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Standard Guide for NAPL Mobility and Migration in Sediments – Screening Process to Categorize Samples for Laboratory NAPL Mobility Testing[1]

This standard is issued under the fixed designation E3281; 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 guide is designed for general application at a wide range of sediment sites where non-aqueous phase liquid (NAPL) is present or suspected to be present in the sediment. This guide describes a process to use field screening methods, specifically visual observations, and the results of shake tests, to categorize the relative amount of NAPL present in a sample. This categorization can then be utilized to select co-located sediment samples for laboratory testing to determine if the NAPL in the sample interval is mobile or immobile at the pore scale, or any other chemical or physical testing.

1.1.1 There is no current industry standard methodology to select sediment samples for laboratory NAPL mobility testing; the use of different methodologies is possible. This guide focuses on a selection process that uses visual observations and shake tests. This process has the advantage of being simple to use and, if applied in a disciplined manner, has been demonstrated to provide good results in the field.

1.2 This guide is intended to inform, complement, and support characterization and remedial efforts performed under international, federal, state, and local environmental programs but not supersede local, state, federal, or international regulations. The users of this guide should review existing information and data available for a sediment site to determine applicable regulatory agency requirements and the most appropriate entry point into and use of this guide.

1.3 ASTM International (ASTM) standard guides are not regulations; they are consensus standard guides that may be followed voluntarily to support applicable regulatory requirements. This guide may be used in conjunction with other ASTM guides developed for assessing sediment sites.

1.4 This guide does not address methods and means of sample collection (Guide E3163).

1.5 *Units*—The values stated in SI or CGS units are to be regarded as the standard. No other units of measurement are included in this standard.

1.6 *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, health, and environmental practices and determine the applicability of regulatory limitations prior to use.*

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

2. Referenced Documents

2.1 *ASTM Standards:*[2]

D2487 Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System)

D2488 Practice for Description and Identification of Soils (Visual-Manual Procedures)

D7203 Practice for Screening Trichloroethylene (TCE)-Contaminated Media Using a Heated Diode Sensor

E2531 Guide for Development of Conceptual Site Models and Remediation Strategies for Light Nonaqueous-Phase Liquids Released to the Subsurface

E2856 Guide for Estimation of LNAPL Transmissivity

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

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

E3268 Guide for NAPL Mobility and Migration in Sediment—Sample Collection, Field Screening, and Sample Handling

E3282 Guide for NAPL Mobility and Migration in Sediments – Evaluation Metrics

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

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

F2534 Guide for Visually Estimating Oil Spill Thickness on Water

3. Terminology

3.1 *Definitions:*

3.1.1 *immobile NAPL, n*—NAPL that does not move by advection within the connected void spaces of the sediment under specified physical and chemical conditions, as may be demonstrated by laboratory testing, or may be interpreted based on mathematical calculations or modeling. **E3248**

3.1.2 *mobile NAPL, n*—NAPL that may move by advection within the connected void spaces of the sediment under specific physical and chemical conditions, as may be demonstrated by laboratory testing, or as may be interpreted based on mathematical calculations or modeling. **E3248**

3.1.3 *non-aqueous phase liquid, NAPL, n*—chemicals that are insoluble or only slightly soluble in water that exist as a separate liquid phase in environmental media. **E3248**

3.1.3.1 *Discussion*—NAPL may be less dense than water (light non-aqueous phase liquid [LNAPL]) or more dense than water (dense non-aqueous phase liquid [DNAPL]).

3.1.4 *pore scale, n*—the scale of the connected void spaces within the sediment. **E3248**

3.1.5 *sediment(s), n*—a matrix of pore water and particles including gravel, sand, silt, clay, and other natural and anthropogenic substances that have settled at the bottom of a tidal or nontidal body of water. **E3163**

3.1.6 *sheen, n*—a silvery, rainbow, or dark rainbow film on the surface of the sediment sample or on a water surface.

4. Significance and Use

4.1 NAPLs (for example, chlorinated solvents, petroleum products, and creosote) can be emplaced in sediments through a variety of mechanisms (Guide E3248). Dense non-aqueous phase liquids (DNAPLs) are more dense than water, whereas light non-aqueous phase liquids (LNAPLs) are less dense than water.

4.2 Standardized guidance and test methods currently exist for assessing NAPL mobility at upland sites, from organizations such as ASTM (Guides E2531 and E2856), Interstate Technology & Regulatory Council (**1**)[3] and the American Petroleum Institute (**2, 3**).

4.3 Guide E3248 provides guidance regarding when a NAPL movement evaluation is warranted. After confirming that NAPL is present and evaluating nature and extent as appropriate, the next step in any NAPL movement evaluation is to evaluate if NAPL is mobile or immobile at the pore scale—this is done using tiered or weight of evidence (WOE) approaches. This guide provides a structured process to select samples to submit to the laboratory for NAPL mobility testing that is part of a NAPL movement evaluation.

4.4 This guide may be used by various parties involved in sediment corrective action programs, including regulatory agencies, project sponsors, environmental consultants, toxicologists, risk assessors, site remediation professionals, environmental contractors, and other stakeholders.

4.5 This guide should be used in conjunction with other reference material (refer to Section 2 and References) that direct the user in developing and implementing sediment assessment programs.

4.6 This guide is related to Guide E3163, concerning sediment analytical techniques used during sediment programs. This relates to Guide E3248, which discusses generic models for the emplacement and advection of NAPL in sediments. It is related to Guide E3268, which describes sample collection, field screening and sample handling considerations in NAPL movement evaluations. And this is related to Guide E3282, which describes evaluation metrics and frameworks to determine if NAPL is immobile or immobile at the pore scale, or if it is migrating or stable at the NAPL body scale.

4.7 This guide does not replace the need for engaging competent persons to evaluate NAPL emplacement and movement in sediments. Activities necessary to develop a conceptual site model should be conducted by persons familiar with NAPL-impacted sediment site characterization techniques, physical and chemical properties of NAPL in sediments, fate and transport processes, remediation technologies, and sediment evaluation protocols. The users of this guide should consider assembling a team of experienced project professionals with appropriate expertise to scope, plan, and execute sediment NAPL data acquisition activities.

4.8 This guide provides a framework based on overarching features and elements that should be customized by the user, based on site-specific conditions, regulatory context, and program objectives for a particular sediment site. This guide should not be used alone as a prescriptive checklist.

4.9 The user of this guide should review the overall structure and components of this guide before proceeding with use, including:

5. Summary of the Process for Screening and Selection of Samples for Laboratory NAPL Mobility Testing

5.1 One key factor that typically influences the potential for NAPL mobility of advectively emplaced NAPL is the NAPL

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

saturation (that is, the percentage of the total pore space that is filled with NAPL); the distribution of NAPL within the pores also has an effect on the mobility of the NAPL (that is, a relatively small amount in NAPL within the largest pores can produce mobility). Generally, the potential for NAPL mobility is greater in sediments containing relatively more NAPL and less in sediments containing relatively less NAPL; for depositionally emplaced NAPLs, the mobility is also strongly influenced by the degree of encapsulation of the NAPL. Therefore, this guide offers a process for qualitatively categorizing the relative amount of NAPL present in sediments. This information is then used to select locations and depth intervals for laboratory NAPL mobility testing.

5.2 There are two ways in which the categorization process presented in this guide can be used to select locations and depth intervals for laboratory NAPL mobility testing.

5.2.1 In the first method, often used in sediment investigations, grab samples of surface sediment and core samples of subsurface sediment are collected to determine the nature and extent of NAPL. Once the relative amount of NAPL in various areas and depths within the sediment has been categorized using the process described in this guide, NAPL mobility sampling is performed at targeted locations during a subsequent sampling event.

5.2.1.1 The advantage of this approach is that previously collected data can be used to select targeted locations and general depths for laboratory NAPL mobility testing, so the subsequent NAPL mobility sampling is focused and efficient.

5.2.1.2 A disadvantage to this approach is that multiple sampling events are necessary, which could extend the time required to complete the site investigation. In some cases, depending on site-specific conditions (for example, difficult access, small sampling area) and the number of cores to be collected, this approach could be more expensive than the second method.

5.2.2 In the second method, whose use depends on site-specific conditions, the approach is to collect multiple co-located samples at each sample location during a single sampling event. With this approach, one core is collected to determine the nature and extent of NAPL. Additional cores from the same sampling location are archived and preserved in the original core liners to provide co-located samples for subsequent laboratory NAPL mobility testing. Once the relative amount of NAPL in various areas and depths of sediment has been characterized, using the methods described in this guide, NAPL mobility sampling is performed at targeted locations and depths in the archived co-located samples.

5.2.2.1 One advantage of this approach is that laboratory NAPL mobility test results can be obtained more quickly, because sample material is already available. This approach generally also has the advantage of being performed in only one mobilization.

5.2.2.2 The disadvantage of this approach is that it requires collecting co-located samples that can be used for laboratory NAPL mobility testing at every sampling station during the initial investigation of the nature and extent of NAPL. Because many of the co-located samples would not undergo laboratory testing for NAPL mobility, this approach is less efficient and can add considerable expense to the investigation program.

5.3 The process for screening and selecting locations and general depths for laboratory NAPL mobility testing as presented in this guide consists of the four major steps summarized in Fig. 1 and discussed in detail in 5.4. This process is typically performed in the field, but there is nothing precluding the process being applied to sediment samples elsewhere (for example, the consultant's office or at a laboratory).

5.4 In this process, sediment samples are screened for the presence of NAPL using a standardized methodology consisting of visual observations (*Step 1*) and sediment-water shake

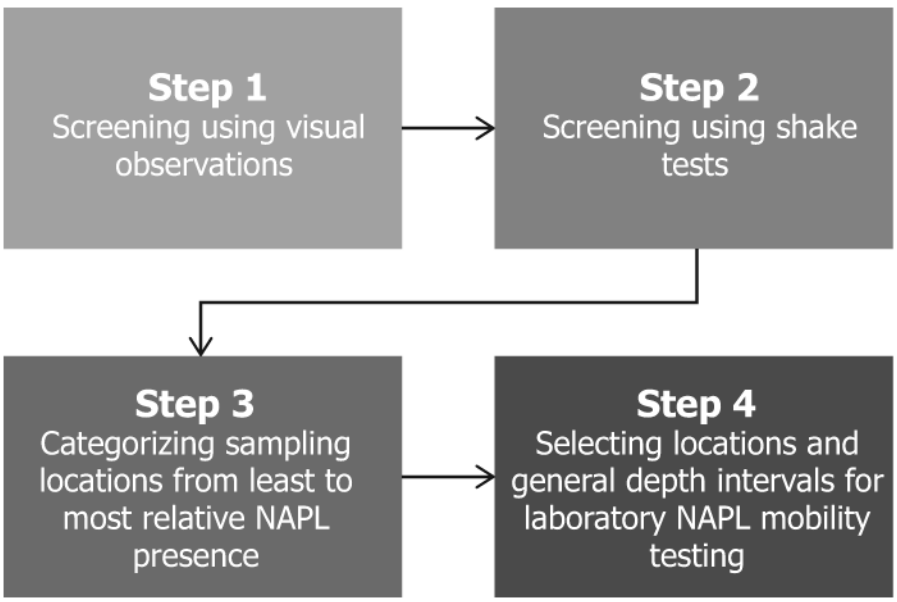

FIG. 1 Summary of the Process for Screening and Selection of Samples for Laboratory NAPL Mobility Testing