

Designation: D7294 - 13 (Reapproved 2021)

Standard Guide for Collecting Treatment Process Design Data at a Contaminated Site—A Site Contaminated with Chemicals of Interest¹

This standard is issued under the fixed designation D7294; 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 lists the physical and chemical treatment processes design data needed to evaluate, select, and design treatment processes for remediation of contaminated sites. This data is listed in Tables 1 and 2. Much of these data can be obtained and analyzed at the site with instruments and test kits.

1.2 It is recommended that this guide be used in conducting environmental site assessments and Remedial Investigations/ Feasibility Studies (RI/FS) and selections of remedy in U.S. Code of Federal Regulations 40 CFR 300.430.

1.3 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.

1.4 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

D422 Test Method for Particle-Size Analysis of Soils (Withdrawn 2016)³

D1067 Test Methods for Acidity or Alkalinity of Water

- D1293 Test Methods for pH of Water
- D1498 Test Method for Oxidation-Reduction Potential of Water

- D2216 Test Methods for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass
- D2434 Test Method for Permeability of Granular Soils (Constant Head)
- D3590 Test Methods for Total Kjeldahl Nitrogen in Water
- D3921 Test Method For Oil and Grease and Petroleum Hydrocarbons in Water (Withdrawn 2013)³
- D4327 Test Method for Anions in Water by Suppressed Ion Chromatography
- D4564 Test Method for Density and Unit Weight of Soil in Place by the Sleeve Method (Withdrawn 2013)³
- D4611 Test Method for Specific Heat of Rock and Soil
- D4943 Test Method for Shrinkage Factors of Cohesive Soils by the Water Submersion Method
- D4972 Test Methods for pH of Soils
- D5084 Test Methods for Measurement of Hydraulic Conductivity of Saturated Porous Materials Using a Flexible Wall Permeameter
- D5334 Test Method for Determination of Thermal Conductivity of Soil and Soft Rock by Thermal Needle Probe Procedure
- D5463 Guide for Use of Test Kits to Measure Inorganic Constituents in Water
- D5730 Guide for Site Characterization for Environmental Purposes With Emphasis on Soil, Rock, the Vadose Zone and Groundwater (Withdrawn 2013)³
- D6836 Test Methods for Determination of the Soil Water Characteristic Curve for Desorption Using Hanging Column, Pressure Extractor, Chilled Mirror Hygrometer, or Centrifuge
- E953/E953M Practice for Fusibility of Refuse-Derived Fuel (RDF) Ash
- 2.2 Other Documents:
- Remediation Technologies Screening Matrix and Reference Guide⁴
- U.S. Code of Federal Regulations 40 CFR 300.430⁵

¹This guide is under the jurisdiction of ASTM Committee D34 on Waste Management and is the direct responsibility of Subcommittee D34.01.01 on Planning for Sampling.

Current edition approved Jan. 1, 2021. Published January 2021. Originally approved in 2006. Last previous edition approved in 2013 as D7294 – 13. DOI: 10.1520/D7294-13R21.

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.

³ The last approved version of this historical standard is referenced on www.astm.org.

⁴ Available at http://www.frtr.gov.

⁵ Available at http://www.gpoaccess.gov/cfr/index.html.

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TABLE 2 Soil, Sediment, and Slurry Parameters⁴

3. Terminology

3.1 Definitions:

3.1.1 *contaminants of concern, n*—any substance potentially hazardous to human health or the environment and present at the site and above background concentrations.

3.1.2 remedial treatment process, n—as used in this guide, physical, chemical, and biological technologies used to destroy, contain, or remove contaminants of concern at contaminated sites.

3.1.3 treatment process design data, n—as used in this guide, physical and chemical data that are needed in addition to data on contaminants of concern, characterization of the subsurface, and major factors affecting the surface and subsurface environment that are addressed in Guide D5730 to evaluate and design treatment processes for remediation of contaminated sites. Examples are cations and anions commonly present in water such as calcium, iron, carbonate/ bicarbonate, Total Organic Carbon (TOC), pH, temperature, and sieve analysis of the soil. See Tables 1 and 2 for the complete list.

4. Significance and Use

4.1 This guide allows the decision maker to determine which remedial treatment processes are and are not applicable to remediate an area of soil, surface water, or ground water that contains contaminants of concern.

4.2 This guide provides the data to make cost comparisons of the remedial treatment processes.

4.3 Analysis of treatment process design data can often be performed at the site with field instruments and test kits.

4.4 Tables 1 and 2 are a guide to selecting and obtaining physical and chemical treatment process design data. Data marked with an "X" is needed to evaluate alternatives and select a remedial treatment process. Once the remedial process is selected, the additional data that are needed to design the selected remedial treatment process are marked with an "O." It

may be advisable to also collect the data marked with an "O" during the initial sampling event to minimize sampling trips to the site.

4.5 Tables 3 and 4 list laboratory and field methods for analyzing this data. More than one analytical method may be listed. The most suitable method must be chosen for each application.

4.6 This guide does not address sampling for contaminants of concern and sampling locations. See EM 200-1-2 Technical Project Planning (TPP) under Engineering Manuals⁶ for information on sampling contaminants of concern. It is recommended that the treatment process design sampling be coordinated with the sampling for chemicals of concern to minimize duplicate sampling and trips to the site.

4.7 This guide does not address physical and chemical properties related to contaminant transport. This is addressed in Guide D5730.

4.8 This guide does not address why the data is needed to evaluate each treatment technology. This information is addressed in the Federal Remediation Technologies Roundtable (FRTR) site at http://www.frtr.gov in the U.S. Army Corps of Engineers guidance documents at http://www.usace.army.mil/ inet/usace-docs/ and the United Facilities Guide Specifications (UFGS) available at http://www.ccb.org/.

4.9 This guide does not address Quality Assurance / Quality Control (QA/QC) or sampling design strategy. See U.S. Army Corps of Engineers Engineering Regulation ER 1110-1-263 and Engineering Manual EM 200-1-3⁶ for information on QA/QC. This needs to be addressed in the Quality Assurance Project Plan (QAPP).

5. Keywords

3 (5.1) assessment; environmental; hazardous waste; remediation; sampling; solid waste; wastewater [7294_13202]

⁶ United States Army Corps of Engineers, Publications of the Headquarters, available at http://www.usace.army.mil/.

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TABLE 3 Water Analytical Methods^A

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Dissolved Oxygen (DO) ^{D,F} EPA 380.1 ^F ; SM 4500-0 ⁹ 360.2 0-20 mg/L Spec/Meter' (spec/Meter' 1-10 mg/L (spec/Meter' 200 mS 0-400 NTU0.1-100 NTU Conductivity ^{D,F} EPA 180.1 ^F SM 4500-0 ⁹ 360.2 0-20 mg/L Meter' 200 mS Turbidity ^{D,F} EPA 180.1 ^F SM 4500-0 ⁹ 360.2 0-400 NTU0.1-100 NTU 0-400 NTU0.1-100 NTU Turbidity ^{D,F} EPA 180.1 ^F SM 4500-0.01-2.0 mg/L Spec/Kit ⁺ 0-25. mg/L Ammonia EPA 350.1735.2/35.3 ^F ; SM 4500- 0.01-2.0 mg/L Spec/Kit ⁺ 0-2.0 mg/L Aminas EPA 351.1735.2/35.3 ^F ; SM 4500- 0.1-1000 mg/L Spec/Kit ⁺ 0-2.01-0 mg/L Anions EPA 352.1 ^F ; SM 4500-NO2 ⁻⁰ 3000 0.01-1.0 mg/L as N Spec/Kit ⁺ 0-300-10 mg/L NO ₃ ⁻ EPA 355.1 ^F ; SM 4500-NO2 ⁻⁰ 3000 0.01-1.0 mg/L as N Spec/Kit ⁺ 0-300-10 mg/L SO ₄ ⁻ EPA 355.1 ^F ; SM 4500-SO 4 ^{0,2} ; Test 0.01-200 mg/L as CACO ₃ Spec/Kit ⁺ 0-300-10 mg/L SO ₄ ⁻ EPA 351.1 ^F ; SM 4500-NO2 ⁻⁰ 3000 0.01-200 mg/L as CACO ₃ Spec/Kit ⁺ 0-30-010 mg/L SO ₄ ⁻ EPA 3510.1 ^F ;	Temperature ^{D,E}	FPA 170 1 ^F · SM 2550 ^G	0–100 °C	motor	
ConductivityD ^{2,E} EPA 120.1 ^F St 20.0 ^G 1-1000 µS/cm Mater 200 mS TurbidityD ^{2,E} EPA 180.1 ^F 0-40 NTU Spec/Meter 0-4000 mg/L 0-200 mg/L Ammonia EPA 330.1350.2350.3 ^F ; SM 4500 0.01-2.0 mg/L Spec/Kit ^H 0-220 mg/L 0-220 mg/L Ammonia EPA 330.1350.2350.3 ^F ; SM 4500 0.01-2.0 mg/L Spec/Kit 1-150 mg/L Ammonia EPA 330.1350.2350.3 ^F ; SM 4500 0.1-1000 mg/L Spec/Kit 0-220 mg/L Anions F F013B-electrode EPA 332.1325.2325.3 ^F ; SM 4500 1-200 mg/L Spec/Kit 0-20/S-400 Cl EPA 332.1325.2325.3 ^F ; SM 4500 1-200 mg/L Spec/Kit 0-30/0-10 mg/L NO ₃ ⁻ EPA 332.1 ^F ; SM 4500-NO2. ^G (300) 0.1-1.0 mg/L as N Spec/Kit ^H 0-30/0-10 mg/L SO ₄ ⁻ EPA 332.1 ^F ; SM 4500-NO2. ^G (300) 0.01-1.0 mg/L as N Spec/Kit ^H 0-30/0-10 mg/L SO ₃ ⁻ Method D427 0300 10-200 mg/L Spec/Kit ^H 0-30/0-10 mg/L SO ₃ ⁻ SM 4500-S0.3 ^F ; SM 4500.21/2 10-200 mg/L <t< td=""><td>Dissolved Oxygen (DO)^{D,E}</td><td>EPA 360.1^{<i>F</i>}; SM 4500-O^{<i>G</i>} 360.2</td><td>0–20 mg/L</td><td>Spectrophotometer (spec)/Meter^H</td><td>1–10 mg/L</td></t<>	Dissolved Oxygen (DO) ^{D,E}	EPA 360.1 ^{<i>F</i>} ; SM 4500-O ^{<i>G</i>} 360.2	0–20 mg/L	Spectrophotometer (spec)/Meter ^H	1–10 mg/L
Turbidity $P^{d_{1}}$ EPA 180.1 ^f 0-40 NTU Spec/Meter 0-400 NTU(1-100 NTU Total Dissolved Solids EPA 180.1 ^f 10-200 0mg/L Meter 0-200 mg/L 0-200 mg/L Ammonia EPA 180.1 ^f 10-200 0mg/L Meter 0-200 mg/L 0-200 mg/L Kijeldahl (TKN) EPA 351.1/351.2/351.3/351.4 ^r ; SM 4500- 0.01-2.0 mg/L Spec/Kit 1-150 mg/L Anions EPA 340.1/340.2/340.3 ^f ; SM 4500- 0.1-1000 mg/L Spec/Kit 0-200/f.400 Ci EPA 335.1/352.2/325.3 ^f ; SM 4500 1-200 mg/L Spec/Kit 0-30/f.000 NO ₅ EPA 335.1/75.2/375.2/375.4 ^f ; SM 4500- 1-200 mg/L Spec/Kit 0-30/f.000 NO ₅ EPA 355.1/75.2/375.3/375.4 ^f ; SM 4500-102- ⁶ 0300 0.01-10 mg/L as N Spec/Kit ^H 0-30/f.0-10 mg/L SO ₄ EPA 355.1/75.2/375.3/375.4 ^f ; SM 3-400 mg/L Spec/Kit ^H 0-70/50-200 mg/L 0-70/50-200 mg/L SO ₄ EPA 355.4 ^f SM 4500-50.301 0.01-20 mg/L as CaCO ₃ Kit 10-4000 mg/L Prosphorus (Total) EPA 6010/6/020/7000F' 236.1/2 Spec/Kit ^H 0-30/f.0-10 mg/L 0-30/f.0-10 mg/L Cations EPA 6010/6/02	Conductivity ^{D,E}	EPA 120.1 ^F : SM 2510 ^G	1–1000 µS/cm	Meter	200 mS
Total Dissolved Solids EPA 160.1 ^e 10-20 000 mg/L Meter 0-20 00 mg/L Ammonia EPA 350.1/350.2/350.3 ^e ; SM 4500- 0.01-2.0 mg/L Spec/Kit [#] 0-2.5 mg/L Kipledahl (TKN) EPA 351.1/351.2/351.3/ 351.4 ^e ; SM 4500- 0.05-2.0 mg/L Spec/Kit 0-2.5 mg/L Anions EPA 351.1/351.2/351.3/ 351.4 ^e ; SM 4500- 0.1-1000 mg/L Spec/Kit 0-2 mg/L/0-2 mg/L CI EPA 352.1/352.2/325.3 ^e ; SM 4500- 0.1-200 mg/L Spec/Kit 0-20/5-400 NO ₃ ⁻ EPA 351.1 ^e ; SM 4500-NO3- ^a ; Test 0.1-20 mg/L Spec/Kit ^{#/H} 0-30/0-10 mg/L NO ₃ ⁻ EPA 351.1 ^e ; SM 4500-NO2- ^a 0300 0.01-1.0 mg/L as N Spec/Kit ^{#/H} 0-30/0-10 mg/L NO ₂ ⁻ EPA 351.1 ^e ; SM 4500-NO2- ^a 0300 0.01-1.0 mg/L as S Spec/Kit ^{#/H} 0-30/0-10 mg/L SO ₂ ⁻ EPA 351.1 ^e ; SM 320.2 ^a 0.01-20 mg/L as CaCO ₃ Kit 410-4000 mg/L No ₂ ⁻ EPA 351.1 ^e ; SM 320.2 ^a 0.01-20 mg/L as CaCO ₃ Kit 0-4000 mg/L No ₂ ⁻ EPA 451.0 ^e ; 28.2 ^a 0.01-20 mg/L as CaCO ₃ Kit 0-4000 mg/L No ₃ ⁻ SM 4500-SOA ^{B^B} ; 28.3 1.1/2 10-200 mg/L as	Turbiditv ^{D,E}	EPA 180.1 ^F	0–40 NTU	Spec/Meter	0-4400 NTU/0.1-100 NTU
Ammonia EPA 350.1350.2/350.3 ^c ; SM 4500- 0.01-2.0 mg/L Spec/Kit ^H 0-2.5 mg/L Kjeldahl (TKN) EPA 351.1363.13/351.4 ^r ; SM 4500- 0.01-2.0 mg/L Spec/Kit 1-150 mg/L Anions F0013B—electrode ^r EPA 340.1340.2340.3 ^r ; SM 4500- 0.1-1000 mg/L Spec/Kit 0-2 mg/L/0-2 mg/L Cl EPA 325.1325.2325.3 ^r ; SM 4500- 1-200 mg/L Spec/Kit 0-20/5-400 NO ₃ ⁻ EPA 351.1725.2375.37 f; SM 4500- 1-200 mg/L Spec/Kit ^H 0-30/0-10 mg/L NO ₃ ⁻ EPA 354.1 ^r ; SM 4500-NO2- ^G 3000 0.01-1.0 mg/L as N Spec/Kit ^H 0-30/0-10 mg/L SO ₄ ⁻ EPA 355.175.2375.375.4 ^r ; SM 30-400 mg/L Spec/Kit ^H 0-30/0-10 mg/L 0-70/50-200 mg/L SO ₄ ⁻ EPA 355.175.2375.375.4 ^r ; SM 320 ^O 10-200 mg/L as CaCO ₃ Kit 10-4000 mg/L Klakinity (HCO ₃ , CO ₂ ²) EPA 350.1310.2 ^F ; SM 4500-N02- ^G 0300 Kit 4500-1000 mg/L SO ₃ ⁻ SM 4500-S02-8 ^G EPA 351.12 -000 mg/L Spec/Kit ^H 0-30/0-10 mg/L Fe ² × ^E USGS 1-1388-78 ^K Spec/Kit ^H 0-30/0-10 mg/L <t< td=""><td>Total Dissolved Solids</td><td>EPA 160.1^F</td><td>10-20 000 ma/L</td><td>Meter</td><td>0-200 ma/L</td></t<>	Total Dissolved Solids	EPA 160.1 ^F	10-20 000 ma/L	Meter	0-200 ma/L
Kjeldahl (TKN) EPA 351.1/351.2/351.3/ 351.4 ^F ; SM 0.05–2.0 mg/L Spec/Kit 1–150 mg/L Anions F0013B—electrode* FPA 30.1/340.2/340.3 ^F ; SM 4500 0.1–1000 mg/L Spec/Kit 0–2 mg/L0–2 mg/L C1 CPA 352.1725.2/325.3 ^F ; SM 4500 1–200 mg/L Spec/Kit* 0–20/5–400 NO ₃ * EPA 352.17; SM 4500-NO.2 ^{-G} ; Test 0.1–2 mg/L as N Spec/Kit* 0–30/0–10 mg/L NO ₃ * EPA 351.17; SM 4500-NO.2 ^{-G} (Test 0.1–2 mg/L as N Spec/Kit* 0–30/0–10 mg/L SO ₄ * EPA 351.17; SM 4500-NO.2 ^{-G} (Test 0.1–2 mg/L as N Spec/Kit* 0–30/0–10 mg/L SO ₄ * EPA 351.17; SM 350-MO.2 ^{-G} (Test 0.1–2 mg/L as N Spec/Kit* 0–30/0–10 mg/L SO ₄ * SM 4500-SO2- ³ (Test M-400 mg/L Spec/Kit* 0–30/0–10 mg/L SO ₄ * SM 4500-SO3-8 ^T ; SM 320 ^O 10–200 mg/L Spec/Kit* 0–30/0–10 mg/L SO ₃ * M 4500-SO3-8 ^T ; SM 320 ^O 10–200 mg/L Spec/Kit* 0–30/0–10 mg/L Cations EPA 8010.C/60207000B* 235.1/2 5–40 µg/L Spec/Kit* 0–30/0–10 mg/L Fe ² eff	Ammonia	EPA 350.1/350.2/350.3 ^F ; SM 4500- NH ₃ ^G	0.01–2.0 mg/L	Spec/Kit ^H	0–2.5 mg/L
$ \begin{array}{llllllllllllllllllllllllllllllllllll$	Kjeldahl (TKN)	EPÄ 351.1/351.2/351.3/ 351.4 ^F ; SM 4500-N _{org} ^G	0.05–2.0 mg/L	Spec/Kit	1–150 mg/L
$ \begin{array}{cccccccccccccccccccccccccccccccccccc$	Anions	0.9			
Ci EPA 325.1/325.2/32.3/ ⁶ ; SM 4500 1-200 mg/L Spec/Kit 0-20/5-400 NO3 EPA 352.1 ⁶ ; SM 4500-NO3- ^G ; Test 0.1-2 mg/L as N Spec/Kit ^H 0-30/0-10 mg/L NO3 ⁻ EPA 352.1 ⁶ ; SM 4500-NO2- ^G 0300 0.01-1.0 mg/L as N Spec/Kit ^H 0-0.3/0-10 mg/L SO ₃ ⁻ EPA 351.1 ⁷ / _{375.2} /375.3 ⁷ / _{375.4⁷} ; SM 3-400 mg/L Spec/Kit ^H 0-70/50-200 mg/L SO ₃ ⁻ EPA 375.1/375.2/375.3 ⁷ / _{375.4⁴} ; SM 3-400 mg/L Spec/Kit ^H 0-70/50-200 mg/L SO ₃ ⁻ SM 4500-SO3- ^{BO} ; EPA 377.1 ^{7/} Kit Alkalinity (HCO ₃ ⁻ , CO ₃ ²⁻) EPA 310.1/310.2 ^e ; SM 2320 ^G 10-200 mg/L as CaCO ₃ Kit ^H 0-3/0-10 mg/L Cations Fe ^{2+E} USGS 1-1388-78 ^K Spec/Kit ^H 0-3/0-10 mg/L Fe total (Fe ²⁺ and Fe ³⁺) EPA 6010C/6020/7000B ⁴ 256.1/.2 5-40 µg/L Spec/Kit ^H 0-3/0-10 mg/L Na* EPA 6010C/6020/7000B ⁴ 256.1/.2 5-40 µg/L Spec/Kit ^H 0-3/0-10 mg/L Na* EPA 6010C/6020/7000B ⁴ 256.1/.2 5-40 µg/L Spec/Kit ^H 0-3/0-10 mg/L Na* EPA 6010C	F 0013B—electrode ⁻	EPA 340.1/340.2/340.3 ^{<i>F</i>} ; SM 4500- F- ^{<i>G</i>} 0300	0.1-1000 mg/L	Spec/Kit	0–2 mg/L/0–2 mg/L
NO3 ⁻ EPA 352.1 ^F ; SM 4500-NO3- ^G ; Test 0.1–2 mg/L as N Spec/Kit ^H 0–30/0–10 mg/L NO3 ⁻ EPA 354.1 ^F ; SM 4500-NO2- ^G 0300 0.01–1.0 mg/L as N Spec/Kit ^H 0–0.3/0–1.0 mg/L SO4 ⁻² EPA 354.1 ^F ; SM 4500-NO2- ^G 0300 0.01–1.0 mg/L as N Spec/Kit ^H 0–0.3/0–1.0 mg/L SO4 ⁻² EPA 375.1/375.2/375.3/ 375.4 ^F ; SM 3–400 mg/L Spec/Kit ^H 0–70/50–200 mg/L SO5 SM 4500-SO3.8 ^D ; EPA 377.1 ⁻¹ Kit 10–4000 mg/L Spec/Kit ^H 0–3/0–10 mg/L Alkalinity (HCO3, CO3 ⁻²) EPA 310.1/310.2 ^F ; SM 2320 ^G 10–200 mg/L as CaCO3 Kit ^H 10–4000 mg/L Cations Fe ^{2+E} USGS 1-1388-78 ^K Spec/Kit ^H 0–3/0–10 mg/L Spec/Kit ^H 0–3/0–10 mg/L K ⁺ EPA 6010C/6020/7000B ⁺ ; 258.1 10–200 µg/L Spec/Kit ^H 0–3/0–10 mg/L Spec/Kit ^H 0–3/0–10 mg/L Na ⁺ EPA 6010C/6020/7000B ⁺ ; 258.1 10–200 µg/L Spec/Kit ^H 0–3/0–10 mg/L Spec/Kit ^H 0–3/0–10 mg/L Mg ²⁺ EPA 6010C/6020/7000B ⁺ ; 251.2 50–200 µg/L Spec/Kit ^H 1–350 mg/L 0–3/0–10 mg/L	CI	EPA 325.1/325.2/325.3 ^F ; SM 4500 Cl- ^G 0300	1–200 mg/L	Spec/Kit	0–20/5–400
$ \begin{array}{cccccccccccccccccccccccccccccccccccc$	NO ₃	EPA 352.1 ^{<i>F</i>} ; SM 4500-NO3- ^{<i>G</i>} ; Test Method D4327	0.1–2 mg/L as N	Spec/Kit ^H	0-30/0-10 mg/L
$\begin{array}{cccccccccccccccccccccccccccccccccccc$	NO ₂ ⁻	EPA 354.1 ^F ; SM 4500-NO2- ^G 0300	0.01–1.0 mg/L as N	Spec/Kit ^H	0-0.3/0-1.0 mg/L
$ \begin{array}{cccccccccccccccccccccccccccccccccccc$	SO_{4}^{2}	EPA 375.1/375.2/375.3/ 375.4 ^F ; SM 4500-SO ₄ ^{2-G} ;	3–400 mg/L	Spec/Kit ^H	0-70/50-200 mg/L
SO3 SM 4300/S03-B : EPA 37.1° NI Alkalinity (HCO3, CO3 ²) EPA 310.1/310.2 ^F ; SM 2320 ^G 10-200 mg/L as CaCO3 Kit ^H 10-4000 mg/L Phosphorus (Total) EPA 365.4 0.01-20 mg/L Spec/Kit ^H 0-3/0-10 mg/L Fe ^{2+E} USGS 1-1388-78 ^K Spec/Kit ^H 0-3/0-10 mg/L Fe ^{2+E} USGS 1-1388-78 ^K Spec/Kit ^H 0-3/0-10 mg/L K ⁺ EPA 6010C/6020/7000B ^J 236.1/.2 5-40 µg/L Spec/Kit ^H 0-3/0-10 mg/L Na ⁺ EPA 6010C/6020/7000B ^J 273.1/.2 10-200 µg/L Meter 0sat Ca ²⁺ EPA 6010C/6020/7000B ^J 273.1/.2 10-200 µg/L Kit ^H 10-4000 mg/L Mg ²⁺ EPA 6010C/6020/7000B ^J 243.1/.2 0-100 µg/L Kit ^H 10-4000 mg/L Ma ²⁺ EPA 6010C/6020/7000B ^J 243.1/.2 0.1-10 µg/L Spec/Kit ^H 0-0.7/0-3 mg/L Dissolved H ₂ EPA NRMRL Ada OK method CO2 SM 4500-CO2 ^G 10-100 µg/L Spec/Kit ^H 10-1000 mg/L/10-100 mg/L BOD—5 day EPA 415.1/415.2 ^F ; SM 5310B ^G 50 µg/L-10 mg/L 50 µg/L-10 mg/L 50 µg/L-10 mg/L 50 µg/L-10 mg/L OC EPA 415	- 63	CM 4500 CO2 DG EDA 277 1/		K:t	
Alkalmity (HC03, C03 ⁺) EPA 310.1/310.2 ⁺ ; SM 2320 ⁺ 10-200 mg/L as CaC03 Klt ⁺ 10-4000 mg/L Phosphorus (Total) EPA 365.4 0.01-20 mg/L Spec/Kit ^H 0-3.5/0-5 mg/L Cations Fe total (Fe ²⁺ and Fe ³⁺) EPA 6010C/6020/7000B ⁴ ; 236.1/.2 5-40 µg/L Spec/Kit ^H 0-3/0-10 mg/L K ⁺ EPA 6010C/6020/7000B ⁴ ; 258.1 10-200 µg/L Spec 0-7 mg/L Na ⁺ EPA 6010C/6020/7000B ⁴ ; 273.1/2 1-200 µg/L Meter 0-sat Ca ² * EPA 6010C/6020/7000B ⁴ ; 242.1/2 1-100 µg/L Kit ⁺ 10-350 mg/L Mg ²⁺ EPA 6010C/6020/7000B ⁴ ; 243.1/.2 0.1-1.0 µg/L Spec/Kit ⁺ 0-0.7/0-3 mg/L Mn ²⁺ EPA 6010C/6020/7000B ⁴ ; 243.1/.2 0.1-1.0 µg/L Spec/Kit ⁺ 0-0.7/0-3 mg/L Dissolved H ₂ EPA 8015D Modified ⁴ ; RSK-175 ^L 10-100 µg/L Spec/Kit ^H 0-1000 mg/L/10-100 mg/L Volatile Fatty Acid SM 5500-Organic & Volatile Acids ⁶ 1-20 mg/L Spec/Kit ^H 10-1000 mg/L/10-100 mg/L BOD—5 day EPA 405.1 ^F ; SM 52106 ⁶ 50 µg/L-10 mg/L Spec/Kit ^H 10-1000 mg/L -100 mg/L GOD M 5220 ⁶ ; 401.1/2/3/4	SU_3	SMI 4500-SO3-B ^o . EPA 377.1 ^o	10,000	Kit Kit	10, 1000
Phosphorus (fotal) EPA 365.4 $0.01-20 \text{ mg/L}$ Spec/Kit ^{-//} $0-3.5/U-5 \text{ mg/L}$ Cations Fe ^{2+£} USGS 1-1388-78 ^K Spec/Kit ^{+//} $0-3/0-10 \text{ mg/L}$ Fe total (Fe ²⁺ and Fe ³⁺) EPA 6010C/6020/7000B ^J 236.1/.2 $5-40 \text{ µg/L}$ Spec/Kit ^{+//} $0-3/0-10 \text{ mg/L}$ K ⁺ EPA 6010C/6020/7000B ^J 258.1 $10-200 \text{ µg/L}$ Spec $0-7 \text{ mg/L}$ Na ⁺ EPA 6010C/6020/7000B ^J 215.1/2 $1-200 \text{ µg/L}$ Meter $0-\text{sat}$ Ca ²⁺ EPA 6010C/6020/7000B ^J 243.1/2 $1-100 \text{ µg/L}$ Kit ^{+//} $1-350 \text{ mg/L}$ Mg ²⁺ EPA 6010C/6020/7000B ^J 243.1/2 $0.1-1.0 \text{ µg/L}$ Spec/Kit ^{+//} $0-3/0-10 \text{ mg/L}$ Mn ²⁺ EPA 6010C/6020/7000B ^J 243.1/2 $0.1-1.0 \text{ µg/L}$ Spec/Kit $0-0.7/0-3 \text{ mg/L}$ CH ₄ , C ₂ H ₄ , C ₂ H ₆ EPA 8015D Modified ^J ; RSK-175 ^L $10-100 \text{ µg/L}$ Spec/Kit ^{+//} $10-1000 \text{ mg/L}$ Dissolved H ₂ EPA 8015D Modified ^J ; RSK-175 ^L $10-100 \text{ µg/L}$ Spec/Kit ^{+//} $10-1000 \text{ mg/L}$ Volatile Fatty Acid SM 5500-00rganic & Volatile Acids ^{6//} $1-20 \text{ mg/L}$ TOC EPA 415.1/315.2 ^F ; SM 5310B ^G 50 µg/L-10 mg/L BOD—5 day EPA 405.1 ^F ; SM 5210B ^G Total Suspended Solids (TSS) SM -2540 D ^G ; 160.2 ST 1724-13(2021) SM 5220 ^G ; 410.1/2/3/4 St 96692 864-40c6-433b-91cc-8f7942c2ef59/astm-d7294-132021 Oli/Grease SM 5220 ^G ; 431.1/2	Alkalinity (HCO_3 , CO_3^-)	EPA 310.1/310.2 ; SM 2320	$10-200 \text{ mg/L} \text{ as } \text{CaCO}_3$		10-4000 mg/L
Calors Fe ^{2+<i>E</i>} USGS 1-1388-78 ^K Spec/Kit ^H 0-3/0-10 mg/L Fe total (Fe ²⁺ and Fe ³⁺) EPA 6010C/6020/7000B ^J 236.1/.2 5-40 µg/L Spec/Kit ^H 0-3/0-10 mg/L K* EPA 6010C/6020/7000B ^J (236.1/.2 5-40 µg/L Spec 0-7 mg/L Na* EPA 6010C/6020/7000B ^J (273.1/.2 1-200 µg/L Meter 0-sat Ca ²⁺ EPA 6010C/6020/7000B ^J (215.1/.2 50-200 µg/L Kit ^H 1-350 mg/L Mg ²⁺ EPA 6010C/6020/7000B ^J (242.1/.2 1-100 µg/L Kit 10-4000 mg/L Mn ²⁺ EPA 6010C/6020/7000B ^J (243.1/.2 0.1-1.0 µg/L Spec/Kit 0-0.7/0-3 mg/L Sisolved H ₂ EPA 6015D Modified ^J (RSK-175 ^L) 10-100 µg/L Spec/Kit 0-0.7/0-3 mg/L Volatile Fatty Acid SM 5500-Organic & Volatile Acids ^G EPA 10.100 µg/L Spec/Kit ^H 10-1000 mg/L/10-100 mg/L Volatile Fatty Acid SM 5500-Organic & Volatile Acids ^G EPA 451.1/376.2 ^F ; SM 5310B ^G 50 µg/L-10 mg/L Spec/Kit ^H 10-1000 mg/L/10-100 mg/L Volatile Fatty Acid SM 5200 ^G ; 410.1/2/3/4 SM 5200 ^G ; 410.1/2/3/4 Spec/Kit ^H 10-1000 mg/L/10-100 mg/L Volatile Fatty Acid <td>Phosphorus (Total)</td> <td>EPA 365.4</td> <td>0.01–20 mg/L</td> <td>Spec/Kit</td> <td>0-3.5/0-5 mg/L</td>	Phosphorus (Total)	EPA 365.4	0.01–20 mg/L	Spec/Kit	0-3.5/0-5 mg/L
Fe^{-1} $OSGS 1-1386-78^{-1}$ $O-3/0-10 mg/L$ Fe total (Fe^{2*} and Fe^{3*}) $EPA 6010C/6020/7000B^J 236.1/.25-40 \ \mu g/LSpec/Kit^{H}O-3/0-10 \ mg/LK^+EPA 6010C/6020/7000B^J ; 258.110-200 \ \mu g/LSpecO-7 \ mg/LNa^+EPA 6010C/6020/7000B^J ; 273.1/21-200 \ \mu g/LMeterO-satCa^{2*}EPA 6010C/6020/7000B^J ; 215.1/250-200 \ \mu g/LMeterO-satMg^{2+}EPA 6010C/6020/7000B^J ; 243.1/.250-200 \ \mu g/LKitH1-350 \ mg/LMn^{2*}EPA 6010C/6020/7000B^J ; 243.1/.20.1-1.0 \ \mu g/LKit0-0.7/0-3 \ mg/LMn^{2+}EPA 8015D \ Modified^J ; RSK-175^L10-100 \ \mu g/LSpec/Kit0-0.7/0-3 \ mg/LDissolved H_2EPA 8015D \ Modified^J ; RSK-175^L10-100 \ \mu g/L0-0.7/0-3 \ mg/L0-0.7/0-3 \ mg/LVolatile Fatty AcidSM 5560-Organic & Volatile Acids^GDT204-13 \ CD211-20 \ mg/L10-1000 \ mg/LPOCEPA 415.1/415.2^F ; SM 5310B^G50 \ \mu g/L-10 \ mg/L10-1000 \ mg/L10-1000 \ mg/LBOD5 \ dayEPA 405.1^F ; SM 5210B^GDT204-13 \ CD21T0CSM 5220G^G ; 410.1/2/3/4T00.2SM 5200B^G ; 431.1/2SM 5200B^G ; 431.1/2SM 5200B^G ; 431.1/2SM 5200B^G ; 431.1/2$		UCCC 1 1000 70K		Space/WitH	0.2/0.10 mg/
$\begin{array}{llllllllllllllllllllllllllllllllllll$	Fe^{-1}		E 40	Spec/Kit ^H	0-3/0-10 mg/L
K' EPA 6010C/6020/7000B ³ ; 293.1/2 10-200 µg/L Spec 0-7 mg/L Na* EPA 6010C/6020/7000B ³ ; 273.1/2 1-200 µg/L Meter 0-sat Ga ²⁺ EPA 6010C/6020/7000B ³ ; 215.1/2 50-200 µg/L Kit 10-4000 mg/L Mg ²⁺ EPA 6010C/6020/7000B ³ ; 243.1/2 1-100 µg/L Kit 10-4000 mg/L Mn ²⁺ EPA 6010C/6020/7000B ³ 243.1/2 0.1-1.0 µg/L Spec/kit 0-0.7/0-3 mg/L Dissolved H ₂ EPA 8015D Modified ³ ; RSK-175 ^L 10-100 µg/L Spec/kit 0-0.7/0-3 mg/L Using the state of the state	Fe total (Fe ⁻¹ and Fe ³¹)	EPA 6010C/6020/7000B° 236.1/.2	5-40 μg/L	Spec/Kit	0-3/0-10 mg/L
Na* EPA 6010C/6020/7000B ² ; 213.1/2 1-200 µg/L Meter 0-sat Ca ²⁺ EPA 6010C/6020/7000B ³ ; 215.1/2 50-200 µg/L Kit ^H 1-350 mg/L Mg ²⁺ EPA 6010C/6020/7000B ³ ; 242.1/2 1-100 µg/L Kit 10-4000 mg/L Mn ²⁺ EPA 6010C/6020/7000B ³ ; 243.1/.2 0.1-1.0 µg/L Spec/kit 0-0.7/0-3 mg/L CH ₄ , C ₂ H ₄ , C ₂ H ₆ EPA 8015D Modified ^J ; RSK-175 ^L 10-100 µg/L Spec/kit 0-0.7/0-3 mg/L Dissolved H ₂ EPA 8015D Modified ^J ; RSK-175 ^L 10-100 µg/L Spec/kit 0-0.7/0-3 mg/L Volatile Fatty Acid SM 5500-Organic & Volatile Acids ^G Previous Spec/Kit ^H 10-1000 mg/L/10-100 mg/L Volatile Fatty Acid SM 5560-Organic & Volatile Acids ^G Previous Spec/Kit ^H 10-1000 mg/L/10-100 mg/L BOD—5 day EPA 405.1 ^F ; SM 5210B ^G 50 µg/L-10 mg/L State and the second se		EPA 6010C/6020/7000B°; 258.1	10-200 μg/L	Spec	0-7 mg/L
Ca ²⁺ EPA 6010C/6020/7000B ³ ; 215.1/2 50-200 µg/L Kit ²⁺ 1-350 mg/L Mg ²⁺ EPA 6010C/6020/7000A ³ ; 242.1/2 1-100 µg/L Kit 10-4000 mg/L Mn ²⁺⁺ EPA 6010C/6020/7000B ³ 243.1/2 0.1-1.0 µg/L Spec/kit 0-0.7/0-3 mg/L CH ₄ , C ₂ H ₄ , C ₂ H ₆ EPA 8015D Modified ³ ; RSK-175 ^L 10-100 µg/L Spec/kit 0-0.7/0-3 mg/L Dissolved H ₂ EPA NRMRL Ada OK method Spec/Kit 10-1000 mg/L/10-100 mg/L 10-1000 mg/L/10-100 mg/L Volatile Fatty Acid SM 5560-Organic & Volatile Acids ^a EPA 376.1/376.2 ^e ; SM 4500-S ^{2-a} 1-20 mg/L 10-1000 mg/L/10-100 mg/L BOD—5 day EPA 405.1 ^e ; SM 5210B ^a 50 µg/L-10 mg/L 50 µg/L-10 mg/L 50 µg/L-10 mg/L COD SM 5220 ^a ; 410.1/2/3/4 SM 520692864-40c6-433b-91ee-8f7942c2ef59/astm-d7294-132021 SM 5220E ^a ; 431.1/2 Oil/Grease SM 5220B ^a ; 431.1/2 SM 9000 ^a SM 9200 ^a ; 431.1/2 SM 9200 ^a ; 431.1/2		EPA 6010C/6020/7000B°; 273.1/2	1–200 μg/L	Meter	0-sat
Mg ²⁺ EPA 6010C/60207/000A ⁶ ; 242.1/2 1-100 µg/L Kit 10-4000 mg/L Mn ²⁺ EPA 6010C/60207/000B ³ 243.1/2 0.1-1.0 µg/L Spec/kit 0-0.7/0-3 mg/L SM 3120 B SM 3120 B EPA 8015D Modified ³ ; RSK-175 ^L 10-100 µg/L Spec/kit 0-0.7/0-3 mg/L Dissolved H ₂ EPA NRMRL Ada OK method 10-100 µg/L 10-100 µg/L 10-100 mg/L/10-100 mg/L Volatile Fatty Acid SM 5560-Organic & Volatile Acids ^G PTEV Spec/Kit ^H 10-1000 mg/L/10-100 mg/L Volatile Fatty Acid SM 5560-Organic & Volatile Acids ^G PTEV Spec/Kit ^H 10-1000 mg/L/10-100 mg/L Volatile Fatty Acid SM 5560-Organic & Volatile Acids ^G 1-20 mg/L Spec/Kit ^H 10-1000 mg/L/10-100 mg/L VOC EPA 415.1/415.2 ^F ; SM 5310B ^G 50 µg/L-10 mg/L Spec/Kit ^H 10-1000 mg/L/10-100 mg/L BOD—5 day EPA 405.1 ^F ; SM 5210B ^G SM 5220G ^G ; 410.1/2/3/4 SM 5220G ^G ; 410.1/2/3/4 SM 52202 Mg/L-10 mg/L COD SM 5210 B SM 5220B ^G ; 431.1/2	Ca ²⁺	EPA 6010C/6020/7000B°; 215.1/2	50–200 µg/L	Kit''	1–350 mg/L
$\begin{array}{llllllllllllllllllllllllllllllllllll$	Mg ²⁺	EPA 6010C/6020/7000A ^o ; 242.1/2	1–100 μg/L	Kit	10–4000 mg/L
$\begin{array}{llllllllllllllllllllllllllllllllllll$	Mn ²⁺	EPA 6010C/6020/7000B° 243.1/.2 SM 3120 B	0.1–1.0 µg/L	Spec/kit	0–0.7/0–3 mg/L
Dissolved H ₂ EPA NRMRL Ada OK method CO ₂ SM 4500-CO ₂ ^G Volatile Acids ^G CPT Prev Spec/Kit ^H 10–1000 mg/L/10–100 mg/L Volatile Fatty Acid SM 5560-Organic & Volatile Acids ^G CPT Prev Spec/Kit ^H 10–1000 mg/L/10–100 mg/L H ₂ S (sulfide) EPA 376.1/376.2 ^F ; SM 4500-S ^{2-G} 1–20 mg/L TOC EPA 415.1/415.2 ^F ; SM 5210B ^G 50 μ g/L–10 mg/L BOD—5 day EPA 405.1 ^F ; SM 5210B ^G SM - 2540 D ^G ; 160.2 COD standards tehn S220G ^G ; 410.1/2/3/4 SM 5220G ^G ; 410.1/2/3/4 SM 5220G ^G ; 411.1/2 SM 5220B ^G ; 431.1/2 SM 5220B ^G ; 431.1/2	CH4, CoH4, CoHe	EPA 8015D Modified ^J : BSK-175 ^L	10–100 µg/L		
CO2 SM 4500-CO2 ^G Sm 4500-CO2 ^G Image: Construction of the second seco	Dissolved H _o	EPA NBMBL Ada OK method	· · · · · · · · · · · · · · · · · · ·		
Volatile Fatty Acid SM 5560-Organic & Volatile Acids ^G PTEVIEW H_2S (sulfide) EPA 376.1/376.2 ^F ; SM 4500-S ^{2-G} 1–20 mg/L TOC EPA 415.1/415.2 ^F ; SM 5310B ^G 50 µg/L–10 mg/L BOD—5 day EPA 405.1 ^F ; SM 5210B ^G SM - 2540 D ^G ; 160.2 COD SM 5220 ^G ; 410.1/2/3/4 SM 5500-92864-40c6-433b-91ee-8f7942c2ef59/astm-d7294-132021 Oil/Grease SM 5220B ^G ; 431.1/2 Bacteria Count SM 9000 ^G	CO	SM 4500-CO _o ^G		Spec/Kit ^H	10–1000 ma/L/10–100 ma/L
Hys. (sulfide) EPA 376.1/376.2 ^F ; SM 4500-S ^{2-G} 1–20 mg/L TOC EPA 415.1/415.2 ^F ; SM 5310B ^G 50 µg/L–10 mg/L BOD—5 day EPA 405.1 ^F ; SM 5210B ^G SM - 2540 D ^G ; 160.2 Total Suspended Solids (TSS) SM - 2540 D ^G ; 160.2 ASTM D7294-13(2021) SOD /standards.iteh SM 5220 ^G ; 410.1/2/3/4 SITM D7294-13(2021) OOC SM 5220 ^G ; 431.1/2 SM 5220 ^G ; 431.1/2 Bacteria Count SM 9000 ^G	Volatile Fatty Acid	SM 5560-Organic & Volatile Acids ^G		EW.	
Toc EPA 415.1/415.2 ^F ; SM 5310B ^G 50 μg/L–10 mg/L BOD—5 day EPA 405.1 ^F ; SM 5210B ^G 50 μg/L–10 mg/L Total Suspended Solids (TSS) SM - 2540 D ^G ; 160.2 ASTM D7294-13(2021) COD //standards.itehai SM 5220 ^G ; 410.1/2/3/4 Sist/9e692864-40c6-433b-91ee-8f7942c2ef59/astm-d7294-132021 Oil/Grease SM 5220B ^G ; 431.1/2 SM 5000 ^G SM 5200 ^G ; 431.1/2	H _a S (sulfide)	EPA 376 $1/376 2^{F} \cdot SM 4500 \cdot S^{2-G}$	1-20 mg/l		
BOD 5 day EPA 405.1 ^F ; SM 5210B ^a S210B ^a Total Suspended Solids (TSS) SM - 2540 D ^a ; 160.2 ASTM D7294-13(2021) COD //standards.iteh.ai/ SM 5220 ^a ; 410.1/2/3/4 Sist/9c692864-40c6-433b-91ee-8f7942c2ef59/astm-d7294-132021 Oil/Grease SM 5220 ^B ; 431.1/2 SM 5000 ^a SM 5000 ^a	TOC	EPA 415 $1/415 2^{F}$ SM 5310B ^G	50 ug/l = 10 mg/l		
Total Suspended Solids (TSS) SM - 2540 D ^a ; 160.2 ASTM D7294-13(2021) COD SM 5220 ^a ; 410.1/2/3/4 SM 5220 ^a ; 410.1/2/3/4 DOC SM 5210 B SM 5220 ^a ; 410.1/2/3/4 Oil/Grease SM 5220 ^b ; 431.1/2 Bacteria Count SM 900 ^a	BOD—5 day	FPA 405 1 ^F · SM 5210B ^G	66 µg, 2 16g, 2		
COD SM 520° ; 410.1/2/3/4 DOC SM 5210 B Oil/Grease SM 5200B° SM 5200B° ; 431.1/2	Total Suspended Solids (TSS)	$SM = 2540 D^{G} \cdot 160.2 ASTM$			
DOC SM 5210 B SM 5220B ^G ; 431.1/2 SM 52	COD	SM 5220 ^G 410 1/2/3/4			
UII/Grease SM 52208°; 431.1/2 Bacteria Count SM 9000 ^G	DOC //standards.iteh.ai/	SM 5210 B			
	Oll/Grease	SIVI 52208 ; 431.1/2			

^A This table was developed jointly by the U.S. Army Corps of Engineers, Hazardous, Toxic, and Radioactive Waste Center of Expertise and the U.S. Environmental Protection Agency Technical Support Project—Engineering Forum. Additional information and methods can be found in 40 CFR 136, EPA SW-846, and Standard Methods for Evaluation of Water and Wastewater, most current edition.
^B Estimated sensitivity and detection ranges are method/kit specific. Detection ranges are estimates. Verify these methods are suitable for the samples at this site. Consult

^B Estimated sensitivity and detection ranges are method/kit specific. Detection ranges are estimates. Verify these methods are suitable for the samples at this site. Consult the method or manufacturer's catalogs for details.

^C Spectrometers and meters are instruments that can be used to analyze for many parameters. Kits cost much less, but usually analyze for only one parameter. There are many manufacturers of field test equipment. Verify that the field methods are applicable to the medium at this site.

^D USEPA 600/4-84-017, The Determination of Inorganic Anions in Water by Ion Chromatography, March 1984.

^E Parameters that should be analyzed in the field.

F USEPA 600/4-79/020, Methods for Chemical Analysis of Water and Wastes, March 1983.

^G American Public Health Association, Standard Methods for the Examination of Water and Wastewater. Use the most recently published methods.

^HUse of test kits—Guide D5463.

¹ Use Nernst equation to check ORP field data.

^J USEPA SW-846, Test Methods for Evaluating Solid Wastes, Physical/Chemical Methods, 3rd Edition, Updates I, IIA, IIB, III, IIIA, IVA, and IVB.

^{*K*} A USGS method for ferrous iron analysis.

^L Analysis of Dissolved Methane, Ethane, and Ethylene in Ground Water by a Standard Gas Chromatohraphic Technique, developed by USEPA National Risk Management Laboratory, Ada, OK.

∰ D7294 – 13 (2021)

TABLE 4 Soil, Sediment, and Sludge Analytical Methods

Parameter	Analytical Method ^{A,B,C}	Field Test Kit Method
Reactivity	SW Chapter 7.3	
Atterberg Limits	Test Method D4943	
Specific Heat	Test Method D4611	
Soil Fusion Temperature	Test Method E953/E953M	
Moisture Content	Test Methods D2216, D6836	
Cation Exch. Cap. (CEC)	SW 9080/9081	Soil test kit ^D
Bulk Density	Test Method D4564	
Soil pH	Test Method D4972; SW 9045C	Soil test kit ^D
TOC (soil)	Walkley-Black; SW 9060 modified	
Field Capacity	Test Method D6836	
Halogen Content (Fluoride, Chloride)	SW 6010B / 6020A / 7000A ^E	
Fe	SW 7380 / 7381 / 6010B / 6020A ^{E,F}	
Mn	SW 7460/7461/6010B/6020A/7000B ^{E,F}	
Low Volatile Metals (Sb,As, Be,Cr, Na, K)	SW 6010B / 6020A / 7000B ^{E,F}	
Semi Volatile Metals (Pb, Cd, Hg)	SW 6010B / 6020A / 7000B ^{E,F}	Hg SW 7471A
Phosphorous (total)	SW 6010B ^E	Soil test kit ^D
Particle Size Analysis	Test Method D422	
Nitrate, Nitrite	SW 9210	Soil test kit ^D
Soil Permeability	Test Method D2434, Test Methods D5084 ^G	
Humic Content	Н	
Oil and Grease	SW 9071B Test Method D3921	
Alkalinity	SM 4500-CO2 B Test Methods D1067	
Kjeldahl Nitrogen	SM 4500-N, EPA 351.2 with acid dig. ¹ Specification D3590	
Potassium	SW 6010B, 6020, 7000A ^E	Soil test kit ^D
Soil Oxygen	Field instrument with probe	Field instrument or detector tube with
		probe-tube and hand sample pump
Soil CO ₂	Detector tubes	Field detector tubes with probe-tube and
		hand sampling pump
Thermal Conductivity	Test Method D5334	
Capillary Pressure	Test Methods D6836	
Na, Ca, Mg	SW 6010B/6020A	
Sulfate	SW 9035,9036,9038,9056	
Sulfur	Method 0016 in 40 CFR Part 60, Appendix A	
	Commonly done following TOC high temperature methods	

A Standard Methods (SM) for the Examination of Water and Wastewater, 18th edition, 1992.

^B Except for soil oxygen and soil CO₂, soil samples can be analyzed in an offsite laboratory.

^C Test Methods for Evaluating Solid Waste, Physical/Chemical Methods (SW-846).

^D Field test kits are often available that test for multiple parameters. There are several manufacturers of field soil test kits.

^E Sample digestion required prior to analysis—see water parameters table.

^{*F*} These metals can also be analyzed by atomic adsorption.

^G Screening level.

^H Estimate with Walkley-Black TOC and subtract other substances included in the TOC analysis.

¹ USEPA /600 /4-79 /020, Methods for Chemical Analysis of Water and Wastes, March 1983.

https://standards.iteh.ai/catalog/standards/sist/9c692864-40c6-433b-91ee-8f7942c2ef59/astm-d7294-132021

APPENDIX

(Nonmandatory Information)

X1. EXAMPLE APPLICATION

X1.1 Knowing what data to collect relevant to treatment process design is an iterative process. Site history and other early information gathered at the site, and sampling for chemicals of concern and analysis from the contaminated site combined with professional judgment should provide ideas as to the contaminants of concern at the site. This information, combined with the information in the references listed in 4.8, can be used to develop a list of remedial treatment processes that may be applicable to this contaminated site. Tables 1 and 2 can then be used to determine the treatment process design data that should be collected at the site to evaluate which of the applicable treatment process or processes are best for this site. These data are marked with an "X." More extensive data are needed to design the selected treatment process. These data are marked with an "O."

X1.2 An example use of this data is in evaluating activated carbon adsorption as a treatment process for removal of volatile organic contaminants (VOCs) from ground water. It is important to know the concentration of iron and calcium in the ground water, because these chemicals can foul and plug an activated carbon adsorption unit.

X1.3 The number of treatment process design data samples taken for analysis during the initial field sampling events should be kept to a minimum to save time and costs. Data that can be used as estimates for other parameters should be collected. For example, the humic content of the soil may be required for the final design of the selected process. Total Organic Carbon (TOC) soil analysis estimated by the Walkley-Black Method is recommend in Tables 1 and 2 instead of

Chemical Oxygen Demand (COD) or Dissolved Organic Carbon (DOC), as it is fairly easy to obtain and should provide an estimate of humic content and other organic chemical materials. Nitrogen is a nutrient needed for biological treatment processes. The Kjeldahl Method measures much of the nitrogen in the soil and water with the exception nitrate (NO_3) and nitrite (NO_2) . Nitrate and nitrite should be measured if in-situ reductive dechlorination is being considered. Phosphorous is also a needed nutrient for biological treatment processes. Total phosphorous analysis in water and available phosphorous in soil are good estimators of phosphorous. For metals, consider having a laboratory analyze for all applicable metals as it may not cost much more than analyzing for a selected few. Ferrous iron should be analyzed in the field. Also, analyzing for some parameters in the field may provide immediate information as to other samples to take at that time to eliminate the need for an additional trip to the site. It is recommended that the following water data be routinely analyzed on every contaminated site during an early field-sampling event:

Temperature pH Conductivity Turbidity Dissolved Oxygen Oxygen Reduction Potential (ORP) TOC

X1.3.1 These data provide much information on the water phase and are easily measured with instruments or test kits except for TOC that must be analyzed in the laboratory. It is also recommended that soil samples be collected for sieve analysis during the initial sampling event. Sieve analysis can provide a rough estimate of the following data: plasticity, field capacity, bulk density, particle density, permeability, porosity, and soil classification.

X1.4 Tables 3 and 4 provide laboratory and test kit analysis methods. The laboratory methods are well defined. They consist primarily of analytical methods in *Standard Methods for the Examination of Water and Wastewater*, EPA SW-846, EPA 600 methods, and ASTM methods. The field methods are not as well defined as laboratory methods. Manufacturers' literature, the internet, and other information should be used to select the test kits that best meet the analytical and cost needs for a site. See Guide D5463 for more information. Additional information on the selection of various ASTM standards that are available for the investigation of soil, rock, the vadose zone and ground water for environmental purposes can be found in Guide D5730.

X1.5 Appendix A—Example:

X1.5.1 This example illustrates the use of Tables 1-4 in obtaining and analyzing the data needed to select a treatment process for a site where ground water near a former dry cleaner is contaminated with perchloroethylene (PCE). Monitoring wells will be installed to determine the extent of the contamination in the ground water and in the vadose zone. The Remediation Technologies Screening Matrix and Reference

Guide contains information that will help in developing a list of in-situ and ex-situ treatment processes that may be applicable to treating halogenated VOCs (such as PCE) in the vadose zone and in the ground water at this site. The site is in an urban setting where excavation and ex-situ treatment of soil is difficult. A few of the processes discussed in the above reference have been selected to show how to use Tables 1-4 to evaluate remedial processes. For an actual site, all applicable processes should be evaluated. Actual sites can be very complex. Therefore, the data collection recommendations in this guide must be combined with professional judgment and expertise must be used to determine the actual data to collect. The processes being evaluated in this example are as follows:

X1.5.1.1 Soil—In-Situ Treatment:

Soil vapor extraction Thermally enhanced SVE

X1.5.1.2 Ground Water—In-Situ Treatment:

Phytoremediation Permeable reactive barriers (passive treatment walls) Monitored natural attenuation Enhanced bioremediation Air sparging Bioslurping Dual (multiphase) phase extraction In-well air stripping

X1.5.1.3 Ground Water—Ex-Situ Treatment:

Air stripping

Adsorption (carbon)

X1.5.2 The data needed to evaluate the above processes is shown in boldface type in Tables X1.1 and X1.2. The details are as follows: DO, temperature, turbidity, pH (field), ORP (field), chlorides, Ca, Mg, Mn, Na, K, TOC, alkalinity, conductivity, ferrous iron, sulfate/sulfite, nitrate/nitrite, and sieve analysis. Tables 3 and 4 list analytical methods used to obtain this data. Many of these parameters can be analyzed at the site with probes or analytical field kits.

X1.5.3 The above data in conjunction with information in Guide D5463 and U.S. Army Corps of Engineers and Support Center Engineering Publications⁷ are used in the evaluation and selection of a treatment process for the ground water and the vadose zone. For purposes of this example, assume that monitored natural attenuation has been selected for remediation of the ground water and assume that in-situ SVE has been selected for remediation of the vadose zone. Assuming the treatment processes have already been selected, the additional data needed to design these two processes are marked with an "O" in Tables X1.1 and X1.2. These are as follows:

X1.5.3.1 Monitored Natural Attenuation for the Ground Water— CO_2 , H_2S , dissolved H_2 , alkalinity (already sampled), volatile fatty acids, phosphorous, and Kjeldahl nitrogen (from Table 2—in situ).

X1.5.3.2 *In-Situ SVE for the Vadose Zone*—TOC and bulk density.

⁷ United States Army Engineering and Support Center Engineering Publications, available at http://www.hnd.usace.army.mil/techinfo/engpubs.htm.