



Designation: E2137 – 17

# Standard Guide for Estimating Monetary Costs and Liabilities for Environmental Matters<sup>1</sup>

This standard is issued under the fixed designation E2137; 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 ( $\epsilon$ ) indicates an editorial change since the last revision or reapproval.

## 1. Scope

1.1 *Purpose*—The purpose of this document is to provide a standard guide for good commercial and customary practice in estimating *costs and liabilities* for environmental matters.<sup>2</sup> Many possible uses for estimates of *costs and liabilities* for environmental matters exist, including but not limited to business decision making and portfolio optimization, due diligence and communications involving acquisitions and divestitures, regulatory requirements, third-party lawsuits, insurance premium calculation and claim settlement, change of property use, revitalization, compliance planning, construction and project control, analysis of remedial alternatives, budgeting, strategic planning, audit defense, financing, and investment analysis by shareholders. The use of estimated *costs and liabilities* developed in accordance with this standard may be subject to other standards applicable to the matter involved. For example, it is not intended to supersede accounting and actuarial standards. This standard does not address the establishment of reserves or disclosure requirements.

1.2 *Objectives*—The objective of this standard is to provide guidance on approaches for estimating *costs and liabilities* for environmental matters.

1.3 *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<sup>3,4</sup>

### 2.1 ASTM Standards:

<sup>1</sup> 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 E50.05 on Environmental Risk Management.

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<sup>2</sup> For the purposes of this standard, costs and values are defined as monetary estimates.

<sup>3</sup> Appendix X1 includes citations for additional relevant documents and requirements from other organizations including FASB, GASB, PCAOB, FASAB, IASB, and SEC.

- E1527 Practice for Environmental Site Assessments: Phase I Environmental Site Assessment Process
- E1739 Guide for Risk-Based Corrective Action Applied at Petroleum Release Sites
- E2081 Guide for Risk-Based Corrective Action
- E2091 Guide for Use of Activity and Use Limitations, Including Institutional and Engineering Controls
- E2107 Practice for Environmental Regulatory Compliance Audits
- E2150 Classification for Life-Cycle Environmental Work Elements—Environmental Cost Element Structure
- E2173 Guide for Disclosure of Environmental Liabilities
- E2205 Guide for Risk-Based Corrective Action for Protection of Ecological Resources
- E2247 Practice for Environmental Site Assessments: Phase I Environmental Site Assessment Process for Forestland or Rural Property
- E2637 Guide for Utilizing the Environmental Cost Element Structure Presented by Classification E2150
- E2718 Guide for Financial Disclosures Attributed to Climate Change

## 3. Terminology

### 3.1 Definitions:

3.1.1 *accretion*—an increase to the present value of a liability solely due to the passage of time, normally a year; also known as “unwinding the discount.”

3.1.2 *activity and use limitations (AULs)*—legal or physical restrictions or limitations on the use of, or access to, a site or facility to eliminate or minimize potential exposures to chemicals of concern, or to prevent activities that could interfere with the effectiveness of a response action, to ensure maintenance of a condition of “acceptable risk” or “no significant risk” to human health and the environment. These legal or physical restrictions are intended to prevent adverse impacts to individuals or populations that may be exposed to chemicals of concern.

<sup>4</sup> For referenced ASTM standards, visit the ASTM website, [www.astm.org](http://www.astm.org), or contact ASTM Customer Service at [service@astm.org](mailto:service@astm.org). For *Annual Book of ASTM Standards* volume information, refer to the standard’s Document Summary page on the ASTM website.

3.1.3 *allocation or allocated share*—the portion of *cost or liability* for which a party is responsible for payment or reimbursement.

3.1.4 *asset retirement obligation (ARO)*—*legal or constructive obligations* associated with the retirement of a tangible long-lived asset that result from the acquisition, construction, development, or normal operation of a tangible long-lived asset. Activities include (but are not limited to) demolition, decommissioning, decontamination, reclamation, restoration and abandonment.<sup>5</sup>

3.1.5 *constructive obligation*—the concept that past practice creates a valid expectation on the part of a third party. An example of this is a company policy to excavate underground storage tanks once removed from service. Also known as promissory estoppel.

3.1.6 *costs and liabilities*—economic expenses, accrued liabilities, *asset retirement obligations*, and loss contingencies.

3.1.7 *dutyholder*—party responsible for the *costs and liabilities*.

3.1.8 *environmental compliance*—operations, permits, equipment, facilities, products, records, documentation, reports, training, procedures, inspections, certifications, monitoring, controls, or other conditions or activities that must conform to environmental statutes including, but not limited to, CAA, CWA, OPA, RCRA, CERCLA, TSCA, FIFRA, SDWA, and state and local laws, as well as any international jurisdictional requirements.

3.1.9 *estimator*—an individual or entity that prepares and analyzes *costs and liabilities*.

3.1.10 *event*—a condition or incident which occurred, or may occur, with respect to an environmental condition and/or *environmental compliance* issue, that affects or leads to potential *costs and liabilities*. Examples of events include: a new requirement for air emission controls (for example, NO<sub>x</sub>), a hazardous waste site that requires remediation, a claim for personal injury related to an alleged environmental incident, or the need to comply with NPDES standards as a result of a process change.

3.1.11 *fair value*—an estimate of the price that could be received for an asset or paid to settle a *liability* in a current transaction between marketplace participants that are unrelated, knowledgeable about factors relevant to the *liability* and the transaction, able, and willing to transact in the reference market for the *liability*.<sup>6</sup>

3.1.12 *legal obligation*—duty to carry out what the law or a contract states.

3.1.13 *liability*—an actual or potential obligation that may or may not be accrued. This includes *legal obligations* as well as *constructive obligations* (promissory estoppel), and may also be in the form of commitments, guarantees or contingencies.

3.1.14 *obligating event*—a past outcome which confirmed a financially recognizable obligation.<sup>7</sup>

3.1.15 *orphan share—liability* assigned to a *PRP* that cannot be located or that is insolvent, or the *liability* associated with pollutants which cannot be attributed to a *PRP*.

3.1.16 *potentially responsible party (PRP)*—any individual, legal entity, or government—including owners, operators, transporters, or generators—potentially responsible for, or contributing to, the environmental impacts at an *event*.

3.1.17 *recognition benchmark*—stages in the assessment and remediation process which create the expectation of a more comprehensive or robust estimate.<sup>8</sup>

3.1.18 *studies*—investigations such as regulatory interpretations and applicability studies, compliance analysis, environmental regulatory compliance audits, operating scenarios study, engineering design and analysis, cost estimation, process hazard analysis, modeling, communication plans, preliminary investigation, sampling and analysis, site assessment, site characterization, Phase I and II studies, remedial action plan, remedial investigation, contamination assessment report, feasibility study, risk assessment, treatability study, ecological impact assessment, environmental impact report, work plans, ASTM Risk-Based Corrective Action (RBCA) analysis, RCRA facility investigation, RCRA facility assessment, report of waste discharge, corrective measures study, corrective action report, health and safety plan, quality assurance plan, and other studies.

### 3.2 Acronyms:

3.2.1 *AICPA*—American Institute of Certified Public Accountants.

3.2.2 *ASC*—Accounting Standards Codification

3.2.3 *AULs*—Activity and Use Limitations.

3.2.4 *CAA*—Clean Air Act.

3.2.5 *CERCLA*—Comprehensive Environmental Response, Compensation and Liability Act of 1980 (as amended, 42 USC Section 9601 et seq.).

3.2.6 *CWA*—Clean Water Act.

3.2.7 *EPA*—United States Environmental Protection Agency.

3.2.8 *EV*—expected value; an estimate of the weighted mean value of an unknown quantity that represents a probability-weighted average over the range of all possible values.

3.2.9 *FAF*—Financial Accounting Foundation.

3.2.10 *FASAB*—Federal Accounting Standards Advisory Board

3.2.11 *FASB*—Financial Accounting Standards Board, a part of FAF.

3.2.12 *FIFRA*—Federal Insecticide, Fungicide and Rodenticide Act.

3.2.13 *GAAP*—Generally accepted accounting principles.

<sup>5</sup> See FASB ASC 410-20 and GASB 18 references in [Appendix X1](#).

<sup>6</sup> See FASB ASC 820, GASB 72, and IFRS 13 references in [Appendix X1](#).

<sup>7</sup> See GASB 49:11 references in [Appendix X1](#).

<sup>8</sup> See GASB 49:12-13 and ASC 410-30-25-15 references in [Appendix X1](#).

3.2.14 *GASB*—Government Accounting Standards Board, a part of FAF.

3.2.15 *MLV*—most likely value.

3.2.16 *NPDES*—national pollutant discharge elimination system.

3.2.17 *OPA*—Oil Pollution Act.

3.2.18 *PCAOB*—Public Company Accounting Oversight Board.

3.2.19 *PRP*—potentially responsible party.

3.2.20 *RBCA*—Risk-based corrective action.

3.2.21 *RCRA*—Resource Conservation and Recovery Act (as amended 42 USC Section 6901 et seq.).

3.2.22 *SDWA*—Safe Drinking Water Act.

3.2.23 *SEC*—Securities and Exchange Commission.

3.2.24 *TSCA*—Toxic Substances Control Act.

#### 4. Significance and Use

4.1 *Use*—The standard is intended for use on a voluntary basis by an *estimator* of *costs and liabilities* for environmental matters. The user may elect to apply this standard for any or all uses outlined in the Purpose. Application of this standard for one use does not compel application of the standard for all or any other use.

4.2 *Principles*—The following principles are an integral part of this standard and should be used to resolve ambiguity or dispute regarding the interpretation of estimated *costs and liabilities* for environmental matters.

4.2.1 *Caution When Repurposing Estimates*—The *estimator* should exercise care when repurposing an estimate generated for one objective and audience. For example, an *estimator* may use the expected value approach on a given *cost and liability*, and find that the “financial assurance estimate” uses unique financial assumptions (inflation, discount rate, time horizon) specified by a state regulator, while a “project controls” or “reserve” forecast – for the very same *cost and liability* -- will use differing financial factors.

4.2.2 *Uncertainty Not Eliminated*—Even though an estimate of *costs and liabilities* for environmental matters is prepared in accordance with this standard, uncertainty remains with regard to, among other things, the resolution of contractual, technological, regulatory, legislative, and judicial issues, which could affect the *costs and liabilities*. However, inherent uncertainty in estimates should not prevent an estimate from being made.

4.2.3 *Periodic Review of Assumptions and Estimates*—Assumptions underlying estimates should be reviewed, documented and periodically analyzed for the purpose of incorporating new information. There is a preference for current information over historical assumptions if the current information is comprehensive and comparable. Subsequent improvements in estimates should be made as more information becomes available, or as *recognition benchmarks* or *obligating events* occur. For example, for remediation of an individual

site, such assumptions include changes to the conceptual site model; contaminant concentration data found in soil, groundwater, air and sediments; the selection of different remedial technologies; the indication of a preferred alternative by the governing agency; the weighting of alternatives; the probability of failure of a remedial technology to achieve the desired outcome in the time anticipated; the probability of accelerated or delayed enforcement; the probability of a compressed remedial construction timetable; the explicit or implied value of impacted drinking water, wetlands, and other natural resources; changes to the default values of fines and penalties and their associated tax consequences; and the ability to pay of *PRPs* or other counterparties. Changes in available information such as contaminant data, market prices, regulatory requirements, precedential court findings, technology, counterparty ability to pay, *dutyholder* ability to pay, property use, inflation and discount rates, or other issues may affect the basis for the estimates, therefore necessitating revisions. (See [Appendix X4](#) for examples of aggregation of portfolio-wide assumptions and metrics.)

4.2.4 *Comparison with Subsequent Estimates*—Subsequent estimates based on additional information should not be construed as indicating the prior estimates of *costs and liabilities* for environmental matters were unreasonable at the time they were made. Estimates should be evaluated on the reasonableness of analyses and judgments made at the time and under the circumstances in which they were made. Subsequent improved estimates should not be considered valid standards on which to measure the reasonableness of a prior estimate based on hindsight, new information, use of developing analytical techniques, or other factors. However, information on trends in estimates over time may be of value to a user of the *cost and liability* estimates. Any comparison should recognize the reasons the estimates were performed, whether they were accomplished under the standard and any differences in technique in the application of the standard.

4.2.5 *Not Exhaustive*—Estimation of *costs and liabilities* for environmental matters does not necessarily require an exhaustive evaluation of all possible outcomes. A point exists at which the cost of obtaining information or the time required to gather it outweighs improvement in the quality of the estimate.

4.2.6 *Assessment of Risk*—The actual or potential risk to human health and the environment should be considered in assessing environmental matters. The degree of risk should be a factor in developing the *cost and liability* estimates associated with those matters.

4.2.7 *Estimator Selection*—An appropriate *estimator* or group of *estimators* will consist of those individuals or groups who possess sufficient knowledge, training, and experience to develop appropriate estimates for the *costs and liabilities* being estimated. It is the responsibility of the entity sponsoring the *cost and liability* estimates to select an *estimator* with the appropriate level of knowledge, training, and experience for the parts of the estimation effort for which that *estimator* is

responsible. The *estimator* should be free of conflicts of interest to provide an objective and reliable estimate.

**5. Procedures for Estimating Costs and Liabilities for Environmental Matters**

5.1 *Determination of Relevant Information and Types of Costs and Liabilities*—There are many types of *costs and liabilities* for environmental matters, including, but not limited to:

5.1.1 An entity’s internal costs, paid by the *dutyholder* responsible (see examples in [Table 1](#)).

5.1.2 Costs paid to an affected party by the *dutyholder* responsible (See examples in [Table 1](#)).

5.1.3 Costs paid to vendors by the *dutyholder* responsible (See examples in [Table 1](#)).

5.1.4 After identifying the types of potential *costs and liabilities* for environmental matters, existing relevant information should be considered to estimate *costs and liabilities* identified in [5.1.1](#), [5.1.2](#), and [5.1.3](#), including, but not limited to:

5.1.4.1 *Event* type (for example, new air emission control requirements, leaking landfill, site *PRP* notice, worker exposure, site decommissioning, compliance audit findings,<sup>9</sup> notice of violation, filing of a lawsuit, and *recognition benchmarks* and *obligating events* (see [Appendix X7](#))).

5.1.4.2 Number and location of affected operations/facilities,

5.1.4.3 Use of surrounding property, including but not limited to sewer systems, groundwater and surface waters,

5.1.4.4 Past, current, and potential future site uses, and constraints imposed upon those future uses by AULs, including institutional controls and/or engineering controls,

5.1.4.5 Findings from environmental and other relevant *studies*,

5.1.4.6 Environmental risks posed by the *event*,<sup>10</sup>

5.1.4.7 Bodily injury or other claims related to the *event*,

5.1.4.8 Relevant federal, state, tribal, local, or other regulatory requirements and alternatives,

5.1.4.9 Federal, state, tribal, local, or other agency involvement, including the preferred alternatives and preferred remedies of governing agencies,

5.1.4.10 Public involvement,

5.1.4.11 Planned or completed remedial activities,

5.1.4.12 Decision documents (for example, Records of Decision),

5.1.4.13 Litigation activities related to the *event* (for example, claims, suits, actions, demands, requests for payment, notices),

5.1.4.14 Resources, tasks, and deadlines,

5.1.4.15 Available technologies and designs,

5.1.4.16 Type and extent of contamination,

5.1.4.17 Number of operable units (CERCLA) or solid waste management units (RCRA),

5.1.4.18 Involvement of various parties at the *event*, and

5.1.4.19 Information on prior experience with similar *events*.

5.1.4.20 Experience with and expectations of enforcement actions by regulatory authorities,

<sup>10</sup> See Practice [E1527](#); Guide [E1739](#); Guide [E2081](#), Guide [E2091](#), Guide [E2205](#), and Practice [E2247](#).

<sup>9</sup> See Practice [E2107](#).

**TABLE 1 Examples of Environmental Costs and Liabilities<sup>A</sup>**

	Entity’s Internal Costs	Costs Paid to an Affected Party	Costs Paid to a Vendor
Project management	✓	✓	✓
Procurement and contracting	✓	...	✓
Studies and environmental assessments	✓	✓	✓
Response actions (including but not limited to soil, groundwater, surface water, and sediments)	✓	✓	✓
Environmental compliance	✓	✓	✓
Plug/abandon pipelines	✓	✓	✓
Demolition	✓	✓	✓
Permitting and reporting expenses	✓	✓	✓
Regulatory oversight reimbursement	...	✓	...
Public comment/involvement	✓	✓	✓
Fines and penalties	...	✓	...
Natural resource damages and ecological damages	...	✓	...
Property damages	✓	✓	...
Compensatory restoration	...	✓	✓
Business interruption	✓	✓	...
Toxic tort, bodily injury, nuisance, negligence, and other damages claims	...	✓	...
Legal defense and litigation	✓	✓	✓
Insurance premiums	...	...	✓
Parent-subsidiary guarantees	✓	...	...
Financial assurance: self-bonding	✓	...	...
Financial assurance: third-party bond	...	...	✓
Counterparty risk	✓	✓	✓
Guarantee to perform response work	...	✓	...
Commitment to buy back impacted property	...	✓	...

<sup>A</sup> Over the life cycle of a *cost and liability*, multiple types of expenses (for example, internal and external expenses) may occur for the same type of activity. See also Classification [E2150](#) and Guide [E2637](#).

5.1.4.21 Timeline to implementation of a given *liability*, through, for example, a remediation program, asset retirement plan, capital expenditure project, claim adjudication, toxic tort investigation, arbitration proceeding, or litigation,

5.1.4.22 Impacts to natural resources and ecological assets, and the interests of relevant natural resource trustees,<sup>11</sup>

5.1.4.23 Ecological assets and environmental projects used to offset assessment or remediation costs (This may include supplemental environmental projects.),

5.1.4.24 Relevant tax consequences.

5.1.5 The organization and application of the foregoing information may be further subject to corporate, accounting, or regulatory policy decisions. The user will need to determine what these policy decisions are, and assess their effect on the cost estimate. Examples of such policy decisions include, but are not limited to:

5.1.5.1 Changes to GAAP,

5.1.5.2 Changes to requirements of external financial auditors,

5.1.5.3 Changes to entity policies to comply with GAAP and auditor requirements,

5.1.5.4 New or modified environmental laws and regulations (for example, critical habitat regulations may change over time),

5.1.5.5 Policy decisions or interpretations to be made by regulatory agencies,

5.1.5.6 Compliance assurance procedures or policies adopted by the *dutyholder*,

5.1.5.7 Acceptable levels of risk (for example, business risk, human health risk, ecological risk),

5.1.5.8 The degree to which societal or external costs and benefits are considered,

5.1.5.9 The duration of the forecast for *costs and liabilities*, and whether or not life cycle costs are considered,

5.1.5.10 The degree to which sustainability/sustainable development are considered,

5.1.5.11 Local environmental management system criteria, including trade-off of emissions across environmental media, alternative methods and permitting options, auditability, and performance oriented metrics,

5.1.5.12 Level of non-governmental organization involvement and scrutiny,

5.1.5.13 The degree of communication with and cooperation of the public.

5.1.6 In the absence or insufficiency of such information, an assessment should be made of the applicable regulatory and industry standard requirements, and a determination made as to whether based on these requirements, significant *costs and liabilities* for environmental matters may be incurred that would indicate the need for further data collection and analysis in the future. This assessment should be documented, as discussed in 5.10.

5.2 *Selection of Estimation Approaches*—A decision framework for estimating *costs and liabilities* for environmental matters is required. For purposes of naming various estimating

<sup>11</sup> For natural resources damages, guidance on deriving estimates of losses can be found at 43 CFR 11 and 15 CFR 990.

methods, the following terminology is used, ranked in level of robustness/comprehensiveness from highest to lowest as shown in Fig. 1.

- Quoted Price
- Expected Value (EV)
- Most Likely Value (MLV)
- Range of Values
- Known Minimum Value

5.2.1 Selection of the estimation approach is dependent on a number of factors, such as the availability of information, the purpose of the estimate, the time and expertise available, and others. The decision to use one or more of these approach(es) for a particular purpose is not arbitrary. The informational value of the estimate supplied by any one approach is not equivalent to the others. When the uncertainties are great (for example, when an *event* is first identified) it may not be possible to make a highly reliable cost estimate. The reliability of estimates should continue to improve as those estimates are periodically updated over the life of a *liability* (see 4.2.3), including through the course of implementing response actions to extinguish the *liability*.

5.2.2 The robustness and comprehensiveness of an estimate and the quantification of uncertainty about the estimate, given adequate information, generally decreases moving from top to bottom of this list of approaches, corresponding with the depth of analysis and use of available information to prepare an estimate. (See Fig. 1.) Depending on availability of information and circumstances, the level of effort required to prepare

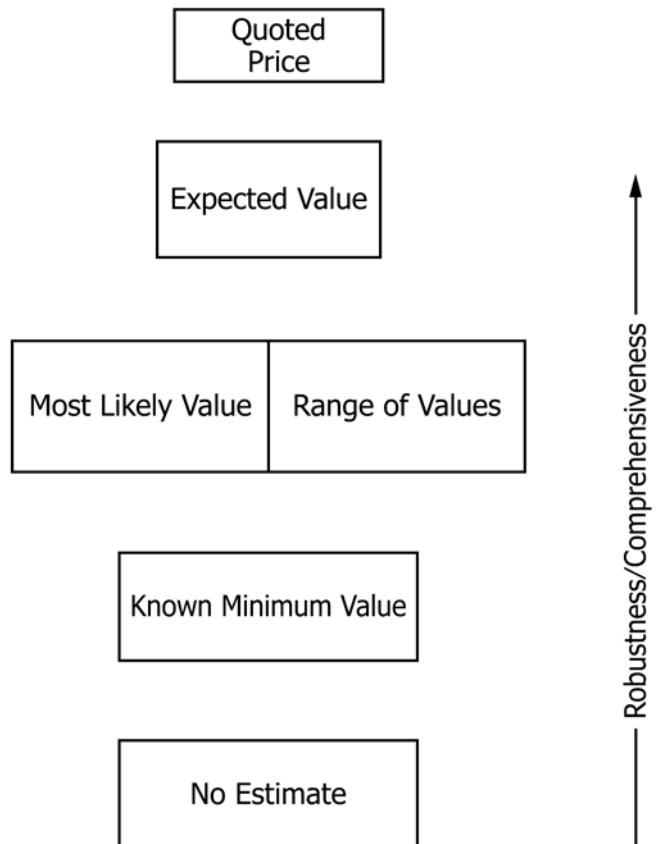


FIG. 1 Hierarchy of Approaches for Estimating *Costs and Liabilities* for Environmental Matters

estimates at the top of the list is typically greater than the bottom of the list. However, any given *event* may have concurrent approaches and estimates underway simultaneously. Given the principles cited in Section 4, it is not necessarily true that the “best” estimate for a given set of circumstances will always be the expected value depending on the purpose of the estimate, availability of information, and level of rigor applied to the estimate. The quality of an estimate is determined both by accurate implementation of the estimation approach, as discussed below, and by the quality of the inputs to the estimate. The user should consider these elements when selecting the estimation approach.

5.2.3 The *estimator* should take into account the number of *events* and quality of the information available or obtainable when selecting the *cost and liability* estimation approach to be used. (These may include the *recognition benchmarks* and *obligating events* listed in **Appendix X7**.) *Estimators* should consider whether it is useful to employ the same estimation approach for a portfolio of matters that are similar (for example, similar in nature or similar in magnitude) to improve comparability.

5.3 *Sources of Uncertainty in Estimation*: There are many sources of uncertainty in estimation that may affect the selection of the cost estimation approach and that should be considered in preparing estimates. These sources include, but are not limited to:

5.3.1 *Decisions*: an entity may complete a capital expenditure project, increase operating expenses, accelerate or defer site assessment, remediation and monitoring work for reasons unrelated to strict compliance with environmental laws and regulations. For example, a mine operator may elect to close an operation before its mineral lease expires because the operation is not expected to be profitable before the lease ends; consequently, by compressing the delay before eventual reclamation work, the *asset retirement obligation* increases to a higher present value.

5.3.2 *Shared decisions/negotiations*: a *dutyholder* may negotiate a compliance program with an environmental regulator to reduce or eliminate an environmental risk. The resulting mix of operating changes, monitoring, remediation, fines/penalties, compensatory restoration and/or capital expenditures may be lower cost and better aligned with the intent of environmental laws and regulations.

5.3.3 *Market pricing*: the market for environmental consulting and legal expertise, landfill space, trucking services, demolition explosives, construction equipment and other inputs are subject to supply and demand. Regional and nationwide price pressure and deflation can occur anywhere, at any time.

5.3.4 *Safety*: an unstaffed industrial or commercial property can be an attractive nuisance where trespassers may be exposed not only to chemicals of concern but also to hazards ranging from confined spaces and airborne pathogens to waterborne bacteria and criminal activity.

5.3.5 *Media properties*: different types of soil, in combination with rock, sand, silt and clay, have different “bulking factors,” meaning that when excavated and transported, the soils expand to a predictable and larger volume. In addition,

contamination migrates within and between different media at differing rates. Also, to prevent slope failure, the angle of side slopes are limited to less-than-vertical angles, meaning that over-excavation of clean soil to reach contaminated soil is likely.

5.3.6 *Mobility, toxicity and volume*: Environmental regulations often focus on the mobility, toxicity and volume of contamination to be addressed. Robust and comprehensive estimates may depend on an understanding of the movement of these compounds through various media, such as a given site’s unique soil structure to a fluctuating groundwater table, and then laterally toward a surface water body or downward to deeper aquifers. Predicting how multiple chemical compounds will interact with each other over time and then respond to different remedial technologies is a complex undertaking. An *estimator* should regularly assess the value of incremental data and periodically state a need for additional data to prepare more reliable estimates of *costs and liabilities*, even if existing data may be sufficient for regulatory purposes. For example, a regulator may only require five soil samples to determine the presence or absence of contamination, but an *estimator* may need twenty soil samples to determine a more precise volume of contaminated soil and to rule out some remedial technologies as technically impractical.

5.3.7 *Financial condition of PRPs sharing costs*: in multi-party *liability* and contractual indemnification situations, one party may be invested in the financial survival of another. For example, bankruptcy or dissolution of one party may transfer costs to the surviving party. These two paths, bankruptcy and dissolution, represent two forms of non-performance risk (that is, counterparty default, or environmental counterparty risk).

5.3.8 *Availability of timely insurance coverage*: while certain assessment and remediation expenses may be theoretically recoverable from insurers, the limitations of insurance should be understood by an *estimator*, including the costs to prepare a claim, the time for an insurer to process a claim, the ratio of claims to allowed expenses, and the probability of litigation to properly assert an insurance claim.

5.3.9 *Timing*: a regulator or property owner may decide to accelerate or defer future phases of assessment, cleanup or decommissioning work, and thereby increase or decrease the environmental *cost or liability* (in present value terms); this uncertain outcome can be caused by such *events* as environmental assessment findings, negative press attention, community complaints, the hiring of additional regulatory staff, a change in zoning/property use, or a natural disaster.

5.3.10 *Other Uncertainties*: The user should be aware that there may be numerous other uncertainties to be investigated and evaluated. The quality of an estimate is determined both by accurate implementation of the estimation approach, as discussed below, and by the quality of the inputs to the estimate.

#### 5.4 *Detailed Description of Approaches for Estimation*

5.4.1 *Quoted Price*—When possible, market information should be used to determine a *fair value* measurement. A quoted price for an identical *cost and liability* in an active

market<sup>12</sup> provides a reliable estimate and should be used when available. If a quoted price for an identical *cost and liability* is not available, quoted prices for similar *costs and liabilities* in active markets may be used after adjustment for differences in cash flows or other relevant factors.<sup>13</sup>

5.4.2 *Expected Value*: The expected value is also known as a weighted arithmetic mean or weighted average. The approach, whether described through a written event tree or complex spreadsheet model, involves the following common steps:

5.4.2.1 Identifying the key issues contributing to the magnitude, sequencing and pace of *event costs and liabilities*. This may involve identifying which issues are decisions, negotiations, or random outcomes.

5.4.2.2 Sequencing the decisions, negotiations and random outcomes, often into an event tree (see example in [Appendix X2](#)) or a computer simulation.

5.4.2.3 Assigning probabilities and cash flows to each node in the event tree or for each issue in the computer simulation. Assign correlations to issues which have a strong relationship to one another, such as soil contaminant levels and offsite disposal costs. The *estimator* should consider whether nodes in the event tree are dependent. For example, if the regulators choose a particular remedy for one portion of the site, this may affect the likelihoods of remedies at other portions of the site.

5.4.2.4 Calculate the expected value, or probability-weighted value (See example in [Appendix X2](#)).

NOTE 1—If required under FASB Concepts Statement 8, determine if the results are relevant, sufficient and reliable.<sup>14</sup> If not, repeat most or all of the preceding steps while using measurements such as rank correlation and sensitivity analysis to determine how to convey information about uncertainty, as described in [5.8](#).

5.4.2.5 The *estimator* should test and confirm the robustness and comprehensiveness of the calculations by reviewing the sensitivity of the expected value to reasonable changes in underlying probabilities, dependencies, outliers, and other factors (such as those described in [5.3](#).)

5.4.2.6 The *estimator* should be careful to include realistic outcomes with statistically significant probabilities to avoid shifting the expected value through the addition of extreme outcomes with insignificant probabilities of occurrence. Statistical significance will vary depending on the quality of data, the magnitudes of the outcomes, and the presence of outliers.

5.4.2.7 An alternative method for performing an expected value calculation is to assemble cost data from comparable *events*. This actuarial approach may be useful when the data are truly sufficient (a sufficient sample size) and comparable (similar to the *event* being estimated). When using this actuarial approach, care should be taken to screen and confirm that the sample population is representative of the *event(s)* being evaluated. For example, data from sites with similar nature of operations, environmental setting, and regulatory framework should be used where available and the variation within the

sample population should be assessed and documented. Care should also be taken when using historical data to assess the effects of changes such as technology enhancements, modified laws and/or regulatory policy, the changing application of presumptive remedies, and the application of risk-based corrective action approaches that could significantly alter current and future costs. Adjustments should be made to population cost data to normalize for regional pricing differences and to bring costs from different time frames to a consistent dollar basis. Where there are a large number of *events*, statistical approaches to estimating the expected value may be particularly appropriate. It is important to realize statistical approaches can be predictive of aggregate *costs and liabilities*, even if expected values for individual *events* are at variance from the actual results. Consideration should be given to the potential loss of relevant information through use of statistical means or averages which may not convey information concerning uncertainty.

5.4.2.8 These approaches can be used in combination or concurrently, or both, as appropriate.

5.4.2.9 Other approaches to estimating an expected value may include Monte Carlo simulation or Markov Chain Monte Carlo simulation, with the possibility of capturing simulation complexities such as underlying unit cost distributions or complex interdependencies.<sup>15</sup> Care should be taken to appropriately select and justify the underlying distributions selected for such modeling, and these assumptions should be clearly documented as discussed in [5.10](#).

5.4.3 *Most Likely Value (MLV)*—When an expected value approach is not practical or appropriate, a Most Likely Value could be developed. This MLV captures the cost of the scenario believed to be most likely to occur (for example, a stated preferred remedy). Typically, the exercises *a priori* judgments (based on experience) about the ranking of likely outcomes, but because of cost or other considerations does not develop a full range of possible outcomes to support an expected value estimate. Care should be exercised in preparing an MLV estimate. For example, the MLV is typically not the mid-point between the high and low cost estimates. The MLV should represent a technical and regulatory scenario that is most likely to occur. The MLV may represent a grouping or cluster of scenarios where the cost outcomes are close in magnitude and the combined probability of the grouping or cluster exceeds the probability of other possible scenarios. The MLV is not useful if no scenario, grouping or cluster of outcomes has a probability of occurrence that is significantly greater than others. For the MLV approach, it is recommended that a Range of Values also be developed to convey a minimum level of information about uncertainty.

5.4.4 *Range of Values*—When an expected value approach is not practical or appropriate, a range of values (without probabilities) may be developed instead. This approach may also be used in addition to the MLV approach to provide additional information, or instead of the MLV approach if

<sup>12</sup> *Fair value* measurement “level 1” estimate under GASB 72, IFRS13, and ASC820

<sup>13</sup> May meet the definition of *fair value* measurement “level 2” under GASB 72, IFRS13, and ASC820.

<sup>14</sup> FASB Concepts Statement 8.

<sup>15</sup> For additional information, see for example J. Mun, *Modeling Risk: Applying Monte Carlo Risk Simulation, Strategic Real Options, Stochastic Forecasting, and Portfolio Optimization*, 2010

probabilities or rankings for various outcomes cannot be determined. The range of values should cover costs from a low cost estimate to a high cost estimate, based on reasonable assumptions. If some outcomes within the range are more probable than others, this standard recommends the additional estimation of a most likely value or an expected value, when possible.

**5.4.5 Known Minimum Value**—In the unusual event that the outcome and cost uncertainties are so great that it is premature to estimate a range of values or a most likely value, then a minimum value including component costs (for example, contracts entered, initial studies) that are reasonably certain to be incurred should be estimated.

**5.5 Contingencies**—Contingency adjustments may be added to correct for costs that are inadequately defined at the time of the estimate, but that are expected to be incurred. Therefore care should be taken, when adding contingencies to base unit cost estimates, that the contingencies are reasonable and expected to be incurred.<sup>16</sup> Users should consider whether contingencies should be similar for similar environmental costs and liabilities. Contingencies should be documented as discussed in 5.10.

**5.6 Inflation and Discounting**—Inflation and discounting assumptions should be clearly documented. Inflation and discount rates should be appropriate to the cash flows being adjusted as well as their expected timing.<sup>17</sup> ( See Appendix X5 for more detail.)

**5.7 Allocation**—In estimate where costs and liabilities for environmental matters involve multiple parties, it may be necessary to apportion these costs among the parties. Determination of an entity’s likely allocated share for an event should be made whenever sufficient information is available, and the allocated share should be factored into the cost estimates developed under 5.2. Private parties and courts have employed a variety of methods to allocate or apportion costs (See Appendix X3). As in the case with cost estimation, the method used to allocate costs is dependent upon the amount of information available and the event facts. Ability to pay and counterparty risk should be taken into account when considering allocation. If the entity (or sponsor of the estimate) has reached the obligating events or recognition benchmarks described in Appendix X7, an estimator should document the assumptions used to determine the range of anticipated allocation outcomes; even though the range of allocation outcomes may include zero, there is no justification in this standard to avoid estimation because it may not yet be legally asserted or absolutely determined. All allocation assumptions should be clearly documented as discussed in 5.10.

**5.8 Uncertainty Associated with Estimation Approaches**—Estimates for costs and liabilities for environmental matters are inherently uncertain until the event matures to resolution where

all costs are known with certainty. When possible and appropriate, the estimator should describe the level of uncertainty associated with the cost and liability estimates. Users of this standard are encouraged to explore the statistical and risk theory literature measurement uncertainty. The best measure of uncertainty for a given application depends on the information available and the facts surrounding the analysis. The estimator should select that measure which most clearly communicates to the user the nature and extent of the uncertainty being evaluated.

NOTE 2—The estimator should consider that uncertainties for single events may be different from those for a portfolio of events.

**5.8.1 Uncertainty with Expected Value Approach**—When providing an uncertainty measure with an expected value estimate, the basis and definition of the uncertainty measure should be included. Following are several uncertainty measurements that may be considered in a communication involving an expected value estimate made using this standard.

**5.8.1.1 Confidence Level**—This measure of the range of the expected value is often explained as a portion of a 100% confidence interval. For example, a “70 % confidence level” indicates an estimator’s expectation that a project will cost out at that value (or less) 70 % of the time on average, or equivalently, the expectation that seven of ten identical projects will cost out at or below the “70 % confidence level” estimate.

**5.8.1.2 Confidence Interval**—This measure assumes a probability distribution function around the arithmetic mean (which is also the “expected value” or “weighted average”), with upper and lower endpoints. For example, a 70% confidence interval would indicate the endpoints at the 15<sup>th</sup> and 85<sup>th</sup> percentiles (if a normal distribution is assumed) on a probability distribution function; the interval itself would be the values between the endpoints. For example, if an expected value is \$5 million, and the 15<sup>th</sup> percentile is \$4 million and the 85<sup>th</sup> percentile is \$6.5 million, the 70% confidence interval around the expected value is \$2.5 million, spanning the range between the endpoints of \$4 million and \$6.5 million.

**5.8.1.3 Probability Distribution**—A probability distribution may be calculated explicitly from an event tree. In addition, Monte Carlo modeling software may be used to model probability distributions. Proper use of these tools requires an understanding of the key inputs described above (See 5.4.2.7, 5.4.2.8 and 5.4.2.9) as well as modeling assumptions (for example, assumptions about underlying distributions and correlations).

**5.8.1.4 Other Statistical Methods**—Additional statistical approaches for measuring uncertainty, such as the coefficient of variation, may be found in standard statistical texts.

**5.8.2 Uncertainty with Most Likely Value (MLV) Approach**—Significant uncertainty may exist in estimates made using the MLV approach. The most likely outcome may not be very likely overall (even though it is the singular most likely outcome in a portfolio of potential outcomes). In addition, MLV analysis provides very little information to quantify the uncertainty. When available, the probability associated with the most likely outcome provides some information concerning related uncertainties. In addition, identification of the range of potential outcomes provides the user of the cost

<sup>16</sup> For additional information on contingencies, see for example F.D. Clark and A.B. Lorenzoni, *Applied Cost Engineering*, NY: Marcel Dekker, 1985, pp. 112-120.

<sup>17</sup> For additional information, see for example *Reference Manual on Scientific Evidence*, Second Edition, Federal Judicial Center, 2000, p. 303; R.A. Brealey, S.C. Myers and F. Allen, *Principles of Corporate Finance*, Boston: McGraw-Hill, eighth edition, 2006.



and liability estimate with bounds on the uncertainty associated with the MLV estimate.

**5.8.3 Uncertainty with Range of Values Approach**—To some extent, the size of the range indicates the breadth of uncertainty associated with these cost estimates. For example, if the range is broad, there may be great uncertainty concerning the ultimate cost. When possible, a most likely outcome value should also be provided. When this is not possible, if there are any cost scenarios of clusters or scenarios within the range that are more likely than others, this information should be provided.

**5.8.4 Uncertainty with Known Minimum Value Approach**—For the known minimum value estimate, the upward uncertainty is unknown. If available, a qualitative description of the potential costs or liabilities may allow a user to roughly assess the extent and likelihood of higher values.

**TABLE 2 Examples of Cognitive Biases which can Affect the Estimation of Environmental Costs and Liabilities**

Cognitive Bias	Definition	Scenario
observation	Estimator subconsciously influences the estimation process	Estimator expects his employer's plant will close if a RCRA closure cost estimate exceeds \$10 million
congruence or confirmation	Estimator seeks out assumptions which fit a conclusion	Estimator keeps cost estimates under a preset budget
distinction	Estimator identifies an artificially narrow range of outcomes as factual or representative	Estimator narrows evaluation to only a passive remedy when the regulator indicates that more activity will be required
status quo	Tendency for an estimator to prefer consistency and repetition of past outcomes	Estimator does not update disposal or transportation costs to reflect current market conditions (for example, fuel, insurance, tipping fees)
zero-risk	Estimator focuses an estimate on reducing inconsequential risks without resolving the liability itself	Estimator seeks to shorten the truck route for soil disposal but has not yet chosen a landfill with a responsible owner

**5.9 Recovery/Offsets**—There may be a potential for third party recovery for, or offsets to, the costs and liabilities for environmental matters (for example, insurance recovery, sunk cost reallocation, cost recovery from rate mechanisms, cost recovery from another party.) Any potential third party recovery/offsets should be evaluated and stated separately from the original cost and liability estimate, using cost estimation approaches as described in this Section 5. The litigation costs for pursuing such actions also should be estimated and stated separately from these potential recovery/offset estimates. Additionally, previously unaccounted for ecological assets may be identified within land holdings, which may be quantified for use in offsetting costs and liabilities.

**5.10 Documentation**—Documentation should include the identity of the estimator(s) and a description of their relevant knowledge, training and experience. Documentation should also state the purpose and objective of an estimate (see examples in 1.1), the estimation approach used and why it was used, which major uncertainties were considered in scope and out of scope, what major assumptions have been factored into the estimate (including but not limited to inflation and discounting), the estimates and accompanying uncertainty/sensitivity analyses, and the sources of information used in making estimates of costs and liabilities for environmental matters. For additional information on disclosure, see Guide E2173 (for environmental liabilities) and Guide E2718 (for climate change). This documentation may be prepared to cover a single event or multiple events estimated in a similar manner, and may consist solely or in part of existing work papers. The estimation documentation shall be sufficient for a user to evaluate the estimates, understand the independence and objectivity of the estimator, and understand and quantify any inherent cognitive bias (see several examples in Table 2).

## 6. Keywords

6.1 asset retirement obligations; cost documentation; cost estimation; costs; environmental; expected value; liabilities; minimum value; most likely value; quoted price; range of values; remediation liabilities; toxic tort liabilities; uncertainty

## APPENDIXES

### (Nonmandatory Information)

#### X1. RELATED DOCUMENTS

##### X1.1 ASTM Standards

E2435 Guide for Application of Engineering Controls to Facilitate Use or Redevelopment of Chemical-Affected Properties

E3033 Guide for Beneficial Use of Landfills and Chemically Impacted Sites

##### X1.2 Financial Accounting Standards Board (FASB) Accounting Standards Codification

Topic 275 Risks and Uncertainties

Topic 410 Asset Retirement and Environmental Obligations

Topic 440 Commitments

Topic 450 Contingencies

Topic 460 Guarantees

Topic 805 Business Combinations

Topic 820 Fair Value Measurement

NOTE X1.1—Users may find a subscription to the current definitive versions of FASB content at [www.fasb.org](http://www.fasb.org)

### **X1.3 Government Accounting Standards Board (GASB)**

Statement 18 Accounting for Municipal Solid Waste Landfill Closure and Postclosure Care Costs

Statement 49 Pollution Remediation Obligations

Statement 62 Codification of Accounting and Financial Reporting Guidance Contained in Pre-November 30, 1989 FASB and AICPA Pronouncements

Statement 70 Nonexchange Financial Guarantees Statement

72 Fair Value Measurement and Application

NOTE X1.2—Users may find a subscription to the current definitive versions of GASB content at [www.gasb.org](http://www.gasb.org). In particular, regular updates on deliberations and a possible new Statement on “Certain Asset Retirement Obligations” are found there. GASB added *asset retirement obligations (AROs)* to their research agenda in December 2013 and approved an exposure draft in December 2015. Users of this standard should determine if GASB’s current published ARO standard development work is relevant

### **X1.4 Public Company Accounting Oversight Board (PCAOB) References**

AS 1015: Due Professional Care in the Performance of Work

AS 1105: Audit Evidence

AS 1210: Using the Work of a Specialist

AS 2501: Auditing Accounting Estimates

AS 2502: Auditing Fair Value Measurements and Disclosures

AS 2705: Required Supplementary Information

Alert 4: Auditor Considerations Regarding Fair Value Measurements, Disclosures, and Other-Than-Temporary Impairments (April 21, 2009)

Alert 10: Maintaining and Applying Professional Skepticism in Audits (Dec. 4, 2012)

NOTE X1.3—Users may find a current definitive version of PCAOB content at [www.pcaobus.org](http://www.pcaobus.org).

### **X1.5 Federal Accounting Standards Advisory Board (FASAB)**

SFFAS 5: Accounting for Liabilities of the Federal Government

SFFAS 6: Accounting for Property, Plant, and Equipment [Chapter 4, Cleanup Costs]

Technical Release 2: Determining Probable and Reasonably Estimable for Environmental Liabilities in the Federal Government

Technical Release 11: Implementation Guidance on Cleanup Costs Associated with Equipment

Technical Bulletin 2006-1: Recognition and Measurement of Asbestos-Related Cleanup Costs

NOTE X1.4—Users will find a current definitive version of FASAB content at [www.fasab.gov](http://www.fasab.gov). In particular, regular updates on guidance for “Establishing Opening Balances for General Property, Plant, and Equipment” are found there.

### **X1.6 International Accounting Standards Board (IASB)**

IAS 37: Provisions, Contingent Liabilities and Contingent Assets

IFRIC 1: Changes in Existing Decommissioning, Restoration and Similar Liabilities

IFRIC 5: Rights to Interests arising from Decommissioning, Restoration and Environmental Rehabilitation Funds

IFRS 13: Fair Value Measurement

NOTE X1.5—Users may find a current definitive version of IASB content at [www.ifrs.org](http://www.ifrs.org). Access to the current versions of standards requires a paid subscription; information on current work plans and developing standards is available without a subscription.

### **X1.7 Other GAAP References**

Australian Accounting Standards Board: AAST Standard 137, Provisions, Contingent Liabilities and Contingent Assets, August 2015

Canadian Public Sector Accounting Board: Section PS 3260, Liability for Contaminated Sites, March 2010

Canadian Institute of Chartered Accountants: Handbook Section 3110, Asset Retirement Obligations, effective January 2011

New Zealand Accounting Standards Board: NZ IAS 37, Provisions, Contingent Liabilities and Contingent Assets, effective July 2014

UK and Ireland: Financial Reporting Council: FRS 102:21, Provisions and Contingencies, September 2015

NOTE X1.6—Users may find definitive versions of the above standards through the respective websites.

### **X1.8 Historical References**

American Institute of Certified Public Accountants (AICPA) Emerging Insurance Task Force (EITF) Abstract 93-5.

American Institute of Certified Public Accountants (AICPA) Statement of Position 96-1, “Environmental Remediation Liabilities,” October 10, 1996

FASB Interpretation 14, “Reasonable Estimation of the Amount of a Loss and Interpretation of FASB-5.”

FASB Interpretation 47, “Accounting for Conditional Asset Retirement Obligations,” March 2005.

FASB Statement 5, “Accounting for Contingencies,” March 1975.

FASB Statement 143, “Accounting for Asset Retirement Obligations,” September 2001.

FASB Statement 157, “Fair Value Measurements,” July 14, 2005.

### **X1.9 Additional References**

“Filling the GAAP: An Approach to Improve SEC Disclosure of Environmental Liabilities,” *Journal of Environmental Law & Practice*, September/October 1994.

*Principles of Corporate Finance* (11th Edition, 2013) by Richard Brealey, Stewart Myers, Franklin Allen. ISBN-13: 978- 0078034763.

U.S. Army Corps of Engineers and U.S. Environmental Protection Agency, *A Guide to Developing and Documenting Cost Estimates During the Feasibility Study*, EPA 540-R-00-002, July 2000.

NOTE X1.7—Users of this standard are cautioned that this document has a limited scope, for comparing alternative remedies under CERCLA, and consequently has several significant shortcomings limiting general use.

These shortcomings include, but are not limited to, the following: use of inflation and discounting assumptions which are neither market-based nor adjusted for the type of cash flows or the credit rating of the dutyholder; general limitation of remedy duration to thirty years; exclusion of significant costs such as financial assurance and counterparty risk; and

omission of project failure risks such as technology failure, vendor failure, and changes in cleanup standards.

SEC Staff Accounting Bulletin No. 92  
SEC Regulation S-K

**X2. EXAMPLE OF EXPECTED VALUE APPROACH**

X2.1 This example provides a simplified overview of how to develop an expected value for *costs and liabilities* for a contaminated site. Note that this example and all values in the example are for illustration only. The number of uncertainties contributing to the estimate has been deliberately kept to a minimum for the sake of clarity. In practice, the expected value approach can be applied in the same manner to consider many more uncertainties and multiple sites concurrently. Similarly, although only soil contamination is considered in this example, the same approach can be applied to include other media at the same site which are sources of *costs and liabilities*.

X2.2 At a hypothetical site, soil contamination has been identified by a limited sampling program. The expected value analysis to estimate the costs associated with the contaminated soil is conducted using the steps defined in 5.4.2.

X2.2.1 *Step 1.* Assume the three key variables are: (1) variability in the extent of soil contamination, (2) the negotiated cleanup level to be applied (which determines the target soil volume), and (3) the decision to select a treatment/disposal technology for remediation.

X2.2.2 *Step 2.* The event tree is constructed to reflect these three variables. Some are random or chance uncertainties, noted by circles (see Fig. X2.1) while others are decisions (diamonds) or negotiations (squares). In the simplified example, each of the variables causes a doubling or halving of costs. An expected value of this event tree is calculated by

applying specific probabilities, through professional judgment and proper documentation, to each variable and therefore each contingent value.

X2.2.2.1 *Extent of Soil Contamination*— The surface area extent of contamination has been well characterized by shallow soil samples, but the vertical extent is defined only by a very limited number of soil borings. Some of the borings indicate that contamination extends to 1 m in depth and others to 2 m.<sup>18</sup>

X2.2.2.2 *Cleanup Level*—State regulations specify a generic soil cleanup standard for the contaminant of concern, but also allow for determination of a risk-based cleanup goal. A risk-based cleanup goal could be a factor of 10 higher than the generic cleanup standard. Based on the site-specific distribution of contamination at the site, this higher cleanup goal could reduce the contaminated soil volume by a factor of two.

X2.2.2.3 *Treatment/Disposal Technology*— The default approach for the contaminants present at the site would be to excavate and dispose of the soil at an offsite landfill. However, based on the soil conditions and levels of contamination present, a less costly soil venting technology may be feasible.

X2.2.3 *Step 3.* The estimated costs for each potential outcome are determined based on the following assumptions.<sup>19</sup>

<sup>18</sup> For the purpose of this example, it is assumed that there is a uniform distribution of samples at 1 m and 2 m depths across the site.

<sup>19</sup> These assumptions are given for the purpose of illustration only.

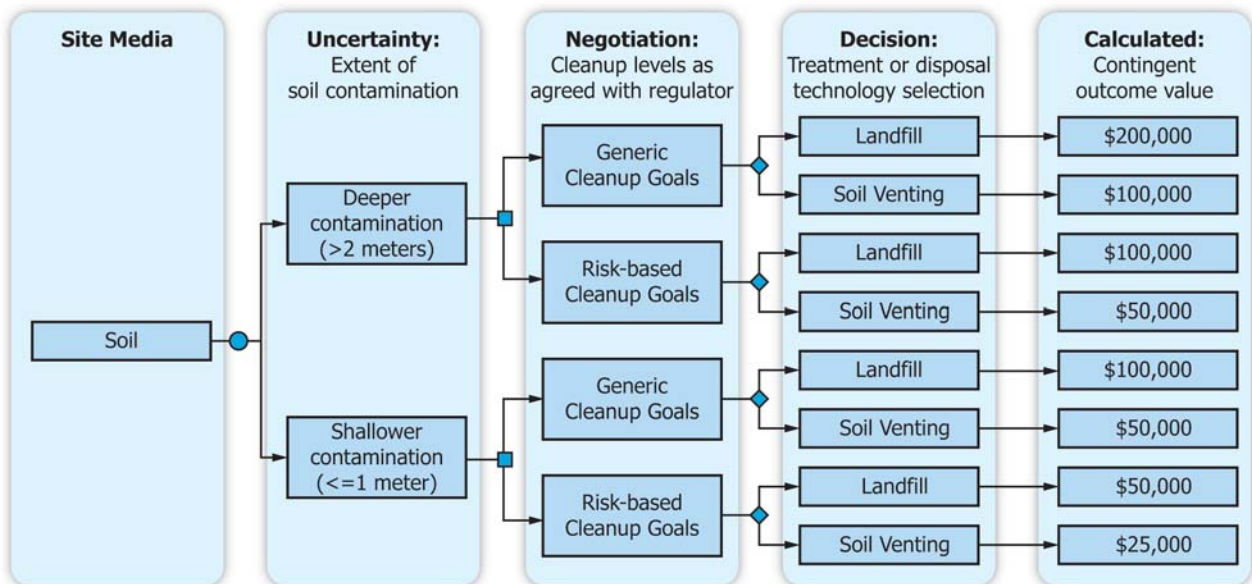


FIG. X2.1 Example Event Tree Uncertainties and Costs

X2.2.3.1 Soil volume for deep (2 m) soil contamination scenario equals 2,000 m<sup>3</sup>.

X2.2.3.2 Unit cost for offsite landfill disposal equals \$100 per m<sup>3</sup>.

X2.2.3.3 Unit cost for soil venting equals \$50 per m<sup>3</sup>.

X2.2.3.4 The costs associated with each potential outcome (represented by a particular path on the decision tree) are shown at the terminal nodes, which are depicted by convention by a triangle as shown in Fig. X2.1. These costs range from a minimum of \$25,000 to a maximum of \$200,000.

X2.2.4 Step 4. The likelihood of each outcome is determined as shown in Fig. X2.2.

X2.2.4.1 Approximately half of the soil borings collected at the site show that contamination extends to a depth of 2 m, and the other half show contamination extending to 1 m. Based on this information, a 50 % probability is assigned to each depth scenario.

X2.2.4.2 Historical experience with the relevant state agency suggests a reasonable likelihood that a site-specific risk assessment will be accepted. Accordingly, a 60 % probability is assigned to the higher risk-based cleanup goal, and a 40% probability is assigned to the default generic cleanup goal. (Note that the probabilities must add to 100 %.)

X2.2.4.3 Historical experience with the soil type present at the site and the level of contamination suggests a high likelihood of soil venting being technically feasible. Therefore,

a probability of 80 % is assigned to soil venting, and a 20 % probability is assigned to offsite landfill disposal.

X2.2.5 The expected value is then calculated by summing the probability-weighted costs for each pathway on the decision tree. Using the assumed probabilities and unit cost data, the expected value is calculated at \$63,000 (See calculation in Fig. X2.2). The probability of each individual outcome, as represented by a pathway on the decision tree, is calculated by multiplying the probabilities along that pathway. Thus, the maximum cost of \$200,000 has a 4 % likelihood (50 % × 40 % × 20 %) and the minimum cost of \$25,000 has a 24 % likelihood (50 % × 60 % × 80 %). The most likely outcome of \$50,000 has a probability of 46 % (by summing the three \$50,000 outcomes with probabilities of 24 %, 16 %, and 6 %).

X2.3 Using the data in the Example Event Tree (Fig. X2.1), estimators are able to display their findings as shown in Fig. X2.3. The example shows:

X2.3.1 The expected value (the Mean in Fig. X2.3) is \$63,190.

X2.3.2 The most likely value (the Mode in Fig. X2.3) is \$50,000.

X2.3.3 The range of values (Certainty Min and Certainty Max in Fig. X2.3) is \$25,000 to \$200,000.

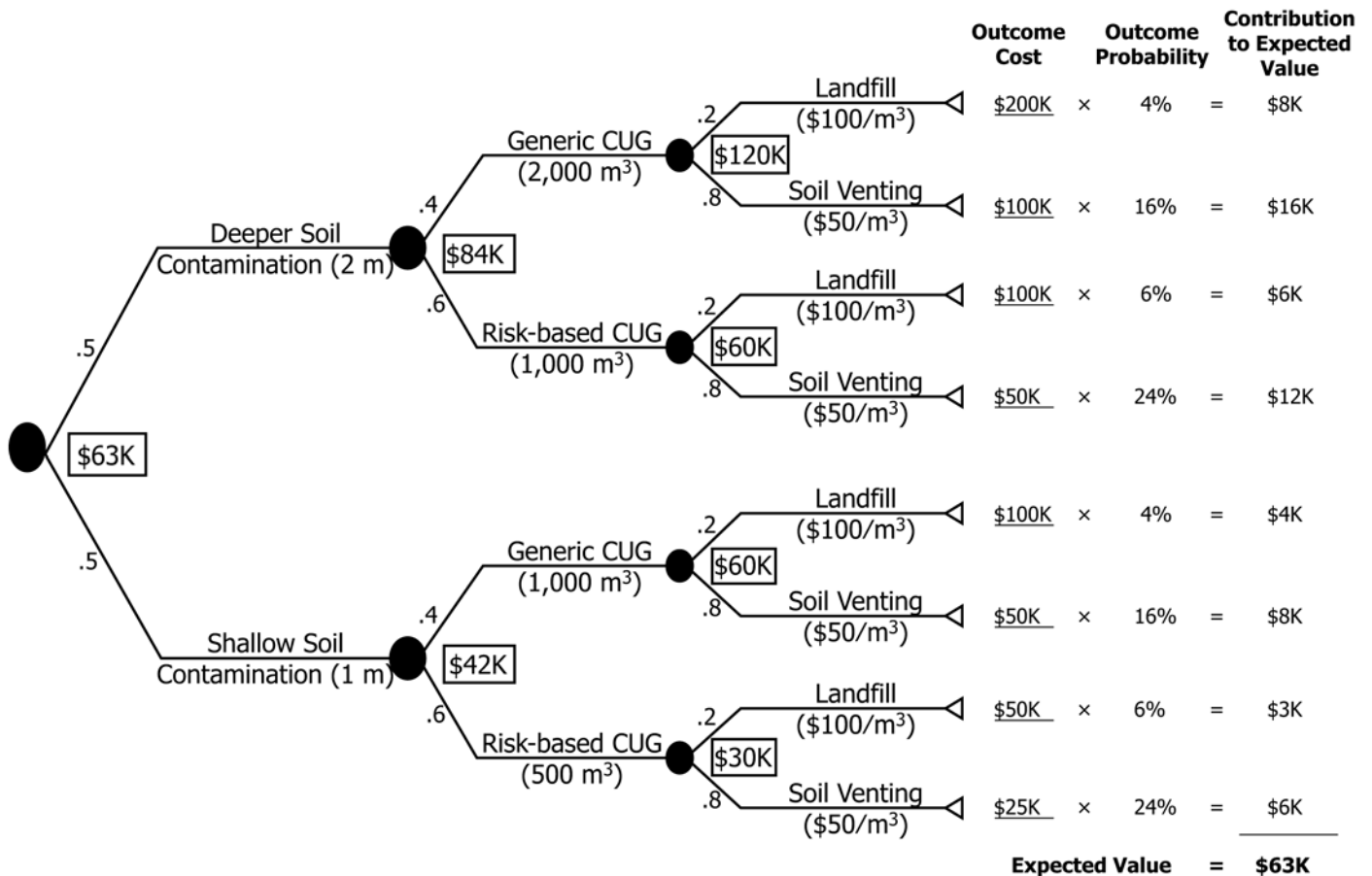


FIG. X2.2 Example Event Tree Expected Value

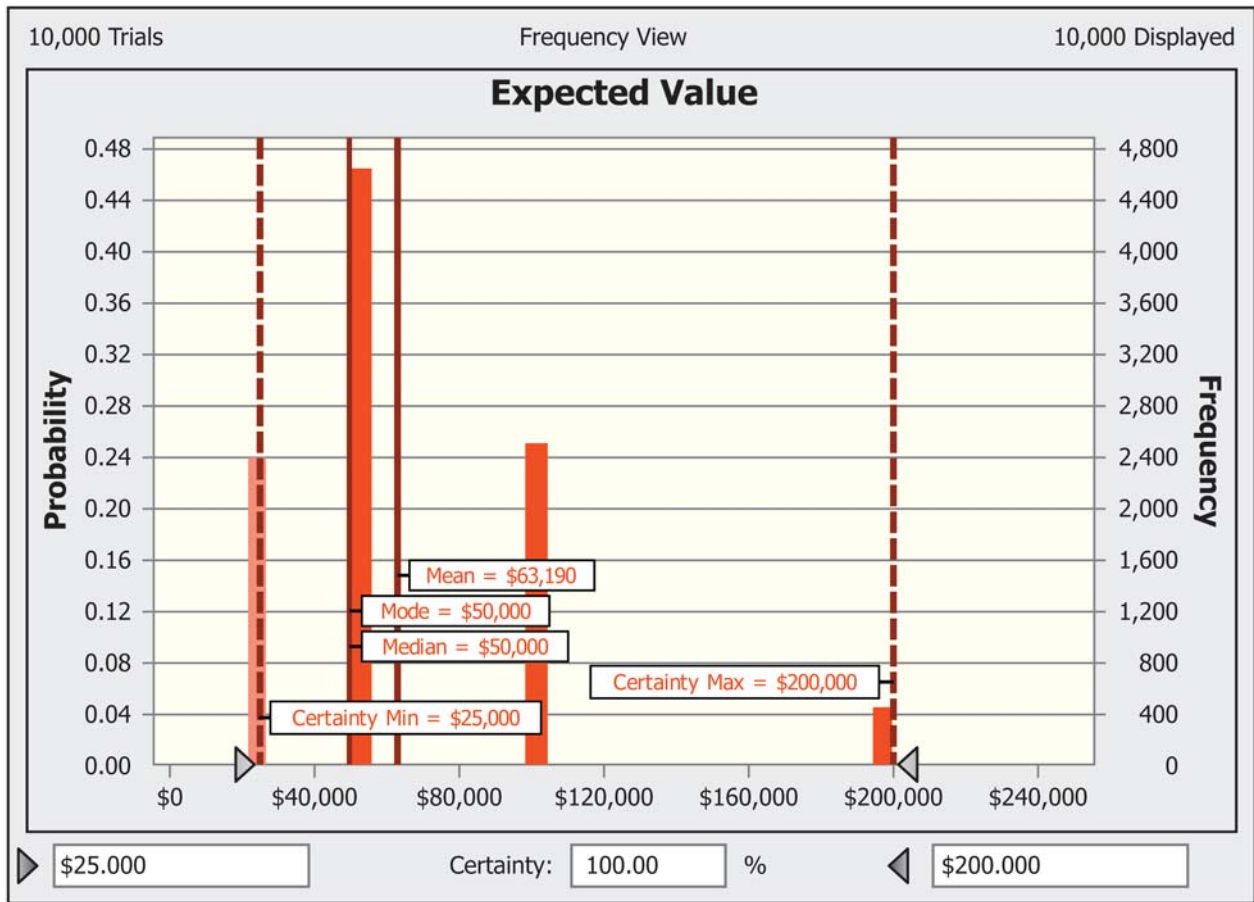


FIG. X2.3 Example Event Tree Statistics

X2.3.4 The known minimum value (Certainty Min in Fig. X2.3) is \$25,000.

X2.4 Other Complexities: As noted elsewhere in this standard, users will periodically find that a liability is not simply valued at the cost of implementing a remedial strategy. In order to bridge the gap between a project’s costs and a liability’s value, complexities such as counterparty risk and remedy failure can be incorporated into the analysis as in the examples below

X2.4.1 Counterparty Risk—Many environmental liabilities have open-ended time tables for resolution, and sometimes play out over decades. The survival of counterparties sharing in those liabilities is never assured, especially over such extended timeframes, and including the probability and consequence of that default may be part of a comprehensive calculation. (The GAAP requirements for this calculation are found at ASC 410-30-30-7, ASC 820-10-35-17, GASB 72:62 and IFRS 13:42.) For example, assuming the costs in the earlier example in X2.2 were for one of two parties that have a 50 percent cost sharing agreement, the variant example in Fig. X2.4 indicates potential outcomes for the soil venting remedy with 50 percent and 100 percent default of the counterparty.

X2.4.2 Remedy Failure—Periodically, a technical remedy or vendor may not meet regulatory or stakeholder expectations, requiring supplementary assessment and remediation. Regardless of fault, the dutyholder often assumes the risk of this failure, and will benefit from pricing in the probabilities and consequences of one or more failures. For example, assuming the costs in the earlier example in X2.2, the variant example in Fig. X2.5 indicates potential outcomes for one branch of the tree with potential remedy failure. Assuming the soil venting remedy is selected, the expanded tree for that remedy shows costs associated with no remedy failure, a design stage remedy failure, and a post-construction remedy failure. The first remedy failure branch has a 25 percent probability of failure at the 30 percent design stage, with an outcome value that includes both the \$30,000 loss and the cost for the \$200,000 landfill remedy. The second remedy failure branch has a 10 percent probability of failure in the post-construction stage, with an outcome value that includes an \$80,000 loss (80 percent of the soil venting remedy cost) plus the cost for the \$200,000 landfill remedy.

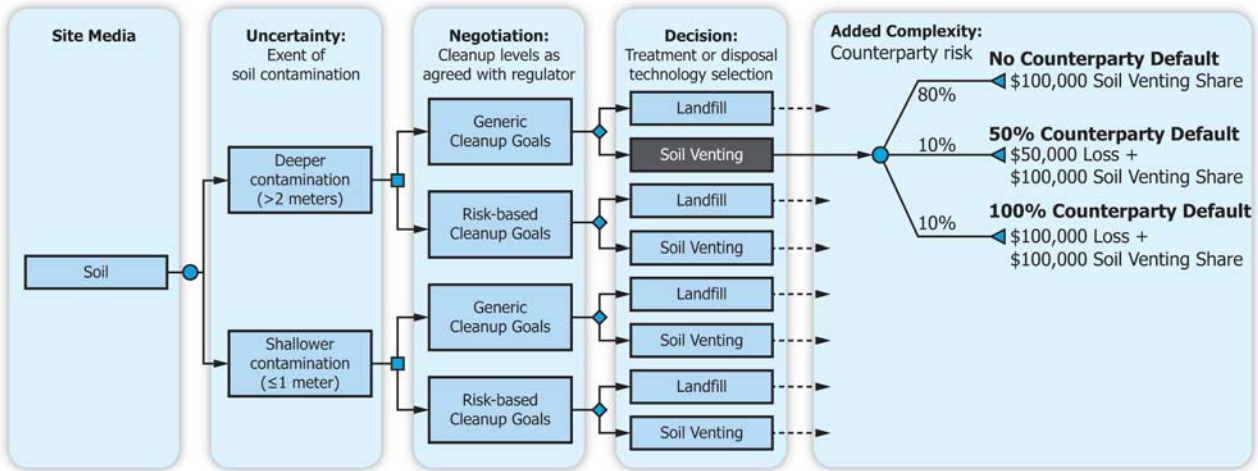


FIG. X2.4 Example Expanded Event Tree Branch for Counterparty Risk Example

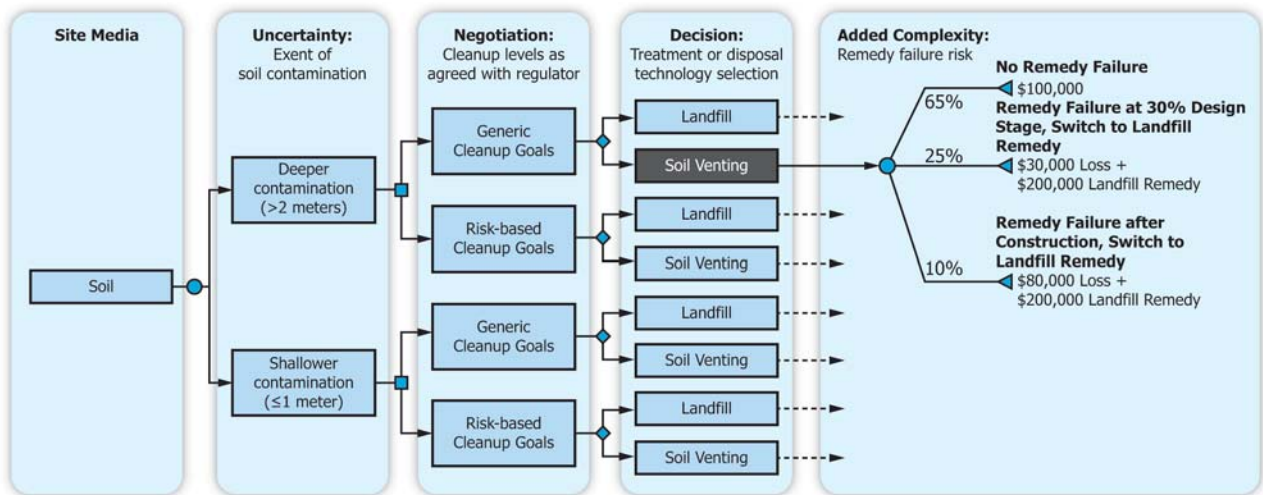


FIG. X2.5 Example Expanded Event Tree Branch for Remedy Failure Risk Example

### X3. POTENTIAL ALLOCATION CONSIDERATIONS

X3.1 The courts, PRP groups, and other parties have considered numerous issues in deriving *allocations* for multiparty environmental *liabilities*.<sup>20</sup> Factors that may be considered include, but are not limited to:

X3.1.1 The ability of the parties to demonstrate that their contribution to a discharge, release or disposal of a hazardous waste can be distinguished;

X3.1.2 The amount of the hazardous waste involved;

X3.1.3 The degree of toxicity of the hazardous waste involved;

<sup>20</sup> CERCLA states that “[In] resolving contribution claims, the court may allocate response costs among the liable parties using such equitable factors as the court determines are appropriate.” Having pointed to “equitable factors,” CERCLA is then silent as to what those factors might be.

X3.1.4 The degree of involvement by the parties in the generation, transportation, treatment, storage or disposal of the hazardous waste;

X3.1.5 The degree of care exercised by the parties with respect to the hazardous waste concerned, taking into account the characteristics of such hazardous waste;

X3.1.6 The degree of cooperation by the parties with federal, state, or local officials to prevent any harm to the public health or the environment.

X3.1.7 Existing contracts between parties on the question of *liability*, such as indemnity agreements;

X3.1.8 Relative fault of the parties (for example, cost causation, stand-alone costs);

X3.1.9 The owner’s acquiescence in the operator’s activities and manner of operation;

X3.1.10 The degree to which each party made efforts to prevent and/or contain any known release of hazardous wastes at the site, at the time the releases occurred;

X3.1.11 Relative economic benefits across the classes of *PRPs*; and

X3.1.12 Benefit to the current owner, if any, of the cleanup.

X3.2 If it is possible that other *PRPs* will not pay their full share, adjustments may be included to reallocate such *orphan shares*.

#### X4. DISPLAY OF PORTFOLIO AGGREGATION

X4.1 To enable periodic improvements in capital stewardship, *estimators* may develop an aggregation of environmental *costs or liabilities*. In the framework of FASB Statement 8, recognition and measurement of environmental *costs and liabilities* are distinct steps from displaying the aggregated portfolio of *costs and liabilities* internally to management and auditors, and those three steps are distinct from disclosure of the data to external users of the estimates. Examples of data tables include the following:

X4.2 *Site population tracking*: displaying three or more years of project counts, to highlight an underlying driver for changes in cost estimates. (See example in [Table X4.1](#).) These data may be used to evaluate whether the portfolio is growing and/or being worked down, and can implicitly describe the very long duration of environmental *costs and liabilities*. *Asset retirement obligations* (see FASB ASC 410-20 and GASB X) should not be combined for display with other types of environmental *costs and liabilities*. *ARO* forecasts must be at a discounted present value and include an annual *accretion* (unwinding of the discount rate). Estimates for other environmental *costs and liabilities* (see FASB ASC 410-30, 440, 450, 460) may be valued at present, current or future value at the choice of the *dutyholder*; although GASB 49 requires the use of current value estimates for pollution remediation obligations (roughly comparable to FASB ASC 410-30), which precludes an annual *accretion*.

X4.3 Site portfolio value tracking: displaying three or more years of the comparable financial information explains progress in stabilizing or reducing a portfolio value by using component factors. This format is based on FASB ASC 410-20-50-1 and enables improved auditing and disclosure (see Guide [E2173](#)) through medium-term display of detail behind *liability* changes. Examples of useful portfolio tracking tables are shown below in [Table X4.2](#), [Table X4.3](#), and [Table X4.4](#).

X4.4 Tax Implications Reporting: By including the pre-tax *liability* on a balance sheet, an entity normally will project the accompanying deferred tax asset, to account for the fact that spending from the reserve or provision will be tax deductible when paid (not when reserved). The balance sheet included both values, reserve and deferred tax asset, to reflect the after-tax impact of the environmental liabilities. See an example in [Table X4.5](#).

NOTE X4.1—See Guide [E2173](#) for additional reporting and tracking tables and accompanying discussion.

**TABLE X4.1 Example of Site Population Tracking**

ASC 410-30 Remediation	2015	2014	2013
Sites at start of fiscal year	47	47	40
Sites added or reopened	0	2	10
Sites closed or transferred	(1)	(2)	(3)
Sites at end of fiscal year	46	47	47

**TABLE X4.2 Example of Site Portfolio Tracking**

ASC 410-20 Asset Retirement (\$ millions)	2015	2014	2013
Liability value – start of fiscal year	125	160	150
Liabilities incurred	10	10	10
Liabilities settled (includes spending)	(15)	(30)	(30)
Accretion expense	0	0	0
Revisions in estimated cash flows	20	(15)	30
Liability value – end of fiscal year	140	125	160
Deferred tax assets due to liabilities reserved	28	25	32
Corporate tax rate assumption applied	20%	20%	20%
% balance in 3 <sup>rd</sup> party financial assurance instrument	10%	0%	0%
% balance self-insured	90%	100%	100%
Reasonably possible increment (liability range between current liability value and remote increment, as defined by entity policy)	20	30	40
Remote increment (liability range above reasonably possible increment, as defined by entity policy)	105	115	125

**TABLE X4.3 Example of Site Portfolio Assumption Tracking**

	2015	2014	2013
Inflation assumption (average) applied to portfolio	0%	0%	0%
Discount assumption (average) applied to portfolio	0%	0%	0%
Time horizon used for portfolio liability forecasting	10 yrs	10 yrs	10 yrs
Percent of liability balance calculated using expected value	90%	85%	80%
Percentile we used for determining our own "ability to pay" (max = 100)	94%	90%	95%
Weighted average percentile of counterparties' abilities to pay (max = 100)	21%	17%	33%
Percent of liability balance concentrated in five largest environmental counterparties (or PRPs)	2%	25%	18%
Percentage of liability balance with updated estimates	40%	0%	10%
Date of cost index used	June 2015	Jan 2012	Jan 2012

**TABLE X4.4 Example of Site Portfolio Recoveries/Offsets Tracking**

ASC 410-30 Remediation (\$ millions)	2015	2014	2013
Recoveries – start of fiscal year	0	0	0
Recoveries added	10	15	15
Recoveries received	(10)	(15)	(15)
Recoveries – end of fiscal year	0	0	0
Recoveries – reasonably possible	30	35	40
Recoveries - remote	65	70	75

**TABLE X4.5 Example of Tax Implications Reporting**

ASC 410-30 Remediation (\$ millions)	2015	2014	2013
Liability balance, end of year	140	125	160
Tax rate applied to generate asset value	30%	25%	25%
Deferred tax asset associated with liability balance	42	31	40

## X5. INFLATION AND DISCOUNT RATE ASSUMPTIONS

X5.1 Depending on the purpose of the estimate disclosure (such as due diligence/acquisition, financial assurance, feasibility study, reserve or provision setting, or budgeting) alternative calculations may be performed on the same cash flows. It is important to consider the following when applying inflation and discounting to cash flows:

(1) Check with any regulations, standards, or court rulings that may govern your disclosure to determine guidance on required inflation/discounting applications

(2) Determine what type of value you are calculating and whether inflation/discounting is required. For example, you may be calculating one of the following, and it is important to understand the difference:

- a. Current value, which is estimated in today's dollars, and excludes the impact of inflation and discounting
- b. Future value, which inflates values to a future date, and may include interest
- c. Present value, which includes discounting to a specified date

(3) Understand the type of cash flows that you are working with, and to the extent possible, match the inflation/discounting rates that are appropriate to your cash flows. For example:

a. If your cash flows are in real (uninflated) dollars, use a real discount rate

b. If your cash flows are in nominal (inflated) dollars, use a nominal discount rate

c. If your cash flows are pre-tax, use a pre-tax discount rate; if your cash flows are after-tax, use an after-tax discount rate

d. Think about what your cash flows represent (for example, chemical processing, construction, energy, labor) and consider whether there is an inflation rate (whether retrospective or prospective) that best matches the cash flow being inflated

e. Think about whether your cash flows should be discounted with a risk-free rate or a risk-adjusted rate (and if risk-adjusted, what risks are being captured)

(4) Keep in mind the timing of the cash flows, and match historical or forecast inflation/discount rates that are appropriate to the timing of the cash flows.

(5) Understand whether compounding is appropriate for your calculations.

All inflation/discounting assumptions should be clearly disclosed.



## X6. THRESHOLD FOR PERFORMING ADDITIONAL ANALYSIS

X6.1 In order to improve capital stewardship over time and focus attention on higher-priority analysis first, an *estimator* may find it productive to develop a threshold framework for determining when to perform additional analysis. The thresholds will be dependent on the circumstances, but may include items such as a percentage or order-of-magnitude change in cost, elapsed time since last estimate, or key milestones seen as

cost drivers. An example of a threshold analysis is shown below in **Table X6.1**. Note that all values and items in this table are for illustration purposes only.

NOTE X6.1—Examples of environmental watch lists can be found in the appendices of Guide **E2173**.

**TABLE X6.1 Example of Threshold Table**

Expected cost to close	<\$0.1 M	\$0.1 - \$0.5 M	\$0.5 - \$1 M	\$1 - \$5 M	\$5 M +	Project with a financial assurance requirement
Estimate detail	x	x	x	x	x	x
Cost bracketing	x	x	x	x	x	x
Remedy scenarios	...	x	x	x	x	...
Non-remedy scenarios	...	...	x	x	x	...
Weighting of scenarios	x	x	x	x	x	...
Detailed decision analysis	...	...	x	x	x	...
Sensitivity analysis	...	...	...	x	x	...
Peer review of costs	...	...	...	x	x	...
Peer review of remedy constructability	...	...	...	...	x	...

## X7. RECOGNITION BENCHMARKS AND OBLIGATING EVENTS

X7.1 As an environmental *cost or liability* reaches a different *recognition benchmark* or *obligating event*, an updated cost estimate is necessary.

*Recognition Benchmarks* (from ASC 410-30-25-15)

- (1) Identification and verification of an entity as a *potentially responsible party*
- (2) Receipt of a unilateral administrative order.
- (3) Participation, as a *potentially responsible party*, in the remedial investigation-feasibility study
- (4) Completion of feasibility study.
- (5) Issuance of record of decision
- (6) Remedial design through operation and maintenance, including postremediation monitoring.

*Recognition Benchmarks* (from GASB49:12)

- (1) Receipt of an administrative order.
- (2) Participation, as a responsible party or a *PRP*, in the site assessment or investigation.
- (3) Completion of a corrective measures feasibility study.
- (4) Issuance of an authorization to proceed.
- (5) Remediation design and implementation, through and including operation and maintenance, and post-remediation monitoring

*Obligating events* (from GASB49:11):

- (1) The government is compelled to take pollution remediation action because of an imminent endangerment.
- (2) The government violates a pollution prevention–related permit or license.
- (3) The government is named, or evidence indicates that it will be named, by a regulator as a responsible party or *potentially responsible party (PRP)* for remediation, or as a government responsible for sharing costs.
- (4) The government is named, or evidence indicates that it will be named, in a lawsuit to compel participation in pollution remediation.
- (5) The government commences or legally obligates itself to commence pollution remediation.

NOTE X7.1—Certain international accounting requirements and guidelines also address *obligating events* that may trigger a new or updated cost estimate. For example, International Accounting Standard (IAS) 37 and Australian Accounting Standards Board (AASB) 137 address “An event that does not give rise to an obligation immediately may do so at a later date, because of changes in the law or because an act (for example, a sufficiently specific public statement) by the entity gives rise to a *constructive obligation*.”

## X8. GUIDANCE FROM PCAOB AUDIT STANDARD 2501.05

### INTRODUCTION

*The following narrative is directly from PCAOB Audit Standard 2501.05. The full text is on the [www.pcaob.org](http://www.pcaob.org) website. Note the process and results checked by auditors are intentionally mirrored in this standard guide.*

X8.1 Developing Accounting Estimates: .05 Management is responsible for establishing a process for preparing accounting estimates. Although the process may not be documented or formally applied, it normally consists of:

- (a) Identifying situations for which accounting estimates are required.
- (b) Identifying the relevant factors that may affect the accounting estimate.
- (c) Accumulating relevant, sufficient, and reliable data on which to base the estimate.
- (d) Developing assumptions that represent management’s judgment of the most likely circumstances and events with respect to the relevant factors.

(e) Determining the estimated amount based on the assumptions and other relevant factors.

(f) Determining that the accounting estimate is presented in conformity with applicable accounting principles and that disclosure is adequate.

The risk of material misstatement of accounting estimates normally varies with the complexity and subjectivity associated with the process, the availability and reliability of relevant data, the number and significance of assumptions that are made, and the degree of uncertainty associated with the assumptions.

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