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Standard Guide for Data and Information Options for Conducting an Ecological Risk Assessment at Contaminated Sites[1]

This standard is issued under the fixed designation E2020; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 An ecological-risk assessment (ERA) is a process for organizing and analyzing data, information, assumptions, and uncertainties to evaluate the likelihood that adverse ecological effects might occur or are occurring as a result of a stressor. This guide is intended to assist remedial project teams, specifically ecological risk assessors, in identifying data and information options that may be used to perform a screening or complex ecological risk assessment (ERA) at a contaminated site.

NOTE 1—While the intent of ERA is to evaluate risk (that is, the probability of adverse effects occurring in ecological receptors), there are no measures, statistics, or metrics that calculate or express risk explicitly. However, various metrics or indices, a common example being the hazard quotient, are used to inform risk assessments.

1.2 The identification of data and information options for human health risk assessment is outside the scope of this guide.

1.3 This guide is intended to provide a list for identifying data and information options and does not recommend a specific course of action for ERA activities.

1.4 This guide addresses data and information options for the ecological risk assessment, not verification or long-term monitoring studies.

1.5 This guide lists many of the common data and information options for ERA, but there may be others relevant for any particular site.

1.6 This guide considers one component of an ERA, that is, identification of data and information options. Other ASTM guides have been developed, for example, Guides E1689 and E1848, and are being developed to cover other components of the risk assessment process.

1.7 This guide does not provide information on how to perform any of the analytical procedures used to perform a risk assessment once data collection options are defined.

1.8 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

D5730 Guide for Site Characterization for Environmental Purposes With Emphasis on Soil, Rock, the Vadose Zone and Groundwater (Withdrawn 2013)[3]

E1391 Guide for Collection, Storage, Characterization, and Manipulation of Sediments for Toxicological Testing and for Selection of Samplers Used to Collect Benthic Invertebrates

E1525 Guide for Designing Biological Tests with Sediments

E1689 Guide for Developing Conceptual Site Models for Contaminated Sites

E1848 Guide for Selecting and Using Ecological Endpoints for Contaminated Sites

E3163 Guide for Selection and Application of Analytical Methods and Procedures Used during Sediment Corrective Action

E3164 Guide for Sediment Corrective Action – Monitoring

E3240 Guide for Risk-Based Corrective Action for Contaminated Sediment Sites

E3242 Guide for Determination of Representative Sediment Background Concentrations

E3248 Guide for NAPL Mobility and Migration in Sediment – Conceptual Models for Emplacement and Advection

2.2 *Other Documents:*

ISO 21365:2019 Soil quality -- Conceptual site models for potentially contaminated sites[4]

[1] This guide is under the jurisdiction of ASTM Committee E50 on Environmental Assessment, Risk Management and Corrective Action and is the direct responsibility of Subcommittee E50.04 on Corrective Action.

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[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

[3] The last approved version of this historical standard is referenced on www.astm.org.

[4] Available from International Organization for Standardization (ISO), ISO Central Secretariat, Chemin de Blandonnet 8, CP 401, 1214 Vernier, Geneva, Switzerland, https://www.iso.org.

EPA/600/R-17/448F, 2018 USEPA. Procedures For Delineating And Characterizing Watersheds For Stream And River Monitoring Programs (Final Report). U.S. EPA Office of Research and Development, Washington, DC.[5]
Government of Canada. Federal Contaminated Site Action Plan: Ecological Risk Assessment Guidance, March 2012

3. Terminology

3.1 *Definitions of Terms Specific to This Standard:*

3.1.1 *assessment endpoint, n*—an explicit expression of the environmental value to be protected.

3.1.2 *baseline condition, n*—the initial physical, biological, and environmental condition of the project area, prior to intervention or disruption.

3.1.2.1 *Discussion*—The baseline condition may include soil properties, the geological characteristics, the topography, watershed properties, the initial level of environmental impairment of water, air, soil, sediment, the biodiversity of the area, types of flora and fauna, species richness, species distribution, types of ecosystems, presence or absence of endangered species and/or sensitive ecosystems etc.

3.1.3 *baseline ecological risk assessment, n*—an ecological risk assessment completed using quantitative methods, which relies on site-specific data and may include toxicity testing, field biological surveys, and probabilistic analysis.

3.1.4 *bioaccumulation, n*—the net increase of contaminant concentrations in organisms following uptake from the ambient environmental medium.

3.1.4.1 *Discussion*—Different sources of exposure contribute to contaminant bioaccumulation.

3.1.5 *chemical stressor, n*—a chemical, chemical mixture, or radionuclide present in an environmental medium that is known or suspected to induce an adverse biological, toxicological, or ecological response in an exposed ecological receptor.

3.1.6 *complex ecological risk assessment, n*—an ecological risk assessment completed using quantitative methods, which relies on site-specific data and may include toxicity testing, field biological surveys, and probabilistic analysis.

3.1.7 *data quality objective, n*—a specification of the amount and quality of data required to adequately complete the risk assessment such that a risk management decision can be made.

3.1.8 *ecological receptor, n*—ecosystems, communities, populations, and individual organisms (except humans), that can be exposed directly or indirectly to site stressors.

3.1.9 *ecological-risk assessment (ERA)*—a process for organizing and analyzing data, information, assumptions, and uncertainties to evaluate the likelihood that adverse ecological effects might occur or are occurring as a result of a stressor.

3.1.10 *measurement endpoint, n*—a measurable response to a stressor that is quantifiably related to the valued characteristic chosen as the assessment endpoint.

3.1.11 *non-chemical stressor, n*—a biological agent, physical disturbance, condition, or nonchemical characteristic of a waste material, substrate, or source associated with a contaminated site and corrective actions that is known or suspected to interfere with the normal functioning of an ecological receptor.

3.1.12 *screening ecological risk assessment, n*—an ecological risk assessment completed using qualitative or simple quantitative methods, which relies on literature information and is unlikely to include toxicity testing, field biological surveys, or probabilistic analysis.

3.1.13 *site, n*—the terms "site," "on-site," and "off-site," have not been defined in this guide. They will need to be defined on a case-by-case basis. They could be defined by regulatory needs, natural boundaries, or property boundaries.

3.2 *Acronyms:*

3.2.1 *CEC*—Cation Exchange Capacity

3.2.2 *DOC*—Dissolved Organic Carbon

3.2.3 *DQO*—Data Quality Objective

3.2.4 *EPA / USEPA*—United States Environmental Protection Agency

3.2.5 *ERA*—Ecological Risk Assessment

3.2.6 *GIS*—Geographic Information System

3.2.7 *PCB*—Polychlorinated Biphenyls

3.2.8 *TDS*—Total Dissolved Solids

3.2.9 *TOC*—Total Organic Carbon

3.2.10 *TSS*—Total Suspended Solids

4. Summary of Guide

4.1 This guide provides a series of lists of data and information options for conducting an ecological risk assessment at a contaminated site and is organized in accordance with the major components of the risk assessment process: problem formulation, exposure characterization, effects characterization, and risk characterization (**1-4**).[6] Lists are provided for screening and complex ERAs.

5. Significance and Use

5.1 This guide is significant in that it addresses the data and information options of each component of the ecological risk assessment process, for both a screening and complex ERA. It outlines the data and information options while recognizing that an ecological risk assessment may be focused to achieve a particular stated goal. This guide is not intended to represent the views of the U.S. Environmental Protection Agency (USEPA), or any other regulatory agency, on data collection for ecological risk assessment.

5.2 This guide is to be used by managers, scientists, and technical staff of contractors, industry, government agencies, and universities responsible for conducting ecological risk assessments at contaminated sites. It is to be used to guide data collection phases of the ecological risk assessment. It will assist in the development of the conceptual site model (see Guide E1689) and the identification of potential assessment and measurement endpoints (see Guide E1848 and US EPA's

[5] Available from United States Environmental Protection Agency (EPA), William Jefferson Clinton Bldg., 1200 Pennsylvania Ave., NW, Washington, DC 20460, http://www.epa.gov.

[6] The boldface numbers in parentheses refer to the list of references at the end of this standard.

Generic Ecological Assessment Endpoints, 2016 (**5**)). While it was written to assist in planning an ERA, the list also may be used in the review of a completed ERA.

6. General Guidance on Determining Data Collection Options for Ecological Risk Assessment

6.1 It is imperative that the goals of the ERA are outlined at the beginning of the ERA process. Data collection efforts may then be focused to ensure a sound scientific approach and cost-effective use of resources, for example, time and money.

6.2 The lists are not meant to be exhaustive. Neither are they intended to be lists of data required for all ERAs. The amount and type of data required for a screening or complex ERA will depend upon the size and location of the site, the future intended use of the site, the baseline condition of the site, and the outcome of the data quality objectives (DQO) process (**6**). A typical site may utilize only a small percentage of these data and information options. These lists are intended to serve as a general index to data collection efforts.

6.2.1 Data Collection should include the type of habitat determination (critical, occupied, unoccupied) and the location of the habitat to ensure proper data collection of ecological indicators.

7. Lists

7.1 Not all of the components within the following lists will be relevant at every contaminated site. In addition, some information may be site-specific and other information may be obtained from the literature. Literature data are more prevalent in screening ERAs and site-specific data are more prevalent in complex ERAs. Whenever practicable, site-specific data are preferred over literature data.

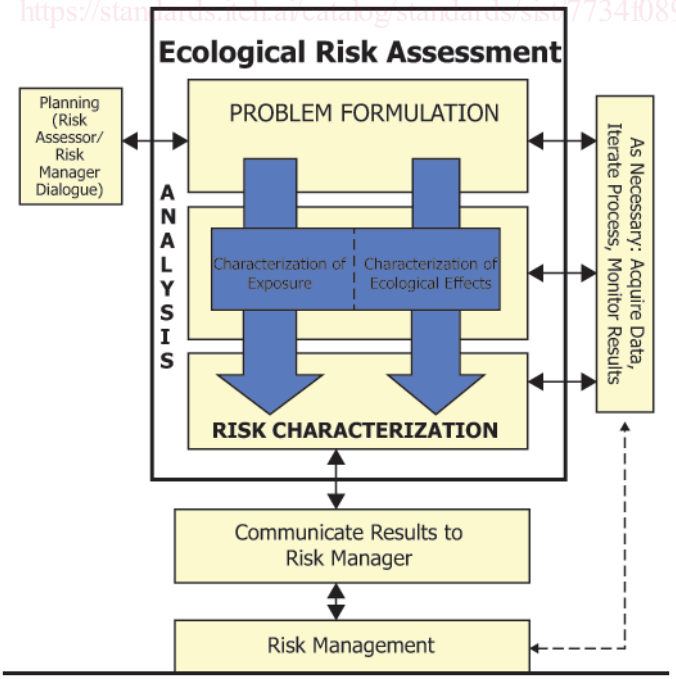

FIG. 1 Source EPA's Guidelines for Ecological Risk Assessment, April 1998. (EPA/630/R-95/002F)

7.2 The options in the lists are not in any particular order. Risk assessment often is an iterative process, and it may be more scientifically sound and cost-effective to complete certain options before others. The order for the completion of options will need to be determined on a case-by-case basis.

8. Data Options for Problem Formulation

8.1 Most of the data and information options in problem formulation are applicable to both screening and complex ERAs and are outlined below; however, the information will be more detailed in a complex ERA. Additional data and information options typically found only in complex ERAs are listed in Section 9.

8.2 Clearly define the goals of the ERA (**7**).

8.3 Define data quality objectives (DQOs) for the assessment (**6**).

8.3.1 State the problem that the risk assessment should address.

8.3.2 Identify the decision(s) that require new environmental data to address the contamination problem.

8.3.3 Identify the inputs (data or information) needed to support the decision.

8.3.4 Define the scale (spatial and temporal) of the assessment.

8.3.5 Develop a decision rule that defines choice among alternative solutions.

8.3.6 Specify acceptable limits on decision errors used to establish performance goals for limiting uncertainty.

8.3.7 Optimize the design for obtaining data, by identifying the most resource-effective sampling and analysis plan.

8.3.8 Identification of indicator species for specific habitats.

8.3.9 Identification of additional considerations for threatened and endangered species.

8.4 Complete the conceptual site model (see Guide E1689 or ISO 21365:2019)

8.4.1 Identify the current and historical sources of potential chemical stressors, such as the following:

8.4.1.1 Process areas;

8.4.1.2 Landfill;

8.4.1.3 Burial ground;

8.4.1.4 Underground or aboveground storage tanks, or both;

8.4.1.5 Lagoons;

8.4.1.6 Holding ponds;

8.4.1.7 Air stacks or other air emission sources;

8.4.1.8 Effluent pipes; or,

8.4.1.9 Historical spills or accidental releases.

8.4.2 Identify nonchemical, for example, physical and biological stressors, such as the following:

8.4.2.1 Nonnative or exotic species;

8.4.2.2 Pathogens;

8.4.2.3 Temperature;

8.4.2.4 Suspended solids;

8.4.2.5 Change in water levels;

8.4.2.6 Oxygen depletion;

8.4.2.7 pH;

8.4.2.8 Predators;

8.4.2.9 Habitat alteration, degradation or destruction; or,

8.4.2.10 Non-site-related stressors, for example, local releases from municipal or industrial development.

8.4.3 Identify potential constituent migration pathways.

8.4.4 Identify geological features that control movement of constituents and dictate exposure pathways. In particular, note any features which would cause unpredictable movement of constituents, for example, karst formations in limestone often cause difficulties in tracing ground water movement.

8.4.5 Identify all relevant constituent-bearing media, such as the following:

8.4.5.1 Soil;

8.4.5.2 Ground water;

8.4.5.3 Surface water;

8.4.5.4 Sediment;

8.4.5.5 Air; or,

8.4.5.6 Biota.

8.4.6 Identify direct and indirect complete exposure pathways. Ensure that exposure pathways are identified appropriately, for example, PCBs may not be detected in surface water, but may be detected in fish tissues, and therefore, food web exposure pathways are appropriate to consider. Exposure pathways may include the following:

8.4.6.1 Inhalation;

8.4.6.2 Ingestion;

8.4.6.3 Dermal uptake;

8.4.6.4 Root uptake; or,

8.4.6.5 Food web.

8.4.7 Identify normal and atypical weather patterns for the site location, such as the following:

8.4.7.1 Excessive dry periods with high winds may lead to increased levels of constituents in air from fugitive dusts, and destruction of habitat;

8.4.7.2 Storm events, for example, hurricanes, that may mobilize constituents, for example, suspension of sediments may increase the bioavailability of constituents;

8.4.7.3 Periodic flooding may result in certain exposure pathways that may otherwise not exist, for example, contamination of the floodplain community from a stream; or,

8.4.7.4 Fluctuations in salinity.

8.4.8 Define the assessment endpoints and include rationale for their selection (see Guide E1848 and EPA Procedures For Delineating And Characterizing Watersheds For Stream And River Monitoring Programs, 2018).

8.4.8.1 Ensure the assessment endpoints are relevant to decision-making. **(8)**

8.4.8.2 Consider whether endpoints are ecologically relevant.

8.4.8.3 Consider whether endpoints have societal importance.

8.4.8.4 Determine whether endpoint species are or could be at the site.

8.4.8.5 Consider whether endpoint species are sensitive to site constituents.

8.4.8.6 Consider whether endpoint species are likely to receive high exposures.

8.4.9 Identify any threatened, or endangered species (plant or animal), or both, known to inhabit, or that could potentially inhabit, the vicinity of the site. Also, identify the presence of habitat that could be utilized by threatened and endangered species. Consider using state or federal listings of threatened, rare and endangered species, for example, Natural Heritage Program. Consider local laws and regulations to identify any protected species or species of local concern.

8.4.10 Identify any commercially or recreationally important species in the area of the site.

8.4.11 Describe the food web. Identify multiple food sources, where appropriate, in the foraging area of each receptor species. Consider consulting with local naturalists, for example, Department of Natural Resources, Fish and Wildlife Service, Department of Environmental Protection, Natural Heritage Program, to obtain information on local species.

NOTE 2—Graphic representation of the food web is recommended.

8.4.12 Define measurement endpoints and include rationale for their selection. Also, describe relation between assessment endpoints and measurement endpoints.

8.4.13 Present both current and future exposure scenarios. Future exposures should be based on reasonably anticipated future land use. Describe how future exposures may change, as a result of the following scenarios, for example:

8.4.13.1 Increased release from a ground water plume to a stream;

8.4.13.2 Increased habitat from forest succession causes additional ecological receptor species to be in contact with constituents;

8.4.13.3 Decreased exposure because of scouring of sediments out of a stream, but increased exposure downstream where sediments settle;

8.4.13.4 Weather-related seasonal or periodic changes; or,

8.4.13.5 Continued physical degradation or biodegradation of constituents.

8.5 Environmental Description of Site **(9)**:

8.5.1 Describe and map current and potential future land use scenarios of the site and surrounding area, to ensure assessment endpoints and ecological receptor species are selected that are appropriate for current and future land uses. Land uses may include the following:

8.5.1.1 Residential;

8.5.1.2 Park land/recreational;

8.5.1.3 Industrial;

8.5.1.4 Commercial;

8.5.1.5 Agricultural;

8.5.1.6 Forested;

8.5.1.7 Wetlands;

8.5.1.8 Wildlife preservation area; or,

8.5.1.9 Aquatic habitat.

8.5.2 Describe and map the aquatic habitat.

8.5.2.1 Describe and map features as follows:

(a) Type and area of habitat;

(b) Function of habitat;

(c) Water and sediment quality parameters;

(d) Pattern of ground water and surface water flow;

(e) Ground water discharge and recharge points; or,

(f) Flora and fauna historically present, currently present, or expected to be present.

(g) Adjoining habitats for downstream or adjacent contaminant and species travel or migration that could be affected.

8.5.2.2 Consider photographing relevant features.

8.5.2.3 Consider utilizing geographic information systems (GIS) or similar visualization tools.

8.5.3 Describe and map the terrestrial habitat.

8.5.3.1 Describe and map features as follows:

(a) Type and area of habitat;

(b) Function of habitat;

(c) Topography;

(d) Soil types;

(e) Flora and fauna (including avifauna) historically present, currently present, or expected to be present; or,

(f) Fragmentation of terrestrial habitat, for example, by roads.

8.5.3.2 Consider photographing relevant features.

8.5.3.3 Consider utilizing geographic information systems (GIS) or similar visualization tools.

8.5.4 Describe magnitude and extent of constituents in media, for example, area, depth, volume, using available preliminary data. This information will be used to determine appropriate endpoints and to estimate exposures.

8.5.5 Detail the proximity of any potentially sensitive ecological areas or areas of local ecological or social importance.

8.5.6 Describe field conditions and physical parameters that may be relevant to sample integrity, as follows:

8.5.6.1 Potential background sources/contamination;

8.5.6.2 Nearby spraying of pesticides, for example, farmer, groundskeeper, homes;

NOTE 3—Consider aerial application of pesticides.

8.5.6.3 Use of fertilizers; or,

8.5.6.4 Location of aquifers.

8.5.7 Identify wetlands and floodplains. Define relevant seasonal changes that may influence the wetlands. Surveys may be required (see 13.3.1).

8.6 *Identification of Constituents of Concern*—The identification of constituents of concern should be based on ecological and not human health considerations. Screen constituents and other stressors to determine those that are likely to contribute to significant ecological risk.

8.6.1 Water analyses required may include the following:

8.6.1.1 Filtered water samples for aquatic biota endpoints (to determine soluble, bioavailable fraction);

8.6.1.2 Total water analyses;

8.6.1.3 Dissolved organic carbon (DOC) and total organic carbon (TOC) analyses;

8.6.1.4 Total dissolved solids (TDS) and total suspended solids (TSS);

8.6.1.5 Analytical detection limits below regulatory concentrations, where technically and economically feasible;

8.6.1.6 Hardness or salinity;

8.6.1.7 pH;

8.6.1.8 Dissolved oxygen; or,

8.6.1.9 Background or reference site concentrations.

8.6.2 Sediment analyses (see Guide E1391, E3163, E3164, E3240, E3242, E3248) required may include the following:

8.6.2.1 Whole sediment chemical analysis;

8.6.2.2 TOC analyses;

8.6.2.3 Cation exchange capacity (CEC) measurements;

8.6.2.4 Pore water analysis;

8.6.2.5 DOC analysis of pore water;

8.6.2.6 Acid volatile sulfides (AVS) and simultaneously extracted metals (SEM);

8.6.2.7 Particle/grain size; or,

8.6.2.8 Background or reference site concentrations.

8.6.3 Soil analyses required may include the following:

8.6.3.1 Soil type and classification;

8.6.3.2 Organic carbon;

8.6.3.3 Moisture content;

8.6.3.4 Grain size distribution;

8.6.3.5 pH;

8.6.3.6 Oxidation reduction potential (Eh);

8.6.3.7 Cation exchange capacity; or,

8.6.3.8 Background or reference site concentrations.

8.6.4 Air analyses may include the following:

8.6.4.1 Volatile constituent concentrations;

8.6.4.2 Constituent concentrations of particulates; or,

8.6.4.3 Background or reference site concentrations.

9. Additional Data Options for a Complex ERA Problem Formulation

9.1 In addition to the data and information options listed in Section 8, the following may be considered in a complex ERA problem formulation.

9.2 *Ecological Receptor Species Information:*

9.2.1 Collect appropriate ecological receptor species information for the ERA, such as the following:

9.2.1.1 Habitat preferences or needs;

9.2.1.2 Home range size;

9.2.1.3 Population densities;

9.2.1.4 Food, water, sediment, air, and soil intake rates;

9.2.1.5 Diet composition;

9.2.1.6 Body weight;

9.2.1.7 Sensitivity to specific constituents;

9.2.1.8 Reproductive status;

9.2.1.9 Migratory potential;

9.2.1.10 Sex and age; or,

9.2.1.11 Lifespan.

9.2.2 Obtain chemical and toxicological information for the completion of a toxicity profile for selected constituents of concern. Necessary information may include the following: **(8)**

9.2.2.1 Chemical speciation;

9.2.2.2 Chemical mobility;

9.2.2.3 Persistence;

9.2.2.4 Biodegradation;

9.2.2.5 Bioconcentration, bioaccumulation, biomagnification;

9.2.2.6 Partitioning, for example, K_{ow};

9.2.2.7 Interactions with other constituents, for example, additive, synergistic;

9.2.2.8 Biological effects; or,

9.2.2.9 Mechanism of action.

9.3 *Biota Analyses*—Biotic samples should be collected and co-located with environmental abiotic/biotic media so that site