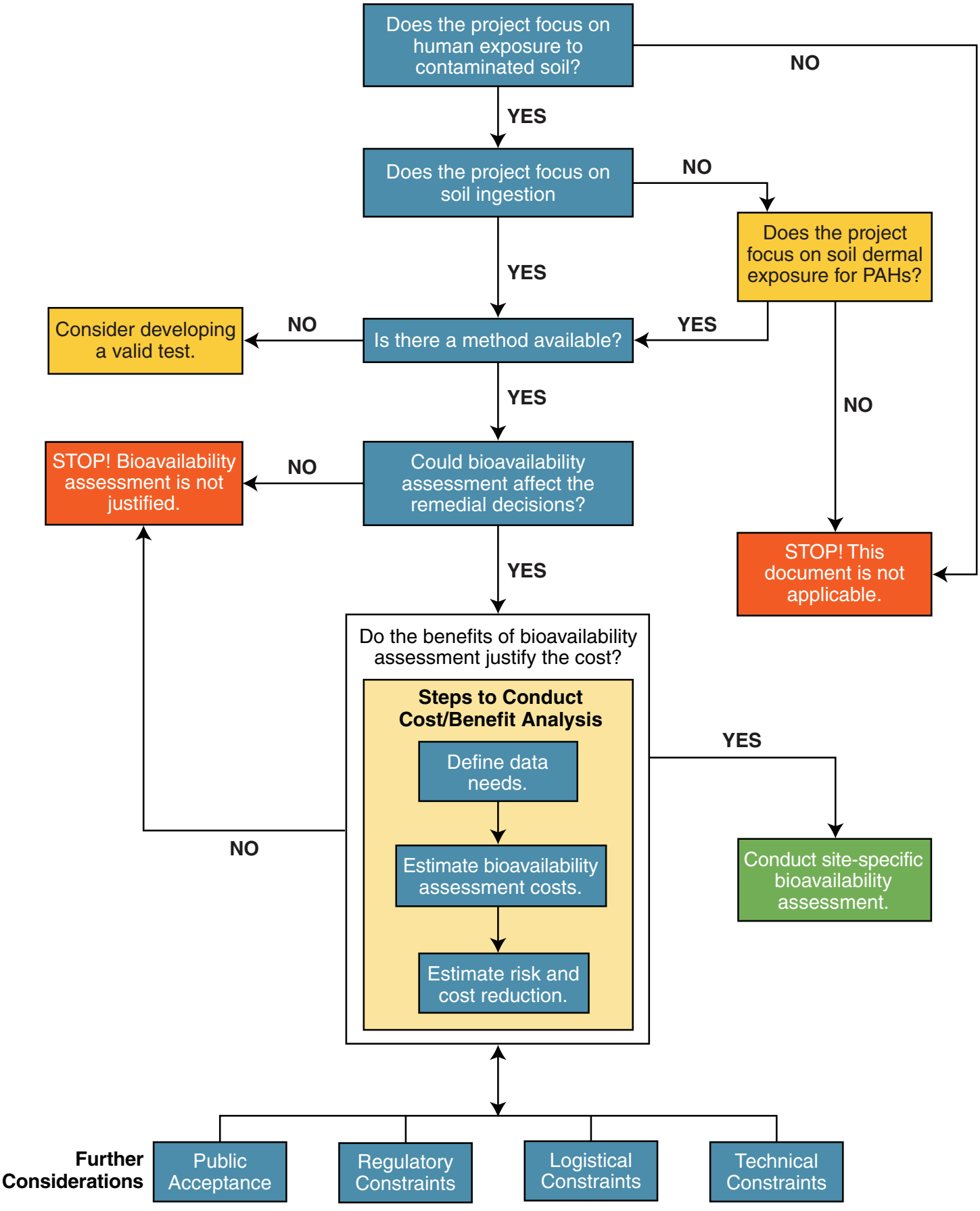
Printed from: Interstate Technology & Regulatory Council (ITRC). 2017. *Bioavailability of Contaminants in Soil: Considerations for Human Health Risk Assessment.* BCS-1. Washington, D.C.: Interstate Technology & Regulatory Council, Bioavailability in Contaminated Soil Team. http://bcs-1.itrcweb.org.



1.3 Definition of Terms

The pharmacokinetic theory regarding chemical absorption (bioavailability) is well developed and has been applied in the pharmaceutical industry for decades. However, the commonly accepted pharmaceutical definition has not always been applied to environmental sciences, and so the definition of bioavailability is sometimes ambiguous when applied in the risk assessment process. For example, NRC (2003) offers 15 definitions for this term, drawn from dictionaries, the published literature, agency documents, textbooks, and guidance. Similarly, "absolute bioavailability" and "relative bioavailability" have multiple definitions in different documents and contexts. Below is a brief discussion of some of these definitions, together with the definition as used in this guidance; see the Glossary for additional terms used in this guidance.

- **Bioavailability**
  While definitions of bioavailability vary, all refer to the ability of a substance to be absorbed by a living organism. For assessing potential exposures from environmental media, bioavailability refers to the portion of the total quantity of a chemical present that is absorbed by a living organism (Klassen 2013) and reaches the central (blood) compartment, whether exposure occurs via the gastrointestinal (GI) tract, skin, or lungs (NEPI 2000).

- **Absolute Bioavailability**
  Absolute bioavailability (ABA) is the fraction or percentage of an administered dose (ingested or dermally applied) that is absorbed and reaches the blood stream. The ABA can range from 0 to 100% of the administered dose. One way to measure ABA is by comparing the area under the blood concentration curve (AUC) that results from the administered dose to the AUC that results from the same dose if given intravenously.

- **Relative Oral Bioavailability**
  This term refers to the comparison between the bioavailability of a chemical administered in different dosing media. For use in the human health risk assessment of chemicals in contaminated soil, the relative oral bioavailability (RBA) refers to the ratio of the absorption of a chemical from soil, relative to the absorption in the exposure medium used in the critical toxicity study (the study that forms the basis for the cancer slope factor or reference dose). This critical distinction is central to the concepts that are addressed in this guidance. Using a site-specific RBA in the risk assessment process accounts for potential differences between the bioavailability of a chemical studied to determine the dose-response relation (in the toxicity study) and the bioavailability of that same chemical from environmental media. The RBA is generally less than the ABA, but theoretically could exceed the ABA (the RBA could be greater than 100%) if the absorption from environmental media is higher than absorption in the critical toxicity study.

- **Bioaccessibility**
  The term "bioaccessibility" refers to the fraction of the total amount of a chemical present that is potentially available for uptake by an organism. In this guidance, this term refers to the results from chemical extraction tests that have been developed to simulate or predict the RBA of chemicals from soil. In this context, "bioaccessibility" is interchangeable with "in vitro extraction testing," wherein experimental systems have been developed to assess the potential for human exposure to chemicals in soil by capturing a critical component that affects bioavailability.

Figure 1-2 illustrates the terminology used in this document.

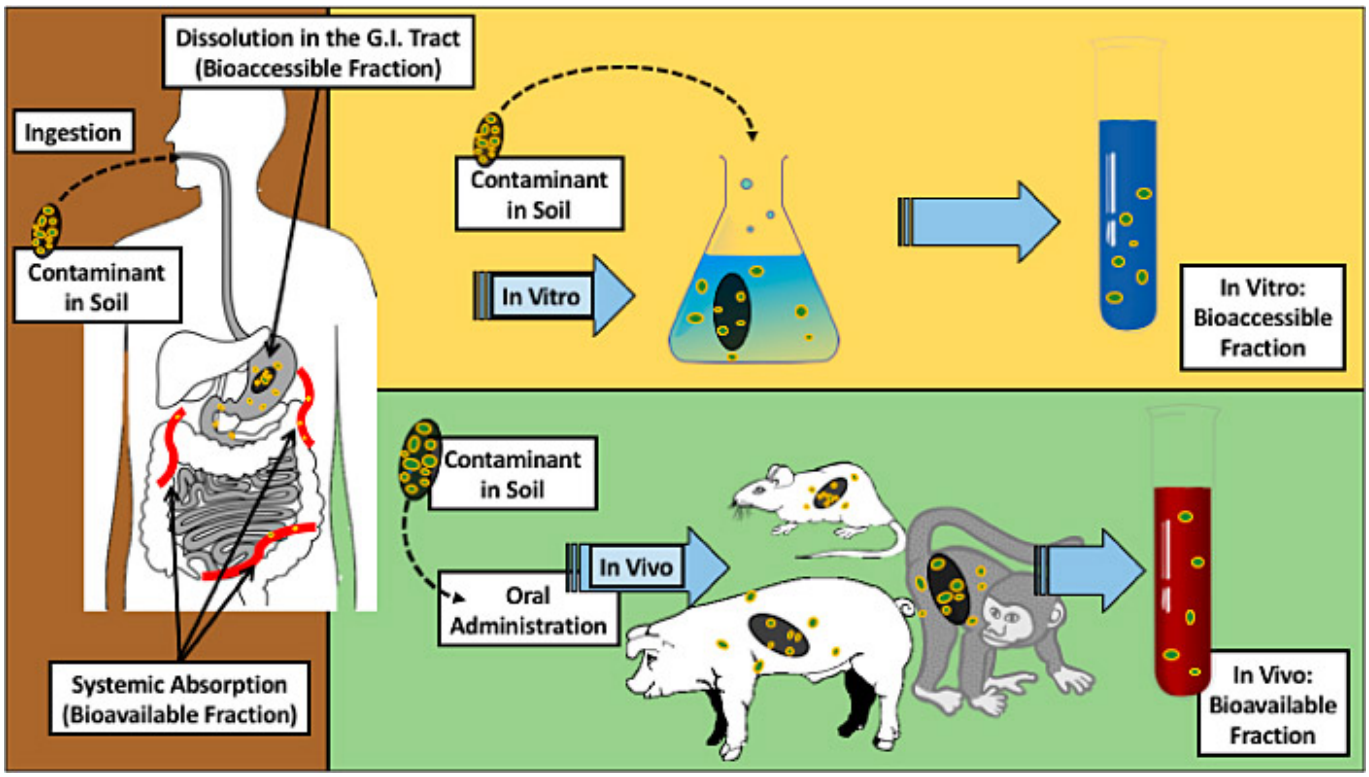


Figure 1-2. Illustration of terminology.

Review Checklist

This checklist summarizes elements that should be considered when developing or reviewing a risk assessment that uses a site-specific bioavailability or relative oral bioavailability (RBA) value. The checklist can be completed by a risk assessor or project manager or used by a reviewer to document that the information contained in the bioavailability assessment is complete and justified. Each site will vary depending on the chemical of interest, objectives, and purpose of the risk assessment.

▢ Are the methods used for soil sampling, chemical analysis and bioavailability testing including rationale for their selection and limitations, adequately described? [Lead, Arsenic, and PAH]

- What soil sampling methods (for example, discrete, ISM) were used? What sieving was performed and what sieve size was used, if applicable?
- What analytical methods for the contaminants were used?
- Identify the bioavailability and bioaccessibility methods (type of in vivo, in vitro, or combination models) used.
- Identify the in vivo – in vitro correlation (IVIVC) used

▢ Is bioavailability assessment beneficial (feasibility; logistical and technical constraints)? [Decision Process and Stakeholder Perspectives]

- Is the site-specific bioavailability likely to affect the remedial decisions?
- Is the cost of the bioavailability assessment justified with respect to the cost of remediation?
- Are validated bioavailability methods available?
- Has the use of site-specific bioavailability been accepted by the regulatory agency?

▢ Consider potential variability of bioavailability between areas where source types or historical releases to the environment may be different, soil characteristics may be different, and background areas.

- Are soil and source types of various exposure units homogeneous or different from each other?
- Is the site-specific RBA value applicable to the area? (if the soil tested was not specifically from the area)
- What are the soil characteristics (soil type, pH)?
- What are the contaminant source types (for example, a highly bioavailable form such as, pesticidal arsenic)?
- What historical use and releases are present?

▢ What is the focus of the risk assessment?

- soil ingestion exposure evaluation, soil dermal exposure evaluation, site-specific cleanup goal, or other purpose
- conceptual site model (CSM) presents exposure pathways and receptors for various exposure units/areas
- land use scenarios
- regulatory (default) cleanup goals

▢ Did bioavailability and risk assessments consider potential differences in RBA values for different exposure units/areas being used for different receptor exposure scenarios?

▢ Does the risk assessment discuss the basis of the site-specific bioavailability, RBA value(s) used?

- RBA estimate basis, mean, 95% upper confidence limit (UCL) of the mean, maximum and rationale
- differences in risk assessment outcomes using different types of RBA estimates
- RBA estimation method consistent with soil concentration statistics (mean, 95% UCL of the mean, maximum)

▢ Is the use of the site-specific bioavailability in the calculation of risk/hazard levels or cleanup goals including assumptions and their rationale clearly presented?

- calculation equation
- assumptions
- calculated values

▢ Did the risk evaluation present analysis/conclusion that includes limitations or uncertainties in the use of bioavailability?

- variability of the RBA and concentrations data and sources of variability
- method-related uncertainties (sampling, bioavailability tests, IVIVC model)
- chemical properties and presence of other chemicals
- background level(s)

▢ Was the public engaged and was there a general understanding about bioavailability and acceptance? [Stakeholder Perspectives]

- Note the participants.
- Identify the feedback mechanism.
- Did the investigation and risk assessment consider post-assessment stakeholder engagement and feedback with regards to the use of bioavailability in the risk assessment?

▢ Other