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Standard Guide for NAPL Mobility and Migration in Sediment—Sample Collection, Field Screening, and Sample Handling¹

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1. Scope

1.1 This guide provides considerations to inform sample collection, field screening, and sample handling of sediments impacted with non-aqueous phase liquid (NAPL) to assist in data collection for the evaluation of NAPL movement in sediment. The conditions affecting NAPL emplacement and movement in sediments are significantly different than in upland soils. As such, the framework for the assessment of NAPL movement in upland soils has been determined to have limited applicability for sediments.

1.2 This guide is applicable to sediment sites where the presence or suspected presence of NAPL has been identified. Sediments are the subject media considered in this guide, not surface water or groundwater.

1.3 The goal of this guide is to provide a technical framework for sample collection, field screening, and sample handling activities used to evaluate NAPL conditions, in particular NAPL movement (that is, mobility at the pore scale and migration at the NAPL body scale) in sediments, which can be used to inform the development and selection of remedial options and post-remedial monitoring activities.

1.4 This guide discusses sample collection procedures, including direct methods (that is, core and grab samples) and indirect methods (that is, DART^{®2}, laser-induced fluorescence, and porewater samplers) for assessing NAPL presence or absence in sediment.

1.5 This guide discusses field characterization procedures for assessment of NAPL-impacted sediments including visual screening, stratification assessment, shake test, ultraviolet (UV) light test, NAPL FLUTE^{TM3}, and headspace vapor monitoring.

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 Trademarked by Dakota Technologies. <http://www.dakotatechnologies.com/products/darts>

³ Trademarked by Flexible Liner Underground Technologies.

1.6 This guide discusses considerations to obtain samples representative of *in situ* conditions. This includes methods used to evaluate sediment integrity, sample retrieval from the sediment bed, core identification, sample storage onboard the vessel, sample retrieval from the coring device, sufficient sample recovery, core cutting techniques, sample removal from the core, and sample freezing/cooling considerations.

1.7 This guide discusses the objectives, approaches, and materials for the storage and transport of NAPL-impacted sediment, focusing on samples taken for laboratory NAPL mobility and geotechnical tests. Considerations include sample packaging and handling, storage temperature, and hold times.

1.8 NAPLs such as fuels, oils, coal tar, and creosote are the primary focus of this guide.

1.9 *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.

1.10 *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.*

1.11 *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:⁴

D425 Test Method for Centrifuge Moisture Equivalent of Soils

D854 Test Methods for Specific Gravity of Soil Solids by Water Pycnometer

D1587 Practice for Thin-Walled Tube Sampling of Fine-Grained Soils for Geotechnical Purposes

⁴ 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.

D2216 Test Methods for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass

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

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

D2937 Test Method for Density of Soil in Place by the Drive-Cylinder Method

D3213 Practices for Handling, Storing, and Preparing Soft Intact Marine Soil

D4044 Test Method for (Field Procedure) for Instantaneous Change in Head (Slug) Tests for Determining Hydraulic Properties of Aquifers

D4104 Practice for (Analytical Procedures) Determining Transmissivity of Nonleaky Confined Aquifers by Overdamped Well Response to Instantaneous Change in Head (Slug Tests)

D4318 Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils

D4464 Test Method for Particle Size Distribution of Catalytic Materials by Laser Light Scattering

D4823 Guide for Core Sampling Submerged, Unconsolidated Sediments

D5073 Practice for Depth Measurement of Surface Water

D5084 Test Methods for Measurement of Hydraulic Conductivity of Saturated Porous Materials Using a Flexible Wall Permeameter

D5413 Test Methods for Measurement of Water Levels in Open-Water Bodies

D5906 Guide for Measuring Horizontal Positioning During Measurements of Surface Water Depths

D6151 Practice for Using Hollow-Stem Augers for Geotechnical Exploration and Soil Sampling

D6169 Guide for Selection of Soil and Rock Sampling Devices Used With Drill Rigs for Environmental Investigations

D6282/D6282M Guide for Direct Push Soil Sampling for Environmental Site Characterizations

D6836 Test Methods for Determination of the Soil Water Characteristic Curve for Desorption Using Hanging Column, Pressure Extractor, Chilled Mirror Hygrometer, or Centrifuge

D6913/D6913M Test Methods for Particle-Size Distribution (Gradation) of Soils Using Sieve Analysis

D6914/D6914M Practice for Sonic Drilling for Site Characterization and the Installation of Subsurface Monitoring Devices

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

D7263 Test Methods for Laboratory Determination of Density and Unit Weight of Soil Specimens

D7928 Test Method for Particle-Size Distribution (Gradation) of Fine-Grained Soils Using the Sedimentation (Hydrometer) Analysis

E1391 Guide for Collection, Storage, Characterization, and Manipulation of Sediments for Toxicological Testing and for Selection of Samplers Used to Collect Benthic Invertebrates

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

E3164 Guide for Sediment Corrective Action – Monitoring

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

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 *migrating NAPL, n*—NAPL that can move at the NAPL body scale, such that the NAPL body may advectively expand in at least one direction under observed or reasonably anticipated field conditions. **E3248**

3.1.3 *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**

3.1.4 *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**

3.1.4.1 *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]).

3.1.5 *sediment, 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 body of water. **E3163**

3.2 Definitions of Terms Specific to This Standard:

3.2.1 *core catcher, n*—for the purposes of this guide, a device that grips and supports the core while the sampler is being pulled from the sediment and hoisted to the water surface.

3.2.2 *recovery ratio, n*—for the purposes of this guide, the ratio A/B where A is the distance from the top of the sediment core to the bottom of the cutting bit and B is the distance from the surface of the parent deposit to the bottom of the cutting bit.

3.2.3 *undisturbed sample, n*—for the purposes of this guide, sediment particles that have not been rearranged relative to one another by anthropogenic activity including the collection, transport, and analysis of the sample. In common usage, the term “undisturbed sample” describes particles that have been rearranged, but only to a slight degree.

4. Significance and Use

4.1 Many contaminants, including chlorinated solvents and petroleum products, enter the subsurface in the form of an immiscible liquid, known as a NAPL. Understanding the potential emplacement and transport mechanism for NAPL in sediment is an important element of an overall conceptual site model (CSM) that forms a basis for (1) investigating the nature and extent of NAPL, (2) evaluating if (and how) human and