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Standard Guide for Optimization of Groundwater Monitoring Constituents for Detection Monitoring Programs for Waste Disposal Facilities[1]

This standard is issued under the fixed designation D7045; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

1. Scope*

1.1 This standard provides a general method of selecting effective constituents for detection monitoring programs at Waste Disposal Facilities. The process described in this standard presents a methodology that takes into consideration physical and chemical characteristics of the source material(s), the surrounding hydrogeologic regime, and site-specific geochemistry to identify and select those parameters that provide most effective detection of a potential release from a waste management unit (WMU).

1.2 In the following sections, details of an evaluation of effective monitoring constituents for a groundwater detection-monitoring program were based on site-specific waste characterization.

1.3 The statistical methodology described in the following sections should be used as guidance. Other methods may also be appropriate based on site-specific conditions or for monitoring situations or media that are not presented in this standard.

1.4 This guide offers an organized collection of information or a series of options and does not recommend a specific course of action. This document cannot replace education, experience and professional judgements. Not all aspects of this guide may be applicable in all circumstances. This ASTM standard is not intended to represent or replace the standard of care by which the adequacy of a given professional service must be judged without consideration of a project's many unique aspects. The word standard in the title of this document only means that the document has been approved through the ASTM consensus process.

1.5 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory requirements prior to use.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

D653 Terminology Relating to Soil, Rock, and Contained Fluids

D5792 Practice for Generation of Environmental Data Related to Waste Management Activities: Development of Data Quality Objectives

D6312 Guide for Developing Appropriate Statistical Approaches for Groundwater Detection Monitoring Programs at Waste Disposal Facilities

3. Terminology

3.1 *Definitions*—For common definitions of technical terms used in this standard, refer to Terminology D653.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *leachate*—a liquid that has passed through or emerged from solid waste and contains soluble, suspended, or miscible materials removed from such waste.

3.2.2 *outlier*—a measurement that is statistically inconsistent with the distribution of other measurements from which it was drawn.

3.2.3 *practical quantitation limit (PQL)*—the lowest level that can reliably achieved with specified limits of precision and accuracy during routine laboratory operating conditions.

3.2.4 *qualified groundwater scientist (QGWS)*—a scientist or engineer who has received a baccalaureate or postgraduate degree in the natural sciences or engineering and has sufficient training in groundwater hydrology and related fields as may be demonstrated by state registration, professional certifications, or completion of accredited university programs that enable the individual to make sound professional judgments regarding groundwater monitoring, contaminant fate and transport, and corrective action.

[1] This guide is under the jurisdiction of ASTM Committee D18 on Soil and Rock and is the direct responsibility of Subcommittee D18.21 on Groundwater and Vadose Zone Investigations.

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

*A Summary of Changes section appears at the end of this standard

3.2.5 *upper confidence limit (UCL)*—an upper limit that has a specified probability (for example, 95 %) of including the true concentration (or other parameter). Taken together with lower confidence limit, forms a confidence interval that will include the true concentration with confidence level that accounts for both tail areas.

3.2.6 *upper limit (UL)*—an upper limit of a data set of population (*n*) that may be statistically or non-statistically based.

3.2.7 *waste management unit (WMU)*—a permitted waste disposal unit or temporary containment structure that is designed and constructed to inhibit the migration of wastes to the adjacent environment.

4. Summary of Guide

4.1 The guide is summarized as figures shown in Figs. 1-3. These figures provide a flow-chart illustrating the steps used in characterizing the source material, collecting background data, establishing an upper limit for each analyte included in the program, and/or establishing effective monitoring constituents that will provide an indication of whether the WMU is potentially impacting surface and groundwater in the vicinity of the unit.

5. Significance and Use

5.1 The principal use of this standard is in the identification of effective groundwater monitoring constituents for a detection-monitoring program. The significance of the guide is to minimize the false positive rate for the facility by only monitoring those constituents that are intrinsic to the waste mass and eliminate those constituents that are present in background in concentrations that confound evaluation from downgradient wells.

5.2 Governing regulations require large generic lists of constituents to be monitored in an effort to detect a release from a WMU. However, identification and selection of parameters based on site-specific physical and chemical conditions are in many cases also acceptable to regulatory agencies and result in a more effective and environmentally protective groundwater monitoring system.

5.2.1 Naturally occurring soil and groundwater constituents within and near a WMU area should be determined prior to the development of a monitoring program. This is important in the selection of site-specific constituents lists and avoiding difficulties with a regulatory authority regarding sources of monitored constituents.

5.2.2 Site-specific lists of constituents relative to the WMU will provide for the regulator those constituents which will effectively measure the performance of a WMU rather than the use of a generic list that could include naturally occurring constituents as well as those not present in the WMU.

5.3 Site-specific constituent lists often result in fewer monitored constituents (that is, monitoring programs are optimized). This process is critical to the overall success of the monitoring program for the following reasons:

5.3.1 The reduction of the monitoring constituents to only those found or expected to be found or derived from site-specific source material will reduce the number of false-positive results since only those parameters that could indicate a release are monitored.

5.3.2 The use of constituents that contrast significantly to background groundwater eliminates those that could lead to erroneous results merely due to temporal and spatial variability of components found in the natural geochemistry of the upper-most water-bearing zone.

5.3.3 Where statistics are required, fewer statistical comparisons through well and constituent optimization enhances the statistical power (or effectiveness) of the monitoring program (Gibbons, 1994; USEPA, April 1998).

5.3.4 Eliminating the cost of unnecessary laboratory analyses produces a more efficient and cost-effective monitoring program and minimizes the effort needed by both the local enforcement agency and the owner/operator to respond (either with correspondence or additional field/laboratory efforts) to erroneous detection decisions.

5.4 This type of approach is acceptable to regulatory agencies arid applicable under most groundwater monitoring programs.

NOTE 1—For example, in the United States, determining the alternate constituent list at Solid Waste Facilities, 40 CFR 258.54(a)(l) allows for deletion of 40 CFR 258 Appendix I constituents if it can be shown that the removed constituents are not reasonably expected to be in or derived from the waste contained in the unit. 40 CFR 258(a)(2) allows approved States to establish an alternate list of inorganic parameters in lieu of all or some of the heavy metals (constituents 1-14 in Appendix I to Part 258), if the alternative constituents provide a reliable indication of inorganic releases from the unit to groundwater.

5.5 The framework for this standard is generally based on the guidelines established under 40 CFR 258.54(a)(l) to optimize a groundwater-monitoring network in such a manner as to still provide an early warning system of a release from the WMU. This guidance document is, however, applicable for most WMU, not just those associated with solid waste disposal facilities. In determining the alternative constituents, consideration must be made for: *(1)* the types, quantities, and concentrations of constituents in wastes managed at the waste management unit (or WMU); *(2)* the mobility, stability, and persistence of waste constituents in the unsaturated zone beneath the WMU; *(3)* the detectability of indicator parameters, waste constituents, and reaction products in groundwater; and *(4)* the concentration or contrast between monitoring constituents in leachate and in background groundwater.

5.6 An essential factor in this guide is the knowledge of the quality of the potential source material [for example, the types and concentrations of liquid or other leachable wastes (that is, leachate) within the WMU]. The characterization of the source material is critical in determining an optimum set of indicator parameters that provide an early warning system of a release from the unit. Details for the appropriate levels of effort to characterize the waste stream or source(s) in the WMU are not included within this guidance document. Waste stream and/or source data collected by the owner/operator as well as liquid data from key collection points (that is, sumps or natural gravity drain collection points) are an integral part of any waste characterization process.

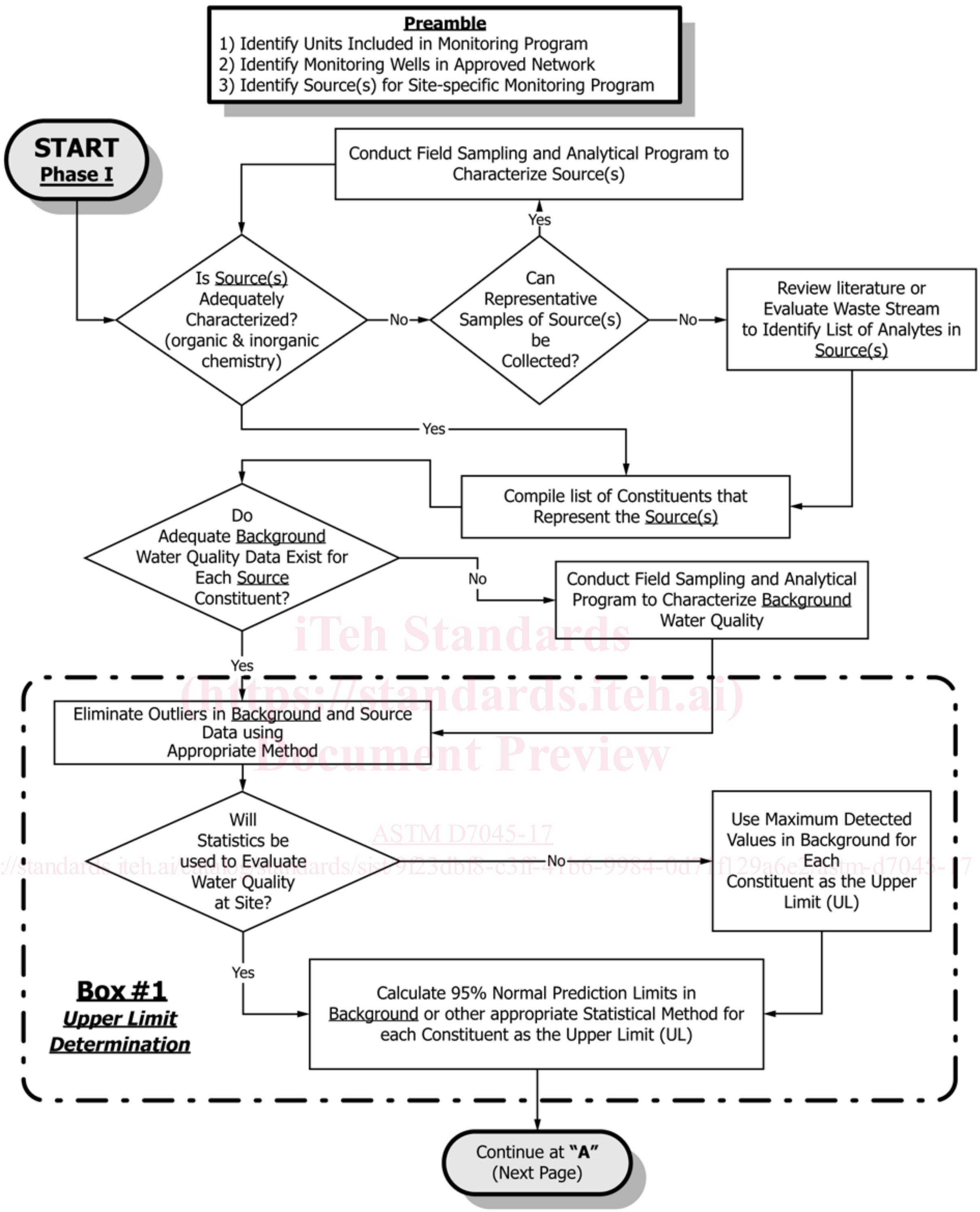

FIG. 1 Phase I—Indicator Parameter Identification

5.7 Another key factor to be used in this guide is knowledge of background quality of groundwater unaffected by the WMU and knowledge of local sources other than the WMU that may presently be impacting groundwater quality. The main objective then is to choose those constituents that are derived from the WMU (for example, are present in the leachate or residual liquids) at much higher concentrations than groundwater and/or that are only present in the waste or waste residuum (for

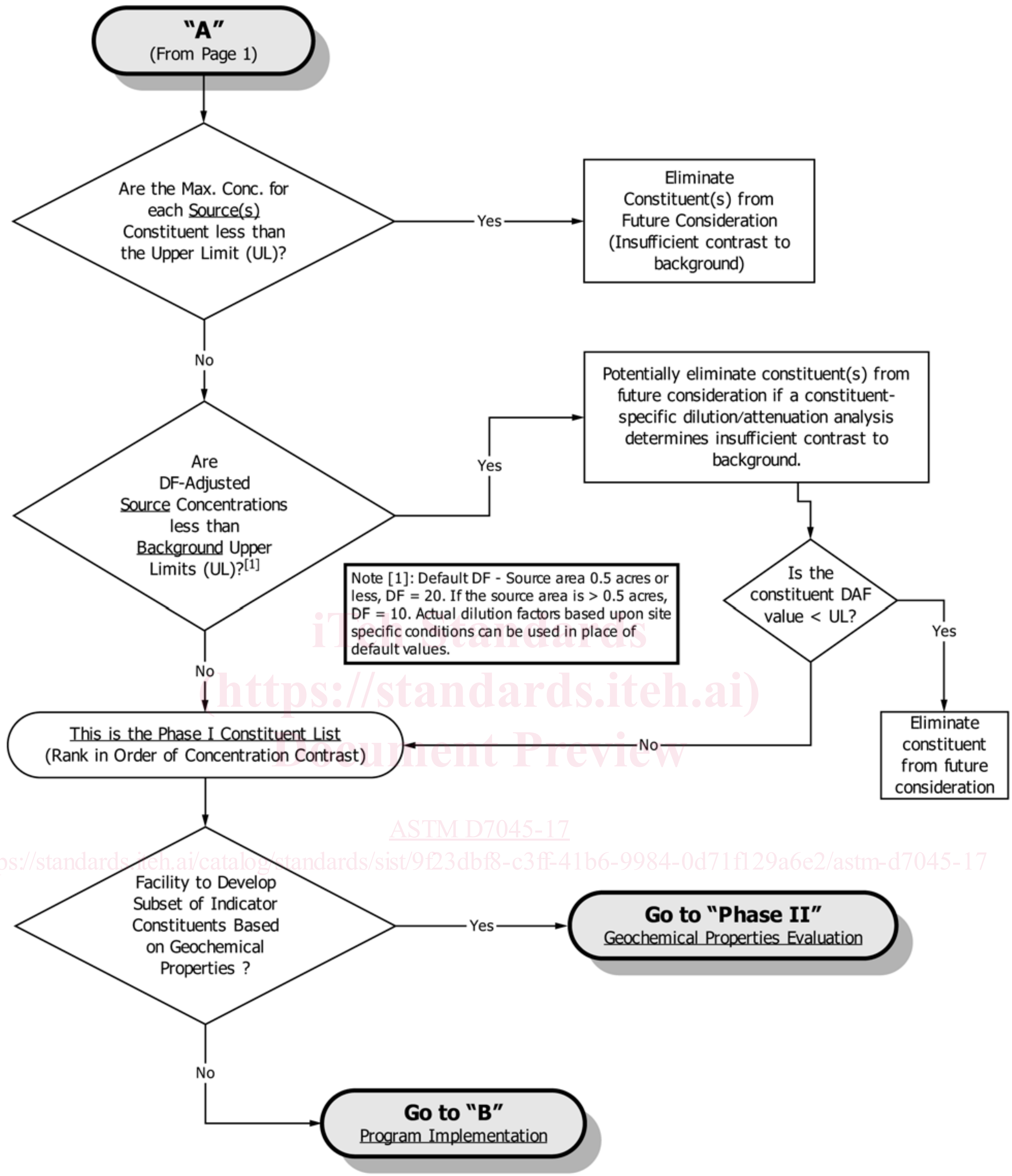

FIG. 1 Phase I—Indicator Parameter Identification *(continued)*

example, leachate) and absent in groundwater. The analytes chosen must also be mobile, persistent, and easily quantifiable in the specific hydrogeologic and groundwater regime.

6. Procedure

6.1 This guide is used to identify and select site-specific monitoring constituents. The practice requires site-specific characterization of the liquids derived from the source (that is, leachate) and background groundwater geochemistry (that is, the types, quantities, and concentrations of constituents present in the WMU). First, comparison of maximum detected leachate constituents to background prediction limits are used as a "first-order" process to identify indicator parameters in leachate that contrast significantly to background groundwater quality. Next, a mixing model is used as a "second-order" process, if necessary, to further identify analytes that are best

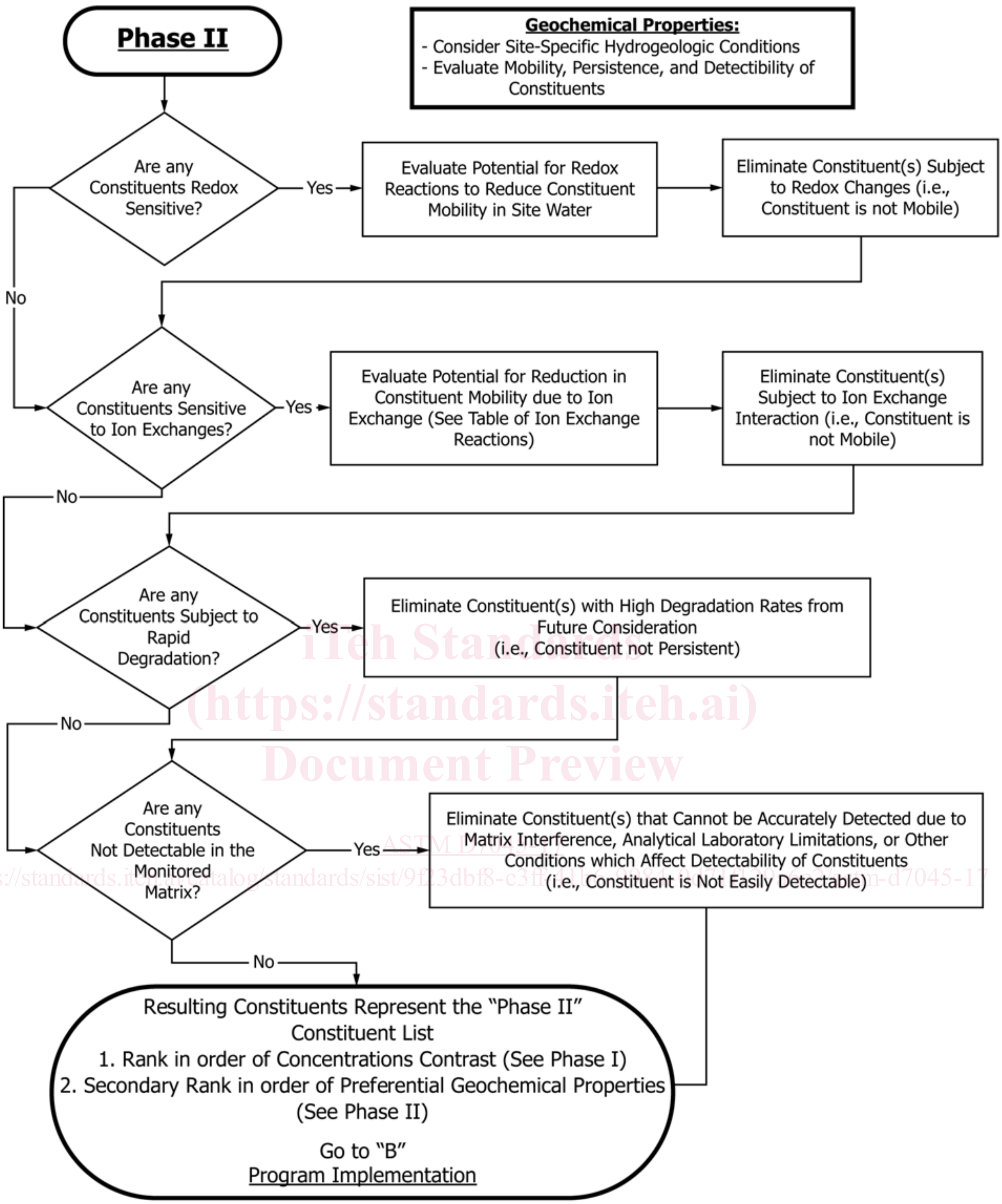

FIG. 2 Phase II—Geochemical Properties Evaluation

suited for the detection-monitoring program based on site hydrogeology (that is, groundwater flow rates). Finally, other processes, primarily geochemical chemical interactions, can be addressed as a "third order screening process" for those sites that have adequately completed the first two processes and desire a more representative subset of the source material. Once a suitable list of site specific constituents is identified, a QGWS can select and propose an analyte list for the detection-monitoring program at the WMU. A sequential flow chart has been included as Attachment 1 to provide a means to follow the constituent optimization program outlined in this standard.

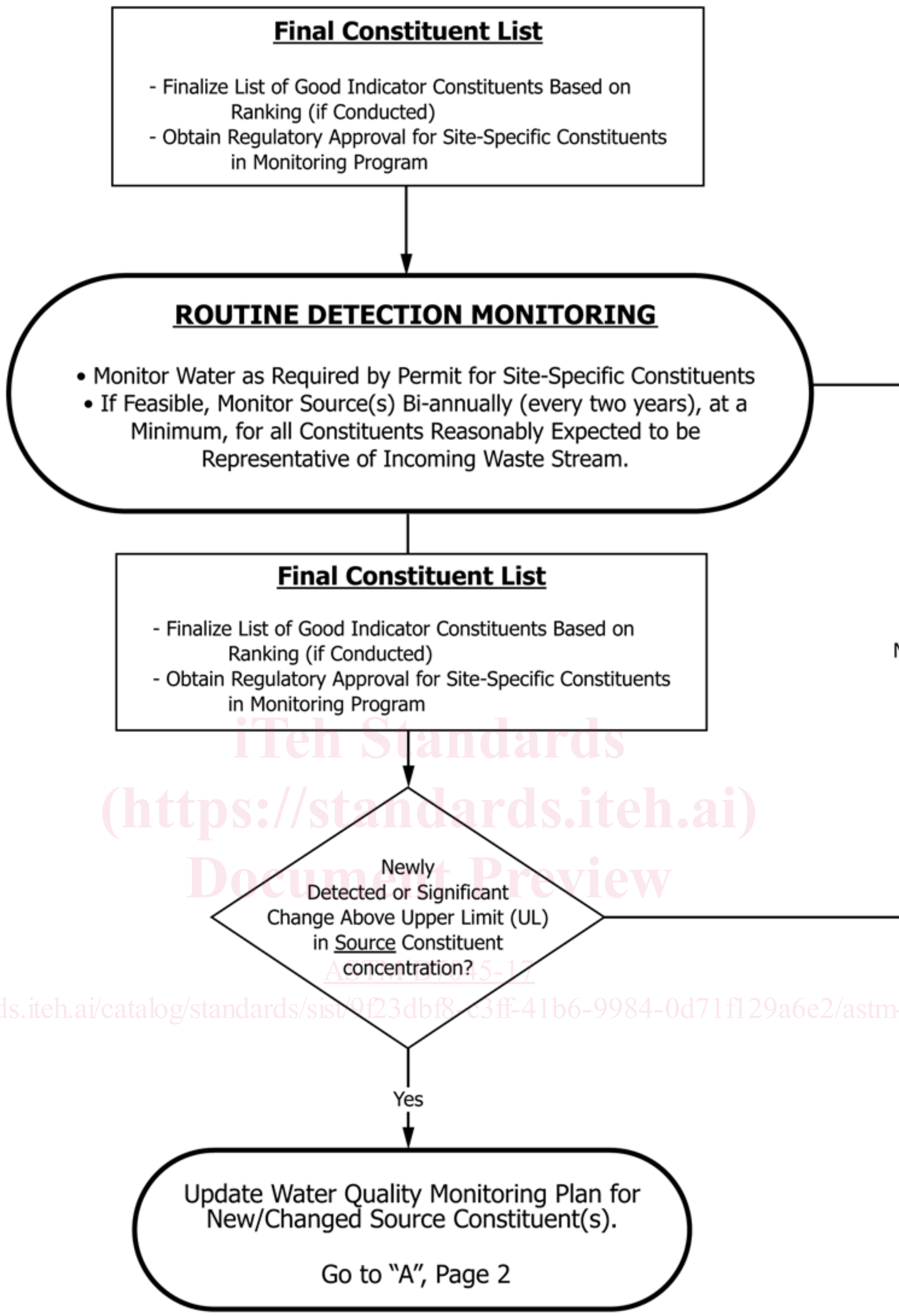

FIG. 3 Monitoring Program Implementation

6.2 *Source Characterization:*

6.2.1 As a first-order screening process, the owner/operator needs to determine if sufficient source characterization data exists to be able to define (that is, fingerprint) the liquid, or the more mobile, waste stream contained within the WMU. For the purposes of this standard, we refer to liquids derived from the WMU as leachate. Leachate is a complex matrix containing a variety of soluble, insoluble, organic, inorganic, ionic, nonionic, and bacteriological constituents in an aqueous medium. Leachate usually is more than 99 % water.

6.2.2 Leachate characterization should include an assessment and demonstration of the quantity and composition of leachate contained within the WMU. Estimates of volumetric production rates of leachate are important in evaluating the fate and transport of the constituents. Leachate production rates depend on rainfall, run-on, run-off, evapo-transpiration, water