Field Testing for Storm water Compliance Using Colorimetric and Turbidimetric Technique

Overview

According the U.S. Census bureau the world's population went from 2.5 billion in 1950 to 6 billion in 2000 and is on pace to exceed 9 billion by 2050. We will soon have 3 times the global population we had only in 1950, and with this growth comes enormous impacts on the surface of our globe. As buildings and pavement expand so do our obligations to control storm water effluents. Urban development creates new pollution, which can either be washed or directly dumped into storm sewer systems, and ultimately into our waterways and coastal areas. Storm runoff leaving developed urban areas is significantly greater in inorganic content than runoff from the same area prior to development.

Storm water is typically defined as water that that is created as a result of a precipitation event. This water may flow through any path (gully, stream, conduit, channel, etc.) or adjacent area that is subject to overflow or flood water generated from that event. This water passes through a wide variety of natural or artificial environments, often sweeping organic and inorganic constituents into the watercourse through municipal storm drain systems. These environments can include pipeline projects, construction sites, landscaped areas, agricultural runoff, irrigation ditches, industrial sites, and a variety of other sources. In most cases this material is eventually fed into a stream, river, or other waterway, contributing to the overall pollutant load in that body of water.

While onsite sampling and offsite testing can be completed over the course of a number of days, the source of this outfall continues to contaminate the watercourse with both inorganic and organic constituents during subsequent precipitation events. A means is required by which to screen the outfall to potentially determine its source, the contribution it is making to the pollutant load, and the proper course of action to take.

Instrumentation and reagent systems are currently available to make measurements necessary to provide a preliminary screening of the outflow, and determine whether it is contributing to the overall pollutant load as it relates to inorganic constituents. In many cases these measurements can be made near the source, using handheld instrumentation, test strips, and/or reagents, which may provide some indication as to the source and content of the outflow, or provide some indication of what additional testing is required.

Examples of Outflows

Outflows attributable to a rainwater event can occur across a number of different environments. These include:

- Agricultural runoff
- Industrial sites
- Construction sites
- Irrigation runoff
- Parking lots and pavement
- Other

While illicit discharges of various chemical constituents into storm water drains represent a portion of the overall problem, these are not defined as storm water events. These outflows can contain a wide variety of both inorganic and organic contaminants, and must be considered when characterizing the source of outflow. Inorganic constituents can often provide an indicator of such outflows when used in a manner that takes all indicators into account.

Where there are questions and concerns, either generated through the use of inorganic indicators, or when there are suspicions regarding organic contaminants, samples should be sent for further analysis.

While individual test measurements can be effectively used for screening outflows, long term trends are important after establishing baseline values for inorganic indicators (and organic indicators as needed).

Making Measurements

Colorimetric

Colorimetric methods are based on measuring the intensity of color of a colored target chemical or reaction product. The optical absorbance is measured using light of a suitable wavelength. The concentration is determined by means of a calibration curve obtained using known concentrations of the determinant.

Turbidimetric

Turbidimetric methods (also known as nephelometry) use an instrument for measuring the concentration of suspended particulates in a liquid. A nephelometer (turbidimeter) measures suspended particulates by employing a light beam (source beam) and a light detector set to one side (90 degrees) and/or directly opposite (180degrees) the source beam. Particle density is then a function of the light reflected and/or directed into the detectors from the particles.

Making Measurements (Continued)

Titrimetric

In volumetric titration, chemicals are analysed by titration with a standardized titrant. The titration end-point is identified by the development of color resulting from the reaction with an indicator, by the change of electrical potential or by the change of pH value.

Ion Selective Electrode

ISE is a transducer (or sensor) that converts the activity of a specific ion dissolved in a solution into an electrical potential, which can be measured by a voltmeter or pH meter. The sensing part of the electrode is usually made as an ion-specific membrane, along with a reference electrode.

Indicators

Ammonia

Ammonia is a good indicator of sewage, since its concentration is much higher there than in groundwater or tap water. High ammonia concentrations may also indicate liquid wastes from some industrial sites. Ammonia is relatively simple and safe to analyse. Some challenges include the tendency for ammonia to volatilize and its potential generation from non-human sources, such as pets or wildlife.

Chlorine

Chlorine is used throughout the country to disinfect tap water, except where private wells provide the water supply. Chlorine concentrations in tap water tend to be significantly higher than most other discharge types. Unfortunately, chlorine is extremely volatile, and even moderate levels of organic materials can cause chlorine levels to drop below detection levels. Because chlorine is unstable, it is not a reliable indicator, although if very high chlorine levels are measured, it is a strong indication of a water line break, swimming pool discharge, or industrial discharge from a chlorine bleaching process.

Color

Color is a numeric computation of the color observed in a water quality sample, as measured in cobalt-platinum units (APHA, 1998). Both industrial liquid wastes and sewage tend to have elevated color values.

Unfortunately, some “clean” flow types can also have high color values. Field testing has found high color values associated for all contaminated flows, but also many uncontaminated flows, which yielded numerous false positives. Overall, color may be a good first screen for problem outfalls, but needs to be supplemented by other indicator parameters.

Conductivity

Conductivity, or specific conductance, is a measure of how easily electricity can flow through a water sample. Conductivity is often strongly correlated with the total amount of dissolved material in water, known as Total Dissolved Solids. The utility of conductivity as an indicator depends on whether concentrations are elevated in “natural” or clean waters. In particular conductivity is a poor indicator of illicit discharge in estuarine waters or in northern regions where de-icing salts are used (both have high conductivity readings).Conductivity has some value in detecting industrial discharges that can exhibit extremely high conductivity readings.

Fluoride

Fluoride is added to drinking water supplies in most communities to improve dental health, and normally found at a concentration of two parts per million in tap water. Consequently, fluoride is an excellent conservative indicator of tap water discharges or leaks from water supply pipes that end up in the storm drain. Fluoride is obviously not a good indicator in communities that do not fluoridate drinking water, or where individual wells provide drinking water.

Hardness

Hardness measures the positive ions dissolved in water and primarily include magnesium and calcium in natural waters, but are sometimes influenced by other metals. Field testing suggests that hardness has limited value as an indicator parameter, except when values are extremely high or low (which may signal the presence of some liquid wastes). Hardness may be applicable in communities where hardness levels are elevated in groundwater due to karst or limestone terrain. In these regions, hardness can help distinguish natural groundwater flows present in outfalls from tap water and other flow types.

pH

Most discharge flow types are neutral, having a pH value around 7, although groundwater concentrations can be somewhat variable. pH is a reasonably good indicator for liquid wastes from industries, which can have very high or low pH (ranging from 3 to 12). The pH of residential wash water tends to be rather basic (pH of 8 or 9). The pH of a discharge is very simple to monitor in the field with low cost test strips or probes. Although pH data is often not conclusive by itself, it can identify problem outfalls that merit follow-up investigations using more effective indicators. Normal rainwater has a pH of approximately 5.6

Potassium

Potassium is found at relatively high concentrations in sewage, and extremely high concentrations in many industrial process waters. Consequently, potassium can act as a good first screen for industrial wastes, and can also be used in combination with ammonia to distinguish wash waters from sanitary wastes.

Surfactants

Surfactants are the active ingredient in most commercial detergents. They are a synthetic replacement for soap, which builds up deposits on clothing over time. Since surfactants are not found in nature, but are always present in detergents, they are excellent indicators of sewage and wash waters. The presence of surfactants in cleansers, emulsifiers and lubricants also makes them an excellent indicator of industrial or commercial liquid wastes.

Turbidity Turbidity is a quantitative measure of cloudiness in water, and is normally measured with a simple field probe. While turbidity itself cannot always distinguish between contaminated flow types, it is a potentially useful screening indicator to determine if the discharge is contaminated (i.e., not composed of tap water or groundwater).