



Environmental Analysis Program

Pomona College
Biogeochemistry Laboratory

SOP-L418

Water-Extractable Dissolved Organic Carbon (Soil)

Standard Operating Procedure

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1. Purpose

This procedure describes the extraction and quantification of water-extractable dissolved organic carbon (WEOC) from soil. WEOC represents the fraction of soil organic matter that is readily

soluble in water and includes simple sugars, organic acids, amino acids, and other low-molecular-weight compounds. It is a sensitive indicator of labile carbon availability, microbial substrate supply, and changes in soil management or land use (Ghani et al., 2003; Jones et al., 2006).

WEOC is distinct from the K_2SO_4 -extractable DOC measured in the chloroform fumigation-extraction method (SOP-L409) and from total soil organic carbon (SOP-L407). The water extraction uses no salt, making it a closer analogue to the dissolved organic carbon that would leach from soil under natural rainfall or irrigation.

2. Scope

- **Applies to:** Mineral and organic soil samples, compost, and organic amendments. Samples should be collected per SOP-F400 Soil Sampling and stored at 4 °C (for field-moist analysis) or air-dried.
- **Does not apply to:** Water samples (analyze directly on the TOC-L), K_2SO_4 extracts for microbial biomass carbon (see SOP-L409), or total soil carbon by combustion (see SOP-L407)
- **Location:** EA Program laboratory, SGM 133

3. Responsibilities

Role	Responsibility
Lab PI	Approve SOP, ensure training compliance
Trained Personnel	Perform extraction and submit samples for TOC analysis
New Students	Complete training before independent use

4. Definitions

- **Dissolved organic carbon (DOC):** Organic carbon that passes through a 0.45 µm filter; in soil extracts, includes low-molecular-weight organic acids, fulvic acids, amino acids, and other water-soluble organic compounds.
- **Hot-water extractable carbon (HWE):** A more aggressive extraction using hot water (80 °C); releases more labile organic carbon than cold-water extraction; a closer proxy for microbially available carbon and total labile carbon.
- **KHP (potassium hydrogen phthalate):** The primary standard for TOC calibration; a pure, stable organic acid weighed accurately to prepare standards of known carbon concentration.
- **Labile organic carbon:** Readily decomposable organic carbon fractions that turn over on timescales of days to months; includes microbial biomass, water-extractable organic carbon, and dissolved organic carbon; sensitive to management and land use.
- **NPOC (non-purgeable organic carbon):** The organic carbon remaining in a sample after acidification and sparging to remove inorganic carbon; the quantity measured by the Shimadzu TOC-L and the operational definition of DOC.

- **Soil-to-water ratio:** The ratio of soil mass to extraction water volume (typically 1:5 or 1:10 w/v) in the water extraction step; must be reported alongside results and held constant within a study.

5. Safety and Hazards

Hazards

- **Physical:** Drying oven (105 C) and orbital shaker pose minor physical hazards.
- **Biological:** Soil samples may harbor pathogens. Wash hands after handling soil.
- **Chemical:** Concentrated HCl (if used for acidification before TOC analysis) is corrosive.

5.1. Required PPE

- ☐ Safety glasses
- ☐ Lab coat
- ☐ Nitrile gloves

5.2. Emergency Procedures

For acid splashes, flush with water for at least 15 minutes. Refer to [SOP-L002 Laboratory Safety](#).

6. Equipment and Materials

6.1. Equipment

Item	Location	Notes
Orbital or end-over-end shaker	SGM 133	
Centrifuge (capable of 4,000 x g)	SGM 133	
Vacuum filtration apparatus or syringe filters	SGM 133	
Shimadzu TOC-L analyzer	SGM 133	See SOP-L204
Analytical balance (0.01 g)	SGM 133	See SOP-L200
Drying oven (105 C)	SGM 133	For gravimetric moisture

6.2. Reagents and Consumables

Item	Notes
Deionized water (Type I or II, 18.2 MOhm)	Carbon-free; verify with TOC blank

Item	Notes
50 mL centrifuge tubes (polypropylene)	Pre-rinsed with DI water
0.45 um membrane or syringe filters	Pre-combusted glass fiber (GF/F) or PVDF; do not use cellulose acetate (leaches DOC)
Pre-combusted 40 mL glass vials with PTFE-lined caps	For TOC-L analysis
2 M HCl	For acidifying extracts if NPOC mode is used

7. Procedure

7.1. Sample Preparation

1. If using field-moist soil, determine gravimetric moisture content on a separate subsample per [SOP-L400](#)
2. If using air-dried soil, pass through a 2 mm sieve and determine residual moisture content

7.2. Extraction

1. Weigh 5.0 g (oven-dry equivalent) of soil into a 50 mL centrifuge tube. Record the exact mass.
2. Add 25 mL of deionized water (1:5 soil-to-water ratio) (Ghani et al., 2003; Jones et al., 2006)
3. Cap the tube and shake on an end-over-end or orbital shaker at approximately 150 rpm for 1 hour at room temperature
4. Centrifuge at 4,000 x g for 10 minutes to separate the supernatant

Tip

Some protocols use a hot water extraction (80 C for 16 hours) to capture a larger fraction of labile carbon (Ghani et al., 2003). If hot water extraction is desired, specify the temperature and duration explicitly in the lab notebook and report, as the two methods are not directly comparable.

7.3. Filtration

1. Filter the supernatant through a 0.45 um filter into a pre-combusted glass vial
2. If using syringe filters, discard the first 2–3 mL of filtrate to flush any carbon leached from the filter
3. Collect at least 15 mL of filtrate for TOC analysis (enough for multiple injections plus rinse volume)

7.4. Storage

1. If extracts cannot be analyzed within 24 hours, acidify to pH less than 2 with 2 M HCl (approximately 1 drop per 10 mL) and store at 4 C
2. Analyze within 7 days of extraction; prolonged storage may alter DOC concentrations even when acidified

7.5. DOC Analysis

1. Analyze filtered extracts on the Shimadzu TOC-L in NPOC mode per [SOP-L204](#)
2. Prepare a deionized water blank and extraction blanks (DI water processed through the full extraction procedure) alongside samples
3. Run calibration standards (potassium hydrogen phthalate, KHP) as described in SOP-L204

7.6. Calculations

$$\text{WEOC (mg C kg}^{-1} \text{ dry soil)} = \frac{(C_{\text{sample}} - C_{\text{blank}}) \times V_{\text{extract}}}{m_{\text{soil}}}$$

where:

- C_{sample} = DOC concentration in the filtered extract (mg C/L)
- C_{blank} = DOC concentration in the extraction blank (mg C/L)
- V_{extract} = total volume of extractant added (L; e.g., 0.025 L)
- m_{soil} = oven-dry mass of soil extracted (kg)

8. Quality Control and Acceptance Criteria

- Include extraction blanks (DI water only, no soil) in each batch to quantify background carbon from filters, tubes, and water
- Run sample duplicates for at least 10% of samples; CV between duplicates should be less than 10%
- Include a laboratory reference soil in each batch
- Verify that extraction blank DOC is less than 1 mg/L; if higher, troubleshoot water quality and filter blanks
- Instrument QC follows [SOP-L204](#) requirements (calibration verification, instrument blanks, replicate injection CV less than 2%)

9. Waste Disposal

Waste Type	Disposal Method
Soil residue after extraction	Standard trash or return to sample stock
Filtered water extracts	Drain with copious water (non-hazardous)

Waste Type	Disposal Method
Acidified extracts	Neutralize and drain, or collect for EH&S
Used filters	Standard trash

10. References

- Ghani, A., Dexter, M., & Perrott, K. W. (2003). Hot-water extractable carbon in soils: A sensitive measurement for determining impacts of fertilisation, grazing and cultivation. *Soil Biology and Biochemistry*, 35(9), 1231–1243. [https://doi.org/10.1016/S0038-0717\(03\)00186-X](https://doi.org/10.1016/S0038-0717(03)00186-X)
- Jones, D. L., Willett, V. B., Stockdale, E. A., Sherlock, R., & Murphy, D. V. (2006). Dissolved organic carbon dynamics and fluxes in agricultural soils. *Geoderma*, 135, 200–211.

11. Training Record

Before performing this procedure independently, personnel must:

1. Read this SOP in full
2. Complete [SOP-L002 Laboratory Safety](#) training
3. Complete [SOP-L400 Soil Moisture](#) training (required for moisture correction)
4. Be trained on [SOP-L204 Shimadzu TOC-L](#) or have extracts analyzed by a trained operator
5. Perform the extraction under supervision with acceptable duplicate precision (CV less than 10%)
6. Be signed off by the PI or lab manager