Monitoring of Turbidity in Stormwater Runoff From Construction Activities

Introduction

The clarity of water is reduced by the presence of suspended and dissolved solids. Depending on the nature and concentration, such solids may have a detrimental impact on water quality. The Vermont Water Quality Standards includes a standard for the relative clarity of surface waters, termed turbidity.

Under the National Pollutant Discharge Elimination System (NPDES) Phase II, construction activities involving one or more acres of earth disturbance require a stormwater discharge permit. In Vermont, permit requirements are related to the risk of a discharge of sediment-laden stormwater to waters of the State. Individual Construction Permits, and moderate risk projects under General Permit 3-9020 (Amended 2007) include turbidity monitoring requirements. This document, based in part on a guide from the Washington State Department of Ecology, describes how to conduct field monitoring of turbidity to satisfy these requirements.

What is Turbidity?

Higher NTU values indicate more turbid, or muddier, water. Low values indicate less turbid, or clearer, water.

ASTM defines turbidity as an "expression of the optical property that causes light to be scattered and absorbed rather than transmitted in straight lines through the sample." The scattering of light through water is due principally to the presence of suspended particles. In surface waters, these solids include materials such as clay, silt, organic and inorganic materials, soluble colored compounds, plankton, and microscopic organisms.

In general, the greater the concentration of suspended particles in a sample of water, the greater the absorption and scattering light passing through it, and the higher the turbidity of the sample. Unlike characteristics such as temperature, however, turbidity is not a physical property of water. Rather, it is a qualitative characteristic of the water, the measurement of which is relative to the procedure and equipment used.

Historically, a number of approaches have been developed to assess turbidity. Older methods to measure turbidity relied upon the subjective assessment of the *attenuation* of light as it passed through the medium. Modern methods instead evaluate the *intensity* of reflected light. This provides a more meaningful measure of the turbidity caused by suspended particles because it can be performed objectively with very sensitive equipment and because the light scatter is a property of the particles dependent upon shape, reflectivity, and color. The measurement of turbidity in this manner is termed nephelometry (from the Greek *nephos* for cloud) and the units are Nephelometric Turbidity Units (NTUs). The equipment used for these measurements is properly termed a nephelometer, though turbidity meter and turbidimeter are commonly used (these can also refer to devices measuring the attenuation of light due to cloudiness).

Vermont Water Quality Standards for Turbidity:
Class A(1) Waters: 10 NTU
Class A(2) Waters: 10 NTU
Class B Cold Water: 10 NTU
Class B Warm Water: 25 NTU

sample under defined conditions
with the intensity of light

EPA Standards for Measuring Nephelometry

For NPDES permits, the EPA has established Standard 180.1 for measuring turbidity of surface waters by nephelometry. This approach employs sensitive photoelectric detectors to measure the scatter of light with a particular geometric arrangement of the light source, sample, and detector. The turbidity value generated by the device relates the intensity of light scattered by the

- **Light source: Tungsten lamp op- erated at a color temperature be- tween 2200-3000 °K.**
- **Distance traversed by incident light and scattered light within the sample tube: Total not to exceed 10 cm.**
- **Detector: Centered at 90° to the incident light path and not to ex- ceed ± 30°C from 90°C. The De- tector, and filter system if used, shall have a spectral peak re- sponse between 400 and 600 nm.**

Nephelometer Characteristics Required By EPA 180.1

scattered by a standard reference suspension. The higher the intensity of scattered light, the higher the turbidity.

The standard includes other requirements related to the source and path of the incident light (see sidebar on previous page). Ensure your nephelometer meets these criteria, since other designs may produce discrepant results.

Steps for Proper Sampling & Analysis with Nephelometers

Step 1. Calibration

New nephelometers should have been factory-calibrated before leaving the manufacturer. However, with use over time, the calibration will need to be repeated to ensure instrument precision and accuracy. Calibration should always be done according to manufacturer's guidelines, but the general approach is to have the device register the turbidity of a standard suspension of known turbidity. EPA Standard 180.1 accepts the use of a Formazin standard for calibration. Formazin is a stable synthetic polymer with very reproducible light scatter characteristics. Commercially available, ready-to-use preparations of stabilized formazin with known turbidity are available for calibration purposes.

Calibration should be carried out prior to each day's use of the nephelometer. If verification indicates significant deviation from the standard value (greater than ± 10%), thoroughly clean and recalibrate the instrument.

Step 2. Sample Collection

Materials Needed For Sampling:

- Calibrated Nephelometer
- Clean Sample Bottles
- Distilled Water for Rinsing Bottles
- Pole or Scoop if Necessary
- Blank Inspection Sheets

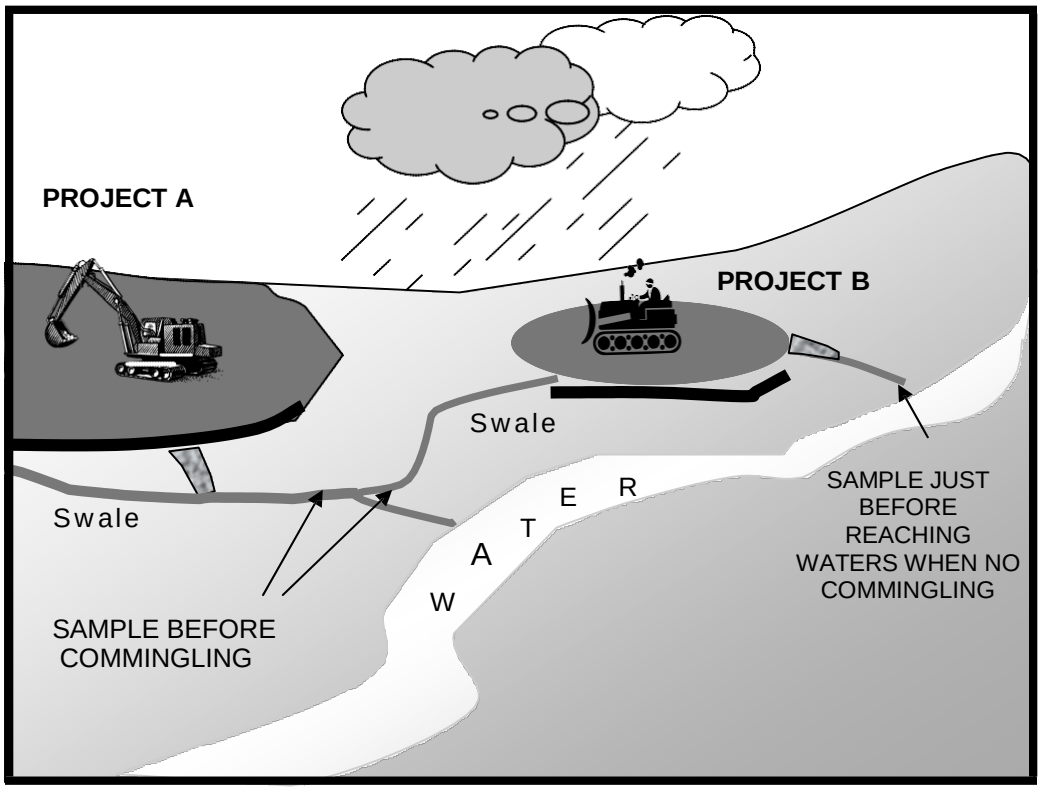
The following is the accepted procedure for collecting samples and making turbidity measurements of stormwater runoff from construction activities. A flow chart describing the monitoring and sampling protocol required under General Permit 3-9020 (Amended 2008) is included at the end of this guidance document. Individual Discharge Permits for construction stormwater will

typically contain very similar requirements, but the permit should be consulted for specifics since there could be deviations from the requirements of General Permit 3-9020.

Identification of Sampling Point

The general permit requires that if stormwater runoff from your site is discharging to state waters, than you must sample the discharge. The following protocol shall be followed in determining the appropriate sampling point:

If you have access to the point where stormwater runoff from your construction site discharges to state waters, then you must sample your runoff at the point immediately before it discharges to state waters. However, if your stormwater runoff commingles with runoff from other sites prior to discharging to state waters, then you must sample your runoff at the point immediately up-stream of where the commingling first occurs. This is to ensure that your sample is representative of the flow from your construction site.

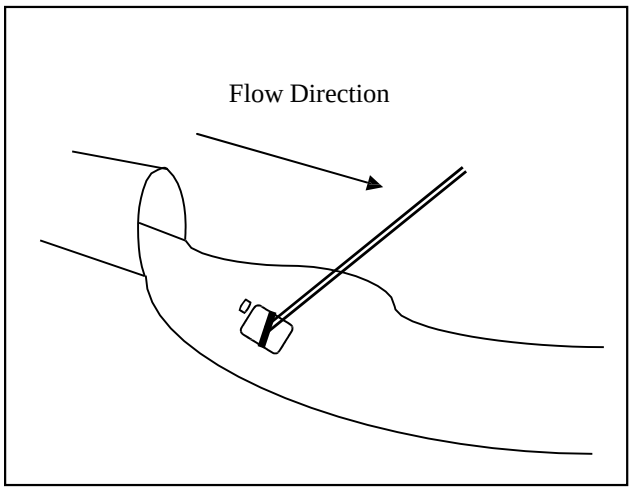


If you do not have access to the point where stormwater runoff from your construction site discharges to state waters, then you must sample your runoff as close as possible

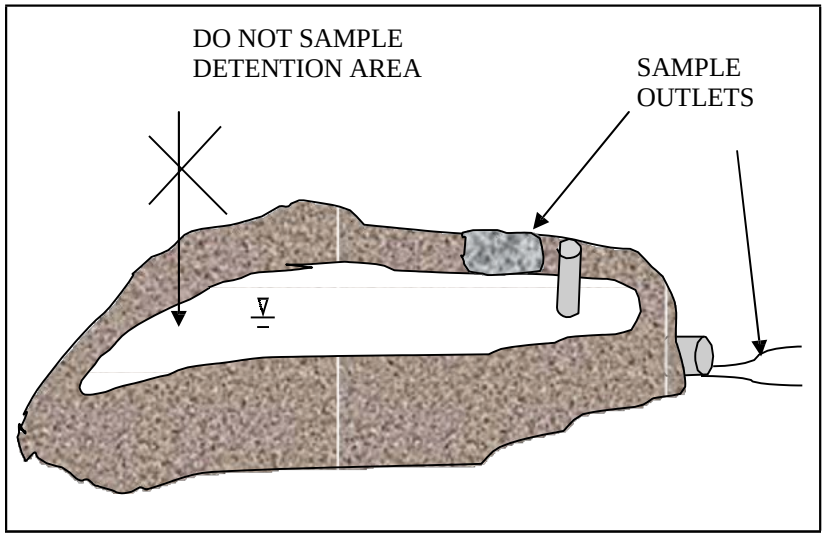
to the point where the discharge to state waters is occurring. However, if your storm-water runoff commingles with runoff from other sites upstream from this point then, you must sample your runoff at the point immediately before it commingles with runoff from other sites. This is to ensure that your sample is representative of the flow from your construction site.

Other Sampling Considerations

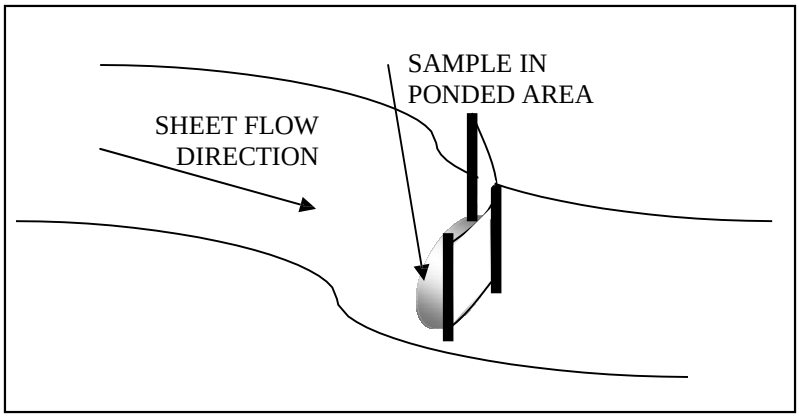
If stormwater runoff leaves your site via a pipe, ditch or swale, identify the appropriate sampling location using the protocol discussed above. When sampling in a ditch, hold the bottle with the opening face upstream and be sure not to overfill the bottle. To ensure the sample is representative of the construction site runoff, be careful not to stir up sediment by walking through areas of stormwater flow.



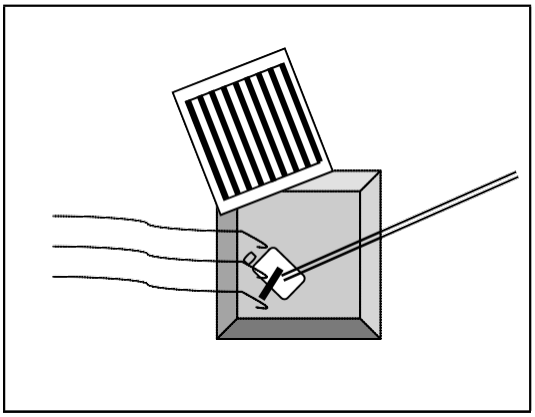
If stormwater is stored on your site in detention basins, sediment traps, or other management practices designed to retain water, runoff from your construction site may not occur until late in a particular storm. These practices should be inspected for runoff during and after storm events and samples should be taken within 30 minutes of when runoff from the management practice first occurs. Samples should be taken at the appropriate sampling location using the protocol discussed above.



For overland stormwater flow, if the location of the discharge to state waters is known ahead of the storm event, a ponding location to facilitate sampling can be created. One method is to dig a small depression in the low point of the flow area. Alternatively, a small obstruction to partially dam the sheet flow can be installed (e.g. 2-3 feet of silt fence installed in a U-shaped fashion; or an asphalt berm on paved areas). These areas should be stabilized prior to sampling with rolled erosion control product or sod to avoid increased turbidity at the sampling point. If necessary, use a clean, shallow scoop (e.g. dustpan) to collect the sample and deposit it in a sample bottle.



For stormwater runoff leaving the construction site through drainage outlets, removal of the storm grate may be helpful where a grab sample cannot be readily made. Always exercise caution in handling the storm grate and ensure it is replaced once the sample is collected. If there is inlet protection in place, it may be necessary to sample upstream or downstream from the drainage inlet to avoid loss of collected sediment into the storm drain system.



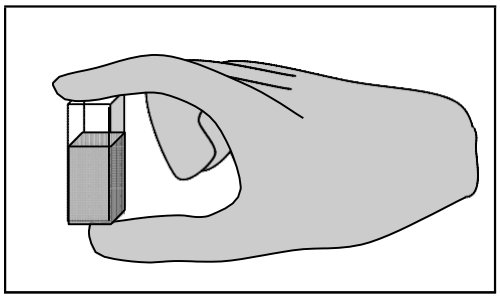
Safety should always be the primary consideration when collecting samples. If there are hazards associated with unstable footing, thin ice, deep water, or swift currents, monitoring personnel should work in pairs. Personnel should be cognizant of dangers associated with extreme weather, including lightning. No personnel should enter storm drain manholes without proper training or attempt to sample stormwater

<u>Personal Safety</u> should be the primary consideration. No personnel should be put in danger to collect a sample.

runoff from areas with vehicle traffic without assistance.

Step 3 . Sample Analysis

Once a sample has been collected, it should be promptly analyzed for turbidity. To be useful as a management tool, and to comply with the monitoring requirements of the General Permit, **turbidity measurements must be made on-site, not sent to a lab.**



The following steps should be taken to ensure an accurate measurement:

1. Wear gloves to prevent contamination of the sample.
2. Gently mix the capped sample without adding air bubbles.
3. Prepare a sample vial for use with the nephelometer. Taking care to touch only the top and bottom of the vial, inspect it for scratches or dirt that could affect the reading. Add a few drops of silicone oil to the outside of the vial to mitigate the effects of minor scratches and condensation. Wipe with a clean, lint-free cloth.
4. Fill the vial carefully with the sample.
5. Set up the meter on a level surface and turn it on.
6. Follow the directions to line up the vial correctly for the meter you are using. Insert the vial in the meter. Close the lid and press read. Be careful not to bump or move the turbidity meter while it is taking its reading.
7. Record the value in the inspection log, noting the time and location of the sample.
8. Quickly rinse the glass vial with distilled water. If you choose, you may take another sample. Remix the remaining sample and fill the vial as before. Average the results. Averaging is an option, not a requirement.

Equipment Maintenance

Nephelometers need to be properly stored and operated to maintain their accuracy. Do not subject the equipment to mechanical shock, extreme heat or humidity. Prevent moisture and dust from entering and accumulating inside the nephelometer.

Contributions from Off-Site Sources

Stormwater quality may be influenced by stormwater runoff hat originates up-gradient from the construction site. In cases where run-on flows of stormwater are contributing to your construction site runoff, it is advised that you sample, test, and thoroughly document these flows from upgradient of your construction site (i.e. before intermingling with the runoff from your construction activities). Adapted Best Management Practices, such as diversion of the upgradient stormwater flow, may be necessary to alleviate such situations.

For More Information

Please visit the Stormwater Section website at:
http://www.watershedmanagement.vt.gov/stormwater.htm
If you require additional information, please contact the technical reviewer who is assigned the area you are in. Contact information can be found here:
http://www.watershedmanagement.vt.gov/stormwater/htm/sw_districtcontacts_newcm.htm

Our Mailing address is:
Vermont Department of Environmental Conservation
Stormwater Management Program
1 National Life Drive, Main 2
Montpelier, VT 05620-3522

Construction General Permit 3-9020 (Amended 2008)
Monitoring and Sampling Requirement Guidance[1] Flow Chart for Moderate Risk Sites

STEP 1— Inspect & Maintain

As soon as reasonably possible, during or after every rainfall event which produces runoff from the construction site:

Is runoff of visibly discolored stormwater leaving the construction site?

YES — As soon as practicable inspect and maintain BMPs for compliance with EPSC Plan.

NO — STOP

Is runoff of visibly discolored stormwater continuing to leave the construction site?

YES

NO

Proceed to Step 2

STEP 2 — Evaluate Discharge

Is runoff of visibly discolored stormwater leaving the construction site discharging to waters of the State?

YES — Immediately evaluate the need for additional BMPs and install as necessary to correct or halt discharge.

NO — Supplement BMPs as necessary to correct the runoff. Continue to inspect and maintain BMPs.

Is runoff of visibly discolored stormwater continuing to discharge to waters of the State?

YES

NO

Proceed to Step 3

STEP 3 — Sample for Turbidity

Sample for turbidity at each point where of visibly discolored stormwater from disturbed areas that have not been finally stabilized discharges to waters of the State[2]. Clearly mark all sample points in the field with flags, stakes, tape or other visible marker and note on the EPSC Plan.

Is the turbidity reading over 25 NTU?

YES — As soon as practicable, evaluate need for and install supplemental BMPs as necessary to correct the discharge, Within 72 hours file written report with DEC, and update EPSC Plan.

Resample turbidity as above.

NO

For details on particular steps, consult the General Permit Subsection 6.3

selecting sampling location,

1.This flow chart is intended to summarize the sequence of actions required for turbidity monitoring and sampling.

2. For guidance on

refer to Turbidity Monitoring Guidance Factsheet.

Is the turbidity reading over 25 NTU?

YES

Immediately contact DEC to report situation.

NO

No further sampling required at this point for this event.