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Standard Guide for Risk-Based Corrective Action for Protection of Ecological Resources¹

This standard is issued under the fixed designation E2205/E2205M; 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.

INTRODUCTION

This guide for risk-based corrective action for the protection of ecological resources (Eco-RBCA) provides a flexible framework for a tiered approach to ecological risk assessment (ERA) and risk management decision-making at chemical release sites. The framework of the Eco-RBCA guide parallels the framework in Guide E2081 with respect to the tiered approach for data gathering, evaluation and decision-making, and should, when possible, be conducted concurrent with the broader RBCA process activities. The Eco-RBCA guide directs the user to Guide E2081 for development and implementation of a corrective action program. This guide supplements Guide E2081 and was developed after careful consideration of the peer-reviewed published literature and existing federal, regional, and state ecological risk-assessment guidance. The user of this guide, as defined in 3.1.45, needs to be familiar with Guide E2081 and the overall RBCA process. The RBCA process provides a flexible, technically defensible framework for corrective action that has applicability to a wide range of sites and chemicals of concern.

ASTM guides are not federal or state regulations; rather, they are consensus standards that can be followed voluntarily. It is not within the scope of this standard to provide the details of specific regulatory requirements. Collectively, the Eco-RBCA and RBCA guides provide an integrated framework to corrective action. Eco-RBCA is intended to complement rather than replace the decision-making structures of regulatory programs. In addition, Eco-RBCA is intended to provide a framework for sites not covered under regulatory programs, for sites under regulatory programs that lack guidance, or for sites under programs with guidance that lack detail. Eco-RBCA may also provide a useful framework to help merge an approach when multiple regulatory programs apply. Even when a site is not currently governed by a regulatory program, consultation with the appropriate regulatory agency(ies) will ensure regulatory compliance and provide technical guidance.

The Eco-RBCA process is intended to accommodate a diversity of sites and conditions by providing a framework that can address site-specific needs. The appendixes provide useful technical details and case study examples, although the application of this guide does not require their use. Eco-RBCA is a process for evaluating ecological risk and decision making. To facilitate the implementation of Eco-RBCA, the framework is organized into ten steps and three risk assessment tiers that begin with relatively simple analyses and progress to more complex assessments as site conditions warrant (see Fig. 1). Although organized into steps and tiers, the user should recognize that Eco-RBCA progresses conceptually in a linear manner, but may not be implemented in a linear manner. The objective should be to conduct the evaluation in the manner that most appropriately meets the needs and goals of the assessment. Each tier includes five types of activities that increase in complexity and level of effort as the evaluation progresses through the RBCA process. These activities are (1) planning and scoping, (2) data and information acquisition, (3) analysis and evaluation, (4) decision making, and (5)

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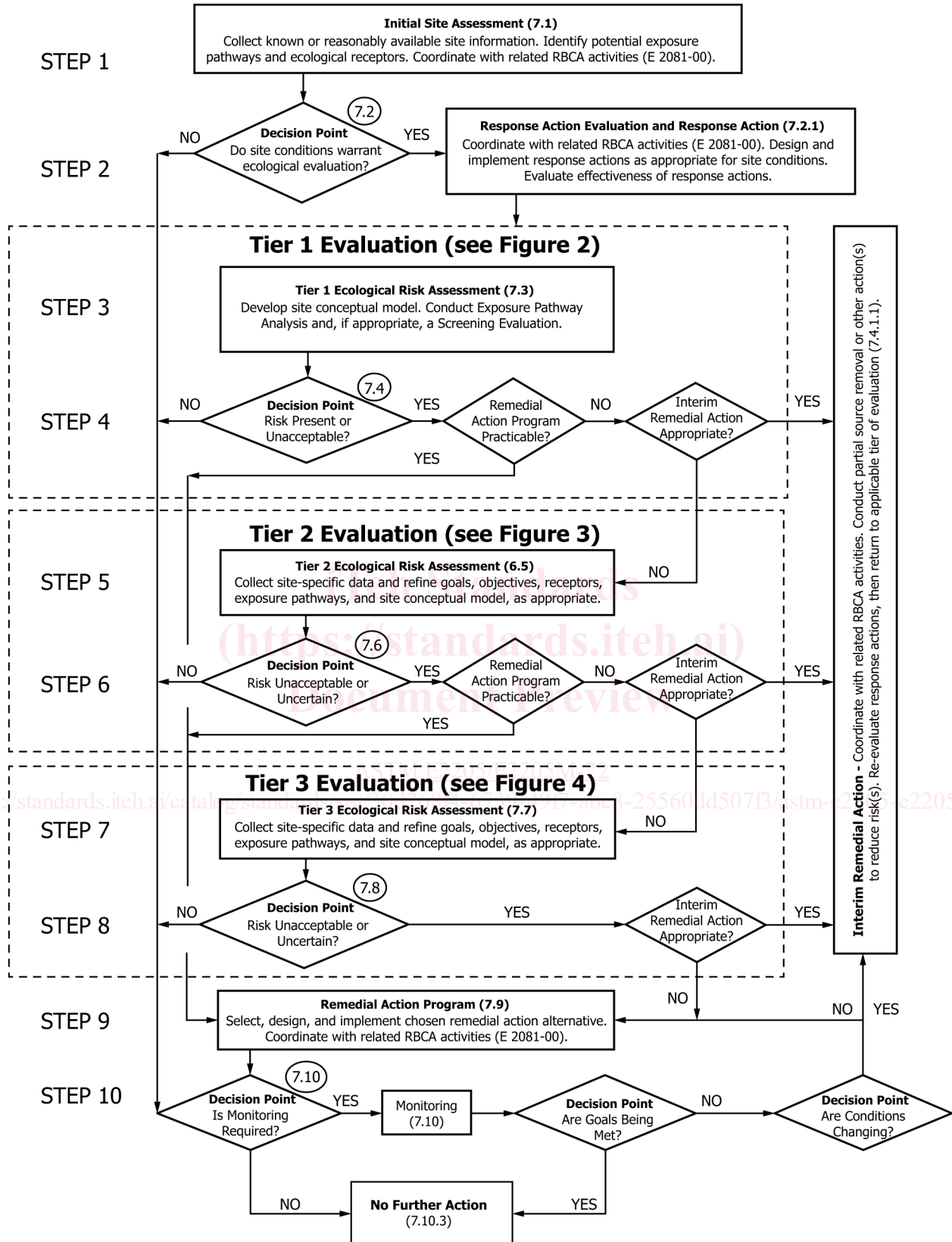


FIG. 1 Eco-RBCA Process Flowchart—Adapted from the RBCA Flowchart (Guide E2081)

From Step 2

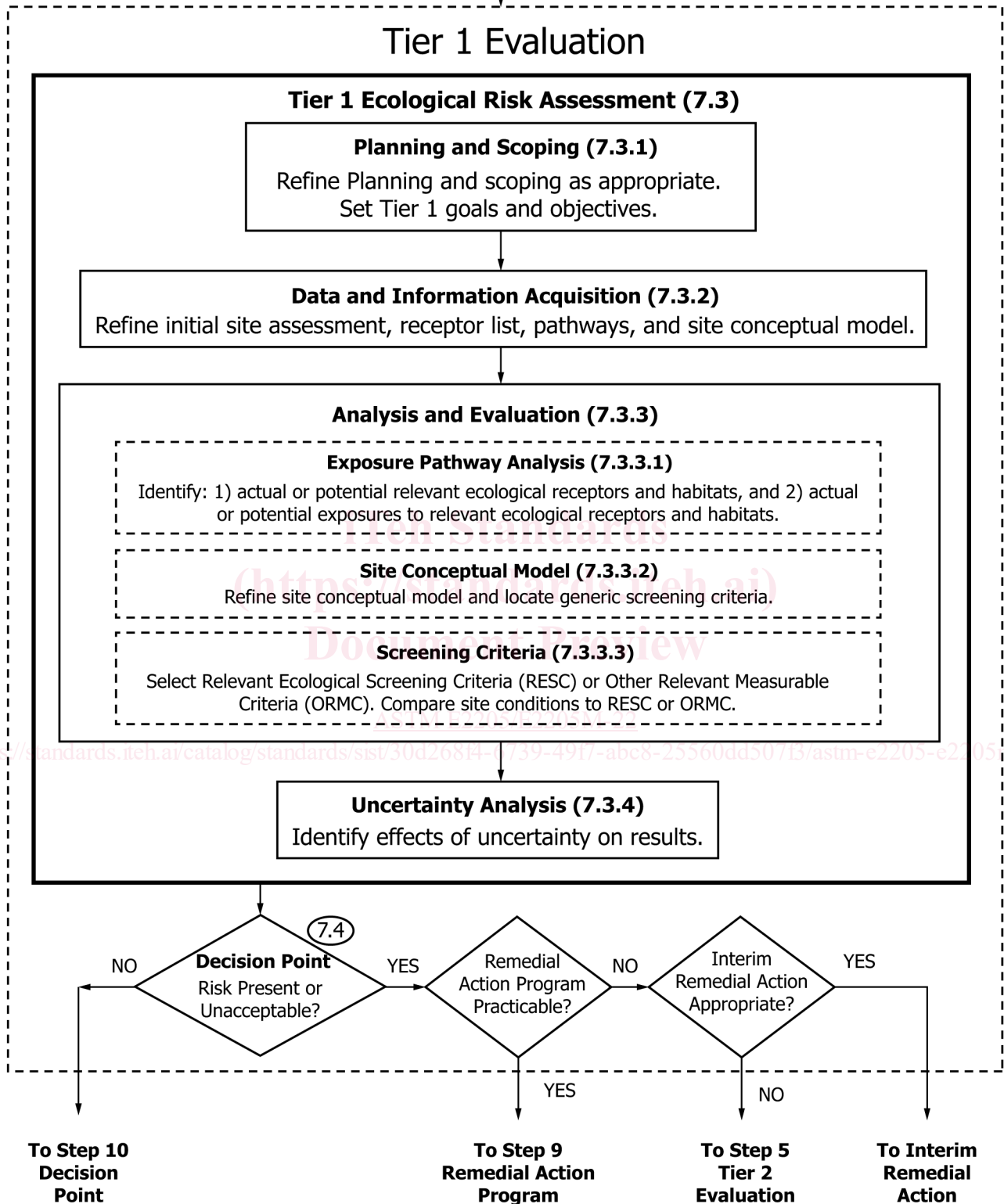


FIG. 2 Tier 1 Evaluation Flowchart

From Step 4

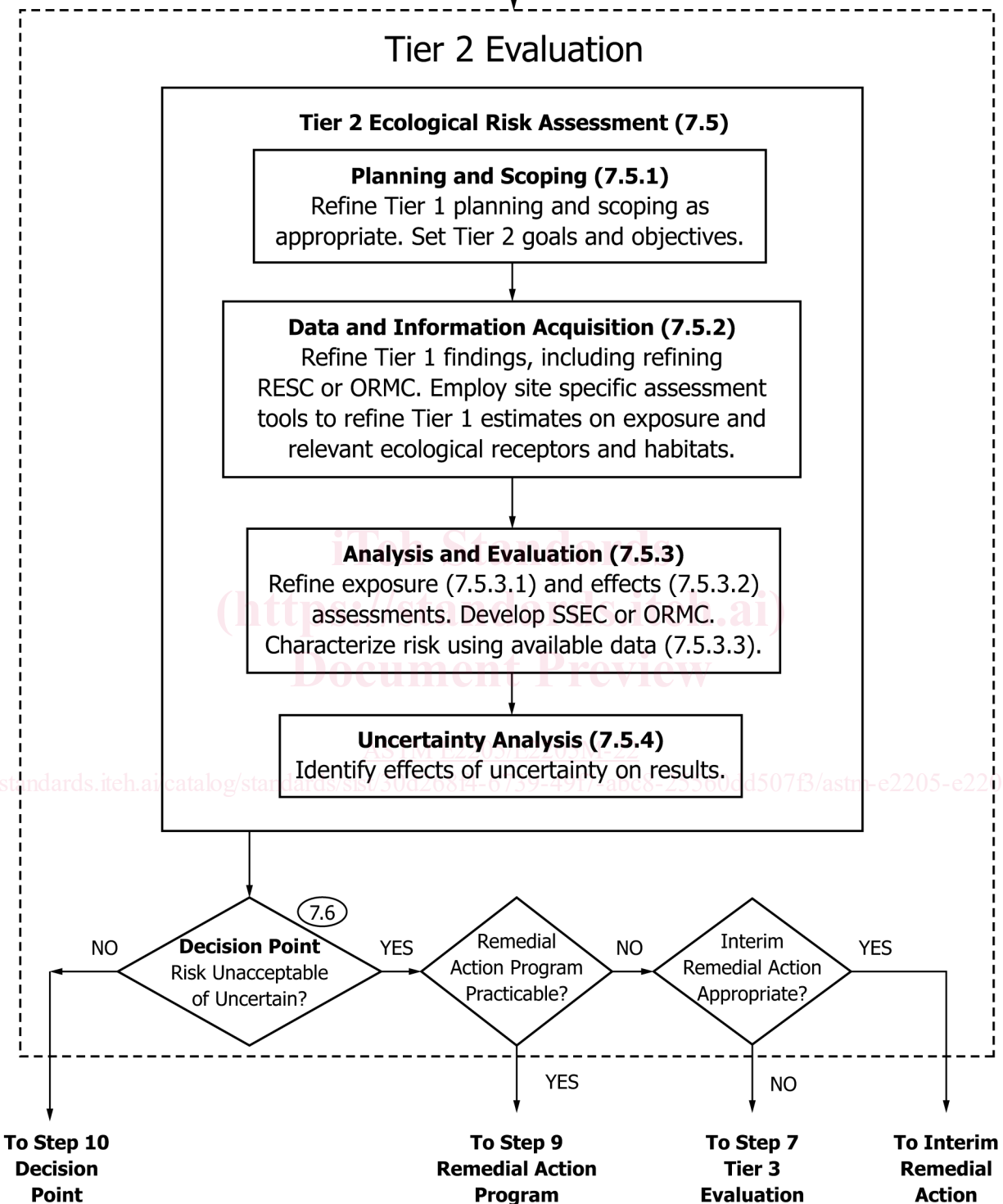


FIG. 3 Tier 2 Evaluation Flowchart

From Step 6

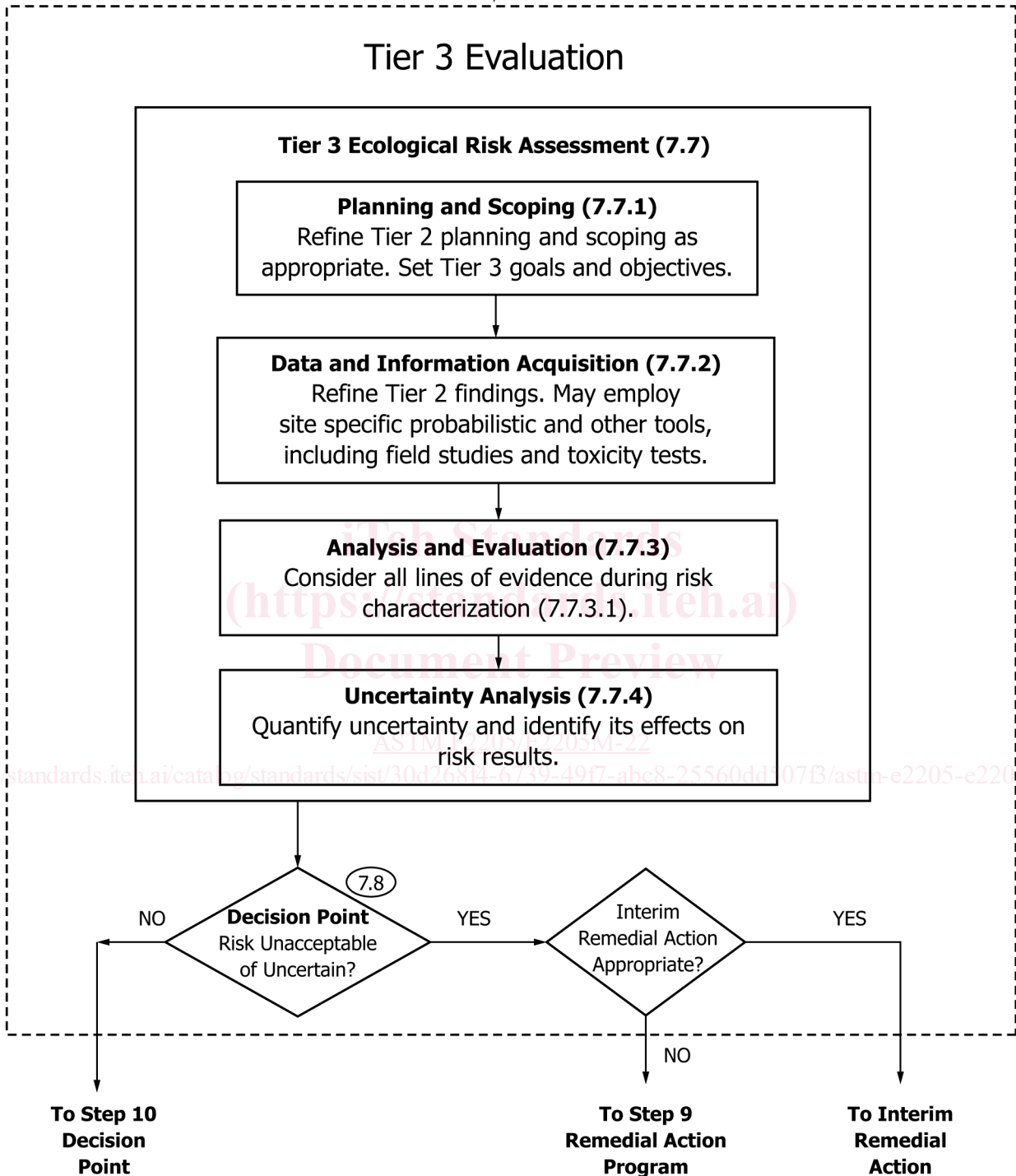


FIG. 4 Tier 3 Evaluation Flowchart

remedial actions. The details of the activities and how they are implemented can vary, depending on the nature and complexity of the site and the tier level. Early in the Eco-RBCA process, assumptions are biased toward being overly protective (that is, “conservative”) because of uncertainties inherent in non–site-specific data. Typically, as the site progresses through the tiered evaluation, more site-specific information is collected and uncertainty decreases; therefore, less-conservative assumptions can be used in the evaluation.

NOTE 1—This is a consequence of the screening process since the primary purpose is to quickly refine the lists of chemicals of concern to understand which ones are the primary risk drivers. Commensurate with this reduced uncertainty, the user can employ more site-specific and less conservative estimates and assumptions of exposure and effects due to refinement of the list of chemicals of concern. As understanding of site conditions improves, confidence often increases, in the conclusions and decision should also increase. The progression of the evaluation through the tiered process is accompanied by an increasing degree of formalization that could include the documentation of a screening-level assessment or the use of formal ecological risk assessment (ERA) methods. As additional site-specific information is developed, the uncertainty associated with site conditions is reduced. Commensurate with this reduced uncertainty, the user can employ more site-specific and less conservative estimates and assumptions of exposure and effects. The manner in which uncertainty, conservatism, data quality, and other technical aspects are addressed is by technical policy decisions.

Technical policy decisions (TPDs) are an important part of the Eco-RBCA process, and while it is not within the scope of this standard to identify the TPDs appropriate for a specific site, **Appendix X2** and **Guide E2081** provide additional insight into their identification, understanding, and development. Technical policy decisions generally fall into three categories: (1) those that are identified as existing prior to the Eco-RBCA assessment and will not change (that is, prescribed and without flexibility such as regulations or policy), (2) those that are identified as existing prior to the Eco-RBCA assessment but may change or be modified based on site-specific information (for example, sampling protocols, selection of fate and transport models or other tools, data quality objectives, or corrective-action goals), and (3) those that are developed specifically for the Eco-RBCA assessment (for example, development of a site-specific model). Technical policy decisions are typically identified, negotiated (if appropriate), and documented in the initial site assessment (see **7.1**). It is the responsibility of the user of the Eco-RBCA guide to identify and consider the TPDs and appropriate stakeholders for a site. These TPDs may need to be reevaluated each time the Eco-RBCA evaluation proceeds through an iteration or progresses to a new tier. Both the RBCA and Eco-RBCA processes encourage user-led initiatives and appropriate stakeholder involvement in identifying TPDs and developing the Eco-RBCA program. Laws and regulations may require coordination with federal, state, and natural resource trustees.

This guide serves to complement existing guidance for hazardous-waste sites and facilities and to provide guidance for sites not under regulatory programs. This guide does not substitute for applicable federal, regional, state, local, or other regulatory requirements. This guide is not a regulation itself and may not apply to a particular situation, based on the circumstances.

This guide is not intended to replace professional judgment or to recommend a specific course of action. All aspects of this guide might not be applicable in all circumstances. This guide is not intended to represent or replace the standard of care by which the adequacy of a given professional service is judged, nor should this document be applied without consideration of a project’s many unique aspects. The word “Standard” in the title of this document means only that the document has been approved through the ASTM consensus process.

1. Scope

1.1 This is a guide to risk-based corrective action for the protection of ecological resources and supplements the RBCA process (Guide E2081). The primary objective of the Eco-RBCA process is to provide a flexible framework for a tiered approach to ERA and risk management decision making at chemical release sites. To this end, available guidance documents from various federal and state agencies were reviewed and their common attributes incorporated into this guide, where possible. The Eco-RBCA process complements existing technical and regulatory ecological risk guidance (see 4.2). In particular, it is intended to be compatible with the USEPA programmatic guidelines for ERA (1)², guidance for the Superfund program (2), and other USEPA (3) risk assessment and corrective-action programs. Eco-RBCA might also be used in conjunction with corrective action strategies that include human health issues (for example, Guide E2081).

1.2 Chemical release sites vary greatly in terms of complexity, physical and chemical characteristics, and the risk that they might pose to ecological resources. The Eco-RBCA process, as described in Guide E2081, recognizes this variability and incorporates a tiered approach that integrates site assessment, response actions, and remedial actions with ERA. The process begins with relatively simple analyses in Tier 1 and, if necessary, proceeds to more detailed evaluations in Tier 2 or Tier 3. The process of gathering and evaluating data is conducted in such a manner that only those data that are necessary for a given tier's decision making are collected at each tier. Hence, this can facilitate effective use of resources and reduce initial data requirements.

1.3 Eco-RBCA is intended to provide a framework for sites not covered under regulatory programs and for sites under regulatory programs that lack specific guidance. Eco-RBCA may also provide a useful framework to help merge several possible approaches into a single approach when multiple regulatory programs apply. The user should be aware of the federal, state, and local corrective action programs and policies that are applicable for the site and, regardless of the program, that agency approvals might be required to implement the process for completing ERAs.

1.4 Various TPDs will need to be made regarding the aspects of Eco-RBCA. These TPDs may cover both the philosophical and methodological aspects, from what values to protect to exactly how the Eco-RBCA process will be performed. TPDs may affect every stage of the process, from the initial site assessment to development and monitoring of the remedy. It is the responsibility of the user to identify the appropriate TPDs. Section 7, Appendix X2, and Guide E2081 provide more detail regarding TPDs in the Eco-RBCA process.

1.5 The general performance standard for this document requires that:

1.5.1 Applicable TPDs be identified, beginning at the initiation of the Eco-RBCA process, and as appropriate, at later stages;

1.5.2 Data used in the Eco-RBCA process be of sufficient quantity and quality to answer the questions and support the decisions made at the tier of investigation;

1.5.3 Site assessments be distinguished into tiers of appropriate levels of evaluation;

1.5.4 Actions taken should integrate the Eco-RBCA process for the protection of relevant ecological receptors and habitats and RBCA for the protection of human health (see Guide E2081), as appropriate;

1.5.5 Applicable federal, state, and local laws and regulations be followed; and

1.5.6 Potential adverse effects on relevant ecological receptors and habitats be considered when selecting remedial action alternatives. The remedial action alternatives should be consistent with the TPDs and the RBCA process (see Guide E2081).

1.6 Ecological resources are the focus of this guide; risks to human health are addressed for petroleum releases and chemical releases in other ASTM RBCA standards (Guides E1739 and E2081). There are many features common to all three of the RBCA guides. These three guides share the basic elements of RBCA: (1) site assessment; (2) tiered evaluations of exposure, effects, and risk; (3) risk-based decision making; and (4) response, remedial action, and monitoring. There are a number of distinctions between

² The boldface numbers in parentheses refer to the list of references at the end of this standard.

human health and ecological risk assessments. For example, while human health risk assessments focus on individuals, evaluations of ecological risk typically focus on populations, communities, or ecosystems. Exceptions are species or critical habitats designated for special protection (for example, endangered or culturally-important species). Biological data to support an ERA are more amenable to direct field observation than are human exposure and epidemiological data.

1.7 The Eco-RBCA process addresses current and potential future risks to relevant ecological receptors and habitats at chemical release sites. It is not intended to apply to current permitted releases and permit applications.

1.8 Eco-RBCA focuses on chemical stressors. However, the user may need to consider biological or physical stressors at the site or effects from chemical sources unrelated to the site.

1.9 The process described in this guide integrates the principles of current ERA practices with site assessment activities and remedial-action selection to ensure that the risk management decision protects ecological resources. Fig. 1 illustrates the following activities in Eco-RBCA and those described in Section 7 (7.1 – 7.10):

1.9.1 *Step 1*—Initial Site Assessment;

1.9.2 *Step 2*—Decision Point;

1.9.3 *Step 3*—Tier 1 Ecological Risk Assessment;

1.9.4 *Step 4*—Tier 1 Decision Point;

1.9.5 *Step 5*—Tier 2 Ecological Risk Assessment;

1.9.6 *Step 6*—Tier 2 Decision Point;

1.9.7 *Step 7*—Tier 3 Ecological Risk Assessment;

1.9.8 *Step 8*—Tier 3 Decision Point;

1.9.9 *Step 9*—Implementing the Remedial Action Program; and

1.9.10 *Step 10*—Monitoring Programs (7.10).

1.9.11 The above steps can be applied in a flexible manner. It may not be necessary to conduct a full tier of evaluation if existing site information indicates that a subsequent tier is more applicable to address site-specific concerns. Where experience indicates that a more sophisticated assessment is warranted at a site, the user may elect to proceed conceptually through any earlier tiers to conduct a site-specific assessment typical of Tier 2 or Tier 3. Additionally, the decision points in Steps 4, 6, and 8 allow the user to exit the tiered evaluation process and select the appropriate remedial action once adequate information is available for decision making.

1.10 This guide is organized as follows:

1.10.1 Section 2 lists referenced ASTM documents;

1.10.2 Section 3 defines terminology used in this guide;

1.10.3 Section 4 describes the significance and use of this guide;

1.10.4 Section 5 describes the tiered approach to the Eco-RBCA process;

1.10.5 Sections 6 and 7 presents Eco-RBCA procedures in a step-by-step process; and

1.10.6 The reference section provides all documents cited in this guide.

1.11 This guide also includes the following appendices, which are provided as supplemental information and are not included as mandatory sections of this guide:

- 1.11.1 **Appendix X1** presents information related to risk management issues;
- 1.11.2 **Appendix X2** presents issues regarding TPDs;
- 1.11.3 **Appendix X3** presents information on the activities occurring in each tier of the Eco-RBCA process;
- 1.11.4 **Appendix X4** describes screening criteria and how they can be applied within the Eco-RBCA framework;
- 1.11.5 **Appendix X5** presents the selection and use of relevant ecological screening benchmarks;
- 1.11.6 **Appendix X6** includes two examples of the application of the Eco-RBCA framework; and
- 1.11.7 **Appendix X7** presents information on uncertainty and its role in Eco-RBCA.

1.12 The values stated in either SI units or inch-pound units are to be regarded separately as standard. The values stated in each system may not be exact equivalents; therefore, each system shall be used independently of the other. Combining values from the two systems may result in non-conformance with the standard.

1.13 *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.³

- [E1689 Guide for Developing Conceptual Site Models for Contaminated Sites](#)
- [E1739 Guide for Risk-Based Corrective Action Applied at Petroleum Release Sites](#)
- [E1848 Guide for Selecting and Using Ecological Endpoints for Contaminated Sites](#)
- [E2020 Guide for Data and Information Options for Conducting an Ecological Risk Assessment at Contaminated Sites](#)
- [E2081 Guide for Risk-Based Corrective Action](#)
- [E2531 Guide for Development of Conceptual Site Models and Remediation Strategies for Light Nonaqueous-Phase Liquids Released to the Subsurface](#)
- [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 Referenced Documents:

- [California of Environmental Health Hazard Assessment, Toxicity Criteria Database, <https://data.ca.gov/dataset/toxicity-criteria-database>, May 2019](#)
- [Federal Contaminated Sites Action Plan \(FCSAP\) Ecological Risk Assessment Guidance, Government of Canada, March 2012](#)
- [Generic Ecological Assessment Endpoints \(GEEs\) For Ecological Risk Assessment: Second Edition With Generic Ecosystem Services Endpoints Added. EPA/100/F15/005, July 2016](#)
- [International Standards Organization ISO 21365:2019- Soil quality -- Conceptual site models for potentially contaminated sites](#)
- [U.S. EPA ECOTOX database; <https://cfpub.epa.gov/ecotox>](#)
- [USEPA Comptox Dashboard: <https://comptox.epa.gov/dashboard>](#)
- [Washington Dept. of Ecology Sediment Management Standard, Chapter 173-240 WAC](#)

3. Terminology

3.1 Definitions:

³ 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.

3.1.1 The user should be familiar with the definitions presented here before reading the remainder of this guide, as many of the terms might have specific regulatory definitions within existing federal, regional, state, or local programs that vary from that used in this guide. The following terms are being defined to reflect their specific use in this guide. The user should not assume that these definitions replace existing regulatory definitions. Where the definition or use of a term in this guide differs from an existing regulatory definition or use, the user should address these differences before proceeding with the Eco-RBCA process. The definitions presented here are intended to be consistent with those provided in Guide E2081.

3.1.2 *acceptable ecological risk*—a condition under which the likelihood of adverse effects to relevant ecological receptors and habitats is within tolerable limits, as defined by TPDs.

3.1.3 *assessment endpoint*—the explicit expression of the environmental value that is to be protected, operationally defined by an ecological entity and its attributes (1). The term in this standard for ecological entity is relevant ecological receptors and habitats (see 3.1.26). Additional information regarding assessment endpoints can be found in Guide E1848.

3.1.4 *bioavailability*—the degree to which a material in environmental media can be assimilated by an organism (2).

3.1.5 *chemical release*—any spill or leak to, or detection of chemicals of concern in, environmental media other than permitted discharges.

3.1.6 *chemical of concern (COC)*—specific constituent and its breakdown products that are identified for evaluation in the risk assessment process. Identification can be based on a chemical's historical and current use at a site; detected concentration in environmental media; or mobility, toxicity, and persistence in the environment. Chemical(s) of concern may be identified at many points in the RBCA process. The term COC does not imply the degree of risk.

3.1.7 *corrective action*—the sequence of actions that may include site assessment and investigation, risk assessment, response actions, interim remedial action, remedial action, operation and maintenance of equipment, monitoring of progress, making no further action determinations, and termination of the remedial action.

3.1.8 *corrective-action goal*—a remedial action performance criterion that once achieved, is protective of relevant ecological receptors and critical habitats and requires no further action. Examples include chemical concentrations, environmental quality indices, or physical conditions based on Relevant Ecological Screening Criteria (RESC), Site Specific Ecological Criteria (SSEC), or Other Relevant Measurable Criteria (ORMC) (see 3.1.22, 3.1.27, and 3.1.37). A corrective action goal for a site can vary with each tier of evaluation, dependent on the level of uncertainty associated with each tier. Tier 1 evaluations with higher uncertainty may have more conservative corrective action goals than would subsequent tiers with lower uncertainty.

3.1.9 *data quality objectives (DQO)*—a qualitative or quantitative statement that clarifies study objectives, defines the appropriate type of data, and specifies the tolerable levels of potential decision errors that will be used as the basis for establishing the quality and quantity of data to support decisions. A formal DQO process is presented in USEPA (3).

3.1.10 *decision point*—an occasion during the Eco-RBCA process when assessment results are integrated with risk management goals and TPDs for the purpose of risk management decision making. At such points, the user must decide the appropriate course of action.

3.1.11 *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.

3.1.12 *exposure assessment*—the determination or estimation (qualitative or quantitative) of the magnitude, frequency, duration, and route of exposure between a source and a receptor.

3.1.13 *exposure pathway*—the course a chemical of concern takes from the source area(s) to a relevant ecological receptor and habitat. An exposure pathway describes a mechanism by which an individual or population is exposed to a chemical of concern originating from a site. Each exposure pathway includes a source or release from a source of a chemical of concern, a point of exposure, an exposure route, and a relevant ecological receptor and habitat. If the exposure point is not at the source, a transport or exposure medium, or either (for example, soil or water), is also included.

3.1.14 *exposure route*—the manner in which a chemical of concern comes in contact with a relevant ecological receptor and habitat (for example, ingestion or direct contact).

3.1.15 *exposure scenario*—the description of the circumstances, including site properties and chemical properties, or the potential circumstances under which a relevant ecological receptor or habitat could be in contact with chemical(s) of concern.

3.1.16 *facility*—the property where a chemical release has occurred. A facility might include multiple sources of chemical releases and therefore, multiple sites.

3.1.17 *hazard quotient*—the numerical ratio that relates receptor exposure to toxicity by comparing an exposure dose or a media concentration (numerator) to a comparable toxicological benchmark or comparable screening value (denominator).

3.1.18 *initial site assessment criteria*—tools used in Step 1 for determining when an ERA might be appropriate for a site or to identify risks that should be considered in the RBCA process. Such screening criteria are discussed in greater detail in [Appendix X5](#).

3.1.19 *interim remedial action*—an intervening action taken to minimize exposure to relevant ecological receptors and habitats. Interim remedial actions are taken to reduce migration of a chemical of concern or to reduce the concentration of a chemical of concern at a source area or areas. Such actions are typically taken when site conditions are considered hazardous or when there is direct evidence of impact. An interim remedial action may or may not become the final remedial action, but may be undertaken for an intervening time until a final remedy is initiated.

3.1.20 *measure of effect*—a change in an attribute of an assessment endpoint or its surrogate in response to a stressor to which it is exposed (1). Measures of effect are also referred to as measurement endpoints.

3.1.21 *natural attenuation*—a reduction in risk due to change in chemical concentration, toxicity, bioavailability, or mobility as a result of naturally occurring physical, chemical, and biological processes (for example, diffusion, dispersion, adsorption, chemical degradation, and biodegradation).

3.1.22 *other relevant measurable criteria (ORMC)*— parameters used to define corrective action goals. The ORMC are concentration values, other numeric values, physical condition, or performance criteria other than RESC and SSEC. Examples of ORMC are regulatory standards, consensus criteria, and aesthetic criteria. Technical policy decisions regarding ORMC may exist, or may need to be made, to determine the appropriate values, conditions, or performance criteria that are used for the corrective action goals.

3.1.23 *potentially complete exposure pathway*— a situation with a reasonably likely chance of occurrence in which a relevant ecological receptor or habitat might become directly or indirectly exposed to the chemical(s) of concern.

3.1.24 *probabilistic analysis*—quantitative procedures used to evaluate the variability or uncertainty, or both, surrounding a distribution when the result depends on a number of factors, each of which has its own variability and uncertainty. Additional detail regarding probabilistic analyses is provided in [Appendix X7](#).

3.1.25 *problem formulation*—the collection and analysis of information needed to determine the appropriate scope and focus of the investigation. Problem formulation is analogous to the planning and scoping phase of Eco-RBCA. The outcome of the problem formulation steps are the selection of the assessment endpoints (see [3.1.3](#)) that will be evaluated in the risk characterization (see [3.1.32](#)) and the identification of the specific measures that will best represent the assessment endpoints. Problem formulation as described in USEPA (1) includes characterization of fate and transport, identification of exposure pathways and receptors, potential toxicological effects, development of the conceptual model, identification of the assessment endpoints, and identification of measures of effect.

3.1.26 *relevant ecological receptors and habitats*— the ecological resources that are valued at the site. Identification of relevant ecological receptors and habitats is dependent upon site-specific factors and is a technical policy decision important to the planning and scoping phase of ecological evaluation. Examples may include species or communities afforded special protection by law or regulation; recreationally, commercially, or culturally important resources; regionally or nationally rare communities; communities

with high aesthetic quality; and habitats, species, or communities that are important in maintaining the integrity and biodiversity of the environment. This may be functionally equivalent to assessment end points (3.1.3).

3.1.27 *relevant ecological screening criteria (RESC)*—non-site-specific ecological measures or guidelines used during the Tier 1 evaluation that are applicable to relevant ecological receptors and habitats, exposure pathways, and site conditions. These might include chemical concentrations, biological measures or other relevant generic criteria consistent with the purpose of the assessment, the problem(s) defined at the site, and TPDs (see [Appendix X2](#) and [Appendix X4](#)).

3.1.28 *remedial action*—an action taken to minimize or eliminate current or potential future exposure to relevant ecological receptors and habitats. Such activities are conducted to reduce concentrations of chemicals of concern or eliminate pathways of exposures to meet corrective action goals.

3.1.29 *response action*—an immediate course of action taken in Step 2 (before an interim remedial action) to mitigate an imminent or known threat to relevant ecological receptors and habitats. Response actions taken may not differ from interim remedial actions or remedial actions taken later in the RBCA process; the key difference between actions is timing and urgency. Response actions may include abatement or containment measures.

3.1.30 *response action evaluation*—a qualitative site analysis in Step 2 based on known or readily available information to identify the need for and urgency of response actions and the need for further information gathering. The evaluation is also used to identify appropriate early risk reduction steps.

3.1.31 *risk*—the likelihood of, potential for, or probability of an adverse effect. Risk might be expressed qualitatively or quantitatively.

3.1.32 *risk characterization*—the integration of the results of the exposure and ecological effects analysis to evaluate the likelihood of adverse ecological effects associated with exposure to the stressor.

3.1.33 *site*—the area defined by the likely physical distribution of a chemical release. A site could be an entire property or facility, a defined area or portion of a facility or property, or multiple facilities or properties. One facility might contain multiple sites. Multiple sites at one facility might be addressed individually or as a group.

3.1.34 *site assessment*—a characterization of a site through an evaluation of its physical and environmental context (for example, subsurface geology, soil properties and structures, hydrology, and surface characteristics) to determine if a release has occurred. The characterization may identify the concentration and distribution of chemical(s) of concern. Information collected during the site assessment may include data on soil, ground water and surface water quality, land and resource use, and potential receptors. This information is used to develop a site conceptual model and support risk-based decision making.

3.1.35 *site conceptual model (also known as conceptual site model)*—a written description or visual representation, or both, of predicted relationships between relevant ecological receptors and habitats and the COCs to which they may be exposed. Site conceptual models describe predicted relationships among sources of released chemicals, exposure pathways, and relevant ecological receptors and habitats, along with the rationale for their selection. The site conceptual model illustrates these relationships.

3.1.36 *site-specific*—activities, information, and data unique to a particular site.

3.1.37 *site-specific ecological criteria (SSEC)*— risk-based measures or guidelines appropriate for evaluating relevant ecological receptors and habitats identified for a particular site under the Tier 2 or Tier 3 evaluations. These qualitative or quantitative criteria might include chemical concentrations, biological measures, or RESC that can be applied on a site-specific basis consistent with the TPDs (see [Appendix X2](#)). SSEC might be revised as data are obtained that better describe the conditions and the relevant ecological receptors and habitats.

3.1.38 *stakeholders*—individuals, organizations, or other entities that affect or are affected by the site conditions or the corrective action, or both. Stakeholders might include, but are not limited to, owners, buyers, developers, lenders, insurers, government agencies, and community groups or members. The number and composition of stakeholders may change throughout the Eco-RBCA process.

3.1.39 *technical policy decision (TPD)*—a consideration that helps form the basis for implementing the Eco-RBCA process for a given site. TPDs are developed for a variety of technical aspects, including context setting in the initial site assessment, analytical approaches, data needs and quality, and action triggers. Paragraphs 6.5 and 7.1.1.1 contain information on TPDs, and Appendix X2 provides supplemental information on TPDs.

3.1.40 *Tier 1 evaluation*—a screening level assessment of ecological risk that uses existing information, generic information, and ecologically protective (that is, conservative) assumptions to ensure that risks are not underestimated. Tier 1 may be comprised of a qualitative ecological screening evaluation for complete and partially complete exposure pathways for relevant ecological receptors and habitats, or relatively simple comparisons of site conditions to RESC, or both. The tier concludes with a risk management decision.

3.1.41 *Tier 2 evaluation*—an assessment of ecological risk that builds on the Tier 1 evaluation by using more site-specific data and assumptions. Tier 2 involves gathering additional information to develop and refine assessment endpoints and measures of effect and compares this additional information to SSEC. The additional information should focus on providing more site-specific information on receptors and their habitats, exposure pathways, and exposure concentrations or doses. The tier concludes with a risk management decision.

3.1.42 *Tier 3 evaluation*—a detailed and quantitative assessment of ecological risk that relies on more site-specific information and sophisticated tools than those used at Tiers 1 and 2. Tier 3 may involve the use of multiple lines of evidence; predictive models; or probabilistic approaches for evaluating exposure, effects and risk or a combination of these. The tier concludes with a risk management decision.

3.1.43 *unacceptable ecological risk*—a condition under which the likelihood of adverse effects to relevant ecological receptors and habitats is not within tolerable limits as defined by TPDs.

3.1.44 *uncertainty*—the lack of knowledge regarding site conditions, the nature of exposure, and effects on relevant ecological receptors and habitats. This lack of knowledge is recognized at each tier of evaluation through an uncertainty analysis.

3.1.45 *user*—an individual or group employing the Eco-RBCA process. Users may include owners, operators, regulators, UST fund managers, government case managers, attorneys, consultants, legislators, and other stakeholders.

3.2 *There are three definitions specific to ASTM that are included here for clarity:*

3.2.1 *standard*—as used in ASTM, a document that has been developed and established within the consensus principles of the Society and that meets the approval requirements of ASTM procedures and regulations.

3.2.2 *guide*—a series of options or instructions that do not recommend a specific course of action.

3.2.3 *practice*—a definitive procedure for performing one or more specific operations or functions that does not produce a test result.

3.3 Acronyms:

3.3.1 *COC*—Chemical of Concern

3.3.2 *COPC*—Chemical of Potential Concern

3.3.3 *DQO*—Data Quality Objectives

3.3.4 *ERA*—Ecological Risk Assessment

3.3.5 *ORMC*—other relevant measurable criteria

3.3.6 *RBCA*—Risk-Based Corrective Action

3.3.7 RBSL—Risk-Based Screening Level

3.3.8 RESC—relevant ecological screening criteria

3.3.9 SSEC—site-specific ecological criteria

3.3.10 SSTL—site-specific target levels

3.3.11 TPD—Technical Policy Decision

3.3.12 USEPA—United States Environmental Protection Agency

4. Significance and Use

4.1 The Eco-RBCA process presented in this guide is a streamlined decision-making process for implementing corrective action protective of ecological resources at chemical release sites in a consistent manner. Eco-RBCA provides a framework for sites not covered under regulatory programs, for sites under regulatory programs that lack guidance, or for sites under programs with guidance that lack detail. Eco-RBCA may also provide a useful framework to help merge an approach when multiple regulatory programs apply.

4.2 Ecological risk assessment is a science-based process that can be used to provide insight for risk management decision-making. Numerous federal and state programs have guidance for conducting ERA. Available regulatory approaches to ERA were reviewed in preparation for the development of this Eco-RBCA guide. Eco-RBCA was designed to be adaptable to the use of a variety of methods for considering risks to relevant ecological receptors and habitats. Some attributes of the standard are:

4.2.1 Use of a tiered approach, including process flow charts to identify critical steps and facilitate the development of an overview of the entire process;

4.2.2 Identification, development, and use of TPDs from Step 1 and throughout the entire Eco-RBCA process;

4.2.3 Indications of the value and timing of stakeholder involvement, recognizing that some regulations require coordination with federal, state, tribal, and natural-resource trustees, and other stakeholders;

4.2.4 Identification of situations under which an ERA may or may not be necessary; and

4.2.5 Identification of decision points where ERA results are used for risk management decision making.

4.3 Activities described in this guide should involve persons with the appropriate skills and expertise. The user may rely on individuals expert in remediation science and technology, ecology/biology, ecotoxicology, ERA practices, and site characterization techniques.

4.4 This guide and supporting appendices provide examples and technical support for the proper application of the Eco-RBCA process. The user should avoid inappropriate actions or use of Eco-RBCA such as:

4.4.1 Prescribing Tier 1 RESC as presumptive remediation cleanup goals rather than as screening criteria or, when appropriate, as site-specific remediation cleanup goals;

4.4.2 Limiting the use of the Eco-RBCA process to Tier 1 evaluation only and not continuing with Tier 2 or Tier 3 evaluations for sites where further tiered evaluation is appropriate;

4.4.3 Placing arbitrary time constraints on the corrective action process that do not reflect the actual urgency and risk posed by the site;

4.4.4 Using Eco-RBCA only at sites where active remedial action is not technically feasible;

- 4.4.5 Initiating remedial action(s) before determining applicable corrective action goals;
- 4.4.6 Limiting options to a single class of remedial action for all sites;
- 4.4.7 Using unjustified or inappropriate exposure factors;
- 4.4.8 Using unjustified or inappropriate toxicity parameters;
- 4.4.9 Using modeling that is not supported by the available data or knowledge of site conditions;
- 4.4.10 Using measurement or assessment endpoints that are ambiguous or insufficiently defined;
- 4.4.11 Drawing conclusions that are not supported by available data;
- 4.4.12 Failing to monitor the effectiveness of engineering or institutional controls;
- 4.4.13 Using an interim remedial action not to reduce risk but solely to delay the Eco-RBCA process;
- 4.4.14 Failing to consider the long-term effectiveness, reliability, and risks to relevant ecological receptors and habitats of potential remedial action options; or,
- 4.4.15 Continuing monitoring or remedial action at sites that have achieved remedial action goals (unless monitoring is specifically required for an engineering or institutional control or other regulatory requirements).

5. A Tiered Approach to Eco-RBCA

5.1 Eco-RBCA is a process that integrates site assessment, ERA, remedial action, and risk management such that corrective-action decisions protective of relevant ecological receptors and habitats can be made in a consistent manner. At the initiation of the Eco-RBCA process, the user should identify the stakeholders and TPDs appropriate for the site. Supplemental information on TPDs is provided in [Appendix X2](#).

5.2 Eco-RBCA is a process for evaluating ecological risk and decision making. To facilitate the implementation of Eco-RBCA, the framework is organized into ten steps and three risk assessment tiers ([Fig. 1](#) and [Appendix X3](#)). Although organized into steps and tiers, the user should recognize that Eco-RBCA does not have to be implemented in a linear manner. Instead, the objective should be to conduct the evaluation in the manner that most appropriately meets the needs and goals of the assessment.

5.3 Eco-RBCA can be used in a flexible manner. As the user proceeds to higher tiers, the understanding gained about the site is used to tailor the degree of investigation needed. In some cases, completion of a detailed evaluation in a given tier may be unnecessary. For example, the user may determine that conducting a detailed Tier 1 evaluation is unnecessary because of the wealth of historical data available at a site. Starting the evaluation at Tier 2 in this case would be a more efficient means of achieving corrective action goals.

5.4 Throughout the Eco-RBCA process, appropriate DQOs (see [3.1.9](#)) should be determined for the initial site assessment and all subsequent tiers of evaluation. These objectives integrate site-specific data needs for each task and applicable regulatory requirements. To meet these objectives, the user might generate site-specific data for key physical characteristics or make reasonable estimates from readily available site data. Sufficient quantity and quality of data should be collected to meet the DQOs for each tier of the Eco-RBCA process conducted. The user is referred to USEPA ([3, 4](#)) and [Guide E2020](#) for a more detailed discussion of DQOs. Data quality objectives are TPDs.

5.5 The results of all of the completed tiers of analyses may be compiled into one Eco-RBCA report at the end of the evaluation. Reporting requirements and approvals could be determined based on federal, state, and local programs if they apply to the site. Otherwise, guidance on reporting is provided in [7.11](#) and in [Guide Guides E2081, E2531, E3240](#).

6. Eco-RBCA Process Overview

Eco-RBCA is a process that provides a framework for evaluating the potential for adverse effects to ecological resources at sites where a chemical release has occurred; this evaluation is then linked to the RBCA process ([Guide E2081](#)) to implement appropriate