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USDA LTAR Common Experiment measurement: Total suspended solids (TSS)

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Brent Dalzell[1], Oliva Pisani[2]

[1]USDA Agricultural Research Service, Soil and Water Management Research, St. Paul, MN;
[2]USDA Agricultural Research Service, Southeast Watershed Research Laboratory, Tifton, GA

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Lori J Abendroth
USDA ARS

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Abstract

Total suspended solids (TSS) refers to all the material from a well-mixed sample retained by a filter media. In the case of environmental water samples, TSS is commonly used to measure sediment in surface waters (field runoff, ditches, and streams) but can also be present in subsurface flow where macropore flow or surface inlets to tile drainage systems are present. In some cases, TSS can also include algae or other plant materials that comprise volatile suspended solids (VSS) because combustion in a muffle furnace eliminates them. The recommended method for measuring TSS includes passing a known sample volume through a pre-weighed filter and measuring the oven-dry weight of the material trapped on the filter.

Materials

Sample Analysis:
Measurement of TSS includes passing a known volume of a well-mixed sample through a pre-weighed filter and measuring the oven-dry weight of the material trapped on the filter (APHA, 2005; USEPA, 1999).

Materials:
1. Glass fiber filters: Whatman 934-AH glass fiber filter (1.5 µm) usage is common for TSS analysis
2. Vacuum filtration apparatus with a funnel that includes filter support
3. Aluminum weighing dishes
4. Forceps
5. Drying oven
6. Balance with a precision of 0.1 mg or better

Sample collection

1 At a minimum, collect 1 mg of TSS residue. At a maximum, TSS should not impede the flow rate of the filter media (slow filtration is more time-consuming but does not impact results).

Note

- The required sample volume will vary with site and event characteristics.
- For many environmental samples, 100 mL of sample solution is a reasonable starting point if using a 4.7 cm diameter filter disc.

2 Return samples to the laboratory On ice and filter them on collection day if possible.

Sample storage and preservation

3 Analyze the samples as soon as possible after collection.

4 If storage is required, refrigerate the samples at 4 °C or store On ice to minimize decomposition of solids.

Note

- Samples should not be stored for more than seven days (APHA, 2005).
- Samples should be at Room temperature for analysis.

Archiving

5 Store water samples for TSS analyses until data certification (QA/QC verification) as this is common practice.

Note

Water sample storage should not exceed seven days.

Glass fiber filter preparation

1h

6 Assemble the vacuum filtration apparatus with a new filter.

7 Apply the vacuum.

8 Rinse the filter three times with distilled water.

9 Maintain the vacuum for a few seconds to remove excess water, then remove the vacuum.

10 Using forceps, carefully remove the rinsed filter to an aluminum weighing dish.

11 Dry in an oven at 103 °C - 105 °C for 1 hour.

12 Store dried filters in a desiccator until needed.

Sample analysis

1h

13 Using forceps, select a prepared glass fiber filter. Weigh it and record the mass to the nearest 0.1 mg in a lab notebook.

14 Unless filtering the entire sample, shake it vigorously before dividing it into a volume suitable for analysis.

15 Select a water sample, weigh the sample + bottle mass, and record the mass in a lab notebook.

16 Assemble the filtration apparatus and apply a vacuum.

17 Pre-moisten the filter with a small volume of distilled water.

18 Shake the sample vigorously and pour it into the filtration apparatus funnel.

19 Maintain the vacuum until all sample water has passed through the filter.

20 Using a wash bottle with distilled water, rinse the sample bottle and sides of the filter funnel three times (for a 4.7 cm filter, each rinse should be roughly 10 ml).

21 Weigh the empty sample bottle and record the mass in a lab notebook.

22 Remove the vacuum.

23 Using forceps, carefully remove the filter paper and place it in a labeled and weighed aluminum weighing dish.

24 Dry the filter paper + sample at 105 °C for 1 hour or longer, if necessary, to remove all water.

25 Remove the samples from the oven and immediately store them in a desiccator or weigh them. Record the mass in a lab notebook.

26 Store the weighed and recorded filters in a desiccator until ready for disposal.

27 Sample the covariate metrics (Total N (TN) and total P (TP) concentrations) concurrently.

28 Perform the calculations using the following formula:
Total suspended solids in a sample (mg/L) = (A-B) * 1000 / C

Note

- A = mass of filter and weighing dish + sample residue (mg)
- B = mass of filter and weighing dish (mg)
- C = volume of sample (L); (mass of bottle with sample - mass of empty bottle)

C can also be obtained directly by pouring the sample into a graduated cylinder and recording the sample volume.

Recommendations for data collection

29 Table 1. Summary of recommendations for the collection and measurement of TSS concentration.

	A	B	C	D
	Attribute	Preferred	Minimum	Comments
	Spatial scale	Field	Plot	
	Frequency	Event-driven	Event-driven	Sample collection frequency will depend on site-specific flow chracteristics and experimental goals
	Covariate metrics	TN, TP	TN, TP	
	Sample preservation and storage	Analyze on collection day	Refrigerate at 4°C or store on ice for up to 7 days	
	Sample analysis	Total suspended solids dried at 103-105° C		
	Water quantity	Discharge or flow rate	Discharge or flow rate	Calculate TSS loads by linking this metric to the water quantity metric “flow"

Covariate metrics = other metrics to sample concurrently. TN = total nitrogen; TP = total phosphorus.

Protocol references

1) American Public Health Association (APHA), 2005. Standard Methods for the Examination of Water and Wastewater, 21st ed. Washington, DC: American Public Health Association, American Water Works Association, and Water Environment Federation.

2) NCASI Technical Bulletin No. 291, March 1977. National Council of the Paper Industry for Air and Stream Improvement, Inc., 260 Madison Ave., NY.

3) US Environmental Protection Agency (USEPA), 1999. Method 160.2, Residue, Non-Filterable (Gravimetric, Dried at 103-105°C) Methods for the Chemical Analysis of Water and Wastes (MCAWW) (EPA/600/4-79/020).