Recommended Best Management Practices for

Dissolved Oxygen & Organic Enrichment

Total Maximum Daily Load Fact Sheet About Dissolved Oxygen & Organic Enrichment

Dissolved Oxygen (DO) in surface water is used by all forms of aquatic life and is typically measured to assess the "health" of lakes and streams; too much or too little DO can result in unhealthy aquatic conditions. In addition, large fluctuations in DO levels over a relatively short period of time can impair or kill fish and invertebrates. The two main sources of dissolved oxygen are the atmosphere and aquatic plants. Atmospheric oxygen is mixed into turbulent stream water as it flows along rocks and riffles in the stream. Atmospheric oxygen can also enter a stream through ground water recharge. Oxygen is also produced by aquatic plants and algae as a product of photosynthesis. Photosynthesis is the process by which green plants and certain bacteria synthesize carbon dioxide (using light as an energy source) and hydrogen (usually water) to produce necessary carbohydrates for development. Most forms of photosynthesis release oxygen as a byproduct.

The amount of oxygen that can dissolve in water is also limited by physical conditions such as temperature, atmospheric pressure, low flow and organic enrichment. Aquatic life can have a hard time in stagnant water that has a lot of rotting, organic material (organic enrichment), especially in the summer. The concentration of DO is inversely related to water temperature; when ambient air temperatures increase, the amount of available DO decreases. Conditions may be especially serious during periods of hot, calm weather and may result in summertime fish kills. Photosynthesis is the primary process affecting the dissolved oxygen/temperature relationship. Water clarity and duration of sunlight affects the rate of photosynthesis. Bacteria in water can also consume oxygen as organic matter decays. Thus, excess organic material in lakes and rivers can cause eutrophic conditions that result in an oxygen-deficient situation that can impact a water body and create a "dead zone."

Sources of Dissolved Oxygen & Organic Enrichment

DO & Organic Enrichment are related to a wide variety of sources of pollution, such as stream bank and streambed erosion, sediment conveyed by storm water runoff, decaying plant and animal matter, industrial discharges, waste and sewage. TMDL reports for DO, organic enrichment and low flow are often developed for localized water quality conditions that can be addressed through the adoption of best management practices.

Best Management Practices for Dissolved Oxygen and Organic Enrichment:

- Protection and maintenance of natural vegetative buffers along waterways
- Management of manure and pet wastes
- Reduction and management of residential and agricultural fertilizers
- Reduction of soil erosion on residential and agricultural land uses
- Composting and management of grass clippings and yard wastes
- Operation & Maintenance of on-site sewage treatments systems
- Pond maintenance education (e.g., manage waterfowl, install aerators, maintain vegetative buffers, etc.)

Recommended Best Management Practices for
Nutrients

(Includes Phosphorus, Nitrogen, & Ammonia)
Total Maximum Daily Load Fact Sheet

Nutrients like phosphorus, nitrogen, and ammonia are needed by all plants and animals, but excessive amounts of nutrients in our water harm ecosystems, economies, and community health.

In Ohio, nutrient pollution causes many problems such as:

- Harmful algal blooms in Lake Erie and inland lakes
- Public health warnings to avoid swimming
- Widespread nuisance growths of aquatic vegetation
- Increased water treatment costs for clean public water supplies
- Changes in aquatic ecosystems and declining fisheries
- Renewed concern over the increased size of anoxic areas or “dead zones” in Lake Erie
- Fewer dollars being spent on water based recreation and tourism

Approximately 48% of Ohio's watersheds are degraded by nutrient loading.

Sources of Nutrients

Excessive nutrients wash into waterbodies and are often the direct result of human activities.

The primary sources of nutrient pollution are:

- Agriculture
  Animal manure, over-application of fertilizer, and soil erosion are some of the large sources of nitrogen, phosphorus, and ammonia pollution in the country.
- Storm Water
  Storm water is precipitation from rain or snowmelt that flows over the ground. Impervious surfaces like driveways, roofs, sidewalks and streets prevent storm water from soaking into the ground where it is filtered and cleaned naturally. Instead, storm water flows over impervious surfaces, picks up pollutants like phosphorus, nitrogen, or ammonia and carries them into a storm sewer system or directly to a lake, stream, river, wetland, or other waterway. Anything that enters a storm sewer system flows untreated into waterbodies that may be used for swimming, fishing and drinking water. Nutrients in storm water comes from many sources like pet waste, lawn fertilizers, failing home sewage treatment systems, combined sewer overflows, and construction activities.

Best Management Practices for Nutrients:

- Protection and maintenance of natural vegetative buffers along waterways
- Management of manure and pet wastes
- Reduction and management of residential and agricultural fertilizers
- Reduction of soil erosion on residential and agricultural land uses
- Reduction of impervious surfaces and increase on-site infiltration
- Composting and management of grass clippings and yard wastes
- Operation & Maintenance of on-site sewage treatments systems
- Pond maintenance education (e.g., manage waterfowl, install aerators, maintain vegetative buffers, etc.)

Recommended Best Management Practices for
Total Suspended Solids

(Includes Sediment and Siltation)
Total Maximum Daily Load Fact Sheet

About Total Suspended Solids

Total Suspended Solids (TSS) are solids in water that can be trapped by a filter. The term TSS should not be confused with the term "total solids", which refers to the amount of matter suspended and dissolved in water or wastewater, and is related to both specific conductance and turbidity. Total Solids includes both total suspended solids (TSS): the portion of total solids retained by a filter; and total dissolved solids: the portion that passes through a filter. TSS can include a wide variety of material, such as silt, decaying plant and animal matter, industrial wastes, and sewage.

High concentrations of suspended solids causes many problems for stream health and aquatic life. High TSS can block light from reaching submerged vegetation. As the amount of light passing through the water is reduced, photosynthesis slows down. Reduced rates of photosynthesis causes less dissolved oxygen (DO) to be released into the water by plants. If light is completely blocked from bottom dwelling plants, the plants will stop producing oxygen and will die. Bacteria use up most of the remaining oxygen during plant decomposition, causing low levels of DO in the water. Low DO can lead to fish kills. High TSS can also cause an increase in surface water temperature, because the suspended particles absorb heat from sunlight. This can cause DO levels to fall even further (warmer waters naturally hold less DO), and can harm aquatic life in many other ways, as discussed in the temperature section.

Decreases in water clarity caused by TSS can affect the ability of fish to see and catch food. Suspended sediment can also clog fish gills, reduce growth rates, decrease resistance to disease, and prevent egg and larval development. When suspended solids settle to the bottom of a water body, they can smother the eggs of fish and aquatic insects, as well as suffocate newly hatched insect larvae. Settling sediments can fill in spaces between rocks which could have been used by aquatic organisms for homes.

High TSS in a water body can often mean higher concentrations of bacteria, nutrients, pesticides, and metals in the water. These pollutants may attach to sediment particles on the land and be carried into water bodies with storm water. In the water, the pollutants may be released from the sediment or travel farther downstream. Furthermore, High TSS can cause problems for industrial use, because the solids may clog or scour pipes and machinery.

Sources of Total Suspended Solids

TSS can come from a wide variety of sources, such as sediment conveyed by storm water runoff, streambank and streambed erosion, decaying plant and animal matter, industrial wastes, and sewage. The primary sources of TSS pollution include:

- High Flow Rates
  The flow rate of the watercourse is a primary factor in TSS concentrations. Fast running water is more erosive and can carry more particles and larger-sized sediment. Heavy rains

can pick up sand, silt, clay, and organic particles (such as leaves, soil, tire particles, etc.) from the land and carry it to surface water. A change in flow rate can also affect TSS; if the speed or direction of the water current increases, particulate matter from bottom sediments may be re-suspended in the water column, and streambank or streambed erosion may accelerate.

- Soil Erosion and Disturbance
  Soil erosion is caused by disturbance of a land surface. Soil erosion can be caused by building and road construction, farming and agricultural activities, streambank hydromodification, logging, and mining. The eroded soil particles can be carried by storm water to surface water and will increase the TSS of the adjacent water body. In-stream soil disturbance from bottom-feeding fish or dredging activities can also contribute to TSS.
- Storm Water Runoff
  During storm events, soil particles and debris from streets and industrial, commercial, agricultural and residential areas can be washed into streams. Large amounts of pavement in urban areas increases storm water runoff volume and velocity and decreases opportunities for infiltration as natural settling areas are removed. Sediment is carried through storm drains directly to creeks and rivers.
- Organic Materials and Excess Nutrients
  As plants and animals decay within the water column, suspended organic particles are released and can contribute to the TSS concentration. Excess nutrients can result in increased algae and vegetation within water columns that will ultimately decay and contribute to TSS.

Best Management Practices for Total Suspended Solid TMDL's:

- Protection and maintenance of natural vegetative buffers along waterways
- Management of manure and pet wastes
- Reduction and management of residential and agricultural fertilizers
- Reduction of soil erosion on residential and agricultural land uses
- Composting and management of grass clippings and yard wastes
- Operation & Maintenance of on-site sewage treatments systems