should be designed not to adversely impact the receptor populations. Particular attention should be given to detection limits when establishing DQOs for analysis of receptor tissues.

Organisms living in direct contact with contaminated media are assumed to be exposed to the COPECs present. For these receptors, the concentrations in the abiotic media to which they are exposed at the site must be measured. Toxicity tests reduce the uncertainty about bioavailability of COPECs, as quantified by analytical chemistry data for abiotic media. Special sampling and analytical techniques may be required to measure the exposure concentrations of COPECs in some media for some endpoint receptors. Particular attention should be given to sampling design and analytical detection limits when establishing DQOs for abiotic exposure media.

PGDP ERA Rule 4—For the study design for PGDP sites with wildlife receptors exposed to COPECs, include the collection and chemical analysis of prey tissue from the site.

There are numerous types of measurements of effects on various biological levels from the chromosome to the community. While measures of suborganismal effects on receptors exposed to COPECs at PGDP sites are possible, the most likely effects measurements for PGDP ERAs are measures of survival and reproduction of organisms: toxicity tests and measures of population/community abundance.

Analytical chemistry data provide estimates of current exposure concentrations and are essential to the interpretation of the toxicity tests and population/community studies. PGDP ERAs that include measures of effect must also include chemical analysis of collocated samples (PGDP ERA Rule 5). Collocated analyses are important to the interpretation of the toxicity test and population/community study results even though analytical data overestimate the bioavailability of some COPECs.

PGDP ERA Rule 5—For the study design for PGDP sites with receptors exposed by direct contact to COPECs, include collocated analytical chemistry data where *in situ*, laboratory toxicity tests, or population/community studies are specified.

Toxicity Tests. For ERAs at PGDP sites with endpoint receptors that are potentially exposed by direct contact with contaminated media, direct tests must be made of the toxicity of the exposure media (PGDP ERA Rule 6). Toxicity tests on abiotic media should use organisms that are representative of the endpoint receptors. Standardized toxicity tests using commercially supplied test species are available for soil, sediment, and surface water (see the following text box). The selection of standardized tests instead of *in situ* tests using local species should be justified and the differences between local and test species in their sensitivity to COPECs discussed. Samples from reference locations are required to identify impacts due to site-related COPECs present at the site, and these locations need to be carefully selected. Even carefully selected reference sites may be impacted by unknown stressors; therefore, the results for both the test site and the reference site must be compared to the laboratory control group run as part of the toxicity test. Some test methods include criteria for an acceptable response at an unimpacted site (for example, at least 80% survival). If the toxicity tests selected do not contain these criteria, the criteria need to be established by the project team during development of DQOs prior to running the toxicity tests.

STANDARDIZED TOXICITY TESTS

Examples of standardized toxicity tests for surface soil, sediment, and surface water are, respectively, as follows:

- American Society for Testing and Materials (ASTM) E 1676-97, Standard guide for conducting laboratory soil toxicity or bioaccumulation tests with the Lumbricid earthworm, *Eisenia fetida* (ASTM 1998);
- EPA Test Method 100.1, *Hyalella azteca,* 10-day survival test for sediments (EPA 2000b); and
- Fathead minnow, *Pimephales promelas*, larval survival and growth test, EPA Method 1000.0 (EPA 2002).

PGDP ERA Rule 6—For the study design for PGDP sites with endpoint receptors exposed by direct contact to COPECs, include *in situ* or laboratory toxicity tests.

Laboratory tests indicate whether the media collected from the site cause toxicity to the test organisms and quantify the magnitude of the toxic effect relative to media from reference locations and laboratory controls. Samples from each site also should be submitted to laboratory analysis to quantify the concentrations of potential COPECs at both sites. Toxicity tests do not produce definitive benchmark concentrations associated with specific levels of adverse effects. Toxicity tests are considered to be chronic tests (EPA 2000b; EPA 2002; ASTM 1998), and test durations are believed to be sufficiently long for adverse effects on sensitive life stages to be observed at concentrations exceeding ecological screening values.

The measurement endpoints in toxicity tests used in PGDP ERAs typically will be survival, reproduction, growth, emergence, or combinations of these endpoints. Survival and reproduction are the primary effects of interest because they are directly related to the assessment endpoints, which are stated in terms of survival of the population and survival of individuals, in the case of T&E species. Reduced growth as a result of chronic exposure to contaminants can have ecological significance in some circumstances, such as when a population experiences severe size-based predation pressure or when overwinter survival depends on achieving a certain pre-winter size. Growth effects indicate only the possibility of adverse effects on a population, so toxicity tests with growth as the only measurement endpoint must be carefully justified. Likewise, emergence is an indirect measure of potential adverse effects on a population (e.g., aquatic insects). Because reduced emergence potentially leads to reduced survival and population size, reliance on emergence as the only measurement endpoint must be justified.

Using toxicity tests as a line of evidence in the risk characterization for PGDP sites assumes four points:

- Effects observed in laboratory tests of site media using surrogate species, beyond those observed in tests of reference site media, will represent effects on assessment endpoints occurring at the site.
- Effects observed for the reference site will not exceed the criteria for comparison to the laboratory control group, or the reference site also will be considered as potentially impacted and comparisons between the investigation site and reference site will not be used to demonstrate "no impact" at the investigation site.

- The substances responsible for any observed toxicity above reference site levels are those COPECs present at concentrations above reference site levels and above benchmarks associated with adverse effects.

- Effects on the test species are caused by contaminants in the tested medium and not artifacts of the test conditions or test organisms.

If these assumptions make toxicity tests unacceptable to risk managers as a basis for remedial decisions, then toxicity tests should not be selected, and population/community studies must be designed to answer the risk questions.

Population/Community Measures. If ERAs at PGDP sites require population/community studies to evaluate effects of COPECs on receptors, then the work plan must provide a detailed description and justification of the study. The EPA DQO process should be implemented (EPA 2006; DOE 1993). Preliminary data on population variability, both temporally and spatially, is a prerequisite to establishing DQOs for population studies. Standardized methods of evaluating whether benthic invertebrate communities and fish have been impacted are available (EPA 1990; KDEP 2015); however, to define the cause of the impacts, careful selection of metrics and reference sites is required to ensure that the results of population/community studies will answer the risk questions.

2.4.2 DQO Process

According to the EPA process document, Steps 3 and 4 of the eight-step ERA process comprise the DQO process (EPA 1997a). The final COPECs, the nature of their effects on biota, the exposure pathways, the assessment endpoints, questions to be answered, and the measurements to be used to answer the ERA questions define the data requirements for the site investigation. The study design, approved at SMDP (c), defines the acceptable level of decision error. Guidance for sampling design is available from EPA, Kentucky state agencies, and the U.S. Geological Survey. The basic elements of the DQO process are described in EPA's *Guidance on Systematic Planning Using the Data Quality Objectives Process* (EPA 2006).

2.4.3 Uncertainties of Step 4

The uncertainties in Step 4 of the ERA process relate to the efficacy of the study as designed to answer the risk questions. Tests can confirm or deny toxicity from site media in excess of the reference site or laboratory control group, but uncertainty remains about the ecological significance of observed levels of effect. Natural variability makes short-term field studies of effects difficult to interpret. Most native species are difficult to rear successfully in the laboratory, and laboratory test species may not be as sensitive to contaminants as are native species. Site-specific tissue concentration data reduce the uncertainty associated with modeling uptake and bioaccumulation. Accurate site-specific exposure parameters, such as ingestion rates and foraging areas, are also difficult to obtain, so there is uncertainty about risk estimates even when exposure estimates are based on site-specific tissue concentration data. Multiple lines of evidence are useful and recommended for reducing the uncertainty of ERAs at PGDP sites. The weighting for lines of evidence, as well as the criteria for comparison of toxicity tests to toxicity control groups, should be set during the scoping process.

2.4.4 Use of Step 4

The work plan, including the SAP and quality assurance/quality control plan, for PGDP sites must prescribe the investigation required to complete the ERA and answer the risk questions. The numbers and types of measurements specified in the work plan are made according to the procedures detailed in the

SAP. The work plan should describe precisely how the resulting data will be used in the risk characterization for the site and will constitute the basis for a conclusion about risk at the site. Approval of the work plan at SMDP (c) signifies that the proposed field investigation design and methods provide acceptable data and levels of decision error to support the risk management decisions for the site.

2.4.5 Reporting Step 4

The ERA work plan and its appendices are the expected mechanism for recording and seeking approval of the DQOs and study design for the site investigation. The methods for collecting and controlling samples for toxicity tests and analytical chemistry are described in the RI work plan and field sampling plan for the site. The work plan or SAP should include the following:

- The number and location of samples of each medium for each purpose,
- The comparison of analytical detection limits and threshold concentrations,
- The full description of toxicity tests and population/community study designs, and
- A description of how the results of site investigations will be used in the risk characterization (Step 7) to answer risk questions.

Neither the ERAWG nor EPA has specific requirements about the timing of the document other than it must follow Steps 1 through 3 and precede the ecological site investigation (EPA 1997a).

2.5 VERIFICATION OF FIELD SAMPLING DESIGN (STEP 5)

Verification of Field Sampling Design, Step 5 of the ERA process, evaluates the probability of successfully completing the study as designed. In this step, measurement endpoints are evaluated for appropriateness and implementability. The work plan or SAP for the ERA should describe the methods for verifying the study design. A memorandum from the ecological risk assessor to the risk manager should describe the outcome of the verification. If the design is verified, then the risk manager should approve the investigation. If the design cannot be verified, the memorandum should describe the revised study design and how it was verified. The verification process and any remaining uncertainties about the study design should be discussed when the results of the investigation are reported.

2.6 INVESTIGATION AND DATA ANALYSIS (STEP 6)

Investigation and Data Analysis, Step 6 of the ERA process, is the implementation of the investigation designed in Step 4 and verified in Step 5. An SMDP during or following the investigation and data analysis is only required if changes to the SAP are required following approval of the work plan. Approved alterations in the work plan for PGDP sites are documented in the report containing the risk characterization (i.e., the baseline ERA report).

2.7 RISK CHARACTERIZATION (STEP 7)

Risk Characterization, Step 7 of the ERA process, is conducted after data collected during the investigation have been analyzed. The risk characterization evaluates the exposure and effects data to assess the risk to the assessment endpoints (risk estimation). The risk characterization also presents

information necessary to interpret the risk assessment and to decide upon adverse effect thresholds for the assessment endpoints (risk description). This presentation should include a qualitative and quantitative summary of risk results and uncertainties.

2.7.1 Risk Estimation

The lines of evidence, for which data were collected in the investigation, are integrated in the risk characterization to support a conclusion about the significance of ecological risk. The different possible lines of evidence are abiotic medium and tissue concentration data, toxicity test results, and population/community data.

The weight given to the different lines of evidence is determined during the scoping process for each site and established in the DQOs (Step 4); thus, the inferences made from the measurements are briefly described in Step 7. Factors confounding the results of the investigation should be discussed. Any alterations to the study design during Field Verification (Step 5) and Investigation (Step 6) should be described.

If site-specific tissue concentration data are available from the investigation, HQs for wildlife receptors preying on those tissues are calculated. These HQs are calculated using the HQ equations (Appendix C) with appropriate exposure estimates and TRVs. In Step 7, the full range of risk estimates can be provided by calculating HQs using the central tendency and maximum tissue concentrations to estimate exposure and TRVs associated with a range of adverse effect from NOAELs to LOAELs.

ERAs for PGDP sites will not present only probabilistic estimates of exposure; point estimates are required. The ERAWG concurs that probabilistic methods of quantifying risk are expected to be of limited value for ERAs at PGDP sites because adequate data are typically lacking. If sufficient data exist to calculate probabilistic risk estimates, they can be reported and used in PGDP ERAs to address the uncertainty of point estimates of risk. ERAs presenting probabilistic risk estimates must have an approved work plan and include the documentation specified in EPA guidance on probabilistic risk assessments (EPA 1997b).

2.7.2 Risk Description

For PGDP ERAs, the risk characterization should put the level of risk at the site in context. The risk description should identify threshold concentrations in source or exposure media for effects on the assessment endpoint. EPA indicates that the range of potential effects be bounded by threshold concentrations associated with no effect and probable effect (EPA 1997a). As discussed in Steps 1 and 2, PGDP NFA levels bound the range at the lower end for receptors exposed by direct contact. Lower bound threshold concentrations for wildlife receptors are calculated using the assumptions used to calculate preliminary HQs in Step 3a. All site-specific parameter values used to calculate HQs must be described and the source of the values identified. The HQ equations (Appendix C) can be used to calculate threshold concentrations by setting the HQ equal to 1 [average daily dose (ADD) = TRV] and solving for the medium concentration. This formula applies only to sites at which a single media is contaminated. A site-specific model needs to be developed for each site with more complex multimedia exposures.

Residual risk, which is the difference between the risk estimate for the site and a risk estimate generated using the same method but with background concentrations as the exposure concentrations, also can be presented in the Step 7 risk description. This information may be useful for risk managers in estimating potential risk reduction, particularly for sites with contaminant concentrations elevated minimally above background.

ERAs for PGDP sites should include estimates for the upper bound on the threshold concentrations for adverse ecological effects, i.e., those concentrations in environmental media that are associated with a probable effect (EPA 1997a). These upper-bound threshold concentrations are calculated using the site-specific exposure assumptions identified in Step 3a, Reevaluation of COPECs, and toxicity benchmarks associated with potential adverse effects on test species (e.g., LOAELs). Upper-bound thresholds must be calculated on a site-specific basis and presented in the ERA report.

2.7.3 Step 7 Uncertainties

At Step 7 of the ERA process for PGDP sites, the uncertainty about the risk posed by a substance should have been reduced to a level that allows risk managers to make a technically defensible remedial decision. Uncertainty will, however, remain at the risk characterization step. The actual cause of observed toxicity and reductions in populations may be unknown, and the actual expected level of exposure of wildlife receptors to contaminated site media may be inaccurate or imprecise. Nevertheless, if the DQOs for the investigation were achieved, risk managers should have sufficient confidence in the conclusions of the ERA to make a risk management decision.

2.7.4 Use of Step 7

The risk characterization provides information to judge the ecological significance of the estimated risk to assessment endpoints in the absence of any remedial action. In the final step of the EPA eight-step ERA process, risk managers use the results of the risk characterization and the conclusions of the professional ecological risk assessor to determine whether remedial action is required.

2.7.5 Reporting Step 7

Step 7 of the ERA process for PGDP sites is reported in the ERA, which may be included in the RI/FS, or as a separate document. Neither the ERAWG nor EPA has specific requirements about the timing of the document, other than it must follow Steps 1 through 6 (EPA 1997a).

2.8 RISK MANAGEMENT (STEP 8)

Step 8 of the ERA process is Risk Management. The role of ecological risk assessors in Step 8 for PGDP sites is to advise risk managers during SMDP (e). EPA provides additional guidance on risk management (EPA 1999b). If the risk characterization (Step 7) concludes there is risk to ecological receptors, the risk management decision is whether to remediate the site or to leave contaminants of concern (COCs) in place with controls on exposure and monitoring. This decision can be documented in the ERA report. If the risk assessment concludes there is no risk to ecological receptors, then the results of the ERA can be summarized in the decision documents, justifying no further evaluation or other actions to address ecological risk. If the ecological assessment concludes that there is unacceptable risk, then the ecological risk assessors continue to provide input as part of the decision making process. If the risk managers conclude there is unacceptable risk, then ecological risk assessors continue to provide input to risk management decisions following the completion of the RI.

2.9 SUMMARY OF ERA PROCESS

The ERA process for PGDP sites includes up to eight steps and five SMDPs. Several documents report the results of these steps and the decisions made by risk managers at the SMDPs. Decisions whether to continue the ERA process occur after the screening-level ERA (Steps 1 and 2) and again after Step 3,

Problem Formulation. The ecological risk assessment input (Step 8) to the risk management decision to remediate the site should occur after the risk characterization (Step 7). Ecological risk assessors for PGDP sites continue to support the risk management decision making process by providing input to decision documents.

3. INPUT TO DECISION DOCUMENTS

Ecological risk assessors should provide input to CERCLA and RCRA decision documents for sites with ecological resources. This input includes summaries of ERAs and screenings; evaluations of the adverse effects on habitats, ecological receptors, and the effectiveness of proposed exposure controls; and the requirements of monitoring plans. Decision documents and documents supporting the selection of response actions include FSs, proposed plans, records of decision (RODs), their corresponding RCRA documents, and other remedy selection decision documents, such as those documenting NFA decisions, engineering evaluation/cost assessments, and site management plans (EPA 1999c). Ecological risk analyses for, and inputs to, FSs, NFA decision documents, proposed plans, RODs, and five-year review documents are discussed in the following subsections.

3.1 FEASIBILITY STUDY

The FS for a PGDP site requires input from ecological risk assessors. Typically, the FS for a PGDP site will include a summary of the findings of the ERA for the site, TCLs for COCs identified in the ERA for the site, and qualitative evaluation of impacts on ecological resources and effectiveness of alternative response actions.

Site-specific TCLs should be derived in the FS for each site considered for remedial action. TCLs for PGDP sites should be reported in the FS for the site, as well as later decision documents. Ecological TCLs for sites having an ERA are typically the highest concentration of a substance in an environmental medium that is protective of assessment endpoints. The assumptions and data used to derive cleanup levels must be justified in the FS. If an FS is produced for sites that have been selected for remedial action before an ERA, then the ecological TCLs for the site should be reported as part of the development of remedial goal options in the FS, and the assumptions and data used to derive them should be discussed.

Radioactive decay should be considered when developing cleanup goals for radionuclides at PGDP sites. Consideration of chemical degradation, however, should not be used to adjust cleanup goals, but may be used to inform if cleanup goals for degradation products should be considered or developed. At this time, quantitative analysis of environmental fate via chemical degradation will not be included in PGDP risk assessments without consultation with the regulatory agencies.

The detailed evaluation of alternative response actions in the FS for PGDP sites with ecological COCs should include a qualitative evaluation of impacts on ecological resources. Impacts on the ERA assessment endpoints must be evaluated so that risk managers will be able to compare, on an equivalent basis, the risks of cleanup alternatives and the NFA alternative. Ecological resources that are not assessment endpoints but which are potentially impacted by response actions also must be evaluated. Evaluating all identifiable impacts to all ecological resources for each alternative will allow those alternatives to be compared.

3.2 NO FURTHER ACTION DECISION DOCUMENTS

NFA decision documents will generally require a summary of site risks. Two of the three CERCLA NFA decision documents identified by EPA guidance on RODs require risk summaries: those where remedial action is not necessary for protection because there is no risk and those where no action is necessary because previous response actions at the site have reduced or eliminated risk (EPA 1999c). According to

EPA, NFA decision documents for sites where there is "No CERCLA authority to take action" do not include a summary of site risks (EPA 1999c).

The summary of site risks in NFA decision documents must include a summary of risks to ecological receptors. The summary should provide sufficient information to support the determination that no remedial action is needed to ensure protection of ecological receptors. The summary should explain the basis for concluding that ecological receptors will not experience unacceptable exposures to, and effects from, hazardous substances. The summary should correlate with current and potential future site conditions and uses of resources at the site.

3.3 PROPOSED PLAN

Proposed plans for PGDP sites and the equivalent for early actions should include a summary of the ecological risk findings (EPA 1999c). The proposed plan facilitates public involvement in the remedy selection process. Among other things, the document explains the reasons why the lead agency recommends the preferred alternative for addressing contamination at the site. A major section of the plan is the Summary of Site Risks, including risks to the environment (i.e., ecological risk).

The Summary of Site Risks section of the proposed plan for PGDP sites should provide a brief, descriptive narrative summary regarding the nature and extent of risk to ecological receptors. The proposed plan is targeted to the general public. Therefore, the proposed plan should not include extensive tables of risk calculations, which are more appropriate to the ROD. If ecological risks are a basis for the selected remedy at a PGDP site, then the proposed plan should include streamlined risk summary tables like those suggested by EPA (EPA 1999c; EPA 2018) (Appendix D and Exhibits 1 and 2).

The summary of the ERA in the proposed plan for PGDP sites should include the following:

- Ecological COCs in each medium,
- Current and reasonably anticipated future habitats and land use,
- Assessment endpoints,
- Exposure pathways for ecological receptors, and
- Summary of risk characterization.

The summary of the risk characterization should address the basis for the conclusions concerning ecological risk for receptors exposed to each medium and the potential for risk to T&E species.

For sites that have been selected for remedial action before an ERA is conducted, site-specific TCLs should be reported in the proposed plan or ROD for the site. TCLs must be estimates of concentrations in environmental media that will protect all or most ecological receptors potentially exposed at the site. Site-specific TCLs may be larger than the corresponding PGDP NFA values. PGDP NFA values are not site-specific and, therefore, must be selected to protect all potential receptors at PGDP sites. Site-specific TCL values may be based on a more limited set of receptors, and more sensitive receptors protected by NFA values may not occur at the site.

3.4 RECORD OF DECISION

The Summary of Site Risks section of RODs for PGDP sites should include a summary of risks to ecological receptors (EPA 1999c). The ROD should summarize the ERA at an appropriate level of detail

for the complexity of the site and the risks identified. Each of the eight steps of the ERA process for PGDP sites should be summarized.

The summary of the ERA in RODs for PGDP sites will contain tables of risk assessment parameters and results. The summary of the screening-level risk assessment (Steps 1 and 2) should include tables of screening-level benchmarks (PGDP NFA levels) and COPECs identified in the screen. Tables of site concentrations (range, mean, and 95% UCLs) should be included in support of the summary of Steps 1 through 3. Tables clearly summarizing preliminary HQs, TRVs, alternative benchmarks, relevant site-specific exposure parameters and effects data, and the conclusions of the reevaluation of COPECs (Step 3a) should be included in the ROD. The summary of the problem formulation should include, as tables or text, brief descriptions of site habitats, the CSM, exposure pathways, assessment endpoints, and the basis for their selection. The types, number, and DQOs of samples and analyses for the site investigations conducted to answer ecological risk questions should be summarized. Tables of results of site-specific studies on effects (e.g., toxicity tests) and risk calculations based on site-specific tissue concentration data will support the summary of the risk characterization.

When calculating residual risks for a group of units, there is no need to include calculations for units previously agreed to be NFA based upon an approved risk assessment (or alternative calculation, such as a screening assessment); however, the documentation should include by reference the NFA site's risk results.

The site-specific TCLs for ecological receptors at a PGDP site should be reported in the ROD as well as in the FS and proposed plan for the site. For sites that have been selected for remedial action before an ERA, these TCLs will be estimates of concentrations of substances present in environmental media that will protect ecological receptors potentially exposed at the site. As discussed above for proposed plans, TCLs are often equal to PGDP screening NFA values, but also may be higher than NFA values.

Input from ecological risk assessors to monitoring plans will be required if RODs for PGDP sites with ecological risk specify monitoring as part of the selected response action. The monitoring required to address ecological risk must address the assessment endpoints and risk questions selected in Step 3 of the ERA process. The work plan for monitoring programs should repeat PGDP ERA Step 4, Study Design and DQO Process, to ensure that the measurements will answer the risk questions being addressed by the monitoring with sufficient confidence to support risk management decisions during 5-year reviews.

3.5 FIVE-YEAR REVIEW

According to EPA and DOE guidance, 5-year reviews at PGDP sites should identify, collect, and compile the necessary information and data to determine whether remedies continue to be fully protective of human health and the environment (EPA 1999c; DOE 2018). For PGDP sites remediated under CERCLA authorities and monitored under the DOE's Long-Term Stewardship Program, information and data collected to assess remedy performance will be based primarily on monitoring requirements established during the implementation and closeout phases of the CERCLA process. In general, these data will be collected under the auspices of the stewardship program and the five-year review requirement incorporated into this program as a reporting tool.

According to DOE, five-year reviews at PGDP sites will include the following actions:

- Evaluate whether the remedy is operational and functional;

- Evaluate those assumptions critical to the effectiveness of remedial measures or the protection of human health and the environment (made at the time of the remedial decision) to determine, given current information, whether these assumptions are still valid;

- Determine whether "fixes" are required to address any identified deficiencies; and

- Evaluate whether there are opportunities to optimize the long-term performance of the remedy or reduce life-cycle costs.

Each of these four review activities must consider ecological risk at the site. An evaluation of those parameters established as appropriate indicators of performance at the site serves as the basis for the determination of whether remedies are operational and functional. Performance indicators, therefore, must include measures relevant to the exposure of ecological receptors identified in the ERA as being at risk from COCs in one or more medium at the site.

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APPENDIX A

PGDP NO FURTHER ACTION LEVELS

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TABLES

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ACRONYMS

COPEC	chemical or radionuclide of potential ecological concern
DOE	U.S. Department of Energy
Eco-SSLs	Ecological Soil Screening Level
EPA	U.S. Environmental Protection Agency
ERA	ecological risk assessment
ERAWG	Ecological Risk Assessment Working Group
ESL	ecological screening level
GLWQI	Great Lakes Water Quality Initiative
KDEP	Kentucky Department for Environmental Protection
LANL	Los Alamos National Laboratory
LOAEL	lowest observed adverse effect level
NCRP	National Council on Radiation Protection
NFA	no further action
NRWQC	National Recommended Water Quality Criteria
NOAEL	no observed adverse effect level
ORNL	Oak Ridge National Laboratory
PGDP	Paducah Gaseous Diffusion Plant
RAIS	Risk Assessment Information System
TRV	toxicity reference value
WWAH	Warm Water Aquatic Habitat

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PGDP NO FURTHER ACTION LEVELS

No Further Action (NFA) levels for chemicals are concentrations in abiotic media used to screen constituents detected at a site to identify those constituents that require further evaluation [i.e., chemicals or radionuclides of potential ecological concern (COPECs)]. NFA levels are generally estimates of chemical concentrations that will not adversely affect ecological receptors with high probability. NFA levels are not necessarily acceptable cleanup goals because of their potentially extreme conservatism.

The NFA level for radionuclides is a threshold "no effect" dose. The threshold dose is for the combined exposure to all radionuclides present at a site. NFA levels cannot be derived for individual radionuclides unless a relative abundance of radionuclides is specified and the relative abundance of radionuclides is a site-specific property. For any specified distribution of radionuclides at a site, NFA levels resulting in the threshold dose can be derived using U.S. Department of Energy (DOE) Standard 1153-2002 (DOE 2002) and the associated RESRAD-BIOTA software (available at http://resrad.evs.anl.gov/).

NFA levels for soil, sediment, and surface water are provided for a limited number of chemical constituents. The available NFA levels come from various sources, which were identified and unanimously agreed upon by the members of the Ecological Risk Assessment Working Group (ERAWG). Representatives of Kentucky Department for Environmental Protection (KDEP), U.S. Environmental Protection Agency (EPA), and DOE developed the hierarchy of sources and the selected values. The agreed-upon NFA levels are briefly described here.

The ERAWG agreed that for Paducah Gaseous Diffusion Plant (PGDP) ecological risk assessment (ERA) substances that potentially bioaccumulate will be considered in Step 3 of the ERA, whether or not they exceed NFA levels. As part of Step 3a, these substances that bioaccumulate will be evaluated through food-chain modeling. The list of substances that bioaccumulate for PGDP appears in Table A.1. NFA levels are based on the risk to organisms that are exposed to single constituents by direct contact with the medium. NFA levels do not protect receptors potentially exposed by ingestion to substances that have accumulated in the tissue of their food items. The presence of substances that bioaccumulate is not necessarily sufficient to trigger Step 3 of the ERA process for PGDP sites, but these substances should be considered if the ERA proceeds to Step 3.

Soil NFA levels—The soil NFA levels for chemicals (Table A.2) are selected based on the following hierarchy:

(1) EPA Region 4 screening values for soil (EPA 2018);

(2) EPA Ecological Soil Screening Level (Eco-SSLs);

(3) Values selected from among KDEP screening values, Los Alamos National Laboratory (LANL) soil screening values [minimum ecological screening level (ESL)], and Oak Ridge National Laboratory (ORNL) soil screening values based on professional judgment.

The NFA value for any particular chemical may be chosen from a lower tier if the value from the higher tier is not appropriate for use at PGDP. Chemicals for which a lower tier value was selected over a value available from a higher tier are footnoted with the rationale for the selection. The source for each value is noted in the screening table next to the value.

The soil NFA levels for radionuclides (Table A.3) are calculated from the NFA dose. The ERAWG consensus NFA dose for receptors exposed to radionuclides in PGDP soil is 0.1 rad/day, which is the recommended National Council on Radiation Protection (NCRP) threshold dose for soil invertebrates (1 rad/day) times a safety factor of 0.1 (NCRP 1991). In lieu of site-specific radionuclide relative abundance data, the PGDP NFA levels for soil are radionuclide soil-screening benchmarks for terrestrial plants and animals using RESRAD-BIOTA, Version 1.8, for soil for the terrestrial animal and plant receptors with the default dose adjusted to the ERAWG consensus value of 0.1 rad/day. The calculated PGDP soil NFA levels for radionuclides are used in the same way as soil NFA levels for chemicals.

Sediment NFA levels—The sediment NFA levels (Table A.4) for chemicals come from the following hierarchy of sources:

(1) EPA Region 4 values (EPA 2018) and

(2) Values selected from among KDEP screening values and ORNL sediment screening values based on professional judgment

The ERAWG consensus NFA dose for receptors exposed to radionuclides in the aquatic environment is 0.1 rad/day. The sediment NFA levels for radionuclides are calculated from the NFA dose (Table A.5). The ERAWG consensus NFA dose for receptors exposed to radionuclides in PGDP sediment is 0.1 rad/day, which is the recommended NCRP threshold dose for aquatic receptors (1 rad/day) times a safety factor of 0.1 (NCRP 1991). In lieu of site-specific radionuclide relative abundance data, the PGDP NFA levels for sediment are generated using RESRAD-BIOTA, Version 1.8, for sediment for the aquatic and riparian animal receptors with the default dose adjusted to the ERAWG consensus value of 0.1 rad/day. The calculated PGDP sediment NFA levels for radionuclides are used in the same way as sediment NFA levels for chemicals.

Surface water NFA levels—The surface water NFA levels (Table A.6) come from the following hierarchy of sources:

(1) EPA Region 4 freshwater values (EPA 2018)

(2) The Kentucky Warm Water Aquatic Habitat (WWAH) criterion

(3) The National Recommended Water Quality Criteria (NRWQC) chronic criterion continuous concentration

(4) Values selected from among KDEP screening values and ORNL surface water screening values based on professional judgment

The surface water screening values listed in Table A.6 assume a hardness of 50 mg/L as calcium carbonate ($CaCO_3$) for those metals whose freshwater criteria depend on hardness, such as cadmium, chromium III, copper, lead, nickel, silver, and zinc. Table A.6 includes supporting information captured in the footnotes. Table A.6 provides the conversion factors and hardness-dependent equations. Where site-specific hardness information is available, surface water NFA levels for hardness-dependent metals should be adjusted accordingly.

The surface water NFA levels for radionuclides are calculated from the NFA dose (Table A.7). The ERAWG consensus NFA dose for receptors exposed to radionuclides in PGDP surface water is 0.1 rad/day, which is the recommended NCRP threshold dose for aquatic receptors (1 rad/day) times a safety factor of 0.1 (NCRP 1991). In lieu of site-specific radionuclide relative abundance data, the PGDP

NFA levels for surface water are generated using RESRAD-BIOTA, Version 1.8, for surface water for the aquatic animal receptor with the default dose adjusted to the ERAWG consensus value of 0.1 rad/day to correspond to PGDP surface water NFA radiological doses of 0.1 rad/day. The radionuclide screening benchmarks are derived for parent isotopes and all short-lived daughter products using the radionuclide exposure model of Blaylock et al. (1993), thus, including internal and external exposures from all major alpha, beta, and gamma emissions for each isotope. Screening benchmarks for small fish are used because vertebrates are thought to be more sensitive than invertebrates (NCRP 1991). The calculated PGDP surface water NFA levels for radionuclides are used in the same way as surface water NFA levels for chemicals.

Table A.8 presents toxicity reference values (TRVs) for wildlife receptors based on no observed adverse effect levels (NOAELs). These benchmarks are expressed as a daily dose. ERAs for PGDP sites will need to explain how all benchmarks are derived and selected. The benchmarks in Table A.8 are taken from similar sources to those discussed for Tables A.2 through A.7. Similarly, Table A.9 presents TRVs for wildlife receptors based on lowest observed adverse effect level (LOAELs).

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Table A.1. List of Substances that Bioaccumulate[a]

Chemical Class	Chemical	Applicable Media
Metals	Cadmium[b]	Surface water, Sediment, Soil
	Mercury	Surface water, Sediment, Soil
	Methylmercury	Surface water, Sediment, Soil
	Selenium	Surface water, Sediment, Soil
Dioxins/Furans	2,3,7,8-tetrachlorodibenzo-p-dioxin (TCDD)	Surface water, Sediment, Soil
	2,3,7,8-tetrachlorodibenzofuran (TCDF)	Soil
Semivolatile Organics	Benz(a)anthracene	Surface water, Sediment, Soil
	Benzo(a)pyrene	Surface water, Sediment, Soil
	Benzo(e)pyrene	Soil
	Benzo(b)fluoranthene	Surface water, Sediment, Soil
	Benzo(g,h,i)perylene	Surface water, Sediment, Soil
	Benzo(k)fluoranthene	Surface water, Sediment, Soil
	bis(2-Ethylhexyl) Phthalate	Surface water, Sediment, Soil
	Chrysene	Surface water, Sediment, Soil
	Dibenz(a,h)anthracene	Surface water, Sediment, Soil
	Fluoranthene	Surface water, Sediment, Soil
	Hexachlorobenzene	Surface water, Sediment, Soil
	Hexachlorobutadiene	Surface water, Soil
	Hexachlorocyclopentadiene	Sediment
	Indeno(1,2,3-cd)pyrene	Surface water, Sediment, Soil
	1-Methyl phenanthrene	Soil
	Pentachlorobenzene	Surface water, Sediment, Soil
	Pentachlorophenol	Surface water, Sediment, Soil
	Perylene	Soil
	Phenanthrene	Surface water, Sediment, Soil
Pesticides/Herbicides/	4,4'-Dichlorodiphenyldichloroethane (DDD)	Surface water, Sediment, Soil
Polychlorinated biphenyls	4,4'-Dichlorodiphenyldichloroethylene (DDE)	Surface water, Sediment, Soil
(PCBs)	4,4'-Dichlorodiphenyltrichloroethane (DDT)	Surface water, Sediment, Soil
	Aldrin	Surface water, Sediment, Soil
	alpha-benzenehexachloride (BHC)	Surface water
	beta-BHC	Surface water, Sediment, Soil
	gamma-BHC	Surface water, Sediment, Soil
	alpha-Chlordane	Soil
	Chlordane	Surface water, Sediment
	gamma-Chlordane	Soil
	PCBs	Surface water, Sediment, Soil
	Demeton	Surface water
	Diazinon	Surface water
	Dieldrin	Surface water, Sediment, Soil
	Endrin	Surface water, Sediment, Soil
	Heptachlor	Surface water, Sediment, Soil
	Kepone (Chlordecone)	Soil
	Methoxychlor	Surface water, Sediment, Soil
	Mirex	Surface water, Sediment, Soil
	Toxaphene	Surface water, Sediment, Soil
	Trifluralin	Surface water, Sediment, Soil

[a] Source EPA 2018, *Region 4 Ecological Risk Assessment Supplemental Guidance*.
[b] Cadmium is included based on EPA 2000, *Bioaccumulation Testing and Interpretation for the Purpose of Sediment Quality Assessment: Status and Needs*.

Table A.2. PGDP Soil NFA Screening Values

Analyte	CAS Number	PGDP NFA Screening Value (mg/kg)	Source for Screening Value
Inorganics			
Metals			
Aluminum	7429-90-5	If soil pH is less than 5.5, use 50; otherwise no evaluation needed	Eco-SSL; KDEP
Antimony	7440-36-0	0.27	EPA Region 4
Arsenic	7440-38-2	18	EPA Region 4
Barium	7440-39-3	330	EPA Region 4
Beryllium	7440-41-7	2.5	EPA Region 4
Boron	7440-42-8	7.5	EPA Region 4
Cadmium	7440-43-9	0.36	EPA Region 4
Chromium (total)	7440-47-3	23	EPA Region 4
Chromium (III)	16065-83-1	26	EPA Region 4
Chromium (VI)	18540-29-9	0.34	EPA Region 4
Cobalt	7440-48-4	13	EPA Region 4
Copper	7440-50-8	28	EPA Region 4
Iron	7439-89-6	narrative statement	EPA Region 4
Lead	7439-92-1	11	EPA Region 4
Lithium	7439-93-2	2	EPA Region 4
Manganese	7439-96-5	220	EPA Region 4
Mercury	7439-97-6	0.013	EPA Region 4
Methylmercury	22967-92-6	0.00035	EPA Region 4
Molybdenum	7439-98-7	2	EPA Region 4
Nickel	7440-02-0	38	EPA Region 4
Selenium	7782-49-2	0.52	EPA Region 4
Silver	7440-22-4	4.2	EPA Region 4
Strontium	7440-24-6	96	EPA Region 4
Thallium	7440-28-0	0.05	EPA Region 4
Tin	7440-31-5	7.6	EPA Region 4
Tungsten		400	KDEP
Uranium	7440-61-1	25	EPA Region 4
Vanadium	7440-62-2	7.8	EPA Region 4
Zinc	7440-66-6	46	EPA Region 4
Other Inorganics			
Bromine (total)	7726-95-6	10	EPA Region 4
Cyanide (total)	57-12-5	0.1	EPA Region 4
Fluoride	16984-48-8	32	EPA Region 4
Fluorine	7782-41-4	200	EPA Region 4
Iodine	7553-56-2	4	EPA Region 4
Volatile Organic Compounds (VOCs)			
Chlorinated Alkanes			
1,1,1,2-Tetrachloroethane	630-20-6	0.07	EPA Region 4
1,1,2,2-Tetrachloroethane	79-34-5	0.127	EPA Region 4
1,1,1-Trichloroethane	71-55-6	0.04	EPA Region 4
1,1,2-Trichloroethane	79-00-5	0.32	EPA Region 4
1,1-Dichloroethane	75-34-3	0.14	EPA Region 4
1,2-Dichloroethane	107-06-2	0.4	EPA Region 4
1,2-Dichloropropane	78-87-5	0.28	EPA Region 4
Dichloromethane (Methylene chloride)	75-09-2	0.21	EPA Region 4
Trichloromethane (Chloroform)	67-66-3	0.05	EPA Region 4
Tetrachloromethane (Carbon tetrachloride)	56-23-5	0.05	EPA Region 4

Table A.2. PGDP Soil NFA Screening Values (Continued)

Analyte	CAS Number	PGDP NFA Screening Value (mg/kg)	Source for Screening Value
Chlorinated Alkenes			
1,1-Dichloroethene	75-35-4	0.04	EPA Region 4
1,2-Dichloroethene	540-59-0	0.04	EPA Region 4
cis-1,2-Dichloroethene	156-59-2	0.04	EPA Region 4
trans-1,2-Dichloroethene	156-60-5	0.04	EPA Region 4
1,3-Dichloropropene	542-75-6	0.001	EPA Region 4
Tetrachloroethene	127-18-4	0.06	EPA Region 4
Trichloroethene	79-01-6	0.06	EPA Region 4
Vinyl chloride	75-01-4	0.03	EPA Region 4
Chlorobenzenes			
Chlorobenzene	108-90-7	2.4	EPA Region 4
1,2-Dichlorobenzene	95-50-1	0.09	EPA Region 4
1,3-Dichlorobenzene	541-73-1	0.08	EPA Region 4
1,4-Dichlorobenzene	106-46-7	0.88	EPA Region 4
1,2,3-Trichlorobenzene	87-61-6	20	EPA Region 4
1,2,4-Trichlorobenzene	120-82-1	0.27	EPA Region 4
1,3,5-Trichlorobenzene	108-70-3	0.07	EPA Region 4
Monoaromatic Hydrocarbons			
1,2,4-Trimethylbenzene	95-63-6	0.09	EPA Region 4
1,3,5-Trimethylbenzene	108-67-8	0.16	EPA Region 4
Benzene	71-43-2	0.12	EPA Region 4
Cymene, p- (4-Isopropyltoluene)	99-87-6	0.18	EPA Region 4
Ethylbenzene	100-41-4	0.27	EPA Region 4
Isopropylbenzene (Cumene)	98-82-8	0.04	EPA Region 4
Styrene (Vinyl benzene)	100-42-5	1.2	EPA Region 4
Toluene	108-88-3	0.15	EPA Region 4
Xylene (total)	1330-20-7	0.1	EPA Region 4
Ketones			
2-Butanone (Methyl Ethyl Ketone)	78-93-3	1.0	EPA Region 4
2-Hexanone	591-78-6	0.36	EPA Region 4
Acetone	67-64-1	1.2	EPA Region 4
Other VOCs			
Tribromomethane (Bromoform)	75-25-2	0.07	EPA Region 4
Bromomethane (methyl bromide)	74-83-9	0.002	EPA Region 4
Carbon Disulfide	75-15-0	0.005	EPA Region 4
Ethylene glycol	107-21-1	0.31	EPA Region 4
Hexachloroethane	67-72-1	0.024	EPA Region 4
Hexane	110-54-3	0.007	EPA Region 4
Chloroanilines			
3-Chloroaniline	108-42-9	20	EPA Region 4
4-Chloroaniline	106-47-8	1	EPA Region 4
3,4-Dichloroaniline	95-76-1	20	EPA Region 4
2,4,5-Trichloraniline	636-30-6	20	EPA Region 4
Pentachloroaniline	527-20-8	100	EPA Region 4
Semivolatile Organic Compounds (SVOCs)			
Chlorobenzenes			
1,2,3,4-Tetrachlorobenzene	634-66-2	10	EPA Region 4
1,2,4,5-Tetrachlorobenzene	95-94-3	0.18	EPA Region 4
Hexachlorobenzene	118-74-1	0.079	EPA Region 4
Pentachlorobenzene	608-93-5	0.5	EPA Region 4

Table A.2. PGDP Soil NFA Screening Values (Continued)

Analyte	CAS Number	PGDP NFA Screening Value (mg/kg)	Source for Screening Value
Dichlorophenols			
Dichlorophenols (2,3-), (2,4-), (2,5-), (2,6-)	120-83-2	0.05	EPA Region 4
3,4-Dichlorophenol (3,4-), (3,5-)	95-77-2	20	EPA Region 4
Trichlorophenols			
2,4,5-Trichlorophenol	95-95-4	4	EPA Region 4
2,4,6-Trichlorophenol	88-06-2	9.94	EPA Region 4
Tetrachlorophenols			
2,3,4,5-Tetrachlorophenol	4901-51-3	20	EPA Region 4
Tetrachlorophenols (2,3,4,6-), (2,3,5,6-)	58-90-2	0.04	EPA Region 4
Other Phenols			
Chlorophenols (2-), (4-)	95-57-8	0.06	EPA Region 4
3-Chlorophenol	108-43-0	7	EPA Region 4
2,4-Dimethylphenol	105-67-9	0.04	
2,4-Dinitrophenol	51-28-5	0.061	EPA Region 4
4-Nitrophenol	100-02-7	5.12	EPA Region 4
2-Methylphenol (Cresol, o-)	95-48-7	0.1	EPA Region 4
3-Methylphenol (Cresol, m-)	108-39-4	0.09	EPA Region 4
4-Methylphenol (Cresol, p-)	106-44-5	0.08	EPA Region 4
Nonylphenol	25154-52-3	1.27	EPA Region 4
Pentachlorophenol (PCP)	87-86-5	2.1	EPA Region 4
Phenol	108-95-2	0.79	EPA Region 4
Energetic SVOCs			
2-Amino-4,6-dinitrotoluene	35572-78-2	14	EPA Region 4
4-Amino-4,6-dinitrotoluene	19406-51-0	12	EPA Region 4
1,3- Dinitrobenzene	99-65-0	0.034	EPA Region 4
2,4-Dinitrotoluene	121-14-2	6	EPA Region 4
2,6-Dinitrotoluene	606-20-2	4	EPA Region 4
HMX (Octahydro-tetranitro-1,3,5,7-tetrazocine)	2691-41-0	16	EPA Region 4
Nitroglycerine	55-63-0	13	EPA Region 4
2-Nitrotoluene	88-72-2	0.19	EPA Region 4
3-Nitrotoluene	99-08-1	0.13	EPA Region 4
4-Nitrotoluene	99-99-0	0.14	EPA Region 4
PETN (Pentaerythrite-tetranitrate)	78-11-5	2.2	EPA Region 4
RDX (Hexahydro-1,3,5-trinitro-1,3,5-triazine)	121-82-4	2.3	EPA Region 4
Tetryl (Methyl-2,4,6-trinitrophenylnitroamine)	479-45-8	0.018	EPA Region 4
1,3,5-Trinitrobenzene	99-35-4	0.3	EPA Region 4
2,4,6-Trinitrotoluene (TNT)	118-96-7	7.5	EPA Region 4
Other SVOCs			
1,1'-Biphenyl	92-52-4	0.2	EPA Region 4
3,3'- Dichlorobenzidine	91-94-1	0.03	EPA Region 4
Benzoic acid	65-85-0	0.01	EPA Region 4
Benzyl Alcohol	100-51-6	0.002	EPA Region 4
Carbazole	86-74-8	0.07	EPA Region 4
Dibenzofuran	132-64-9	0.15	EPA Region 4
Hexachlorobutadiene	87-68-3	0.009	EPA Region 4
Hexachlorocyclopentadiene	77-47-4	0.001	EPA Region 4
N-nitrosodiphenylamine	86-30-6	0.545	EPA Region 4
Nitrobenzene	98-95-3	2.2	EPA Region 4
Pentachloronitrobenzene	82-68-8	0.09	EPA Region 4

Table A.2. PGDP Soil NFA Screening Values (Continued)

Analyte	CAS Number	PGDP NFA Screening Value (mg/kg)	Source for Screening Value
Phthalates			
bis(2-Ethylhexyl) Phthalate	117-81-7	0.02	EPA Region 4
Butylbenzyl phthalate	85-68-7	0.59	EPA Region 4
Diethylphthalate	84-66-2	0.25	EPA Region 4
Dimethylphthalate	131-11-3	0.35	EPA Region 4
Di-n-butyl phthalate	84-74-2	0.011	EPA Region 4
Di-n-octyl phthalate	117-84-0	0.91	EPA Region 4
Polycyclic aromatic hydrocarbons (PAHs)			
Low Molecular Weight (LMW) PAHs			
Acenaphthene	83-32-9	See Total	EPA Region 4
Acenaphthylene	208-96-8	See Total	EPA Region 4
Anthracene	120-12-7	See Total	EPA Region 4
Fluorene	86-73-7	See Total	EPA Region 4
1-Methyl naphthalene	90-12-0	See Total	EPA Region 4
2-Methyl naphthalene	91-57-6	See Total	EPA Region 4
2,6-Dimethyl naphthalene	581-42-0	See Total	EPA Region 4
2,3,5-Trimethylnaphthalene	2245-38-7	See Total	EPA Region 4
Naphthalene	91-20-3	See Total	EPA Region 4
1-Methyl phenanthrene	832-69-9	See Total	EPA Region 4
Phenanthrene	85-01-8	See Total	EPA Region 4
Total LMW PAHs		29	EPA Region 4
High Molecular Weight (HMW) PAHs			
Benzo(a)anthracene	56-55-3	See Total	EPA Region 4
Benzo(b)fluoranthene	205-99-2	See Total	EPA Region 4
Benzo(k)fluoranthene	207-08-9	See Total	EPA Region 4
Benzo(ghi)perylene	191-24-2	See Total	EPA Region 4
Benzo(a)pyrene	50-32-8	See Total	EPA Region 4
Benzo(e)pyrene	192-97-2	See Total	EPA Region 4
Chrysene	218-01-9	See Total	EPA Region 4
Dibenzo(a,h)anthracene	53-70-3	See Total	EPA Region 4
Fluoranthene	206-44-0	See Total	EPA Region 4
Indeno(1,2,3-cd)pyrene	193-39-5	See Total	EPA Region 4
Perylene	198-55-0	See Total	EPA Region 4
Pyrene	129-00-0	See Total	EPA Region 4
Total HMW PAHs		1.1	EPA Region 4
Pesticides/Herbicides			
Acrolein	107-02-8	0.0003	EPA Region 4
Aldrin	309-00-2	0.03	EPA Region 4
Atrazine	1912-24-9	0.00005	EPA Region 4
alpha-BHC	319-84-6	0.0003	EPA Region 4
beta-BHC	319-85-7	0.0003	EPA Region 4
gamma-BHC (Lindane)	58-89-9	0.0031	EPA Region 4
Carbaryl	63-25-2	0.0003	EPA Region 4
Carbofuran	1563-66-2	0.0008	EPA Region 4
alpha-Chlordane	5103-71-9	0.0029	EPA Region 4
gamma-Chlordane	12789-03-6	0.02	EPA Region 4
Chloropyrifos	2921-88-2	0.003	EPA Region 4
Dinoseb	88-85-7	0.015	EPA Region 4
DDT/DDD/DDE (total)		0.021	EPA Region 4

Table A.2. PGDP Soil NFA Screening Values (Continued)

Analyte	CAS Number	PGDP NFA Screening Value (mg/kg)	Source for Screening Value
Diazinon	333-41-5	0.0037	EPA Region 4
Dieldrin	60-57-1	0.0029	EPA Region 4
Endosulfan— alpha	959-98-8	0.0009	EPA Region 4
Endosulfan (alpha and beta)	115-29-7	0.0009	EPA Region 4
Endosulfan sulfate	1031-07-8	0.0065	EPA Region 4
Endrin	72-20-8	0.0019	EPA Region 4
Guthion	86-50-0	0.00006	EPA Region 4
Heptachlor	76-44-8	0.0016	EPA Region 4
Heptachlor epoxide	1024-57-3	0.00015	EPA Region 4
Hexachlorocyclopentadiene	77-47-4	0.0064	EPA Region 4
Kepone (Chlordecone)	143-50-0	0.017	EPA Region 4
Malathion	121-75-5	0.00004	EPA Region 4
Methoxychlor	72-43-5	0.0021	EPA Region 4
Mirex	2385-85-5	0.0036	EPA Region 4
Parathion	56-38-2	0.00019	EPA Region 4
2,4,5-TP (Silvex)	93-72-1	0.055	EPA Region 4
Simazine	122-34-9	0.0083	EPA Region 4
Toxaphene	8001-35-2	0.00015	EPA Region 4
Trifluralin	1582-09-8	0.079	EPA Region 4
PCBs and Dioxins/Furans			
PCDDs, PCDFs (ΣTEQ)	1746-01-6	0.00000315	EPA Region 4
Total PCBs	1336-36-3	0.041	EPA Region 4
Other			
2-Nitroaniline	88-74-4	0.02	EPA Region 4
Diphenylamine	122-39-4	1.01	EPA Region 4
Trichlorofluoromethane	75-69-4	16.4	EPA Region 4

EPA Region 4 screening values taken from EPA 2018.
Eco-SSLs are the smallest values presented in individual papers accessed from http://www.epa.gov/ecotox/ecossl/ in June 2014.
KDEP value is provided in Appendix F of this document for reference.

Table A.3. PGDP Soil NFA Screening Values for Radionuclides

Radionuclide	NFA (pCi/g)
Americium-241	2.16E+03
Cesium-137	2.08E+01
Neptunium-237	8.14E+02
Plutonium-238	1.75E+03
Plutonium-239	1.27E+03
Plutonium-240	1.27E+03
Technetium-99	2.19E+03
Thorium-230	9.98E+03
Uranium-234	5.14E+03
Uranium-235	2.75E+03
Uranium-238	1.57E+03

NFA = activity (pCi/g) resulting in dose of 0.1 rad/day assuming secular equilibrium of parent and daughter products.
NFA values from RESRAD-BIOTA, Version 1.8, Report for Level 2 (default values, except dose adjusted to 0.1 rad/day) RESRAD-BIOTA software is available at http://resrad.evs.anl.gov/

Table A.4a. PGDP Sediment NFA Screening Values (Non-Narcotic Modes of Action)

Analyte	CAS Number	PGDP NFA Screening Value	Units	Source for Screening Value
Inorganics				
Metals				
Aluminum	7429-90-5	25,000	mg/kg	EPA Region 4
Antimony	7440-36-0	2	mg/kg	EPA Region 4
Arsenic	7440-38-2	9.8	mg/kg	EPA Region 4
Barium	7440-39-3	20		EPA Region 4
Cadmium	7440-43-9	1	mg/kg	EPA Region 4
Chromium (Total)	7440-47-3	43.4	mg/kg	EPA Region 4
Cobalt	7440-48-4	50	mg/kg	EPA Region 4
Copper	7440-50-8	31.6	mg/kg	EPA Region 4
Iron	7439-89-6	20,000	mg/kg	EPA Region 4
Lead	7439-92-1	35.8	mg/kg	EPA Region 4
Manganese	7439-96-5	460	mg/kg	EPA Region 4
Mercury *	7439-97-6	0.17	mg/kg	EPA Region 4
Methylmercury	22967-92-6	0.00045	mg/kg	EPA Region 4
Nickel	7440-02-0	22.7	mg/kg	EPA Region 4
Selenium *	7782-49-2	0.72	mg/kg	EPA Region 4
Silver	7440-22-4	1	mg/kg	EPA Region 4
Uranium	7440-61-1	100	mg/kg	EPA Region 4
Vanadium	7440-62-2	0.2	mg/kg	KDEP
Zinc	7440-66-6	121	mg/kg	EPA Region 4
Other Inorganics				
Ammonia	7664-41-7	230	mg/kg	EPA Region 4
Sulfides (Total)	18946-25-8	39	mg/kg	EPA Region 4
Organic compounds				
VOCs				
Acetaldehyde	75-07-0	40	µg/kg	EPA Region 4
Acrolein	107-02-8	0.93	µg/kg	EPA Region 4
Acrylonitrile	107-13-1	30	µg/kg	EPA Region 4
Bromoform (tribromomethane)	75-25-2	142	µg/kg	EPA Region 4
Bromomethane (methyl bromide)	74-83-9	6.5	µg/kg	EPA Region 4
1,3-Dichloropropene (cis and trans)	542-75-6	1.5	µg/kg	EPA Region 4
1,2-Diphenylhydrazine	122-66-7	3.9	µg/kg	EPA Region 4
Dibromochloromethane	124-48-1	198	µg/kg	EPA Region 4
Dichlorobromomethane	75-27-4	210	µg/kg	EPA Region 4
Hexane	110-54-3	0.94	µg/kg	EPA Region 4
Hydrazine	302-01-2	0.87	µg/kg	EPA Region 4
Methylamine	74-89-5	292	µg/kg	EPA Region 4
Vinyl acetate	108-05-4	5.7	µg/kg	EPA Region 4
SVOCs				
Phenols				
2-Chlorophenol	95-57-8	55	µg/kg	EPA Region 4
2-Methylphenol (o-cresol)	95-48-7	119	µg/kg	EPA Region 4
2,3-Dimethylphenol	526-75-0	385	µg/kg	EPA Region 4
2,4-Dimethylphenol	105-67-9	39	µg/kg	EPA Region 4
3-Methylphenol (m-Cresol)	108-39-4	112	µg/kg	EPA Region 4
4-Methylphenol (p-Cresol)	106-44-5	93	µg/kg	EPA Region 4
2-Nitrophenol	88-75-5	168	µg/kg	EPA Region 4
4-Nitrophenol	100-02-7	153	µg/kg	EPA Region 4
2,4-Dinitrophenol	51-28-5	223	µg/kg	EPA Region 4

Table A.4a. PGDP Sediment NFA Screening Values (Non-Narcotic Modes of Action) (Continued)

Analyte	CAS Number	PGDP NFA Screening Value	Units	Source for Screening Value
2-Methyl-4,6-Dinitrophenol	534-52-1	1,477	µg/kg	EPA Region 4
2,4,5-Trichlorophenol	95-95-4	34	µg/kg	EPA Region 4
2,4,6-Trichlorophenol	88-06-2	89	µg/kg	EPA Region 4
3-Methyl-4-Chlorophenol	59-50-7	5	µg/kg	EPA Region 4
Pentachlorophenol *	87-86-5	10	µg/kg	EPA Region 4
Phenol	108-95-2	175	µg/kg	EPA Region 4
Energetic SVOCs				
2-Amino-4,6-dinitrotoluene	35572-78-2	47	µg/kg	EPA Region 4
4-Amino-2,6-dinitrotoluene	19406-51-0	28	µg/kg	EPA Region 4
3,5-Dinitroanaline (DNA)	618-87-1	126	µg/kg	EPA Region 4
1,3-Dinitrobenzene (DNB)	99-65-0	40	µg/kg	EPA Region 4
2,3-Dinitrotoluene	602-01-7	8	µg/kg	EPA Region 4
2,4-Dinitrotoluene	121-14-2	290	µg/kg	EPA Region 4
2,5-Dinitrotoluene	619-15-8	22	µg/kg	EPA Region 4
2,6-Dinitrotoluene	606-20-2	296	µg/kg	EPA Region 4
3,5-Dinitrotoluene	618-85-9	381	µg/kg	EPA Region 4
HMX (Octahydro-tetranitro-1,3,5…)	2691-41-0	108	µg/kg	EPA Region 4
Nitroglycerine	55-63-0	10	µg/kg	EPA Region 4
RDX (Hexahydro-1,3,5-trinitro-1,3,5...)	121-82-4	65	µg/kg	EPA Region 4
1,3,5-Trinitrobenzene (TNB)	99-35-4	15	µg/kg	EPA Region 4
2,4,6-Trinitrotoluene (TNT)	118-96-7	27	µg/kg	EPA Region 4
Other SVOCs				
4-Chloroaniline	106-47-8	0.9	µg/kg	EPA Region 4
3,3'-Dichlorobenzidine	91-94-1	31	µg/kg	EPA Region 4
Aniline	62-53-3	2.3	µg/kg	EPA Region 4
Benzaldehyde	100-52-7	59	µg/kg	EPA Region 4
Benzidine	92-87-5	1.1	µg/kg	EPA Region 4
Decane	124-18-5	726	µg/kg	EPA Region 4
Hexachlorobenzene	118-74-1	20	µg/kg	EPA Region 4
Hexachlorocyclopentadiene*	77-47-4	6.5	µg/kg	EPA Region 4
Hydroquinone	123-31-9	1.5	µg/kg	EPA Region 4
Pesticides				
4,4'-DDD	72-54-8	3.5	µg/kg	EPA Region 4
Total DDD	N/A	4.9	µg/kg	EPA Region 4
4,4'-DDE	72-55-9	1.4	µg/kg	EPA Region 4
Total DDE	N/A	3.2	µg/kg	EPA Region 4
4,4'-DDT	50-29-3	1.0	µg/kg	EPA Region 4
Total DDT*	N/A	4.2	µg/kg	EPA Region 4
DDT/DDE/DDD (Total)	N/A	5.3	µg/kg	EPA Region 4
Acephate	30560-19-1	50	µg/kg	EPA Region 4
Acrolein	107-02-8	0.9	µg/kg	EPA Region 4
Aldrin *	309-00-2	29	µg/kg	EPA Region 4
Atrazine	1912-24-9	0.3	µg/kg	EPA Region 4
alpha-BHC	319-84-6	0.3	µg/kg	EPA Region 4
beta-BHC*	319-85-7	5.0	µg/kg	EPA Region 4
gamma-BHC (Lindane)*	58-89-9	2.4	µg/kg	EPA Region 4
Carbaryl	63-25-2	0.3	µg/kg	EPA Region 4

Table A.4a. PGDP Sediment NFA Screening Values (Non-Narcotic Modes of Action) (Continued)

Analyte	CAS Number	PGDP NFA Screening Value	Units	Source for Screening Value
Carbofuran	1563-66-2	0.9	µg/kg	EPA Region 4
Chlordane*	57-74-9	0.06	µg/kg	EPA Region 4
Chloropyrifos	2921-88-2	3	µg/kg	EPA Region 4
Cyanazine	21725-46-2	30	µg/kg	EPA Region 4
Demeton	126-75-0	0.2	µg/kg	EPA Region 4
Diazinon	333-41-5	0.4	µg/kg	EPA Region 4
Dieldrin*	60-57-1	1.9	µg/kg	EPA Region 4
Dimethoate	60-51-5	0.2	µg/kg	EPA Region 4
Endosulfan	115-29-7	0.01	µg/kg	EPA Region 4
Endosulfan-beta	33213-65-9	0.9	µg/kg	EPA Region 4
Endosulfan Sulfate	1031-07-8	0.7	µg/kg	EPA Region 4
Endrin*	72-20-8	2.2	µg/kg	EPA Region 4
Heptachlor	76-44-8	0.6	µg/kg	EPA Region 4
Heptachlor epoxide	1024-57-3	2.5	µg/kg	EPA Region 4
Malathion	121-75-5	0.67	µg/kg	EPA Region 4
Methoxychlor	72-43-5	30	µg/kg	EPA Region 4
Mirex*	2385-85-5	3.6	µg/kg	EPA Region 4
Parathion	56-38-2	0.2	µg/kg	EPA Region 4
Toxaphene	8001-35-2	0.1	µg/kg	EPA Region 4
Herbicides, Fungicides				
2,4-D	94-75-7	47	µg/kg	EPA Region 4
Captan	133-06-2	47	µg/kg	EPA Region 4
Chlorothalonil	1897-45-6	6.4	µg/kg	EPA Region 4
Dicamba	1918-00-9	8.4	µg/kg	EPA Region 4
Dinoseb	88-85-7	15	µg/kg	EPA Region 4
Diquat	2764-72-9	25	µg/kg	EPA Region 4
MCPA (2-methyl-4-chlorophenoxyacetic acid)	94-74-6	1.6	µg/kg	EPA Region 4
Metolachlor	51218-45-2	22	µg/kg	EPA Region 4
Silvex (2,4,5-TP)	93-72-1	62	µg/kg	EPA Region 4
Simazine	122-34-9	0.3	µg/kg	EPA Region 4
Trifluralin	1582-09-8	79	µg/kg	EPA Region 4
PCBs and Dioxins/Furans				
Total PCBs*	1336-36-3	14	µg/kg	EPA Region 4
Dioxins, total equivalent	1746-01-6	0.0025	µg/kg	EPA Region 4
2,3,7,8-TCDD*	1746-01-6	0.0005	µg/kg	EPA Region 4
Other				
Butyltins				
Monobutyltin	78763-54 -9	0.54	µg/kg	EPA Region 4
Dibutyltin	818-08-6	0.91	µg/kg	EPA Region 4
Tributyltin	688-73-3	0.047	µg/kg	EPA Region 4
Tetrabutyltin	1461-25-2	0.097	µg/kg	EPA Region 4
Bulk Petroleum Hydrocarbons				
Total Petroleum Hydrocarbons–Diesel	68334-30-5	340	µg/kg	EPA Region 4
Total Petroleum Hydrocarbons–Residual	68476-53-9	3,600	µg/kg	EPA Region 4

EPA Region 4 screening values were taken from EPA 2018, Freshwater Sediment Ecological Screening Values.
KDEP value is taken from the former Kentucky Risk Assessment Guidance 2002 (Appendix D). This information is provided in Appendix F of this document for reference.
* The lesser of screening values was used.

Table A.4b. PGDP Sediment NFA Screening Values (Narcotic Modes of Action*)

Analyte	CAS Number	PGDP NFA Screening Value	Units	Source for Screening Value
VOCs				
Chlorinated and Brominated Alkanes				
1,1,1,2-Tetrachloroethane	630-20-6	99	µg/kg	EPA Region 4
1,1,2,2-Tetrachloroethane	79-34-5	250	µg/kg	EPA Region 4
1,1,1-Trichloroethane	71-55-6	70	µg/kg	EPA Region 4
1,1,2-Trichloroethane	79-00-5	538	µg/kg	EPA Region 4
1,1-Dichloroethane	75-34-3	20	µg/kg	EPA Region 4
1,2-Dichloroethane	107-06-2	986	µg/kg	EPA Region 4
1,2-Dichloropropane	78-87-5	428	µg/kg	EPA Region 4
Dichloromethane (methylene chloride)	75-09-2	18	µg/kg	EPA Region 4
Hexachloroethane	67-72-1	27	µg/kg	EPA Region 4
Trichloromethane (Chloroform)	67-66-3	87	µg/kg	EPA Region 4
Tetrachloromethane (Carbon tetrachloride)	56-23-5	57	µg/kg	EPA Region 4
Chlorinated and Brominated Alkenes				
1,1-Dichloroethene	75-35-4	100	µg/kg	EPA Region 4
1,2-Dichloroethene	540-59-0	200	µg/kg	EPA Region 4
1,2-cis-Dichloroethene	156-59-2	432	µg/kg	EPA Region 4
1,2-trans-Dichloroethene	156-60-5	389	µg/kg	EPA Region 4
1,3-Dichloropropene	542-75-6	1.5	µg/kg	EPA Region 4
1,1,2,2-Tetrachloroethene (PCE)	127-18-4	2	µg/kg	EPA Region 4
1,1,2-Trichloroethene (TCE)	79-01-6	78	µg/kg	EPA Region 4
Chloroethene (Vinyl chloride)	75-01-4	482	µg/kg	EPA Region 4
Chlorobenzenes				
Chlorobenzene	108-90-7	30	µg/kg	EPA Region 4
1,2-Dichlorobenzene	95-50-1	95	µg/kg	EPA Region 4
1,3-Dichlorobenzene	541-73-1	89	µg/kg	EPA Region 4
1,4-Dichlorobenzene	106-46-7	30	µg/kg	EPA Region 4
1,2,3-Trichlorobenzene	87-61-6	113	µg/kg	EPA Region 4
1,2,4-Trichlorobenzene	120-82-1	11	µg/kg	EPA Region 4
1,3,5-Trichlorobenzene	108-70-3	68	µg/kg	EPA Region 4
Trichlorobenzene (mixed isomers)	12002-48-1	68	µg/kg	EPA Region 4
Monoaromatic Hydrocarbons				
1,2,4-Trimethylbenzene	95-63-6	97	µg/kg	EPA Region 4
1,3,5-Trimethylbenzene	108-67-8	164	µg/kg	EPA Region 4
Benzene	71-43-2	10	µg/kg	EPA Region 4
Cymene, p- (4-Isopropyltoluene)	99-87-6	184	µg/kg	EPA Region 4
Ethylbenzene	100-41-4	290	µg/kg	EPA Region 4
Isopropylbenzene (Cumene)	98-82-8	35	µg/kg	EPA Region 4
Styrene (Vinyl benzene)	100-42-5	126	µg/kg	EPA Region 4
Toluene	108-88-3	10	µg/kg	EPA Region 4
Xylenes (total)	1330-20-7	130	µg/kg	EPA Region 4
Ketones				
2-Butanone (methyl ethyl ketone)	78-93-3	7,604	µg/kg	EPA Region 4
2-Hexanone (methyl butyl ketone)	591-78-6	45	µg/kg	EPA Region 4
2-Octanone (methyl hexyl ketone)	111-13-7	6.6	µg/kg	EPA Region 4
4-Methyl-2-pentanone (MIBK)	108-10-1	73	µg/kg	EPA Region 4
Acetone	67-64-1	65	µg/kg	EPA Region 4

Table A.4b. PGDP Sediment NFA Screening Values (Narcotic Modes of Action*) (Continued)

Analyte	CAS Number	PGDP NFA Screening Value	Units	Source for Screening Value
Alcohols				
1-Pentanol	71-41-0	40	µg/kg	EPA Region 4
2-Propanol	67-63-0	2.4	µg/kg	EPA Region 4
Ethylene glycol	107-21-1	42,389	µg/kg	EPA Region 4
Methanol	67-56-1	102	µg/kg	EPA Region 4
Propylene glycol	57-55-6	22	µg/kg	EPA Region 4
Other VOCs				
Acetonitrile	75-05-8	4,167	µg/kg	EPA Region 4
4-Bromophenyl phenyl ether	101-55-3	47	µg/kg	EPA Region 4
Carbon disulfide	75-15-0	7.8	µg/kg	EPA Region 4
Methyl tert-butyl ether (MTBE)	1634-04-4	304	µg/kg	EPA Region 4
SVOCs				
Chlorobenzenes				
1,2,3,4-Tetrachlorobenzene	634-66-2	69	µg/kg	EPA Region 4
1,2,4,5-Tetrachlorobenzene	95-94-3	187	µg/kg	EPA Region 4
Pentachlorobenzene	608-93-5	116	µg/kg	EPA Region 4
Phenols				
2,4-Dichlorophenol	120-83-2	57	µg/kg	EPA Region 4
2,4,6-Tribromophenol	118-79-6	47	µg/kg	EPA Region 4
2,3,4,6-Tetrachlorophenol	58-90-2	30	µg/kg	EPA Region 4
Energetic SVOCs				
2-Nitrotoluene	88-72-2	207	µg/kg	EPA Region 4
3-Nitrotoluene	99-08-1	145	µg/kg	EPA Region 4
4-Nitrotoluene	99-99-0	145	µg/kg	EPA Region 4
Phthalates			µg/kg	
bis(2-Ethylhexyl) Phthalate	117-81-7	180	µg/kg	EPA Region 4
Butyl benzyl phthalate	85-68-7	100	µg/kg	EPA Region 4
Diethyl phthalate	84-66-2	630	µg/kg	EPA Region 4
Dimethyl phthalate	131-11-3	678	µg/kg	EPA Region 4
Di-n-butyl phthalate	84-74-2	11	µg/kg	EPA Region 4
Di-n-octyl phthalate	117-84-0	39	µg/kg	EPA Region 4
PAHs				
LMW PAHs				
1-Methylnaphthalene	90-12-0	141	µg/kg	EPA Region 4
2-Methylnaphthalene	91-57-6	20.2	µg/kg	EPA Region 4
Acenaphthene	83-32-9	6.7	µg/kg	EPA Region 4
Acenaphthylene	208-96-8	5.9	µg/kg	EPA Region 4
Anthracene	120-12-7	57	µg/kg	EPA Region 4
Fluorene	86-73-7	77	µg/kg	EPA Region 4
Naphthalene	91-20-3	176	µg/kg	EPA Region 4
Phenanthrene	85-01-8	204	µg/kg	EPA Region 4
Total LMW-PAHs		600	µg/kg	EPA Region 4
HMW PAHs				
Benzo(a)anthracene	56-55-3	108	µg/kg	EPA Region 4
Benzo(a)pyrene	50-32-8	150	µg/kg	EPA Region 4
Benzo(g,h,i)perylene	191-24-2	170	µg/kg	EPA Region 4
Benzo(k)fluoranthene	207-08-9	240	µg/kg	EPA Region 4
Benzo(b)fluoranthene	205-99-2	190	µg/kg	EPA Region 4
Chrysene	218-01-9	166	µg/kg	EPA Region 4

Table A.4b. PGDP Sediment NFA Screening Values (Narcotic Modes of Action*) (Continued)

Analyte	CAS Number	PGDP NFA Screening Value	Units	Source for Screening Value
Dibenzo(a,h)anthracene	53-70-3	33	µg/kg	EPA Region 4
Fluoranthene	206-44-0	423	µg/kg	EPA Region 4
Indeno(1,2,3-cd)pyrene	193-39-5	200	µg/kg	EPA Region 4
Phenanthrene	85-01-8	204	µg/kg	EPA Region 4
Pyrene	129-00-0	195	µg/kg	EPA Region 4
Total HMW-PAHs		1,000	µg/kg	EPA Region 4
Total PAHs		1,610	µg/kg	EPA Region 4
PAH-like Compounds				
1,1-Biphenyl	92-52-4	198	µg/kg	EPA Region 4
Dibenzofuran	132-64-9	510	µg/kg	EPA Region 4
Quinoline	91-22-5	3.0	µg/kg	EPA Region 4
Tetrahydrofuran	109-99-9	4,488	µg/kg	EPA Region 4
Other SVOCs				
4-Bromophenyl phenyl ether	101-55-3	47	µg/kg	EPA Region 4
Benzoic acid	65-85-0	19	µg/kg	EPA Region 4
Benzyl alcohol	100-51-6	3.7	µg/kg	EPA Region 4
Carbazole	86-74-8	69	µg/kg	EPA Region 4
Isodecyl diphenyl phosphate	29761-21-5	89	µg/kg	EPA Region 4
Isophorone	78-59-1	876	µg/kg	EPA Region 4
N-Nitrosodiphenylamine	86-30-6	110	µg/kg	EPA Region 4
Nitrobenzene	98-95-3	407	µg/kg	EPA Region 4
Triphenyl phosphate	115-86-6	70	µg/kg	EPA Region 4

EPA Region 4 screening values were taken from EPA 2018, Freshwater Sediment Ecological Screening Values.
* The sum toxic unit (ΣTU) approach should be used in the screening process to identify COPECs that may collectively contribute narcotic effects to sediment-dwelling organisms. The ΣTU approach is described in EPA 2018.

Table A.5. PGDP Sediment NFA Screening Values for Radionuclides

Radionuclide	NFA (Based on Riparian Animal) (pCi/g)
Americium-241	5.15E+03
Cesium-137	3.13E+03
Neptunium-237	7.63E+03
Plutonium-238	5.73E+03
Plutonium-239	5.87E+03
Plutonium-240	—
Technetium-99	4.14E+04
Thorium-230	1.04E+04
Uranium-234	5.27E+03
Uranium-235	3.79E+03
Uranium-238	2.49E+03

NFA = activity (pCi/g) resulting in dose of 0.1 rad/day assuming secular equilibrium of parent and daughter products.
NFA values from RESRAD-BIOTA, Version 1.8, Report for Level 3 (default values, except dose adjusted to 0.1 rad/day) RESRAD-BIOTA software is available at http://resrad.evs.anl.gov/b.

Table A.6a. PGDP Surface Water NFA Screening Values (Non-Narcotic Modes of Action)

Analyte	CAS Number	PGDP NFA Screening Value (μg/L)	Source for Screening Value
Inorganics			
Metals			
Aluminum	7429-90-5	87	EPA Region 4
Antimony	7440-36-0	190	EPA Region 4
Arsenic (filtered and unfiltered) [a]	7440-38-2	150	EPA Region 4
Arsenic (III) (unfiltered)	22541-54-4	148	EPA Region 4
Barium	7440-39-3	220	EPA Region 4
Beryllium [a]	7440-41-7	11	EPA Region 4
Boron	7440-42-8	7,200	EPA Region 4
Cadmium (filtered)[a]	7740-43-9	0.45	EPA Region 4
Cadmium (unfiltered)	7740-43-9	e(0.7409 (ln Hard*)-4.719)	Kentucky WWAH
Calcium	7440-70-2	116,000	EPA Region 4
Chromium (III) (filtered)[a]	16065-83-1	42	EPA Region 4
Chromium (III) (unfiltered)	16065-83-1	e(0.8190 (lnHard*)+0.6848)	Kentucky WWAH
Chromium (VI) (filtered)	18540-29-9	11	EPA Region 4
Chromium (VI) (unfiltered)	18540-29-9	11	Kentucky WWAH
Cobalt	7440-48-4	19	EPA Region 4
Copper (filtered)[a]	7740-50-8	4.95	EPA Region 4
Copper (unfiltered)	7740-50-8	e(0.8545 (ln Hard*)-1.702)	Kentucky WWAH
Iron	7439-89-6	1,000	EPA Region 4
Lead (filtered)[a]	7439-92-1	1.25	EPA Region 4
Lead (unfiltered)	7439-92-1	e(1.273 (ln Hard*)-4.705)	Kentucky WWAH
Lithium	7439-93-2	440	EPA Region 4
Magnesium	7439-95-4	82,000	EPA Region 4
Manganese	7439-96-5	93	EPA Region 4
Mercury[b]	7439-97-6	0.0013	EPA Region 4
Mercury, methyl	22967-92-6	0.0028	EPA Region 4
Molybdenum	7439-98-7	800	EPA Region 4
Nickel (filtered)[a]	7440-02-0	28.9	EPA Region 4
Nickel (unfiltered)	7440-02-0	e(0.8460 (lnHard*)+0.0584)	Kentucky WWAH
Phosphorus (elemental)	7723-14-0	1,000	EPA Region 4
Potassium	7440-09-7	53,000	EPA Region 4
Selenium (unfiltered) [a]	7782-49-2	5	EPA Region 4
Silver (filtered)[a]	7740-22-4	0.06	EPA Region 4
Silver (unfiltered)	7740-22-4	e(1.72 (ln Hard*)-6.59)	Kentucky WWAH
Sodium	7440-23-5	680,000	EPA Region 4
Strontium	7440-24-6	5,300	EPA Region 4
Thallium	7440-28-0	6	EPA Region 4
Tin	7440-31-5	180	EPA Region 4
Uranium	7440-61-1	2.6	EPA Region 4
Vanadium	7440-62-2	27	EPA Region 4
Zinc (filtered)[a]	7740-66-6	66	EPA Region 4
Zinc (unfiltered)	7740-66-6	e(0.8473 (ln Hard*)+0.884)	Kentucky WWAH
Zirconium	7440-67-7	17	EPA Region 4
Other Inorganics			
Chloride	16887-00-6	230,000	EPA Region 4
Chlorine	7782-50-5	11	EPA Region 4
Cyanide, free	57-12-5	5.2	EPA Region 4
Fluoride	16984-48-8	2,700	EPA Region 4
Hydrogen sulfide	7783-06-4	2	EPA Region 4
Sulfite	14265-45-3	200	EPA Region 4

Table A.6a. PGDP Surface Water NFA Screening Values (Non-Narcotic Modes of Action) (Continued)

Analyte	CAS Number	PGDP NFA Screening Value (μg/L)	Source for Screening Value
VOCs			
Chlorinated and Brominated Alkanes			
1,1,1,2-Tetrachloroethane	630-20-6	85	EPA Region 4
1,1,2,2-Tetrachloroethane	79-34-5	200	EPA Region 4
1,1,1-Trichloroethane	71-55-6	76	EPA Region 4
1,1,2-Trichloroethane	79-00-5	730	EPA Region 4
1,1-Dichloroethane	75-34-3	410	EPA Region 4
1,2-Dichloroethane	107-06-2	2,000	EPA Region 4
1,2-Dichloropropane	78-87-5	520	EPA Region 4
Bromoform (tribromomethane)	75-25-2	230	EPA Region 4
Bromomethane (Methyl bromide)	74-83-9	16	EPA Region 4
Dibromochloromethane	124-48-1	320	EPA Region 4
Dichlorobromomethane	75-27-4	340	EPA Region 4
Dichloromethane (Methylene chloride)	75-09-2	1,500	EPA Region 4
Hexachloroethane	67-72-1	12	EPA Region 4
Methyl chloride	74-87-3	5,500	KDEP
Trichloromethane (Chloroform)	67-66-3	140	EPA Region 4
Tetrachloromethane (Carbon tetrachloride)	56-23-5	77	EPA Region 4
Chlorinated Alkenes			
1,1-Dichloroethene	75-35-4	130	EPA Region 4
1,2-Dichloroethene (total)	540-59-0	970	EPA Region 4
1,2-*cis*-Dichloroethene	156-59-2	620	EPA Region 4
1,2-*trans*-Dichloroethene	156-60-5	558	EPA Region 4
1,3-Dichloropropene (*cis* and *trans*)	542-75-6	1.7	EPA Region 4
1,1,2,2-Tetrachloroethylene (PCE)	127-18-4	53	EPA Region 4
1,1,2-Trichloroethylene (TCE)	79-01-6	220	EPA Region 4
Chloroethene (Vinyl chloride)	75-01-4	930	EPA Region 4
Chlorobenzenes			
Chlorobenzene	108-90-7	25	EPA Region 4
1,2-Dichlorobenzene	95-50-1	23	EPA Region 4
1,3-Dichlorobenzene	541-73-1	22	EPA Region 4
1,4-Dichlorobenzene	106-46-7	9.4	EPA Region 4
1,2,3-Trichlorobenzene	87-61-6	8	EPA Region 4
1,2,4-Trichlorobenzene	120-82-1	130	EPA Region 4
1,3,5-Trichlorobenzene	108-70-3	5	EPA Region 4
Trichlorobenzene (mixed isomers)	12002-48-1	5	EPA Region 4
Monoaromatic Hydrocarbons			
1,2,4-Trimethylbenzene	95-63-6	15	EPA Region 4
1,3,5-Trimethylbenzene	108-67-8	26	EPA Region 4
Benzene	71-43-2	160	EPA Region 4
Cymene, p- (4-Isopropyltoluene)	99-87-6	16	EPA Region 4
Ethylbenzene	100-41-4	61	EPA Region 4
Isopropylbenzene (Cumene)	98-82-8	4.8	EPA Region 4
Styrene (vinyl benzene)	100-42-5	32	EPA Region 4
Toluene	108-88-3	62	EPA Region 4
m-Xylene	108-38-3	1.8	ORNL
Xylenes (total)	1330-20-7	27	EPA Region 4
Energetic VOCs			
Acetonitrile	75-05-8	12,000	EPA Region 4
Acrylonitrile	107-13-1	78	EPA Region 4
1,2-Diphenylhydrazine	122-66-7	1.1	EPA Region 4
Hydrazine	302-01-2	2	EPA Region 4

Table A.6a. PGDP Surface Water NFA Screening Values (Non-Narcotic Modes of Action) (Continued)

Analyte	CAS Number	PGDP NFA Screening Value (μg/L)	Source for Screening Value
Ketones			
2-Butanone (methyl ethyl ketone)	78-93-3	22,000	EPA Region 4
2-Hexanone (methyl butyl ketone)	591-78-6	99	EPA Region 4
2-Octanone (methyl hexyl ketone)	111-13-7	8.3	EPA Region 4
4-Methyl-2-pentanone (MIBK)	108-10-1	170	EPA Region 4
Acetone	67-64-1	1,700	EPA Region 4
Alcohols			
1-Pentanol	71-41-0	110	EPA Region 4
2-Propanol	67-63-0	7.5	EPA Region 4
Ethylene glycol	107-21-1	140,000	EPA Region 4
Methanol	67-56-1	330	EPA Region 4
Propylene glycol	57-55-6	71	
Other VOCs			
1,4-Dioxane	123-91-1	22,000	EPA Region 4
Acetaldehyde	75-07-0	130	EPA Region 4
Acrolein	107-02-8	3	EPA Region 4
Carbon disulfide	75-15-0	15	EPA Region 4
Cyclohexane	110-82-7	158	EPA Region 4
Hexane	110-54-3	0.6	EPA Region 4
Methylcyclohexane	108-87-2	52	EPA Region 4
Methylamine	74-89-5	860	EPA Region 4
Methyl tert-butyl ether (MTBE)	1634-04-4	730	EPA Region 4
Vinyl acetate	108-05-4	16	EPA Region 4
SVOCs			
Chloroanilines			
4-Chloroaniline	106-47-8	0.8	EPA Region 4
2,4-Dichloroaniline	554-00-7	15	EPA Region 4
Pentachloroaniline	527-20-8	5	EPA Region 4
Chlorobenzenes			
1,2,3,4-Tetrachlorobenzene	634-66-2	3	EPA Region 4
1,2,4,5-Tetrachlorobenzene	95-94-3	8.3	EPA Region 4
Hexachlorobenzene[b]	118-74-1	0.0003	EPA Region 4
Pentachlorobenzene[b]	608-93-5	0.02	EPA Region 4
Chlorophenols			
2-Chlorophenol	95-57-8	18	EPA Region 4
2,4-Dichlorophenol	120-83-2	11	EPA Region 4
2,4,5-Trichlorophenol	95-95-4	1.9	EPA Region 4
2,4,6-Trichlorophenol	88-06-2	4.9	EPA Region 4
2,3,4,6-Tetrachlorophenol	58-90-2	1	EPA Region 4
3-Methyl-4-Chlorophenol	59-50-7	1	EPA Region 4
Pentachlorophenol # (aquatic)	87-86-5	15	EPA Region 4
Other Phenols			
2-Methylphenol (Cresol, o-)	95-48-7	67	EPA Region 4
3-Methylphenol (Cresol, m-)	108-39-4	62	EPA Region 4
4-Methylphenol (Cresol, p-)	106-44-5	53	EPA Region 4
2,3-Dimethylphenol	526-75-0	120	EPA Region 4
2,4-Dimethylphenol	105-67-9	15	EPA Region 4
2-Nitrophenol	88-75-5	73	EPA Region 4
4-Nitrophenol	100-02-7	58	EPA Region 4
2,4-Dinitrophenol	51-28-5	71	EPA Region 4
2,4,6-Tribromophenol	118-79-6	5.6	EPA Region 4
Nonylphenol (branched)	84852-15-3	1	EPA Region 4

Table A.6a. PGDP Surface Water NFA Screening Values (Non-Narcotic Modes of Action) (Continued)

Analyte	CAS Number	PGDP NFA Screening Value (μg/L)	Source for Screening Value
Phenol	108-95-2	160	EPA Region 4
Energetic SVOCs			
2-Amino-4,6-dinitrotoluene	35572-78-2	18	EPA Region 4
4-Amino-2,6-dinitrotoluene	19406-51-0	11	EPA Region 4
1,3-Dinitrobenzene (DNB)	99-65-0	22	EPA Region 4
2,3-Dinitrotoluene	602-01-7	2.3	EPA Region 4
2,4-Dinitrotoluene	121-14-2	44	EPA Region 4
2,5-Dinitrotoluene	619-15-8	5.6	EPA Region 4
2,6-Dinitrotoluene	606-20-2	81	EPA Region 4
3,5-Dinitrotoluene	618-85-9	95	EPA Region 4
3,5-Dinitroanaline (DNA)	618-87-1	70	EPA Region 4
HMX (Octahydro-tetranitro-1,3,5,7-tetrazocine)	2691-41-0	220	EPA Region 4
Nitroglycerine	55-63-0	18	EPA Region 4
2-Nitrotoluene	88-72-2	71	EPA Region 4
3-Nitrotoluene	99-08-1	42	EPA Region 4
4-Nitrotoluene	99-99-0	46	EPA Region 4
RDX (Hexahydro-1,3,5-trinitro-1,3,5-triazine)	121-82-4	79	EPA Region 4
1,3,5-Trinitrobenzene (TNB)	99-35-4	11	EPA Region 4
2,4,6-Trinitrotoluene (TNT)	118-96-7	13	EPA Region 4
Phthalates			
bis(2-Ethylhexyl) Phthalate	117-81-7	8	EPA Region 4
Butylbenzylphthalate	85-68-7	23	EPA Region 4
Diethylphthalate	84-66-2	220	EPA Region 4
Dimethylphthalate	131-11-3	1,100	EPA Region 4
Di-n-butylphthalate	84-74-2	19	EPA Region 4
Di-n-Octyl Phthalate	117-84-0	215	EPA Region 4
Phthalate esters		3	KDEP
PAHs			
1-Methylnaphthalene	90-12-0	6.1	EPA Region 4
2-Methylnaphthalene	91-57-6	4.7	EPA Region 4
Acenaphthene	83-32-9	15	EPA Region 4
Acenaphthylene	208-96-8	13	EPA Region 4
Anthracene	120-12-7	0.02	EPA Region 4
Benzo(a)anthracene	56-55-3	4.7	EPA Region 4
Benzo(a)pyrene	50-32-8	0.06	EPA Region 4
Benzo(b)fluoranthene	205-99-2	2.6	EPA Region 4
Benzo(g,h,i)perylene	191-24-2	0.012	EPA Region 4
Benzo(k)fluoranthene	207-08-9	0.06	EPA Region 4
Chrysene	218-01-9	4.7	EPA Region 4
Dibenz(a,h)anthracene	53-70-3	0.012	EPA Region 4
Fluoranthene	206-44-0	0.8	EPA Region 4
Fluorene	86-73-7	19	EPA Region 4
Indeno(1,2,3-cd)pyrene	193-39-5	0.012	EPA Region 4
Naphthalene	91-20-3	21	EPA Region 4
Phenanthrene	85-01-8	2.3	EPA Region 4
Pyrene	129-00-0	4.6	EPA Region 4
PAH-Like Compounds			
1,1-Biphenyl	92-52-4	6.5	EPA Region 4
Carbazole	86-74-8	4.0	EPA Region 4
Dibenzofuran	132-64-9	4.0	EPA Region 4
Quinoline	91-22-5	3.4	EPA Region 4

Table A.6a. PGDP Surface Water NFA Screening Values (Non-Narcotic Modes of Action) (Continued)

Analyte	CAS Number	PGDP NFA Screening Value (μg/L)	Source for Screening Value
Tetrahydrofuran	109-99-9	11,000	EPA Region 4
Other SVOCs			
2,2-Dibromo-3-nitrilopropionamide	10222-01-2	20	EPA Region 4
3,3'-Dichlorobenzidine	91-94-1	4.5	EPA Region 4
4-Bromophenyl phenyl ether	101-55-3	1.5	EPA Region 4
Aniline	62-53-3	4.1	EPA Region 4
Benzaldehyde	100-52-7	143	EPA Region 4
Benzidine	92-87-5	1.5	EPA Region 4
Benzoic acid	65-85-0	42	EPA Region 4
Benzyl alcohol	100-51-6	8.6	EPA Region 4
bis(2-Chloroethyl) ether	111-44-4	2,380	KDEP
2-Chloroethylvinyl ether	110-75-8	3,540	KDEP
Decane	124-18-5	49	EPA Region 4
Hexachlorobutadiene[b]	87-68-3	1	EPA Region 4
Hexachlorocyclopentadiene	77-47-4	0.45	EPA Region 4
Hydroquinone	123-31-9	2.2	EPA Region 4
Isodecyl diphenyl phosphate	29761-21-5	1.7	EPA Region 4
Isophorone	78-59-1	920	EPA Region 4
N-nitrosodiphenylamine	86-30-6	25	EPA Region 4
2-Nitroaniline	88-74-4	17	EPA Region 4
Nitrobenzene	98-95-3	230	EPA Region 4
Triphenyl phosphate	115-86-6	4	EPA Region 4
Pesticides			
4,4'-DDT[b]	50-29-3	0.001	EPA Region 4
4,4'-DDE	72-55-9	0.3	EPA Region 4
4,4'-DDD	72-54-8	0.01	EPA Region 4
Acephate	30560-19-1	150	EPA Region 4
Aldrin	309-00-2	0.04	EPA Region 4
Atrazine	1912-24-9	0.03	EPA Region 4
Azinphos-methyl (Guthion)	86-50-0	0.01	EPA Region 4
alpha-BHC	319-84-6	0.01	EPA Region 4
beta-BHC	319-84-6	0.01	EPA Region 4
gamma-BHC (Lindane)[b]	58-89-9	0.11	EPA Region 4
Carbaryl	63-25-2	0.2	EPA Region 4
Carbofuran	1563-66-2	0.75	EPA Region 4
Chlordane	57-74-9	0.004	EPA Region 4
Chloropyrifos	2921-88-2	0.04	EPA Region 4
Cyanazine	21725-46-2	18.2	EPA Region 4
Demeton	126-75-0	0.10	EPA Region 4
Diazinon	333-41-5	0.17	EPA Region 4
Dieldrin[b]	60-57-1	0.06	EPA Region 4
Dimethoate	60-51-5	0.50	EPA Region 4
Endosulfan (alpha + beta)	115-29-7	0.06	EPA Region 4
Endosulfan, mixed isomers		0.051	ORNL
Endosulfan Sulfate	1031-07-8	0.06	EPA Region 4
Endrin	72-20-8	0.04	EPA Region 4
Heptachlor	76-44-8	0.004	EPA Region 4
Heptachlor epoxide	1024-57-3	0.004	EPA Region 4
Malathion	121-75-5	0.1	EPA Region 4
Methoxychlor	72-43-5	0.03	EPA Region 4
Mirex[b]	2385-85-5	0.001	EPA Region 4
Parathion	56-38-2	0.01	EPA Region 4

Table A.6a. PGDP Surface Water NFA Screening Values (Non-Narcotic Modes of Action) (Continued)

Analyte	CAS Number	PGDP NFA Screening Value (μg/L)	Source for Screening Value
Toxaphene	8001-35-2	0.0002	EPA Region 4
Herbicides, Fungicides			
2,4-D	94-75-7	79.2	EPA Region 4
Captan	133-06-2	16.5	EPA Region 4
Chlorothalonil	1897-45-6	0.6	EPA Region 4
Dicamba	1918-00-9	14.7	EPA Region 4
Dinoseb	88-85-7	0.48	EPA Region 4
Diquat	2764-72-9	6	EPA Region 4
MCPA (2-methyl-4-chlorophenoxyacetic acid)	94-74-6	2.6	EPA Region 4
Metolachlor	51218-45-2	7.8	EPA Region 4
Silvex (2,4,5-TP)	93-72-1	30	EPA Region 4
Simazine	122-34-9	9	EPA Region 4
Trifluralin	1582-09-8	0.48	EPA Region 4
PCBs and Dioxin/Furans			
2,3,7,8-TCDD (Dioxin)	1746-01-6	3.10E-09	EPA Region 4
Total PCBs[b]	1336-36-3	0.00012	EPA Region 4
Other			
Alkalinity	-	20,000	EPA Region 4
Ammonia	7664-41-7	Varies	EPA Region 4
Formaldehyde	50-00-0	180	EPA Region 4
Nitrite (warm water)	14797-65-0	20	EPA Region 4
pH	-	20,000	EPA Region 4
Selenate	14124-68-6	9	EPA Region 4
Selenite	14124-67-5	28	EPA Region 4
Tributyltin	688-73-3	0.072	EPA Region 4
Urea	57-13-6	17,000	EPA Region 4

EPA Region 4 screening values were taken from EPA 2018 (Table 1a), Freshwater Screening Values (Chronic).
ORNL source is Tier II values from Suter and Tsao 1996.
KDEP value is taken from the former Kentucky Risk Assessment Guidance 2002 (Appendix D). This information is provided in Appendix F of this document for reference.
Kentucky WWAH is the Kentucky Water Quality Criteria for the warm water aquatic habitat (chronic) taken from 401 KAR § 10:031.
[a] Screening values for varying degrees of water hardness for freshwater total (unfiltered) samples can be found using the equation in EPA 2018: Filtered Chronic Screening Value = $\exp\{m_C[\ln Hard^*]+b_C\}$ [CF]. Relevant values for use in the equation and example values taken from EPA 2018 (Tables 1b and 1c) are found below.

	Conversion Factors (CF) and Hardness-Dependent Equations (from Table 1b)			Example Screening Values (μg/L) for Varying Degrees of Water Hardness (mg/kg $CaCO_3$) in Unfiltered Samples (from Table 1c)			
Analyte	**m_C**	**b_C**	**CF**	**25**	**50**	**100**	**200**
Arsenic			1				
Beryllium	1.609	-5.017		1.2	3.6	11	33
Cadmium	0.7977	-3.909	1.101672-0.041838(ln Hard*)	0.26	0.46	0.79	1.37
Chromium (III)	0.819	0.6848	0.86	27.7	48.8	86	152
Chromium (VI)			0.962				
Copper	0.8545	-1.702	0.96	2.85	5.16	9.3	16.9
Lead	1.273	-4.705	1.46203-0.145712(ln Hard*)	0.55	1.32	3.2	7.7
Mercury			0.85				
Nickel	0.846	0.0584	0.997	16.1	29	52	94
Selenium							
Silver							
Zinc	0.8473	0.884	0.986	32.7	67	120	216

Where ln Hard* is the natural log of hardness.

[b] The lesser of screening values was used.

Table A.6b. PGDP Surface Water NFA Screening Values (Narcotic Modes of Action*)

Analyte	CAS Number	PGDP NFA Screening Value (μg/L)	Source for Screening Value
VOCs			
Chlorinated and Brominated Alkanes			
1,1,1,2-Tetrachloroethane	630-20-6	360	EPA Region 4
1,1,2,2-Tetrachloroethane	79-34-5	1,784	EPA Region 4
1,1,1-Trichloroethane	71-55-6	496	EPA Region 4
1,1,2-Trichloroethane	79-00-5	2,097	EPA Region 4
1,1-Dichloroethane	75-34-3	2,692	EPA Region 4
1,2-Dichloroethane	107-06-2	2,294	EPA Region 4
1,2-Dichloropropane	78-87-5	1,064	EPA Region 4
Dichloromethane (Methylene chloride)	75-09-2	5,697	EPA Region 4
Hexachloroethane	67-72-1	33	EPA Region 4
Trichloromethane (Chloroform)	67-66-3	5,417	EPA Region 4
Tetrachloromethane (Carbon tetrachloride)	56-23-5	955	EPA Region 4
Chlorinated Alkenes			
1,1-Dichloroethene	75-35-4	1,217	EPA Region 4
1,2-Dichloroethene	540-59-0	1,629	EPA Region 4
1,2-*cis*-Dichloroethene	156-59-2	1,629	EPA Region 4
1,2-*trans*-Dichloroethene	156-60-5	1,629	EPA Region 4
1,1,2,2-Tetrachloroethylene (PCE)	127-18-4	332	EPA Region 4
1,1,2-Trichloroethylene (TCE)	79-01-6	763	EPA Region 4
Chloroethene (Vinyl chloride)	75-01-4	2,276	EPA Region 4
Chlorobenzenes			
Chlorobenzene	108-90-7	356	EPA Region 4
1,2-Dichlorobenzene	95-50-1	115	EPA Region 4
1,3-Dichlorobenzene	541-73-1	115	EPA Region 4
1,4-Dichlorobenzene	106-46-7	115	EPA Region 4
1,2,3-Trichlorobenzene	87-61-6	35	EPA Region 4
1,2,4-Trichlorobenzene	120-82-1	35	EPA Region 4
1,3,5-Trichlorobenzene	108-70-3	35	EPA Region 4
Trichlorobenzene (mixed isomers)	12002-48-1	35	EPA Region 4
Monoaromatic Hydrocarbons			
1,2,4-Trimethylbenzene	95-63-6	56	EPA Region 4
1,3,5-Trimethylbenzene	108-67-8	56	EPA Region 4
Benzene	71-43-2	2,173	EPA Region 4
Cymene, p- (4-Isopropyltoluene)	99-87-6	21	EPA Region 4
Ethylbenzene	100-41-4	308	EPA Region 4
Isopropylbenzene (Cumene)	98-82-8	98	EPA Region 4
Styrene (vinyl benzene)	100-42-5	412	EPA Region 4
Toluene	108-88-3	786	EPA Region 4
Xylenes (total)	1330-20-7	260	EPA Region 4
Ketones			
2-Butanone (methyl ethyl ketone)	78-93-3	65,695	EPA Region 4
2-Hexanone (methyl butyl ketone)	591-78-6	16,871	EPA Region 4
2-Octanone (methyl hexyl ketone)	111-13-7	2,807	EPA Region 4
4-Methyl-2-pentanone (MIBK)	108-10-1	19,142	EPA Region 4
Acetone	67-64-1	117,629	EPA Region 4
Alcohols			
1-Pentanol	71-41-0	12,637	EPA Region 4
2-Propanol	67-63-0	52,874	EPA Region 4
Ethylene glycol	107-21-1	479,638	EPA Region 4
Methanol	67-56-1	112,652	EPA Region 4
Propylene glycol	57-55-6	329,329	

Table A.6b. PGDP Surface Water NFA Screening Values (Narcotic Modes of Action*) (Continued)

Analyte	CAS Number	PGDP NFA Screening Value (μg/L)	Source for Screening Value
Other VOCs			
Acetonitrile	75-05-8	424,883	EPA Region 4
Methyl tert-butyl ether (MTBE)	1634-04-4	30,618	EPA Region 4
SVOCs			
Chlorobenzenes			
1,2,3,4-Tetrachlorobenzene	634-66-2	6	EPA Region 4
1,2,4,5-Tetrachlorobenzene	95-94-3	6	EPA Region 4
Pentachlorobenzene	608-93-5	1	EPA Region 4
Phenols			
2-Chlorophenol	95-57-8	1,041	EPA Region 4
2,4-Dichlorophenol	120-83-2	361	EPA Region 4
2,4,6-Tribromophenol	118-79-6	37	EPA Region 4
2,3,4,6-Tetrachlorophenol	58-90-2	32	EPA Region 4
Nonylphenol	84852-15-3	1.1	EPA Region 4
Energetic SVOCs			
2-Nitrotoluene	88-72-2	1,733	EPA Region 4
3-Nitrotoluene	99-08-1	1,733	EPA Region 4
4-Nitrotoluene	99-99-0	1,733	EPA Region 4
Phthalates			
Butylbenzylphthalate	85-68-7	18	EPA Region 4
Diethylphthalate	84-66-2	819	EPA Region 4
Dimethylphthalate	131-11-3	3,295	EPA Region 4
Di-n-butylphthalate	84-74-2	27	EPA Region 4
PAH-Like Compounds			
1,1-Biphenyl	92-52-4	49	EPA Region 4
Dibenzofuran	132-64-9	61	EPA Region 4
Quinoline	91-22-5	2,731	EPA Region 4
Tetrahydrofuran	109-99-9	19,606	EPA Region 4
Other SVOCs			
4-Bromophenyl phenyl ether	101-55-3	2.0	EPA Region 4
Benzoic acid	65-85-0	4,392	EPA Region 4
Benzyl alcohol	100-51-6	15,538	EPA Region 4
Isophorone	78-59-1	996	EPA Region 4
N-nitrosodiphenylamine	86-30-6	84	EPA Region 4
Nitrobenzene	98-95-3	5,084	EPA Region 4
Propylene glycol	57-55-6	329,329	EPA Region 4

EPA Region 4 screening values were taken from EPA 2018 (Table 1d), Freshwater Screening Values (Chronic).
* The sum toxic unit (ΣTU) approach should be used in the screening process to identify COPECs that may collectively contribute narcotic effects. The ΣTU approach is described in EPA 2018.

Table A.7. PGDP NFA Surface Water Values for Radionuclides

Radionuclide	NFA (Based on Aquatic Animal) (pCi/L)
Americium-241	4.38E+01
Cesium-137	1.05E+02
Neptunium-237	6.85E+00
Plutonium-238	1.76E+01
Plutonium-239	1.87E+01
Plutonium-240	—
Technetium-99	2.47E+05
Thorium-230	2.57E+02
Uranium-234	2.02E+01
Uranium-235	2.18E+01
Uranium-238	2.24E+01

NFA = activity (pCi/g) resulting in dose of 0.1 rad/day assuming secular equilibrium of parent and daughter products.
NFA values from RESRAD-BIOTA, Version 1.8, Report for Level 3 (default values, except dose adjusted to 0.1 rad/day) RESRAD-BIOTA software is available at http://resrad.evs.anl.gov/.

Table A.8. NOAEL-based TRVs for PGDP Wildlife Receptors

Chemical	Mammalian TRV (mg dw/kg bw/d)	Bird TRV (mg dw/kg bw/d)	Source
Aluminum	1.93	110	Sample et al. 1996
Antimony	0.059	Not Available	Eco-SSL
Arsenic	1.04	2.24	Eco-SSL
Barium	51.8	20.8	Eco-SSL/Sample et al. 1996
Beryllium	0.532	Not Available	Eco-SSL
Boron	28	2.92	LANL ECORISK Database
Cadmium	0.77	1.47	Eco-SSL
Chromium (III and total)	2.4	2.66	Eco-SSL
Chromium (VI)	9.24	Not Available	Eco-SSL
Cobalt	7.33	7.61	Eco-SSL
Copper	5.6	4.05	Eco-SSL
Cyanide (total)	68.7	0.04	LANL ECORISK Database
Lead	4.7	1.63	Eco-SSL
Lithium	1.13	Not Available	LANL ECORISK Database
Manganese	51.5	179	Eco-SSL
Mercury (inorganic)	0.075	0.023	Dansaereau et al. 1999/ Spalding et al. 2000
Mercury (methyl)	0.032	0.0064	LANL ECORISK Database
Molybdenum	NA	3.5	LANL ECORISK Database
Nickel	1.7	6.71	Eco-SSL
Selenium	0.143	0.29	Eco-SSL
Silver	6.02	2.02	Eco-SSL
Thallium	0.0074[a]	0.35	Sample et al. 1996/ CHPPM
Tin	23.4	6.8	Sample et al. 1996
Uranium	6.1	78	LANL ECORISK Database
Vanadium	4.16	0.344	Eco-SSL
Zinc	75.4	66.1	Eco-SSL
4,4'-DDT and its metabolites	0.147	0.227	Eco-SSL
1,2-Dichloroethane	49.7	4.6	LANL ECORISK Database
Acrylonitrile	0.46	Not Available	CHPPM
Aldrin	0.2	Not Available	LANL ECORISK Database/ Treon and Cleveland 1995
Benzene	26.36	Not Available	LANL ECORISK Database
alpha-BHC	87	Not Available	LANL ECORISK Database
beta-BHC	0.563	1.5	Vos et al. 1971/EPA 2013/ Chakravarty and Lahiri 1986[b]
gamma-BHC (Lindane)	0.1	1.5	Beard and Rawlings 1998 (for mink)/EPA 2013 and Chakravarty and Lahiri 1986[b]
Carbon tetrachloride	4.8	Not Available	LANL ECORISK Database
Chlordane	4.58	2.14	Wiemeyer 1996/ WHO 1984
Chlorobenzene	60	Not Available	LANL ECORISK Database
Chloroform	15	Not Available	LANL ECORISK Database
Dieldrin	0.015	0.071	Eco-SSL
Diethylphthalate	4600	Not Available	LANL ECORISK Database
Di-n-butylphthalate	1340	0.14	LANL ECORISK Database
Endrin	0.092	0.1	LANL ECORISK/Flemming et al.1982/Spann et al. 1986/Good and Ware 1969

Table A.8. NOAEL-based TRVs for PGDP Wildlife Receptors (Continued)

Chemical	Mammalian TRV (mg dw/kg bw/d)	Bird TRV (mg dw/kg bw/d)	Source
Heptachlor	0.1	0.065	Crum et al. 1993/ Hill and Camardese 1986[c]
Hexachlorobenzene	7.1	0.11	LANL ECORISK Database/ See note "d"
Hexachlorobutadiene	0.2	5	Kociba et al. 1977/ Schwetz et al. 1974
Hexachlorocyclopentadiene	3.8	Not Available	CHPPM
Methoxychlor	4	0.056	Gray et al. 1988/ Ottinger et al. 2005[e]
Mirex	0.024	0.001	Wolfe et al. 1979/ Heath and Spann 1973
HMW PAHs	0.615	0.1	Eco-SSL/Stickel and Dieter 1979
LMW PAHs	65.6	3.1	Eco-SSL/Stickel and Dieter 1979
Total PCBs[a]	0.05	0.043	Restum et al. 1998/ Lillie et al. 1974
Pentachlorobenzene	19	Not Available	Den Besten et al. 1993
Pentachlorophenol	8.42	6.73	Eco-SSL
Phenol	60	Not Available	LANL ECORISK Database
Tetrachloroethene	2	Not Available	LANL ECORISK Database
TCDD	0.000001	0.000014	Sample et al. 1996/ Nosek et al. 1996
TCDF	Not Available	0.000001	Sample et al. 1996
Toluene	26	Not Available	LANL ECORISK Database
Toxaphene	8	1	Kennedy et al. 1973[f]/ Wiemeyer 1996
Trifluralin	225	2	Byrd et al. 1995/ EPA 1992[g]
Trichloroethene	100	Not Available	LANL ECORISK Database
Vinyl chloride	0.17	Not Available	LANL ECORISK Database
Xylene	2.1	107	LANL ECORISK Database

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Table A.8. NOAEL-based TRVs for PGDP Wildlife Receptors (Continued)

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[a] Lowest screening value used.

[b] Mallard duck 45 ppm LOAEL in food for reproduction and 15 ppm as NOAEL. 1-kg duck consuming 100 g food per day = 4.5 mg/kg-day for LOAEL and 1.5 mg/kg-day for NOAEL. EPA (2013). Chakravarty and Lahiri (1986)

[c] Mortality endpoint divided by 10.

[d] LOAEL measured by Vos et al. (1971) using Japanese quail (Cortunix sp.). Reduced egg hatchability and egg volume were observed after 90 days feeding at a dietary hexachlorobenzene concentration of 20 mg/kg. Dose by assuming that the quail weigh 0.15 kg and consume 16.9 g/day of food (Opresko et al. 1994). The value is selected because it is the lowest LOAEL found for hexachlorobenzene and birds. The no effect level found by Vos et al. (1971) was 1 mg/kg. Then NOAEL was 0.11 mg/kg/d.

[e] Japanese quail body weight 0.15 kg. Food ingestion rate of 0.0169 kg/d. 5 ppm reproductive LOAEL = 0.56 mg/kg-bw/d. NOAEL 0.5 ppm = 0.056 mg/kg-bw/d.

[f] Reduction in growth of rats (Trottman and Desaiah 1980).

[g] (5 mg/kg *0.071 kg/d ÷0.17)

Table A.9. LOAEL-based TRVs for PGDP Wildlife Receptors

Chemical	Mammalian TRV (mg dw/kg bw/d)	Bird TRV (mg dw/kg bw/d)	Source
Aluminum	49	549	Sample et al. 1996
Antimony	0.59	Not Available	Eco-SSL
Arsenic	1.66	3.55	Eco-SSL
Barium	119	41.7	Eco-SSL/Sample et al. 1996
Beryllium	0.63	Not Available	Eco-SSL
Boron	280	14.5	LANL ECORISK Database
Cadmium	1	6.35	Eco-SSL
Chromium (III)	58.2	15.6	Eco-SSL
Chromium (VI)	38.4	Not Available	Eco-SSL
Cobalt	10.9	11.5	Eco-SSL
Copper	6.79	4.68	Eco-SSL
Lead	5	1.94	Eco-SSL
Manganese	71	377	Eco-SSL
Mercury	0.15	0.068	Dansereau et al. 1999/ Spalding et al. 2000
Nickel	2.71	11.5	Eco-SSL
Selenium	0.157	0.37	Eco-SSL
Silver	45.3	20.2	Eco-SSL
Thallium	0.074[a]	0.7	Sample et al. 1999/ CHPPM
Vanadium	5.11	0.413	Eco-SSL
Zinc	298	170	Eco-SSL
4,4'-DDT and its metabolites	0.274	0.281	Eco-SSL
Aldrin	1.0	0.016	Treon and Cleveland 1955/ De Witt 1955[b]
bis(2-Ethylhexyl) Phthalate	3.5	Not Available	Fabjan et al. 2006
beta-BHC	2.25	4.5	Vos et al. 1971/EPA 2013 and Chakravarty and Lahiri 1986[c]
gamma-BHC (Lindane)	1	4.5	Beard and Rawlings 1998 (for mink)/EPA 2013/Chakravarty and Lahiri 1986[c]
Chlordane	9.16	10.7	Wiemeyer 1996/ WHO 1984
Dieldrin	0.03	0.179	Eco SSLs
Endrin	0.92	0.3	LANL ECORISK/ Flemming et al.1982/ Spann et al. 1986/Good and Ware 1996
Heptachlor	1	0.65	Crum et al. 1993/ Hill and Camardese 1986[d]
Hexachlorobenzene	0.137	2.25	See note "e"/See note "f"
Hexachlorobutadiene	2.0	0.5	Kociba et al. 1977/ Schwetz et al. 1974
Kepone	10	0.1	Kavlock et al. 1987/ Epstein 1978
Methoxychlor	8	0.56	Gray et al. 1988/ Ottinger et al. 2005[g]
Mirex	0.24	0.1	Wolfe et al. 1979/ Heath and Spann 1973

Table A.9. LOAEL-based TRVs for PGDP Wildlife Receptors (Continued)

Chemical	Mammalian TRV (mg dw/kg bw/d)	Bird TRV (mg dw/kg bw/d)	Source
HMW PAHs	3.07	1.0	Eco-SSL/Stickel and Dieter 1979
LMW PAHs	110	30.5	Eco-SSL/Stickel and Dieter 1979
Total PCBs [a]	0.1	0.13	Restum et al. 1998/ Lillie et al. 1974
Pentachlorobenzene	84	Not Available	Den Besten et al. 1993
Pentachlorophenol	22.7	22.5	Eco-SSL
TCDD	0.00001	0.000064	Sample et al. 1996/ Nosek et al. 1996
TCDF	Not Available	0.00001	Sample et al. 1996
Toxaphene	10	5	Kennedy et al. 1973[h]/ Wiemeyer 1996/Tottman and Desaiah 1980
Trifluralin	475	20	Byrd et al. 1995/ EPA 1992[i]

Notes: LOAEL TRVs from Eco-SSLs are interpreted from Appendix 4-1 of the Eco-SSL document.

EPA Region 4 values are from May 29, 2014, e-mail from Brett Thomas, EPA Region 4 Ecological Risk Assessor.

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[a] Lowest screening value used.
[b] Mortality endpoint De Witt (1955). Acute mortality so used a factor of 100 adjustment to TRV.
[c] Mallard duck 45 ppm LOAEL in food for reproduction and 15 ppm as NOAEL. 1-kg duck consuming 100g food per day = 4.5 mg/kg-day for LOAEL, and 1.5 mg/kg-day for NOAEL. (EPA 2013); (Chakravarty and Lahiri 1986)
[d] Mortality endpoint divided by 10.
[e] LOAEL measured by Bleavins et al. (1984) using captive mink. Reduced survival of kits was observed after 331 days feeding of hexachlorobenzene at a concentration of 1 mg/kg. Dose derived by assuming that the mink weigh 1 kg and consume 137 g/day of food (Opresko et al. 1994). This value is selected for use with piscivorous mammals because it is the lowest experimentally derived dietary LOAEL found, and it relates to reproductive effects in a close relative to the river otter.
[f] LOAEL measured by Vos et al. (1971) using Japanese quail (Cortunix sp.). Reduced egg hatchability and egg volume were observed after 90 days feeding at a dietary hexachlorobenzene concentration of 20 mg/kg. Dose by assuming that the quail weigh 0.15 kg and consume 16.9 g/day of food (Opresko et al. 1994). The value is selected because it is the lowest LOAEL found for hexachlorobenzene and birds. The no effect level found by Vos et al. (1971) was 1 mg/kg. Then NOAEL was 0.11 mg/kg/d.
[g] Japanese quail body weight 0.15 kg. Food ingestion rate of 0.0169 kg/d. 5 ppm reproductive LOAEL = 0.56 mg/kg-bw/d. NOAEL 0.5 ppm = 0.056 mg/kg-bw/d.
[h] Reduction in growth of rats (Trottman and Desaiah 1980).
[i] (5 mg/kg *0.071 kg/d ÷0.17)

Tables A.10 and A.11 present the Environmental Contaminants in Wildlife (ECW) tissue residues for birds and mammals. These tissue residue levels were taken from the Risk Assessment Information System (RAIS) (located at http://rais.ornl.gov/tools/eco_search.php). Table A.12 presents tissue residue levels for fish and aquatic invertebrates.

Table A.10. Tissue Residue Benchmarks for Birds

Analyte	Avian Blood mg/kg	Avian Bone mg/kg	Avian Brain mg/kg	Avian Carcass mg/kg	Avian Diet mg/kg	Avian Egg mg/kg	Avian Kidney mg/kg	Avian Liver mg/kg
Aroclor-1242						1		
Aroclor-1254						4		
Cadmium (Diet)					2		100	40
DDD			50					
DDE, p,p'-			150		0.1	0.1		
DDT			10					
DDT/DDE/DDD (total)			10					
Dieldrin			1		2	0.7		1
Endrin				0.36	3	0.27		
Heptachlor Epoxide						1.5		
Hexachlorobenzene						100		
Lead and Compounds	0.2	10					3	2
Mercury (elemental)					10	0.5	20	20
Methoxychlor						17		
Mirex						20		
Selenium						3		3
Toxaphene				40		50		

Table A.11. Tissue Residue Benchmarks for Mammals

Analyte	Mammal Blood mg/kg	Mammal Fat mg/kg	Mammal Kidney mg/kg	Mammal Liver mg/kg
Cadmium (Diet)			100	
DDD				
Fluoride	10			
Lead and Compounds	0.2			
Mercury (elemental)			30	30
Polychlorinated Biphenyls (high risk)		10		4

Table A.12. Tissue Residue Benchmarks for Fish and Aquatic Invertebrates

Analyte	Receptor (mg/kg wet weight)	
	Fish	Aquatic Invertebrates
Antimony	1.11	1.11
Arsenic	---	2.00
Cadmium	0.17	0.35
Copper	---	7.67
Lead	4.0	---
Mercury	0.37	---
Selenium	1.58	---
Zinc	---	24.1
Tributyl Tin	---	0.15
BEHP	1.6	3.12
DDD	---	1.81
Total DDTs (DDT+DDD+DDE)	0.76	0.97
β-BHC, δ-BHC	4.7	
PCBs, total	0.43	1.32
Endrin	---	0.0037
Lindane	0.24	0.0032
Di-n-butyl pthalate	32	32

Table A.12. Tissue Residue Benchmarks for Fish and Aquatic Invertebrates (Continued)

Analyte	Receptor (mg/kg wet weight)	
	Fish	Aquatic Invertebrates
Butylbenzyl pthalate	6.45	6.45
Hexachlorobutadiene	4.2	4.2

Reference: Burt Shepard, EPA Region 10, personal communication to Brett Thomas, EPA Region 4. Values as given in the poster presentation "Development of Aquatic Biota Tissue Toxicity Reference Values for Use in the Baseline Ecological Risk Assessment of Portland Harbor," presented at the 30th SETAC North America Meeting, New Orleans, LA, Nov 2009.

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APPENDIX B

EXPOSURE PARAMETERS FOR PGDP MODEL
ECOLOGICAL RECEPTORS

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Table B.1. Exposure Parameters for PGDP Model Ecological Receptors

Receptor	Parameter	Value	Details and Sources
Little brown bat	Body weight	0.01 kg	Kroner and Cozzie 2003
	Food ingestion rate (FIR)[a]	0.92 kg/kg BW/day	Kroner and Cozzie 2003
	Water ingestion rate	0.16 L/kg BW/day	Kroner and Cozzie 2003
	Soil/sediment ingestion rate	0% of FIR	Unlikely to contact soil routinely
Shrew	Body weight	0.017 kg	EPA 1993
	FIR [a]	0.81 kg/kg BW/day	EPA 1993
	Water ingestion rate	0.29 L/kg BW/day	EPA 1993
	Soil/sediment ingestion rate	3.7% of FIR	EPA 1993
Woodcock	Body weight	0.17 kg	EPA 1993
	FIR[a]	1.16 kg/kg BW/day	EPA 1993
	Water ingestion rate	0.10 L/kg BW/day	EPA 1993
	Soil/sediment ingestion rate	10.4% of FIR	EPA 1993
American robin	Body weight	0.081 kg	EPA 1993
	FIR[a]	1.52 kg/kg BW/day	EPA 1993
	Water ingestion rate	0.14 L/kg BW/day	EPA 1993
	Soil/sediment ingestion rate	5% of FIR	EPA 1993
Osprey	Body weight	1.5 kg	EPA 1993
	FIR[a]	0.21 kg/kg BW/day	EPA 1993
	Water ingestion rate	0.052 L/kg BW/day	EPA 1993
	Soil/sediment ingestion rate	0% of FIR	EPA 1993 (assumed)
American Kestrel	Body weight	0.12 kg	EPA 1993 (HWIR)
	FIR[a]	0.5 kg/kg BW/day	EPA 1993
	Water ingestion rate	0.0144 L/day	EPA 1993
	Soil/sediment ingestion rate	0% of FIR	EPA 1993 (assumed)

Table B.1. Exposure Parameters for PGDP Model Ecological Receptors (Continued)

Receptor	Parameter	Value	Details and Sources
Marsh wren	Body weight	0.01 kg	EPA 1993 (marsh wren parameters table)
	FIR[a]	1.41 kg/kg BW/day	EPA 1993 (calculated using Eq. 3-4 and 80% moisture content)
	Water ingestion rate	0.28 L/kg BW/day	EPA 1993
	Soil/sediment ingestion rate	18% of FIR	EPA 1993 value for sandpiper
Mink	Body weight	0.896 kg	EPA 1993
	FIR[a]	0.16 kg/kg BW/day	EPA 1993
	Water ingestion rate	0.079 L/kg BW/day	EPA 1993
	Soil/sediment ingestion rate	9.4% of FIR	EPA 1993 value for raccoon
Belted kingfisher	Body weight	0.147 kg	EPA 1993
	FIR[a]	0.5 kg/kg BW/day	EPA 1993
	Water ingestion rate	0.14 L/kg BW/day	EPA 1993
	Soil/sediment ingestion rate	0% of FIR	EPA 1993
Great Blue Heron	Body weight	2.23 kg	EPA 1993
	FIR[a]	0.18 kg/kg BW/day	EPA 1993
	Water ingestion rate	0.045 L/kg BW/day	EPA 1993
	Soil/sediment ingestion rate	2% of FIR	EPA 1993
Green Heron	Body weight	0.2 kg	Gavinio and Dickerman 1972 (interpreted)
	FIR[a]	0.6 kg/kg BW/day	Cornell 2018a
	Water ingestion rate	0.117 L/kg BW/day	Cornell 2018a
	Soil/sediment ingestion rate	2% of FIR	EPA 1993 value for blue heron
Mallard Duck	Body weight	1.134 kg	EPA 1993
	FIR[a]	0.278 kg/kg BW/day	EPA 1993
		0.466 kg/kg BW/day	Sugden 1979; Batt 1992; and Armitage et al. 1995 (calculated)
	Water ingestion rate	0.057 L/kg BW/day	EPA 1993
	Soil/sediment ingestion rate	11% of FIR	Beyer, Perry, and Osenton 2008 (average of freshwater duck sediment ingestion rates, Table 1)

Table B.1. Exposure Parameters for PGDP Model Ecological Receptors (Continued)

Receptor	Parameter	Value	Details and Sources
Wood Stork	Body weight	2.2 kg	National Geographic 2018
	FIR[a]	0.273 kg/kg BW/day	EPA 1993
	Water ingestion rate	0.045 L/kg BW/day	EPA 1993 value for heron
	Soil/sediment ingestion rate	2% of FIR	EPA 1993 value for heron
Meadow Vole	Body weight	0.03 kg	EPA 1993
	FIR[a]	0.35 kg/kg BW/day	EPA 1993
	Water ingestion rate	0.214 L/kg BW/day	EPA 1993
	Soil/sediment ingestion rate	2.4% of FIR	EPA 1993 Table 4-4
Long-Tailed Weasel	Body weight	0.19 kg	Kroner and Cozzie 2003
	FIR[a]	0.6 kg/kg BW/day	Adirondack Ecological Center 2018 and Smithsonian North American Mammals 2018
	Water ingestion rate	0.079 L/kg BW/day	EPA 1993 value for mink
	Soil/sediment ingestion rate	2.8% of FIR	Kroner and Cozzie 2003
Northern Bobwhite quail	Body weight	0.14 kg	EPA 1993
	FIR[a]	0.117 kg/kg BW/day	EPA 1993
	Water ingestion rate	0.02 L/kg BW/day	EPA 1993
	Soil/sediment ingestion rate	9.3% of FIR	EPA 1993
Mourning dove	Body weight	0.12 kg	Cornell 2018b
	FIR[a]	0.2 kg/kg BW/day	Cornell 2018b
	Water ingestion rate	0.02 L/kg BW/day	EPA 1993 value from bobwhite
	Soil/sediment ingestion rate	9.3% of FIR	EPA 1993 value from bobwhite
Red tailed hawk	Body weight	1.224 kg	EPA 1993
	FIR[a]	0.169 kg/kg BW/day	EPA 1993
	Water ingestion rate	0.057 L/kg BW/day	EPA 1993
	Soil/sediment ingestion rate	1% of FIR	EPA 1993
Screech owl	Body weight	0.14 kg	Johnsgard 1988
	FIR[a]	0.385 kg/kg BW/day	Johnsgard 1988
	Water ingestion rate	0.113 L/kg BW/day	Johnsgard 1988
	Soil/sediment ingestion rate	2.0% of FIR	Johnsgard 1988

Table B.1. Exposure Parameters for PGDP Model Ecological Receptors (Continued)

Receptor	Parameter	Value	Details and Sources
Spotted sandpiper	Body weight	0.0471 kg	EPA 1993
	FIR[a]	1.1 kg/kg BW/day	EPA 1993 (calculated using Eq. 3-4 and 80% moisture content)
	Water ingestion rate	0.0071 L/ day	EPA 1993
	Soil/sediment ingestion rate	18% of FIR	Beyer, Conner, et al. 1994
Northern mockingbird	Body weight	0.058 kg	Cornell 2018b
	FIR[a]	1.08 kg/kg BW/day	Nagy 1987
	Water ingestion rate	0.14 L/kg BW/day	EPA 1993 value from robin
	Soil/sediment ingestion rate	5% of FIR	EPA 1993 value from robin
River otter	Body weight	7.4 kg	EPA 1993
	FIR[a]	0.192 kg/kg BW/day	EPA 1993
	Water ingestion rate	0.082 L/kg BW/day	EPA 1993
	Soil/sediment ingestion rate	1% of FIR	EPA 1993
Eastern cottontail	Body weight	1.2 kg	EPA 1993
	FIR[a]	0.472 kg/kg BW/day	EPA 1993
	Water ingestion rate	0.097 L/kg BW/day	EPA 1993
	Soil/sediment ingestion rate	6.3% of FIR	EPA 1993
Deer mouse	Body weight	0.02 kg	EPA 1993
	FIR[a]	0.27 kg/kg BW/day	EPA 1993
	Water ingestion rate	0.24 L/kg BW/day	EPA 1993
	Soil/sediment ingestion rate	2% of FIR	EPA 1993
Red fox	Body weight	4.5 kg	EPA 1993
	FIR[a]	0.11 kg/kg BW/day	EPA 1993
	Water ingestion rate	0.085 L/kg BW/day	EPA 1993
	Soil/sediment ingestion rate	2.8% of FIR	EPA 1993
White tailed deer	Body weight	69 kg	Kroner and Cozzie 2003
	FIR[a]	0.22 kg/kg BW/day	Kroner and Cozzie 2003
	Water ingestion rate	0.07 L/kg BW/day	Kroner and Cozzie 2003
	Soil/sediment ingestion rate	6.8% of FIR	Kroner and Cozzie 2003
Mule deer	Body weight	75 kg	Kroner and Cozzie 2003
	FIR[a]	0.21 kg/kg BW/day	Kroner and Cozzie 2003
	Water ingestion rate	0.07 L/kg BW/day	Kroner and Cozzie 2003
	Soil/sediment ingestion rate	6.8% of FIR	Kroner and Cozzie 2003

Table B.1. Exposure Parameters for PGDP Model Ecological Receptors (Continued)

Receptor	Parameter	Value	Details and Sources
Muskrat	Body weight	1.135 kg	EPA 1993
	FIR[a]	0.34 kg/kg BW/day	EPA 1993
	Water ingestion rate	0.098 L/kg BW/day	EPA 1993
	Soil/sediment ingestion rate	2.4% of FIR	EPA 1993
Raccoon	Body weight	5.98 kg	EPA 1993
	FIR[a]	0.249 kg/kg BW/day	EPA 1993
	Water ingestion rate	0.083 L/kg BW/day	EPA 1993
	Soil/sediment ingestion rate	9.4% of FIR	EPA 1993
Smallmouth bass	Body weight	0.086 kg	Not available[b]
	FIR[a]	2.0 kg/kg BW/day	Not available[b]

[a] All FIR values are in wet weight.
[b] Original sources not available. These values should be used as a starting point for model inputs.

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APPENDIX C

CALCULATING PRELIMINARY HAZARD QUOTIENTS

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CALCULATING PRELIMINARY HQS

Preliminary hazard quotients (HQs) for ecological risk assessments (ERAs) at Paducah Gaseous Diffusion Plant (PGDP) sites are calculated in Step 3a for wildlife receptors potentially exposed indirectly (via the food web) and/or directly (through incidental ingestion of contaminated abiotic media) to chemicals of potential ecological concern (COPECs) in surface soil, surface water, sediment, or groundwater potentially discharging as surface water. The equations used to calculate preliminary HQs are presented below. These equations also may be used to calculate HQs in Step 7 with the appropriate toxicity reference value (TRV).

An HQ is the ratio of the average daily dose (ADD) and the TRV. The ADD (mg COPEC/kg receptor/day) is an estimate of how much COPEC is ingested per day over the period of exposure. The TRV for preliminary HQs for wildlife receptors at PGDP sites is the no observed adverse effect level (NOAEL). The NOAEL (mg COPEC/kg receptor/day) is an estimate of the highest average amount of COPEC that the receptor can ingest per day over a relatively long period without experiencing an adverse effect. Thus,

$$HQ = ADD/NOAEL$$

The preliminary ADD for wildlife receptors exposed directly by ingestion to COPECs in an environmental medium at a site is calculated as the product of the ingestion rate (IR) for that medium and the maximum measured medium concentration at the site:

$$ADD\ (mg/kg/day) = medium\ concentration\ (mg/kg\ or\ mg/L) \times IR\ (kg/kg/day\ or\ L/kg/day)$$

The preliminary ADD for wildlife receptors exposed indirectly to COPECs in an environmental medium at a site is calculated as the product of the IR (kg tissue/kg receptor/day) and the maximum measured tissue concentration (mg COPEC/kg tissue) in food organisms exposed to the medium at the site:

$$ADD\ (mg/kg/day) = food\ tissue\ concentration\ (mg/kg) \times IR\ (kg/kg/day)$$

If site-specific tissue data are not available, the ADD is calculated as the product of the maximum detected concentration in the abiotic medium, the appropriate biotransfer factor for the food organisms exposed to that medium, and the IR for the receptor:

- For wildlife receptors exposed to COPECs in soil-dwelling invertebrates, the biotransfer factor is the unitless soil-to-invertebrate tissue bioaccumulation factor (BAF_i), and the ADD is calculated as follows:

$$ADD = soil\ concentration\ (mg/kg) \times BAF_i \times IR$$

- For wildlife receptors exposed to COPECs in small vertebrate prey, such as small mammals and birds, the biotransfer factor is the unitless prey tissue BAF_v, and the ADD is calculated as follows:

$$ADD = soil\ concentration\ (mg/kg) \times BAF_v \times IR$$

- For wildlife receptors exposed indirectly to COPECs in surface water and groundwater through ingestion of aquatic biota (e.g., fish and crayfish), the biotransfer factor is the BCF for the contaminant in fish tissue (BCF_{fish}), and the ADD is calculated as follows:

$$ADD = water\ concentration\ (\mu g/L) \times BCF\ (L/\mu g) \times IR$$

- For wildlife receptors exposed indirectly to COPECs in sediment through ingestion of sediment-dwelling biota (e.g., crayfish and benthic insect larvae), the biotransfer factor is the unitless BAF for the contaminant in invertebrate tissue (BAF_i), and the ADD is calculated as follows:

$$ADD = sediment\ concentration\ (mg/kg) \times BAF_i \times IR$$

When a wildlife receptor is exposed directly and indirectly by ingestion, the ADD for direct consumption of the abiotic medium is added to the ADD for indirect consumption (ingestion of food).

Table 1 in the main text of this document presents the values of IR for calculating preliminary HQs for model receptors exposed to substances in food at PGDP sites. EPA (1993) and other sources give ingestion rates for abiotic media. Table C.1 presents a list of substances with published soil-to-invertebrate BAFs or water-to-fish BCFs, including values for substances considered by Kentucky Department for Environmental Protection (KDEP) to be bioaccumulative. Values for BAFs and BCFs for radionuclides can be obtained from Baes et al. 1984, PNNL 2003, or other literature sources.

For carnivorous fish, the HQ is calculated as the ratio of the estimated body burden for fish at the site and the TRV body burden for fish. Fish body burdens can be estimated as the product of the maximum concentration of matter ingested by the fish and the biotransfer factor for fish (BAF) plus the component from water, which is estimated as the product of the water concentration and the BCF for fish.

For wildlife receptors, the ADD depends on how many of the food items described above comprise the diet of the receptor. The general wildlife dose equation for dietary exposures (from Section 4.1.2.1 and Figure 4.8 of EPA 1993) is provided below:

$$ADD_{tot} = [(\sum_{k}^{i=1}(C_k \times FR_k \times NIR_k)) + (C_k \times FS \times IR_{total}\ (\text{dry weight})) + (C_{water} \times IR_{water})]$$

ADD_{tot} = Potential average daily dose (e.g., in mg/kg-day).

C_k = Average contaminant concentration in the k^{th} type of food (e.g., in mg/kg wet weight).

FR_k = Fraction of intake of the k^{th} food type that is contaminated (unitless). For example, if the k^{th} component of an animal's diet were salmon, FR_k for salmon would equal the fraction of the salmon consumed that is contaminated at level C_k. If all of the salmon consumed were contaminated at level C_k, then FR_k would equal one.

NIR_k = Normalized ingestion rate of the k^{th} food type on a wet-weight basis (e.g., in g/g-day).

FS = Fraction of soil in diet (as percentage of diet on a dry-weight basis divided by 100; unitless).

IR_{total} = Food ingestion rate on a dry-weight basis (e.g., in kg/day). Nagy's (1987) equations for estimating FI rates on a dry-weight basis (presented in Section 3.1) can be used to estimate a value for this factor. If the equations for estimating FI rates on a wet-weight basis presented in Section 4.2 are used, conversion to ingestion rates on a dry-weight basis would be necessary.

C_{water} = Average contaminant concentration in water.

IR_{water} = Water ingestion rate.

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PNNL (Pacific Northwest National Laboratory) 2003. *Literature Review and Assessment of Plant and Animal Transfer Factors Used in Performance Assessment Modeling.* NUREG/CR-6825, PNNL-1432. Office of Nuclear Regulatory Research, U.S. Nuclear Regulatory Commission, Washington, DC, August.

Table C.1. Example Soil-to-Invertebrate and Water-to-Fish Bioaccumulation Factors

Analyte	Soil-to-Invertebrate Animal (BAF_i) (kg_{soil}/kg_{tissue})	Reference	Water-to-Fish Bioconcentration Factors (BCF) (L/kg)	Reference
	INORGANICS			
Aluminum	2.20E-01	EPA 1999	2.70E+00	EPA 1999
Antimony	$C_e = C_s$	EPA 2007	4.00E+01	EPA 1999
Arsenic	$\ln(C_e)=0.706\times\ln(C_s)-1.421$	EPA 2007	1.14E+02	EPA 1999
Arsenic (III)	1.10E-01	EPA 1999	—	—
Arsenic (V)	1.10E-01	EPA 1999	—	—
Barium	$C_e = 0.091 \times C_s$	EPA 2007	4.00E+00	RAIS 2010
Beryllium	$C_e = 0.045 \times C_s$	EPA 2007	6.20E+01	EPA 1999
Cadmium	$\ln(C_e)=0.795\times\ln(C_s)+2.114$	EPA 2007	5.00E+03	KDEP
Chromium	$C_e = 0.306 \times C_s$	EPA 2007	5.50E+02	KDEP
Cobalt	$C_e = 0.122 \times C_s$	EPA 2007	3.00E+02	RAIS 2010
Copper	$C_e = 0.515 \times C_s$	EPA 2007	5.89E+03	KDEP
Cyanide	1.12E+00	EPA 1999	6.33E+02	EPA 1999
Fluoride	1.00E+00	DOE 1994	—	—
Fluorine	1.00E+00	DOE 1994	1.00E+01	RAIS-R 2010
Iodine	1.00E+00	DOE 1994	—	—
Lanthanum	1.00E+00	DOE 1994	—	—
Lead	$\ln(C_e)=0.807\times\ln(C_s)-0.218$	EPA 2007	1.41E+05	KDEP
Lithium	1.00E+00	DOE 1994	—	—
Manganese	$\ln(C_e)=0.682\times\ln(C_s)-0.809$	EPA 2007	4.00E+02	RAIS 2010
Mercury	3.30E+01	KDEP	1.00E+03	RAIS 2010
Methyl mercury	8.50E+00	EPA 1999	2.51E+06	KDEP
Nickel	2.00E-02	EPA 1999	7.80E+01	EPA 1999
Selenium	$\ln(C_e)=0.733\times\ln(C_s)-0.075$	EPA 2007	1.29E+02	EPA 1999
Silver	$C_e = 2.045 \times C_s$	EPA 2007	8.77E+01	EPA 1999
Thallium	$C_e = 1.38 \times C_s$	EPA 2014	1.00E+04	EPA 1999
Tin	—	—	2.57E+03	KDEP
Vanadium	$C_e = 0.042 \times C_s$	EPA 2007	1.00E-02	DOE 1994
Uranium	2.20E-01	EPA 1999	1.00E+01	RAIS-R 2010
Zinc	$\ln(C_e)=0.328\times\ln(C_s)+4.449$	EPA 2007	2.06E+03	EPA 1999
	ORGANICS			
Volatile organic compounds				
Acetone	5.00E-02	EPA 1999	3.16E+00	RAIS 2010
Benzene	5.00E-02	DOE 1994	4.27E+00	RAIS 2010
Carbon tetrachloride	1.20E+01	EPA 1999	3.00E+01	EPA 1999
Chlorobenzene	5.00E-02	DOE 1994	1.78E+01	RAIS 2010
Chloroform	2.82E+00	EPA 1999	3.59E+00	EPA 1999
1,1,2,2-Tetrachloroethane	—	—	1.30E+01	RAIS 2010
1,2-Dichloroethane	5.00E-02	DOE 1994	4.40E+00	RAIS 2010
1,2-Dichloroethene	5.00E-02	DOE 1994	1.11E+01	RAIS 2010
1,4-Dichlorobenzene	—	—	1.80E+03	KDEP
Ethylbenzene	5.00E-02	DOE 1994	5.56E+01	RAIS 2010
Methylene chloride	5.00E-02	DOE 1994	2.31E+01	RAIS 2010
Methyl ethyl ketone	5.00E-02	DOE 1994	3.16E+00	RAIS 2010
4-chloro-3-methylphenol	—	—	1.10E+02	DOE 1994
4-Methyl-2-pentanone	5.00E-02	DOE 1994	6.00E+00	DOE 1994
Pentachlorobenzene	—	—	2.60E+05	KDEP
Tetrachloroethene	5.00E-02	DOE 1994	5.20E+01	RAIS 2010
Toluene	5.00E-02	DOE 1994	8.32E+00	RAIS 2010
Trichloroethene	5.00E-02	DOE 1994	1.60E+01	RAIS 2010
Vinyl chloride	6.20E-01	EPA 1999	5.47E+00	RAIS 2010
Xylene, total	5.00E-02	DOE 1994	1.41E+01	RAIS 2010

Table C.1. Example Soil-to-Invertebrate and Water-to-Fish Bioaccumulation Factors (Continued)

Analyte	Soil-to-Invertebrate Animal (BAF_i) (kg_{soil}/kg_{tissue})	Reference	Water-to-Fish Bioconcentration Factors (BCF) (L/kg)	Reference
Semivolatile organic compounds				
Acenaphthene	$C_e = 1.47 \times C_s$	EPA 2007	3.89E+02	KDEP
Acenaphthylene	$C_e = 22.9 \times C_s$	EPA 2007	2.71E+02	RAIS 2010
Anthracene	$C_e = 2.42 \times C_s$	EPA 2007	1.68E+04	KDEP
Benzo(a)anthracene	$C_e = 1.59 \times C_s$	EPA 2007	3.57E+04	KDEP
Benzo(a)pyrene	$C_e = 1.33 \times C_s$	EPA 2007	5.00E+02	EPA 1999
Benzo(b)fluoranthene	$C_e = 2.60 \times C_s$	EPA 2007	3.02E+04	RAIS 2010
Benzo(g,h,i)perylene	$C_e = 2.94 \times C_s$	EPA 2007	1.10E+04	RAIS 2010
Benzo(k)fluoranthene	$C_e = 2.60 \times C_s$	EPA 2007	4.99E+03	RAIS 2010
bis(2-Ethylhexyl) Phthalate	1.31E+03	EPA 1999	7.00E+01	EPA 1999
Butylbenzylphthalate	5.00E-02	DOE 1994	1.63E+01	RAIS 2010
Carbazole	5.00E-02	DOE 1994	1.70E+02	RAIS 2010
Chrysene	$C_e = 2.29 \times C_s$	EPA 2007	3.17E+03	EPA 1999
Dibenzo(a,h)anthracene	$C_e = 2.31 \times C_s$	EPA 2007	9.60E+03	EPA 1999
Dibenzofuran	5.00E-02	DOE 1994	1.52E+03	RAIS 2010
3,3'-Dichlorobenzidine	—	—	6.10E+02	KDEP
Diethylphthalate	5.00E-02	DOE 1994	1.84E+01	RAIS 2010
Di-n-butylphthalate	5.00E-02	DOE 1994	5.10E+03	DOE 1994
Di-n-octylphthalate	3.13E+06	EPA 1999	9.40E+03	EPA 1999
Fluoranthene	$C_e = 3.04 \times C_s$	EPA 2007	1.74E+04	KDEP
Fluorene	$C_e = 9.57 \times C_s$	EPA 2007	5.25E+02	RAIS 2010
Indeno(1,2,3-cd)pyrene	$C_e = 2.86 \times C_s$	EPA 2007	1.22E+04	RAIS 2010
2-Methylnaphthalene	5.00E-02	DOE 1994	7.47E+01	RAIS 2010
4-Chloro-3-methylphenol	2.00E-02	DOE 1994	1.10E+02	DOE 1994
4-Methylphenol	5.00E-02	DOE 1994	1.30E+01	DOE 1994
Naphthalene	$C_e = 4.40 \times C_s$	EPA 2007	8.45E+01	RAIS 2010
2-Nitrophenol	5.00E-02	DOE 1994	2.19E+01	RAIS 2010
4-Nitrophenol	5.00E-02	DOE 1994	5.14E+00	RAIS 2010
N-Nitrosodiphenylamine	5.00E-02	DOE 1994	2.13E+01	RAIS 2010
Octachlorostyrene	—	—	3.30E+02	KDEP
Pentachlorophenol	$C_e = 14.63 \times C_s$	EPA 2007	1.05E+03	KDEP
Phenanthrene	$C_e = 1.72 \times C_s$	EPA 2007	1.12E+04	KDEP
Phenol	5.00E-02	DOE 1994	1.74E+01	RAIS 2010
Pyrene	$C_e = 1.75 \times C_s$	EPA 2007	1.51E+03	RAIS 2010
Polycyclic aromatic hydrocarbons (PAHs)				
Total Low Molecular Weight PAHs	$C_e = 3.04 \times C_s$	EPA 2007	—	—
Total High Molecular Weight PAHs	$C_e = 2.6 \times C_s$	EPA 2007	—	—
Pesticides and polychlorinated biphenyls (PCBs)				
Aldrin	5.60E-01	DOE 1994	5.50E+03	RAIS 2010
Aroclor-1254	1.13E+00	EPA 1999	2.30E+05	EPA 1999
Aroclor-1260	5.80E+00	DOE 1994	1.23E+04	RAIS 2010
Total PCBs	2.80E+02	KDEP	2.53E+04	RAIS 2010
alpha-BHC	2.60E+00	DOE 1994	7.10E+02	DOE 1994
beta-BHC	2.60E+00	DOE 1994	7.20E+02	DOE 1994
delta-BHC	2.60E+00	DOE 1994	6.90E+02	DOE 1994
gamma-BHC (Lindane)	2.00E-02	DOE 1994	1.00E+03	DOE 1994
alpha-Chlordane	1.60E+00	DOE 1994	2.68E+04	RAIS 2010
gamma-Chlordane	1.60E+00	DOE 1994	2.68E+04	RAIS 2010

Table C.1. Example Soil-to-Invertebrate and Water-to-Fish Bioaccumulation Factors (Continued)

Analyte	Soil-to-Invertebrate Animal (BAF_i) (kg_{soil}/kg_{tissue})	Reference	Water-to-Fish Bioconcentration Factors (BCF) (L/kg)	Reference
4,4'-DDD	$\ln(C_e)=0.6975\times\ln(C_s)+1.1613$	EPA 2007	5.65E+05	KDEP
4,4'-DDE	$\ln(C_e)=0.8804\times\ln(C_s)+2.4771$	EPA 2007	1.81E+05	KDEP
4,4'-DDT	$\ln(C_e)=0.8689\times\ln(C_s)+2.1247$	EPA 2007	5.88E+04	KDEP
Total 4,4'-DDT	$C_e = 11.2 \times C_s$	EPA 2007	—	—
Dieldrin	$C_e = 14.7 \times C_s$	EPA 2007	6.76E+04	KDEP
Endrin	1.90E+00	DOE 1994	1.30E+04	KDEP
Endrin aldehyde	1.90E+00	DOE 1994	6.87E+02	RAIS 2010
Endrin ketone	1.90E+00	DOE 1994	9.06E+02	RAIS 2010
Heptachlor	1.40E+00	EPA 1999	2.18E+19	KDEP
Heptachlor epoxide	1.00E+00	DOE 1994	2.18E+19	KDEP
Methoxychlor	5.70E-01	DOE 1994	3.15E+02	RAIS 2010
Mirex	3.00E+01	KDEP	1.80E+04	KDEP
Toxaphene	9.00E-01	KDEP	7.60E+04	KDEP
Dioxins and furans				
1,2,3,4,6,7,8-Heptachlorodibenzo-p-dioxin	8.10E-02	EPA 1999	2.16E+02	EPA 1993
1,2,3,4,6,7,8-Heptachlorodibenzofuran	1.70E-02	EPA 1999	4.66E+01	EPA 1993
1,2,3,4,7,8,9-Heptachlorodibenzofuran	6.20E-01	EPA 1999	1.65E+03	EPA 1993
1,2,3,6,7,8-Hexachlorodibenzo-p-dioxin	1.90E-01	EPA 1999	5.08E+02	EPA 1993
1,2,3,6,7,8-Hexachlorodibenzofuran	3.00E-01	EPA 1999	8.05E+02	EPA 1993
1,2,3,7,8,9-Hexachlorodibenzofuran	1.00E+00	EPA 1999	2.67E+03	EPA 1993
1,2,3,4,7,8-Hexachlorodibenzo-p-dioxin	4.90E-01	EPA 1999	1.31E+03	EPA 1993
1,2,3,7,8,9-Hexachlorodibenzo-p-dioxin	2.20E-01	EPA 1999	5.93E+02	EPA 1993
1,2,3,4,7,8-Hexachlorodibenzofuran	1.21E-01	EPA 1999	—	—
2,3,4,6,7,8-Hexachlorodibenzofuran	1.07E+00	EPA 1999	2.84E+03	EPA 1993
2,3,4,7,8-Pentachlorodibenzofuran	2.54E+00	EPA 1999	6.78E+03	EPA 1993
Octachlorodibenzo-p-dioxin	1.90E-02	EPA 1999	5.08E+01	EPA 1993
Octachlorodibenzofuran	2.50E-02	EPA 1999	6.78E+01	EPA 1993
1,2,3,7,8-Pentachlorodibenzo-p-dioxin	1.46E+00	EPA 1999	6.17E+04	KDEP
1,2,3,7,8-Pentachlorodibenzofuran	3.20E-01	EPA 1999	9.32E+02	EPA 1993
2,3,7,8-Tetrachlorodibenzo-p-dioxin	4.21E+01	KDEP	4.24E+03	EPA 1993
2,3,7,8-Tetrachlorodibenzofuran	1.27E+00	EPA 1999	3.39E+03	EPA 1993
Dioxins, total equivalent	1.59E+00	EPA 1999	—	—
Explosives				
1,3-Dinitrobenzene	1.19E+00	EPA 1999	7.40E+01	EPA 1999
2,4-Dinitrotoluene	3.08E+00	EPA 1999	9.15E+00	RAIS 2010
2,6-Dinitrotoluene	2.50E+00	EPA 1999	2.20E+01	RAIS 2010
Nitrobenzene	2.26E+00	EPA 1999	2.10E+01	EPA 1999

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EPA 2014. E-mail from Brett Thomas, EPA Region 4 Ecological Risk Assessor, to LeAnne Garner, May 29.

RAIS value downloaded February 2010 from Risk Assessment Information System on-line database. Value is modeled using EPI BCFBAF software.

RAIS-R value downloaded February 2010 from Risk Assessment Information System on-line database. Value is modeled using RESRAD software.

— = no value

C_s = Concentration in soil (mg/kg) C_e = Concentration in earthworm (mg/kg dry weight)

APPENDIX D

EXAMPLES OF EPA STREAMLINED RISK SUMMARY TABLES

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The tables in this appendix present examples of the preferred format for presentation of the COCs, pathways of concern, and toxicity endpoints; they are taken from EPA 1999, *A Guide to Preparing Superfund Proposed Plans, Records of Decision, and Other Remedy Selection Documents*, EPA 540-R-98-031, Washington, DC, July. Exhibits 1 and 2 (in the main text) present tables for use in a Screening-Level Ecological Risk Assessment taken from EPA 2018, *Region 4 Ecological Risk Assessment Supplemental Guidance*.

It should be noted that for the exposure routes to the different media, the route of exposure to contaminants in these media would not only be via ingestion of the contaminated media itself, but also ingestion of prey items that had been contaminated by contact with these media.

Example **Table D.1. Occurrence, Distribution, and Selection of Chemicals of Concern**

Exposure Medium: Sediment									
Chemical of Potential Concern	**Minimum Conc.[a] (ppm)**	**Maximum Conc.[a] (ppm)**	**Mean Conc. (ppm)**	**95% UCL of the Mean[b] (ppm)**	**Background Conc. (ppm)**	**Screening Toxicity Value (ppm)**	**Screening Toxicity Value Source**	**HQ Value[c]**	**COC Flag (Y or N)**
Aluminum	2,419	12,800	9,808	10,400	3,010	NA	NA	NA	Y
Arsenic	3	69	12	21	3	6	Ont LEL	11.5	Y
Dieldrin	0.01	0.01	0.01	0.01	NA	0.052	EPA SQC	0.19	N
Lead	29	82	50	56	28	47	NOAA ER-L	1.75	Y
Methoxychlor	0.01	0.01	0.01	0.01	NA	0.019	EPA SQB	0.53	N

[a] Minimum/maximum detected concentration above the sample quantitation limit (SQL).
[b] The 95% upper confidence limit (UCL) represents the reasonable maximum exposure concentration.
[c] Hazard quotient (HQ) is defined as maximum concentration/screening toxicity value.
COC = contaminant of concern
Conc. = concentration
NA = not applicable
NOAA ER-L = National Oceanic and Atmospheric Administration effects range–low
Ont LEL = Ontario lowest effects level; *Guidelines for the Protection and Management of Aquatic Sediment Quality in Ontario*; D. Persuad, R. Jaagumagi, and A. Hayton; Ontario Ministry of the Environment, Ontario, August 1993.
SQB = sediment quality benchmark
SQC = sediment quality criteria

Example **Table D.2. Ecological Exposure Pathways of Concern**

Exposure Medium	Sensitive Environment Flag (Y or N)	Receptor[a]	Endangered/ Threatened Species Flag (Y or N)	Exposure Routes	Assessment Endpoints	Measurement Endpoints
Sediment	N	Benthic organisms	N	Ingestion, respiration, and direct contact with chemicals in sediment	Benthic invertebrate community species diversity and abundance	• Toxicity of soil to *Hyallela* • Species diversity index
Surface water	N	Fish	N	Ingestion, respiration, and direct contact with chemicals in surface water	Maintenance of an abundant and productive game fish population	• Toxicity of surface water to *Pimephales promelas* • Species diversity index
Soil	N	Terrestrial invertebrates	N	Ingestion and direct contact with chemicals in wetland soils	Survival of terrestrial invertebrate community	• Toxicity of sediment to *Lumbricus terrestris*
		Terrestrial plants	Y	Uptake of chemicals via root systems	Maintenance/enhancement of native wetland vegetation	• Species diversity index • Survival of seedlings
Surface water (vernal pools)	Y	Aquatic invertebrates	N	Ingestion, respiration, and direct contact with chemicals in surface water	Maintenance of a balanced, indigenous aquatic invertebrate community	• Species diversity index

[a] Receptors representing reptiles and amphibians are not included in this table due to the lack of risk assessment parameters for these receptors. Until values for these parameters are available, it is assumed that assessments protecting other receptors are also protective of reptiles and amphibians.

Example **Table D.3. COC Concentrations Expected to Provide Adequate Protection of Ecological Receptors**

Habitat Type/Name	Exposure Medium	COC	Protective Level[a]	Units	Basis[b]	Assessment Endpoint
Small freshwater stream/West Branch Maple Creek	Sediment	Arsenic	6	mg/kg	Site-specific LOAEL	Benthic invertebrate community species diversity and abundance
		Lead	15	mg/kg	Significant difference in benthic diversity index between the site and the reference site	
		Total PCBs	0.03–0.05	mg/kg	LOAEL and NOAEL	
	Surface water	Aluminum	123	µg/L	NOAEL	Maintenance of an abundant and productive game fish population
		Arsenic	208	µg/L	Mean of values between LOAEL and NOAEL	
		Total PCBs	0.1	µg/L	Bioaccumulation factor modeling	

[a] A range of levels may be provided.
[b] Provide basis of selection: (1) mean of values between lowest observed adverse effect level (LOAEL) and no observed adverse effect level (NOAEL), (2) bioaccumulation factor model, (3) LOAEL and NOAEL, (4)significant difference in benthic diversity index between site and reference site.
COC = contaminant of concern
PCB = polychlorinated biphenyl

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APPENDIX E

CHECKLIST FOR ECOLOGICAL ASSESSMENT/SAMPLING

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Checklist for Ecological Assessment/Sampling

I. SITE DESCRIPTION

1. Site Name: _____

   Location: _____

   _____

   County:_____City:_____State:_____

2. Latitude: _____ Longitude: _____

3. What is the approximate area of the site? _____

4. Is this the first site visit? ☐ yes ☐ no If no, attach trip report of previous site visit(s), if available.

   Date(s) of previous site visit(s):_____.

5. Please attach to the checklist USGS topographic map(s) of the site, if available.

6. Are aerial or other site photographs available? ☐ yes ☐ no If yes, please attach any available photo(s) to the site map at the conclusion of this section.

7. The land use on the site is:

_____% Urban

_____% Rural

_____% Residential

_____% Industrial (☐ light ☐ heavy)

_____% Agricultural

(Crops:_____)

_____% Recreational

(Describe; note if it is a park, etc.)

_____

_____

_____% Undisturbed

_____% Other

The area surrounding the site is:
_____ mile radius

_____% Urban

_____% Rural

_____% Residential

_____% Industrial (☐ light ☐ heavy)

_____% Agricultural

(Crops:_____)

_____% Recreational

(Describe; note if it is a park, etc.)

_____

_____

_____% Undisturbed

_____% Other

8. Has any movement of soil taken place at the site? ☐ yes ☐ no. If yes, please identify the most likely cause of this disturbance:

_____ Agricultural Use _____ Heavy Equipment _____ Mining

_____ Natural Events _____ Erosion _____ Other

Please describe:

9. Do any potentially sensitive environmental areas exist adjacent to or in proximity to the site, e.g., Federal and State parks, National and State monuments, wetlands, prairie potholes? *Remember, flood plains and wetlands are not always obvious; do not answer "no" without confirming information.*

   Please provide the source(s) of information used to identify these sensitive areas, and indicate their general location on the site map.

10. What type of facility is located at the site?

    ☐ Chemical ☐ Manufacturing ☐ Mixing ☐ Waste disposal

    ☐ Other (specify)_____

11. What are the suspected contaminants of concern at the site? If known, what are the maximum concentration levels?

12. Check any potential routes of off-site migration of contaminants observed at the site:

    ☐ Swales ☐ Depressions ☐ Drainage ditches

    ☐ Runoff ☐ Windblown particulates ☐ Vehicular traffic

    ☐ Other (specify)_____

13. If known, what is the approximate depth to the water table?_____

14. Is the direction of surface runoff apparent from site observations? ☐ yes ☐ no If yes, to which of the following does the surface runoff discharge? Indicate all that apply.

    ☐ Surface water ☐ Groundwater ☐ Sewer ☐ Collection impoundment

15. Is there a navigable waterbody or tributary to a navigable waterbody? ☐ yes ☐ no

16. Is there a waterbody anywhere on or in the vicinity of the site? If yes, also complete Section III: Aquatic Habitat Checklist -- Non-Flowing Systems and/or Section IV: Aquatic Habitat Checklist -- Flowing Systems.

☐ yes (approx. distance_____) ☐ no

17. Is there evidence of flooding? ☐ yes ☐ no *Wetlands and flood plains are not always obvious; do not answer "no" without confirming information.* If yes, complete Section V: Wetland Habitat Checklist.

18. If a field guide was used to aid any of the identifications, please provide a reference. Also, estimate the time spent identifying fauna. [Use a blank sheet if additional space is needed for text.]

19. Are any threatened and/or endangered species (plant or animal) known to inhabit the area of the site? ☐ yes ☐ no *If yes, you are required to verify this information with the U.S. Fish and Wildlife Service.* If species' identities are known, please list them next.

20. Record weather conditions at the time this checklist was prepared:

DATE:_____

_____ Temperature (°C/°F) _____ Normal daily high temperature

_____ Wind (direction/speed) _____ Precipitation (rain, snow)

_____ Cloud cover

IA. SUMMARY OF OBSERVATIONS AND SITE SETTING

Completed by_____ Affiliation_____

Additional Preparers_____

Site Manager_____

Date_____

II. TERRESTRIAL HABITAT CHECKLIST

IIA. WOODED

1. Are there any wooded areas at the site? ☐ yes ☐ no If no, go to Section IIB: Shrub/Scrub.

2. What percentage or area of the site is wooded? (_____% _____ acres). Indicate the wooded area on the site map which is attached to a copy of this checklist. Please identify what information was used to determine the wooded area of the site.

3. What is the dominant type of vegetation in the wooded area? (Circle one: Evergreen/Deciduous/ Mixed) Provide a photograph, if available.

   Dominant plant, if known:_____

4. What is the predominant size of the trees at the site? Use diameter at breast height.

   ☐ 0-6 in. ☐ 6-12 in. ☐ > 12 in.

5. Specify type of understory present, if known. Provide a photograph, if available.

IIB. SHRUB/SCRUB

1. Is shrub/scrub vegetation present at the site? ☐ yes ☐ no If no, go to Section IIC: Open Field.

2. What percentage of the site is covered by scrub/shrub vegetation? (_____% _____ acres). Indicate the areas of shrub/scrub on the site map. Please identify what information was used to determine this area.

3. What is the dominant type of scrub/shrub vegetation, if known? Provide a photograph, if available.

4. What is the approximate average height of the scrub/shrub vegetation?

   ☐ 0-2 ft. ☐ 2-5 ft. ☐ > 5 ft.

5. Based on site observations, how dense is the scrub/shrub vegetation?

   ☐ Dense ☐ Patchy ☐ Sparse

IIC. OPEN FIELD

1. Are there open (bare, barren) field areas present at the site? ☐ yes ☐ no If yes, please indicate the type below:

   ☐ Prairie/plains ☐ Savannah ☐ Old field ☐ Other (specify)_____

2. What percentage of the site is open field? (_____% _____ acres). Indicate the open fields on the site map.

3. What is/are the dominant plant(s)? Provide a photograph, if available.

4. What is the approximate average height of the dominant plant?_____

5. Describe the vegetation cover: ☐ Dense ☐ Sparse ☐ Patchy

IID. MISCELLANEOUS

1. Are other types of terrestrial habitats present at the site, other than woods, scrub/shrub, and open field? ☐ yes ☐ no If yes, identify and describe them below.

2. Describe the terrestrial miscellaneous habitat(s) and identify these area(s) on the site map.

3. What observations, if any, were made at the site regarding the presence and/or absence of insects, fish, birds, mammals, etc.?

4. Review the questions in Section I to determine if any additional habitat checklists should be completed for this site.

III. AQUATIC HABITAT CHECKLIST -- NON-FLOWING SYSTEMS

Note: Aquatic systems are often associated with wetland habitats. Please refer to Section V, Wetland Habitat Checklist.

1. What type of open-water, non-flowing system is present at the site?

   ☐ Natural (pond, lake)
   ☐ Artificially created (lagoon, reservoir, canal, impoundment)

2. If known, what is the name(s) of the waterbody(ies) on or adjacent to the site?

   _____

3. If a waterbody is present, what are its known uses (e.g.: recreation, navigation, etc.)?

4. What is the approximate size of the waterbody(ies)? _____ acre(s).

5. Is any aquatic vegetation present? ☐ yes ☐ no If yes, please identify the type of vegetation present if known.

   ☐ Emergent ☐ Submergent ☐ Floating

6. If known, what is the depth of the water? _____

7. What is the general composition of the substrate? Check all that apply.

   ☐ Bedrock ☐ Sand (coarse) ☐ Muck (fine/black)
   ☐ Boulder (>10 in.) ☐ Silt (fine) ☐ Debris
   ☐ Cobble (2.5-10 in.) ☐ Marl (shells) ☐ Detritus
   ☐ Gravel (0.1-2.5 in.) ☐ Clay (slick) ☐ Concrete
   ☐ Other (specify)_____

8. What is the source of water in the waterbody?

   ☐ River/Stream/Creek ☐ Groundwater ☐ Other (specify)_____
   ☐ Industrial discharge ☐ Surface runoff

9. Is there a discharge from the site to the waterbody? ☐ yes ☐ no If yes, please describe this discharge and its path.

10. Is there a discharge from the waterbody? ☐ yes ☐ no If yes, and the information is available, identify from the list below the environment into which the waterbody discharges.

☐ River/Stream/Creek	☐ onsite	☐ offsite	Distance_____
☐ Groundwater	☐ onsite	☐ offsite	
☐ Wetland	☐ onsite	☐ offsite	Distance_____
☐ Impoundment	☐ onsite	☐ offsite	

11. Identify any field measurements and observations of water quality that were made. For those parameters for which data were collected provide the measurement and the units of measure below:

_____ Area

_____ Depth (average)

_____ Temperature (depth of the water at which the reading was taken) _____

_____ pH

_____ Dissolved oxygen

_____ Salinity

_____ Turbidity (clear, slightly turbid, turbid, opaque) (Secchi disk depth _____)

_____ Other (specify)

12. Describe observed color and area of coloration.

13. Mark the open-water, non-flowing system on the site map attached to this checklist.

14. What observations, if any, were made at the waterbody regarding the presence and/or absence of benthic macroinvertebrates, fish, birds, mammals, etc.?

IV. AQUATIC HABITAT CHECKLIST -- FLOWING SYSTEMS

Note: Aquatic systems are often associated with wetland habitats. Please refer to Section V, Wetland Habitat Checklist.

1. What type(s) of flowing water system(s) is (are) present at the site?

☐ River	☐ Stream	☐ Creek
☐ Dry wash	☐ Arroyo	☐ Brook
☐ Artificially created (ditch, etc.)	☐ Intermittent Stream	☐ Channeling
	☐ Other (specify)_____	

2. If known, what is the name of the waterbody?_____

3. For natural systems, are there any indicators of physical alteration (e.g., channeling, debris, etc.)?
☐ yes ☐ no If yes, please describe indicators that were observed.

4. What is the general composition of the substrate? Check all that apply.

☐ Bedrock	☐ Sand (coarse)	☐ Muck (fine/black)
☐ Boulder (>10 in.)	☐ Silt (fine)	☐ Debris
☐ Cobble (2.5-10 in.)	☐ Marl (shells)	☐ Detritus
☐ Gravel (0.1-2.5 in.)	☐ Clay (slick)	☐ Concrete
☐ Other (specify)_____		

5. What is the condition of the bank (e.g., height, slope, extent of vegetative cover)?

6. Is the system influenced by tides? ☐ yes ☐ no What information was used to make this determination?

7. Is the flow intermittent? ☐ yes ☐ no If yes, please note the information that was used in making this determination.

8. Is there a discharge from the site to the waterbody? ☐ yes ☐ no If yes, please describe the discharge and its path.

9. Is there a discharge from the waterbody? ☐ yes ☐ no If yes, and the information is available, please identify what the waterbody discharges to and whether the discharge is on site or off site.

10. Identify any field measurements and observations of water quality that were made. For those parameters for which data were collected, provide the measurement and the units of measure in the appropriate space below:

_____ Width (ft.)

_____ Depth (ft.)

_____ Velocity (specify units):_____

_____ Temperature (depth of the water at which the reading was taken_____)

_____ pH

_____ Dissolved oxygen

_____ Salinity

_____ Turbidity (clear, slightly turbid, turbid, opaque)
(Secchi disk depth _____)

_____ Other (specify)_____

11. Describe observed color and area of coloration.

12. Is any aquatic vegetation present? ☐ yes ☐ no If yes, please identify the type of vegetation present, if known.

    ☐ Emergent ☐ Submergent ☐ Floating

13. Mark the flowing water system on the attached site map.

14. What observations were made at the waterbody regarding the presence and/or absence of benthic macroinvertebrates, fish, birds, mammals, etc.?

V. WETLAND HABITAT CHECKLIST

1. Based on observations and/or available information, are designated or known wetlands definitely present at the site?
   ☐ yes ☐ no

   Please note the sources of observations and information used (e.g., USGS Topographic Maps, National Wetland Inventory, Federal or State Agency, etc.) to make this determination.

2. Based on the location of the site (e.g., along a waterbody, in a floodplain) and site conditions (e.g., standing water; dark, wet soils; mud cracks; debris line; water marks), are wetland habitats suspected?
   ☐ yes ☐ no If yes, proceed with the remainder of the wetland habitat identification checklist.

3. What type(s) of vegetation are present in the wetland?

   ☐ Submergent ☐ Emergent
   ☐ Scrub/Shrub ☐ Wooded

   ☐ Other (specify)_____

4. Provide a general description of the vegetation present in and around the wetland (height, color, etc.). Provide a photograph of the known or suspected wetlands, if available.

5. Is standing water present? ☐ yes ☐ no If yes, is this water: ☐ Fresh ☐ Brackish
   What is the approximate area of the water (sq. ft.)?_____
   Please complete questions 4, 11, 12 in Checklist III - Aquatic Habitat -- Non-Flowing Systems.

6. Is there evidence of flooding at the site? What observations were noted?

   ☐ Buttressing ☐ Water marks ☐ Mud cracks

   ☐ Debris line ☐ Other (describe below)

7. If known, what is the source of the water in the wetland?

   ☐ Stream/River/Creek/Lake/Pond ☐ Groundwater

   ☐ Flooding ☐ Surface Runoff

8. Is there a discharge from the site to a known or suspected wetland? ☐ yes ☐ no If yes, please describe.

9. Is there a discharge from the wetland? ☐ yes ☐ no. If yes, to what waterbody is discharge released?

   ☐ Surface Stream/River ☐ Groundwater ☐ Lake/Pond ☐ Marine

10. If a soil sample was collected, describe the appearance of the soil in the wetland area. Circle or write in the best response.

    Color (blue/gray, brown, black, mottled) _____

    Water content (dry, wet, saturated/unsaturated) _____

11. Mark the observed wetland area(s) on the attached site map.

APPENDIX F

KENTUCKY ECOLOGICAL SCREENING VALUES

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KY Ecological Screening Values

CAS No.		Soil (mg/kg)		Sediment (mg/kg)		Water (µg/L)	
67-64-1	Acetone	2.50E+00	v	4.53E-01	v	1.50E+03	sut
75-05-8	Acetonitrile					7.60E+01	kdep
260-94-6	Acridine					4.40E+00	can
107-02-8	Acrolein					2.10E+00	iv
107-13-1	Acrylonitrile	1.00E+03	iv			7.55E+01	iv
116-06-3	Aldicarb					1.00E+00	can
309-00-2	Aldrin	2.50E-03	iv	2.00E-03	v	3.00E-01	iv
7429-90-5	Aluminum	5.00E+01	iv	2.50E+04	pad	8.70E+01	iv
n/a	Aminodinitrotoluenes					2.00E+01	tal
7664-41-7	Ammonia	pH & temperature dependent				1.70E+00	kdep
62-53-3	Aniline	2.00E+01				2.20E+00	can
7440-36-0	Antimony and compounds	3.50E+00	iv	2.00E+00	eff	1.60E+02	iv
7440-38-2	Arsenic III					4.00E+01	birge
7440-38-2	Arsenic V					3.10E+00	sut
7440-38-2	Arsenic (total)	1.00E+01	iv	5.90E+00	can	5.00E+00	can
1912-24-9	Atrazine	5.00E-05	iv			1.80E+00	can
7440-39-3	Barium and compounds	1.65E+02	iv			3.90E+00	etox
71-43-2	Benzene	5.00E-02	iv	5.70E-02	etox	5.30E+01	iv
92-87-5	Benzidine			1.70E-03	kdep	3.90E+00	sut
65-85-0	Benzoic acid	6.50E+02	kdep	6.50E-01	iii	4.20E+01	sut
100-51-6	Benzyl alcohol	5.70E+00	kdep	1.10E-03	kdep	8.60E+00	sut
7440-41-7	Beryllium and compounds	1.10E+00	iv			5.30E-01	iv
92-52-4	1,1-Biphenyl	6.00E+01	iv	1.10E+00	kdep	1.40E+01	kdep
111-44-4	Bis(2-chloroethyl)ether	2.37E+01	v	2.12E-01	v	2.38E+03	iv
111-91-1	Bis(2-chloroethoxy)methane					1.10E+04	iv
117-81-7	Bis(2-ethylhexyl)phthalate (DEHP)	9.26E-01	v	1.82E-01	iv	3.00E-01	iv
7440-42-8	Boron	5.00E-01	iv			7.50E+02	iv
314-40-9	Bromacil					5.00E+00	can
7726-95-6	Bromine	1.00E+01	iv				
108-86-1	Bromobenzene	1.00E-01	iv				
74-97-5	Bromochloromethane	1.00E-01	iv			1.10E+04	iii
75-27-4	Bromodichloromethane	1.00E-01	iv	1.13E-03	v	1.10E+04	iii
75-25-2	Bromoform (tribromomethane)	1.59E+01	v	9.96E-01	v	2.93E+02	iv
74-83-9	Bromomethane (methyl bromide)					1.10E+02	iv
101-55-3	4-Bromophenyl phenylether			1.55E+00	v	1.50E+00	v
1689-84-5	Bromoxynil					5.00E+00	can
85-68-7	Butyl benzyl phthalate	2.39E-01	v	4.19E+00	v	2.20E+01	iv
7440-43-9	Cadmium and compounds	1.40E+00	can	6.76E-01	eff	1.70E-02	can
133-06-2	Captan					1.30E+00	can
63-25-2	Carbaryl	5.00E-01	iv			2.00E-01	can
1563-66-2	Carbofuran	2.00E-01	iv			1.80E+00	can
75-15-0	Carbon disulfide	9.40E-02	v	1.34E-01	v	9.20E-01	sut
56-23-5	Carbon tetrachloride	1.00E+03	iv	3.57E-02	v	1.33E+01	can
57-74-9	Chlordane	1.00E-01	iv	5.00E-04	eff	4.30E-03	iv
16887-00-6	Chloride					2.30E+05	iv
7782-50-5	Chlorine					1.10E+01	iv
106-47-8	4-Chloroaniline	2.00E+01	iv	1.46E-01	v	5.00E+01	noaa
108-90-7	Chlorobenzene	5.00E-02	iv	6.19E-02	v	1.30E+00	can
75-00-3	Chloroethane	1.00E-01	iv	5.86E+01	v	2.30E+05	v
110-75-8	2-Chloroethyl vinyl ether					3.54E+03	iv
67-66-3	Chloroform	1.00E-03	iv	2.70E-02	v	1.80E+00	can
74-87-3	Chloromethane (methyl chloride)	1.00E-01	iv	7.85E-05	v	5.50E+03	iv
35421-08-0	4-Chloro-3-methylphenol					3.00E-01	iv
91-58-7	beta-Chloronaphthalene	1.00E+00	iv	4.17E-01	v	3.96E-01	v
95-57-8	2-Chlorophenol	1.00E-02	iv	1.17E-02	v	7.00E+00	can
108-43-0	3-Chlorophenol	7.00E+00	iv			7.00E+00	can
7005-72-3	4-Chlorophenyl phenylether			6.56E-01	v		
1897-45-6	Chlorothalonil					1.80E-01	can

KY Ecological Screening Values

CAS No.		Soil (mg/kg)		Sediment (mg/kg)		Water (µg/L)	
95-49-8	o-Chlorotoluene	1.00E-01	iv				
2921-88-2	Chlorpyrifos	1.00E-01	iv			3.50E-03	can
n/a	Total Chromium (1/6 ratio Cr VI/Cr III)	4.00E-01	iv	3.73E+01	can	1.80E+02	kdep
16065-83-1	Chromium III					8.90E+00	can
7440-47-3	Chromium VI	4.00E-01	can			1.00E+00	can
7440-48-4	Cobalt	2.00E+01	iv	5.00E+01	v	3.00E+00	etox
7440-50-8	Copper and compounds	4.00E+01	iv	1.87E+01	iv	5.16E+00	wwq
21725-46-2	Cyanazine					2.00E+00	can
n/a	Cyanides (total)	9.00E-01	can				
57-12-5	Free cyanide	9.00E-01	iv			5.20E+00	iv
110-82-7	Cyclohexane	1.00E-01	iv				
108-94-1	Cyclohexanone	1.00E-01	iv				
75-99-0	Dalapon	1.00E-01	iv				
72-54-8	DDD	2.50E-03	iv	1.22E-03	eff	6.40E-03	iv
72-55-9	DDE	2.50E-03	iv	1.42E-03	can	1.05E+01	iv
50-29-3	DDT	2.50E-03	iv	1.00E-03	eff	1.00E-03	iv
124-18-5	Decane					4.90E+01	sut
52918-63-5	Deltamethrin					4.00E-04	can
8065-48-3	Demeton	1.00E-01	iv			1.00E-01	iv
333-41-5	Diazinon	1.00E-01	iv	1.90E-03	etox	4.30E-02	etox
132-64-9	Dibenzofuran			1.52E+00	v	2.00E+01	noaa
124-48-1	Dibromochloromethane	1.00E-01	iv	2.68E-01	v	6.40E+03	v
96-12-8	1,2-Dibromo-3-chloropropane	1.00E-01	iv	2.00E-02	v	1.12E+02	v
106-93-4	1,2-Dibromoethane	1.23E+00	v	1.24E-02	v	2.25E+01	v
84-74-2	Dibutyl phthalate	2.00E+02	iv	1.11E-01	v	9.40E+00	iv
1918-00-9	Dicamba	1.00E-01	iv			1.00E+01	can
95-50-1	1,2-Dichlorobenzene	1.00E-02	iv	5.00E-02	barr	7.00E-01	can
541-73-1	1,3-Dichlorobenzene	1.00E-02	iv	1.70E-01	barr	5.02E+01	iv
106-46-7	1,4-Dichlorobenzene	1.00E-02	iv	1.20E-02	barr	1.12E+01	iv
91-94-1	3,3-Dichlorobenzidine	6.46E-01	v	2.82E-02	v	9.98E+01	v
764-41-0	1,4-Dichloro-2-butene	1.00E+03	iv				
75-71-8	Dichlorodifluoromethane	1.00E-01	iv	1.33E-03	v	1.10E+04	iii
75-34-3	1,1-Dichloroethane	1.00E-01	iv	5.75E-04	v	4.70E+01	etox
107-06-2	1,2-Dichloroethane (EDC)	4.00E-01	iv	5.42E-02	v	1.00E+02	can
75-35-4	1,1-Dichloroethylene	1.00E-01	iv	2.33E-02	v	3.03E+02	iv
156-59-2	1,2-Dichloroethylene (cis)	1.00E-01	iv	2.09E-01	v	1.16E+04	iii
156-60-5	1,2-Dichloroethylene (trans)	1.00E-01	iv	2.09E-01	v	1.35E+03	iv
540-59-0	1,2-Dichloroethylene (mixture)	1.00E-01	iv	2.09E-01	v	3.10E+02	v
120-83-2	2,4-Dichlorophenol	2.00E+01	iv	1.34E-01	v	3.65E+01	iv
n/a	Dichlorophenols (total)	3.00E-03	iv			2.00E-01	can
94-75-7	2,4-Dichlorophenoxyacetic Acid (2,4-D)	1.00E-01	iv			4.00E+00	can
94-82-6	4-(2,4-Dichlorophenoxy)butyric Acid (2,4-DB)	1.00E-01	iv			4.00E+00	can
78-87-5	1,2-Dichloropropane	7.00E+02	iv	3.52E-01	v	5.25E+02	iv
542-75-6	1,3-Dichloropropene	1.00E-01	iv	2.96E-03	v	2.44E+01	iv
62-73-7	Dichlorvos	1.00E-01	iv				
51338-27-3	Diclofop-methyl					6.10E+00	can
60-57-1	Dieldrin	5.00E-04	iv	2.00E-05	eff	1.90E-03	iv
84-66-2	Diethyl phthalate	1.00E+02	iv	8.04E-03	v	5.21E+02	iv
60-51-5	Dimethoate	1.00E-01	iv	1.90E-01	v	6.20E+00	can
105-67-9	2,4-Dimethylphenol	1.00E-02	v	3.05E-01	v	2.12E+01	iv
131-11-3	Dimethyl phthalate	2.00E+02	iv	2.50E-02	v	3.30E+02	iv
99-65-0	1,3-Dinitrobenzene	6.55E-01	v	6.70E-03	tal	2.00E+01	tal
534-52-1	4,6-Dinitro-2-methylphenol (Dinitro-o-cresol)					2.30E+00	iv
51-28-5	2,4-Dinitrophenol	2.00E+01	iv	1.33E-03	v	6.20E+00	iv
121-14-2	2,4-Dinitrotoluene	1.28E+00	v	7.51E-02	v	3.10E+02	iv
606-20-2	2,6-Dinitrotoluene	3.28E-02	v	2.06E-02	v	4.20E+01	v
88-85-7	Dinoseb	1.00E-01	iv	1.18E-02	v	5.00E-02	can
117-84-0	di-n-Octyl phthalate	7.09E+02	v	4.06E+01	v	3.00E+01	v

KY Ecological Screening Values

CAS No.		Soil (mg/kg)		Sediment (mg/kg)		Water (µg/L)	
122-66-7	1,2-Diphenylhydrazine					2.70E+00	iv
298-04-4	Disulfoton	1.00E-01	iv	3.24E-01	iv	4.02E-02	v
115-29-7	Endosulfan	3.58E-02	v	1.04E-04	v	5.60E-02	iv
72-20-8	Endrin	1.00E-03	iv	2.00E-05	eff	2.30E-03	iv
100-41-4	Ethylbenzene	5.00E-02	iv	3.60E+00	etox	9.00E+01	can
107-21-1	Ethylene glycol	9.70E+01	iv			1.92E+05	can
52-85-7	Famphur			1.78E-03	v		
50-00-0	Formaldehyde	6.40E+00	kdep			9.70E+03	kdep
110-00-9	Furan	6.00E+02	iv				
1071-83-6	Glyphosate					6.50E+01	can
86-50-0	Guthion					1.00E-02	iv
76-44-8	Heptachlor	1.00E-01	iv	6.00E-04	v	3.80E-03	iv
1024-57-3	Heptachlor epoxide	1.52E-01	v	6.00E-04	v	3.80E-03	iv
118-74-1	Hexachlorobenzene	2.50E-03	iv	2.00E-02	v	3.68E-03	noaa
87-68-3	Hexachlorobutadiene	3.98E-02	v	1.38E+00	v	9.30E-01	iv
319-84-6	alpha-Hexaclorocyclohexane (HCH)	2.50E-03	iv	6.00E-03	v	5.00E+02	iv
319-85-7	beta-Hexaclorocyclohexane (HCH)	1.00E-03	iv	5.00E-03	v	5.00E+03	iv
58-89-9	gamma-Hexaclorocyclohexane (Lindane)	5.00E-05	iv	3.20E-04	eff	1.00E-02	can
77-47-4	Hexachlorocyclopentadiene	1.00E+01	iv	9.01E-01	v	7.00E-02	iv
19408-74-3	Hexachlorodibenzo-p-dioxin mixture (HxCDD)	1.00E-01	iv	2.50E-05	iv	2.00E-05	iv
67-72-1	Hexachloroethane	5.96E-01	v	2.23E+00	v	9.80E+00	iv
110-54-3	n-Hexane					5.80E-01	sut
591-78-6	2-Hexanone	1.26E+01	v	1.01E+00	v	9.90E+01	sut
7783-06-4	Hydrogen sulfide					2.00E+00	iv
55406-53-6	3-Iodo-2-propynyl butyl carbamate (IPBC)					1.90E+00	can
7439-89-6	Iron	2.00E+02	iv	2.00E+02	kdep	1.00E+03	iv
78-59-1	Isophorone	1.39E+02	v	4.22E-01	v	1.17E+03	iv
7439-91-0	Lanthanum	5.00E+01	iv				
7439-92-1	Lead	5.00E+01	iv	1.20E+01	pad	1.32E+00	iv
330-55-2	Linuron					7.00E+00	can
7439-93-2	Lithium	2.00E+00	iv				
121-75-5	Malathion	1.00E-01	iv	6.70E-04	kdep	1.00E-01	iv
12427-38-2	Maneb	3.50E+00	iv				
7439-95-4	Magnesium	4.40E+05	iii				
7439-96-5	Manganese and compounds	1.00E+02	iv	6.14E+02	pad	8.00E+01	etox
7439-97-6	Mercuric chloride	1.00E-01	iv	1.30E-01	iv	1.20E-02	iv
22967-92-6	Mercury (methyl)	6.70E-01	iv	2.45E-05	v	3.00E-03	etox
150-50-5	Merphos	1.00E-01	iv				
72-43-5	Methoxychlor	1.99E-02	v	3.59E-03	v	3.00E-02	iv
94-74-6	2-Methyl-4-chlorophenoxyacetic acid (MCPA)	1.00E-01	iv			2.60E+00	can
93-65-2	2-(2-Methyl-4-chlorophenoxy)propionic acid (MCPP)	1.00E-01	iv			4.00E+00	can
74-95-3	Methylene bromide	1.23E+00	v	1.24E-02	v	2.25E+01	v
75-09-2	Methylene chloride	2.00E+00	iv	1.26E+00	v	9.81E+01	can
78-93-3	Methyl ethyl ketone (2-butanone)	8.96E+01	v	1.37E-01	v	7.10E+03	v
108-10-1	Methyl isobutyl ketone (4-methyl-2-pentanone)	4.43E+02	v	5.44E-01	v	3.68E+03	v
298-00-0	Methyl parathion	1.00E-01	iv	7.55E-04	v	1.30E-02	iv
95-48-7	2-Methylphenol	5.00E-01	iv	6.30E-02	iii	1.30E+01	sut
106-44-5	4-Methylphenol	5.00E-01	iv	6.70E-01	iii	4.89E+02	d
51218-45-2	Metolachlor					7.80E+00	can
21087-64-9	Metribuzin					1.00E+00	can
2385-85-5	Mirex					1.00E-03	iv
7439-98-7	Molybdenum	2.00E+00	iv			7.30E+01	can
300-76-5	Naled	1.00E-01	iv				
7440-02-0	Nickel (soluble salts)	3.00E+01	iv	1.59E+01	iv	2.90E+01	wwq
88-74-4	2-Nitroaniline	3.16E+00	v	2.00E-04	v		
99-09-2	3-Nitroaniline	2.19E+01	v	2.00E-04	v		
100-01-6	4-Nitroaniline	3.16E+00	v	2.00E-04	v		
98-95-3	Nitrobenzene	1.31E+00	v	4.88E-01	v	2.70E+02	iv

KY Ecological Screening Values							
CAS No.		Soil (mg/kg)		Sediment (mg/kg)		Water (µg/L)	
88-75-5	2-Nitrophenol					3.50E+03	iv
100-02-7	4-Nitrophenol	7.00E+00	iv	7.78E-03	v	8.28E+01	iv
86-30-6	N-Nitrosodiphenylamine	2.00E+01	iv	1.55E-01	v	5.85E+01	iv
2691-41-0	Octahydro-1357-tetranitro-1357- tetrazocine (HMX)			4.70E-03	tal	3.30E+02	tal
111-13-7	2-Octanone					8.30E+00	sut
56-38-2	Parathion	1.00E-01	iv	3.40E-04	v	1.30E-02	iv
608-93-5	Pentachlorobenzene	2.50E-03	iv			6.00E+00	can
87-86-5	Pentachlorophenol	2.00E-03	iv	6.90E-01	barr	5.00E-01	can
30899-19-5	Pentanol					1.10E+02	sut
108-95-2	Phenol	5.00E-02	iv	2.73E-02	v	4.00E+00	can
298-02-2	Phorate	1.00E-01	iv	8.61E-04	v	3.62E+00	v
n/a	Phthalate esters					3.00E+00	wwq
1918-02-1	Picloram					2.90E+01	can
1336-36-3	Polychlorinated biphenyls (PCBs)	2.00E-02	iv	2.16E-02	eff	1.40E-03	wwq
12674-11-2	Aroclor 1016	2.00E-02	iv	2.16E-02	eff	1.40E-03	wwq
11097-69-1	Aroclor 1254	2.00E-02	iv	2.16E-02	eff	1.40E-03	wwq
	Polynuclear aromatic hydrocarbons (PAHs) - total	1.00E+00	iv	1.68E+00	iv		
83-32-9	Acenaphthene	2.00E+01	iv	6.71E-03	can	5.80E+00	can
208-96-8	Acenaphthylene	6.82E+02	v	5.87E-03	can	4.84E+03	v
120-12-7	Anthracene	1.00E-01	iv	4.69E-02	can	1.20E-02	can
56-55-3	Benz[a]anthracene	5.21E+00	v	3.17E-02	can	1.80E-02	can
205-99-2	Benzo[b]fluoranthene	5.98E+01	v	6.55E-01	iv	9.07E+00	v
207-08-9	Benzo[k]fluoranthene	1.48E+02	v	6.55E-01	iv	5.60E-03	v
191-24-2	Benzo(ghi)perylene	1.19E+02	v	6.55E-01	iv	7.64E+00	v
50-32-8	Benzo[a]pyrene	1.00E-01	iv	3.19E-02	can	1.40E-02	iv
218-01-9	Chrysene	4.73E+00	v	5.71E-02	can	3.30E-02	v
53-70-3	Dibenz[ah]anthracene	1.84E+01	v	6.22E-03	can	1.60E-03	v
206-44-0	Fluoranthene	1.00E-01	iv	1.11E-01	can	4.00E-02	can
86-73-7	Fluorene	1.22E+02	v	2.12E-02	can	3.00E+00	can
193-39-5	Indeno[1,2,3-cd]pyrene	1.09E+02	v	6.55E-01	iv	4.31E+00	v
91-57-6	2-Methylnaphthalene			2.02E-02	can	2.10E+00	sut
91-20-3	Naphthalene	1.00E-01	iv	3.46E-02	can	1.10E+00	can
85-01-8	Phenanthrene	1.00E-01	iv	4.19E-02	can	4.00E-01	can
129-00-0	Pyrene	1.00E-01	iv	5.30E-02	can	2.50E-02	can
71-23-8	Propanol					7.50E+01	sut
110-86-1	Pyridine	1.00E-01	iv				
91-22-5	Quinoline					3.40E+00	can
121-82-4	RDX (Cyclonite)			1.32E-02	tal	1.90E+02	tal
299-84-3	Ronnel	1.00E-01	iv				
7782-49-2	Selenium	8.10E-01	iv	5.00E-02	kdep	1.00E+00	can
7440-22-4	Silver and compounds	2.00E+00	iv	7.33E-01	eff	1.20E-02	iv
122-34-9	Simazine					1.00E+01	can
7440-24-6	Strontium, stable					1.50E+03	sut
100-42-5	Styrene	1.00E-01	iv	4.45E-01	v	5.60E+01	v
18496-25-8	Sulfide					2.00E+00	iv
63705-05-5	Sulfur	2.00E+00	iv				
34014-18-1	Tebuthiuron					1.60E+00	can
1746-01-6	2,3,7,8-TCDD (dioxin)	5.00E-05	keen	1.00E-08	kdep	1.00E-05	iv
1746-01-6	2,3,7,8-TCDD (dioxin) - total equivalents	5.00E-05	keen	8.50E-07	can	1.00E-05	iv
634-66-2	1,2,3,4-Tetrachlorobenzene	1.00E-02	iv			1.80E+00	can
95-94-3	1,2,4,5-Tetrachlorobenzene	1.00E-02	iv			5.00E+01	iv
630-20-6	1,1,1,2-Tetrachloroethane	1.00E-01	iv	1.09E-02	v	2.40E+03	noaa
79-34-5	1,1,2,2-Tetrachloroethane	1.00E-01	iv	9.40E-01	etox	2.40E+02	iv
127-18-4	Tetrachloroethylene (PCE)	1.00E-02	iv	1.96E-01	v	8.40E+01	iv
n/a	Tetrachlorophenols - total	1.00E-03	iv			1.00E+00	can
4901-51-3	2,3,4,5-Tetrachlorophenol	2.00E+01	iv				
109-99-9	Tetrahydrofuran	1.00E-01	iv				
7440-28-0	Thallium	1.00E+00	iv	1.00E-01	kdep	8.00E-01	can

KY Ecological Screening Values

CAS No.		Soil (mg/kg)		Sediment (mg/kg)		Water (µg/L)	
7446-18-6	Thallium sulfate	1.00E+00	kdep	1.00E-01	kdep	4.00E+00	kdep
NA	Thiocyanate	2.00E+00	iv				
n/a	Tin (inorganic, see tributyltin oxide for organic tin)	5.30E+01	iv			7.30E+01	kdep
7440-32-6	Titanium	1.00E+03	iv				
108-88-3	Toluene	5.00E-02	iv	6.70E-01	etox	2.00E+00	can
8001-35-2	Toxaphene	1.19E-01	v	1.09E-04	iv	2.00E-04	iv
56-35-9	Tributyltin oxide (TBTO)					8.00E-03	can
636-30-6	2,4,5-Trichloroaniline	2.00E+01	iv				
634-93-5	2,4,6-Trichloroaniline	7.00E+00	kdep	7.00E-01	kdep	7.00E+02	kdep
87-61-6	1,2,3-Trichlorobenzene	1.00E-02	iv	6.40E-02	barr	8.00E+00	can
120-82-1	1,2,4-Trichlorobenzene	1.00E-02	iv	6.40E-02	barr	2.40E+01	can
71-55-6	1,1,1-Trichloroethane	1.00E-01	iv	1.70E-01	etox	5.28E+02	iv
79-00-5	1,1,2-Trichloroethane	1.00E-01	iv	6.74E-01	v	9.40E+02	iv
79-01-6	Trichloroethylene (TCE)	1.00E-03	iv	1.80E-01	v	2.10E+01	can
75-69-4	Trichlorofluoromethane	1.00E-01	iv	3.07E-03	v	1.10E+04	iii
95-95-4	2,4,5-Trichlorophenol	4.00E+00	iv	8.56E-02	v	6.30E+01	noaa
88-06-2	2,4,6-Trichlorophenol	1.00E+01	iv	8.48E-02	v	3.20E+00	iv
n/a	Trichlorophenols - total	1.00E-03	iv			1.80E+01	can
93-76-5	2,4,5-Trichlorophenoxyacetic Acid	1.00E-01	iv				
93-72-1	2-(2,4,5-Trichlorophenoxy) propionic acid (Silvex)	1.00E-01	iv	7.35E+00	v	3.27E+02	v
96-18-4	1,2,3-Trichloropropane	1.00E-01	iv	8.35E-03	v	1.21E+01	v
95-63-6	1,2,4-Trimethylbenzene	1.00E-01	iv				
108-67-8	1,3,5-Trimethylbenzene	1.00E-01	iv				
99-35-4	1,3,5-Trinitrobenzene	3.76E-01	v	2.40E-03	tal	1.10E+01	tal
118-96-7	2,4,6-Trinitrotoluene			9.20E-02	tal	9.00E+01	tal
668-34-8	Triphenyltin					2.20E-02	can
7440-33-7	Tungsten	4.00E+02	iv				
7440-61-1	Uranium (soluble salts)	5.00E+00	iv	2.60E-01	kdep	2.60E+00	sut
7440-62-2	Vanadium	2.00E+00	iv	2.00E-01	kdep	1.90E+01	etox
108-05-4	Vinyl acetate			8.40E-04	kdep	1.60E+01	sut
75-01-4	Vinyl chloride	1.00E-02	iv	2.00E-03	v	9.20E+00	v
108-38-3	m-Xylene	5.00E-02	iv	2.50E-02	etox	1.80E+00	sut
95-47-6	o-Xylene	5.00E-02	iv	1.88E+00	noaa	1.17E+02	v
106-42-3	p-Xylene	5.00E-02	iv	2.50E-02	etox	1.17E+02	v
1330-20-7	Xylene (mixed)	5.00E-02	iv	1.88E+00	noaa	1.17E+02	v
7440-66-6	Zinc	5.00E+01	iv	1.24E+02	iv	3.00E+01	can
7440-67-7	Zirconium					1.70E+01	sut

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