



Designation: D 3977 – 97 (Reapproved 2002)

## Standard Test Methods for Determining Sediment Concentration in Water Samples<sup>1</sup>

This standard is issued under the fixed designation D 3977; 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 approval. A superscript epsilon ( $\epsilon$ ) indicates an editorial change since the last revision or reapproval.

### 1. Scope

1.1 These test methods cover the determination of sediment concentrations in water and wastewater samples collected from lakes, reservoirs, ponds, streams, and other water bodies. In lakes and other quiescent-water bodies, concentrations of sediment in samples are nearly equal to concentrations at sampling points; in most instances, sample concentrations are not strongly influenced by collection techniques. In rivers and other flowing-water bodies, concentrations of sediment in samples depend upon the manner in which the samples are collected. Concentrations in isokinetically-collected samples can be multiplied by water discharges to obtain sediment discharges in the vicinity of the sampling points.

1.2 The procedures given in these test methods are used by the Agricultural Research Service, Geological Survey, National Resources Conservation Service, Bureau of Reclamation, and other agencies responsible for studying water bodies. These test methods are adapted from a laboratory-procedure manual<sup>2</sup> and a quality-assurance plan.<sup>3</sup>

1.3 These test methods include:

Test Method A—Evaporation	Sections 8 to 13
Test Method B—Filtration	14 to 19
Test Method C—Wet-sieving-filtration	20 to 25

1.4 Test Method A can be used only on sediments that settle within the allotted storage time of the samples which usually ranges from a few days to a few weeks. A correction factor must be applied if dissolved-solids concentration exceeds about 10 % of the sediment concentration.

1.5 Test Method B can be used only on samples containing sand concentrations less than about 10 000 ppm and clay concentrations less than about 200 ppm. The sediment need not

be settleable because filters are used to separate water from the sediment. Correction factors for dissolved solids are not required.

1.6 Test Method C can be used if two concentration values are required: one for sand-size particles and one for the combination of silt and clay-size particles. The silt-clay fraction need not be settleable.

1.7 These test methods must not be confused with turbidity measurements discussed in Test Method D 1889. Turbidity is the optical property of a sample that causes light rays to be scattered and absorbed; it is not an accurate measure of the mass or concentration of sediment in the sample.

1.8 These test methods contain some procedures similar to those in Test Methods D 1888 which pertains to measuring particulate and dissolved matter in water.

1.9 *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 limitations prior to use.*

### 2. Referenced Documents

#### 2.1 ASTM Standards:

- D 1129 Terminology Relating to Water<sup>4</sup>
- D 1193 Specification for Reagent Water<sup>4</sup>
- D 1888 Test Methods for Particulate and Dissolved Matter in Water<sup>5</sup>
- D 1889 Test Method for Turbidity of Water<sup>4</sup>
- D 2777 Practice for Determination of Precision and Bias of Applicable Methods of Committee D-19 on Water<sup>4</sup>
- D 4410 Terminology for Fluvial Sediment<sup>4</sup>
- D 4411 Guide for Sampling Fluvial Sediment in Motion<sup>6</sup>
- E 11 Specification for Wire-Cloth Sieves for Testing Purposes<sup>7</sup>

### 3. Terminology

3.1 *Definitions*—For definitions of water-related terms used in these test methods refer to Terminologies D 1129 and D 4410.

<sup>1</sup> These test methods are under the jurisdiction of ASTM Committee D19 on Water and are the direct responsibility of Subcommittee D19.07 on Sediments, Geomorphology, and Open-Channel Flow.

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<sup>2</sup> Guy, H. P., "Laboratory Theory and Methods for Sediment Analysis," *Techniques of Water Resources Investigations, U.S. Geological Survey*, Book 5, Chapter C1, 1941.

<sup>3</sup> Matthes, W. J., Jr., Sholar, C., J., and George, J. R., "Quality-Assurance Plan for the Analysis of Fluvial Sediment," *U.S. Geological Survey Open File Report* 90, 1990.

<sup>4</sup> *Annual Book of ASTM Standards*, Vol 11.01.

<sup>5</sup> Discontinued; see 1990 *Annual Book of ASTM Standards*, Vol 11.01.

<sup>6</sup> *Annual Book of ASTM Standards*, Vol 11.02.

<sup>7</sup> *Annual Book of ASTM Standards*, Vol 14.02.

### 3.2 Definitions of Terms Specific to This Standard:

3.2.1 *dissolved solids*—soluble constituents in water. The quantity is determined by evaporating a water sample to visible dryness at a temperature slightly below boiling. The temperature is then raised to 105°C and held for about 2 h. This is followed by cooling in a desiccator and weighing the residue.

3.2.2 *fluvial sediment*—particles that are (a) derived from rocks or biological materials and (b) transported by flowing water.

3.2.3 *sediment concentration*—(a) the ratio of the mass of dry sediment in a water-sediment mixture to the mass of the mixture or (b) the ratio of the mass of dry sediment in a water-sediment mixture to the volume of the mixture. As indicated by **Table 1**, the two ratios differ except at concentrations less than 8000 mg/L.

3.2.4 *supernate*—clear, overlying liquid in a sediment sample.

3.2.5 *suspended sediment*—sediment supported by turbulent currents in flowing water or by Brownian movement.

3.2.6 *tare*—weights of empty containers used in analysis procedure.

## 4. Significance and Use

4.1 Suspended-sediment samples contain particles with a wide variety of physical characteristics. By presenting alternate approaches, these test methods allow latitude in selecting analysis methods that work best with the particular samples under study.

4.2 Sediment-concentration data are used for many purposes that include: (1) computing suspended-sediment discharges of streams or sediment yields of watersheds, (2) scheduling treatments of industrial and domestic water supplies, and (3) estimating discharges of pesticides, plant nutrients, and heavy metals transported on surfaces or inside sediment particles.

**TABLE 1 Factors for Conversion of Sediment Concentration in Parts per Million (ppm) to Grams per Cubic Metre (g/m<sup>3</sup>)<sup>A</sup> or Milligrams per Litre (mg/L)**

Range of Concentration, 1000 ppm	Multiply By	Range of Concentration, 1000 ppm	Multiply By	Range of Concentration, 1000 ppm	Multiply By
0–7.95	1.00	153–165	1.11	362–380	1.30
8.0–23.7	1.01	166–178	1.12	381–398	1.32
23.8–39.1	1.02	179–191	1.13	399–416	1.34
39.2–54.3	1.03	192–209	1.14	417–434	1.36
54.4–69.2	1.04	210–233	1.16	435–451	1.38
69.3–83.7	1.05	234–256	1.18	452–467	1.40
83.8–97.9	1.06	257–278	1.20	468–483	1.42
98.0–111	1.07	279–300	1.22	484–498	1.44
112–125	1.08	301–321	1.24	499–513	1.46
126–139	1.09	322–341	1.26	514–528	1.48
140–152	1.10	342–361	1.28	529–542	1.50

<sup>A</sup>Based on water density of 1.000 g/mL and specific gravity of sediment of 2.65. The following equation also applies:

$$C_1 = C / (1.0 - C 622 \times 10^{-9})$$

where:

$C_1$  = sediment concentration, mg/L, and  
 $C$  = sediment concentration, ppm.

## 5. Reagents and Materials

5.1 *Purity of Water*—Unless otherwise indicated, references to water shall be understood to mean reagent water as defined by Type III of Specification **D 1193**.

5.1.1 Requirements can usually be met by passing tap water through a mixed cation-anion exchange resin or by distillation.

## 6. Sampling

6.1 Flows and concentrations in river cross sections are usually unsteady; consequently, in a strict sense, samples represent conditions only at the time and location of sample collection.

6.2 A sample may consist of a single container of a water-sediment mixtures collected at (1) a specific point in a river cross section, (2) a specific vertical in a cross section (a depth-integrated sample), or (3) several verticals in a cross-section. If the verticals are equally spaced and the sample is collected at equal transit rates, it is referred to as an EWI sample. The acronym EWI (equal-width-increment) is synonymous with ETR (equal-transit-rate) which appears in many older reports. A sample may also consist of several containers filled at different points or verticals in a cross-section. If the containers are filled at centroids of equal discharge in a cross section, they are referred to as EDI samples. Details on sampling are given in Guide **D 4411**.

## 7. Sample Handling

7.1 When samples arrive at the laboratory, group them according to gaging stations and then arrange each group in chronological order according to times of sample collection. Separate the samples to be analyzed for concentration from those to be analyzed for particle-size distribution or other properties. A data sheet should then be completed for each concentration sample. Examples of three commonly used forms are shown on **Fig. 1**. Expanded notes can be written on the front of the forms in spaces reserved for other bottles or, if even more space is needed, remarks can be written on the back of the forms along with reference numbers keyed to the appropriate bottles.

7.2 Check each sample for: (1) loss of water caused by leakage or evaporation, (2) loss of sediment which is sometimes revealed by the presence of particles on the outside of the sample bottle, (3) accuracy of sample-identification notes, and (4) a container tare which is usually etched on the bottle. Enter all appropriate notes, observations, and data on the laboratory form. Be particularly careful to enter the etched tare reading on the form under the heading Weight of Sample—Tare.

7.3 Remove the bottle caps then weigh each container along with its water-sediment mixture to the nearest 0.5 g. Record each reading on the corresponding bottle and on the laboratory form under the heading Weight of Sample—Gross.

7.4 Replace the caps then store the samples in a cool, dark place to minimize microbiological and algal growth. Inspect the bottles frequently; if the sediment does not settle within about 14 days, use Test Method B (filtration procedure) for the analysis. If settling proceeds at an acceptably rapid rate, use Test Methods A, B, or C.

The figure shows three identical forms for recording field and laboratory data for sediment samples. Each form is divided into several sections:

- Stream and location:** A header section for recording the source of the sample.
- Date and Time:** Fields for recording the date and time of collection.
- Gage height and Discharge:** Fields for recording water level and flow rate.
- Temperature:** A field for recording the water temperature.
- Sampling Sta.:** A field for recording the specific sampling location.
- WEIGHT OF SAMPLE:** A section with three rows for recording Gross, Tare, and Net weights of the sample.
- Container no.:** A field for recording the identification number of the container.
- WEIGHT OF SEDIMENT:** A section with four rows for recording Gross, Tare, D.S. Corr., and Net weights of the sediment.
- Conc. (ppm):** A field for recording the concentration of the sample in parts per million.
- pH:** A field for recording the pH of the sample.
- SPECIFIC CONDUCTANCE:** A section with four rows for recording R(KCl), R(sample), Temp. °C, and Micromhos at 25°C.
- DISSOLVED SOLIDS:** A section with five rows for recording Vol (ml), Gross Wt., Tare Wt., Net Wt., and D. S. (mg/l).

FIG. 1 Alternate Forms for Recording Field and Laboratory Data for Sediment Samples

TEST METHOD A—EVAPORATION

8. Scope

8.1 This test method can be used only with sediments that settle under the influence of gravity. This test method is applicable to samples ranging from 0.2 to 20 L in volume, from 5 to 550 000 mg/L in sediment concentration, and having less than 35 000 mg/L in dissolved-solid concentration.

9. Summary of Test Method

9.1 After the sediment has settled, most of the supernatant water is poured or siphoned away. The volume of water-sediment mixture remaining is measured so that a dissolved-solids correction can be applied later. The sediment is then dried and weighed. Sediment concentration is calculated in accordance with Section 12.

10. Apparatus

10.1 *Evaporating Dishes or Beakers*—Preweighed containers of porcelain or glass with capacities of about 150 mL are needed for holding the sediment and water during drying.

10.2 *Vacuum System*, trapped to prevent sample carry-over to the vacuum source during removal of supernate.

10.3 *Drying Oven*, equipped with a 90 to 120°C thermostat is needed to control temperatures while evaporating water from the sediment. A gravity-convection type oven is preferred but a mechanically ventilated (forced draft) style can be used if air-flow rates are low.

10.4 *Desiccator*, for preventing air-borne moisture from collecting in the sediment specimens while they are cooling.

10.5 *Laboratory Balance*, top-loading type with a resolution of 0.0001 g and a capacity of 150 g is needed for weighing the dry sediments.

10.6 *Laboratory Balance*, top-loading type with a resolution of 0.1 g and a capacity of about 4000 g is needed for weighing sample bottles containing water and sediment.

11. Procedure

11.1 After the sediment has settled, decant or vacuum away as much supernate as possible without disturbing the sediment. This can be accomplished by connecting a J-shaped plastic, copper, or glass tube to the vacuum line and lowering the tube until the curved section is near the bottom of the sample bottle. Supernate enters the upward-facing end of the tube and thereby flows away without creating currents and eddies in the sediment layer. Save the supernate for a dissolved-solids correction factor to be determined later.

11.2 After decanting, about 40 to 70 mL of water-sediment mixture should be left. To determine the exact volume, place the sample bottle on a level support then mark the liquid surface on the outside of the bottle. Use water to wash all of the sediment and supernate into an evaporating dish, then refill the sample bottle to the mark with water from a small graduate. Record the volume added to the sample bottle on the sample-data form.