

# Wastewater Management Handbook for Community Officials



This pamphlet provided by MWEA  
[www.mi-wea.org](http://www.mi-wea.org)

## **Overview**

This brochure provides an overview of wastewater treatment and is intended to provide a brief description of what processes may be at your wastewater plant. Although each plant is designed for particular conditions, there are many similarities in how different processes operate. There may be differences between your plant and a neighboring plant in terms of size, ground area, shape of tanks (circular or rectangular), or the types of treatment processes they use.

## **What is wastewater?**

Wastewater or sewage is the byproduct of many uses of water. There are the household uses such as showering, dishwashing, laundry and, of course, flushing the toilet. Additionally, industries and commercial enterprises use water for these and many other purposes, including processes, products, and cleaning or rinsing of parts.

After the water has been used, it enters the wastewater stream, and it flows to the wastewater treatment plant. When people visit a treatment plant for the first time, often it is not what they perceived it would be. These wastewater plants are complex facilities and produce a high quality product or effluent.

## **Why treat wastewater?**

We need to remove the wastewater pollutants to protect the environment and protect public health. When water is used by our society, the water becomes contaminated with pollutants. If left untreated, these pollutants would negatively affect our water environment. For example, organic matter can cause oxygen depletion in lakes, rivers, and streams. This biological decomposition of organics could result in fish kills and/or foul odors. Nutrients in wastewater, such as phosphorus, can cause premature aging of our lakes, called Eutrophication. Waterborne diseases are also eliminated through proper wastewater treatment. Additionally, there are many pollutants that could exhibit toxic effects on aquatic life and the public.

## **How do we collect the wastewater?**

The sewer or collection system is designed so that it flows to a centralized treatment location. The collection system is comprised of smaller sewers with a diameter of about eight inches. As more homes and companies are connected along the system, the pipes become larger in diameter. Where gravity systems are not practical, pumping stations are often included to lift the wastewater. In many communities, there are some very old collection systems. Some sewer piping was actually installed in the late 1800's! Materials of construction and methods of construction have changed significantly over

the years. Many systems experience problems during wet weather periods with inflow and infiltration. This is commonly referred to as "I&I." Wet weather operating periods typically occur when the snow melts in the spring and/or during heavy rainstorms. Water resulting from snowmelt or storms should flow into a storm water system and not into the sanitary sewer system. Unfortunately, this isn't always the case.

### **What is Inflow & Infiltration (I&I)?**

Inflow is rain water that gets into a sewer from surface inlets, holes or leaks in manholes or manhole covers, sump pumps, or roof leaders. This is relatively clean water that should be discharged to a storm water system. In some cases, homeowners in low lying areas connect sump pumps (illegally) to the sewer because it is relatively easy and inexpensive compared to proper management. Some communities have "combined sewers" that intentionally receive inflow, instead of having separate sanitary sewers and storm sewers.

New combined sewer systems have not been allowed since the 1950s. Infiltration is groundwater that leaks into the sanitary sewer. All sewer pipes have leaking joints or cracks that allow the groundwater to enter the system to some extent. Infiltration is usually most severe in the spring when melting snow and rain saturate the ground. Many older systems have severe I&I problems that consume treatment plant capacity and can cause basements to flood or cause illegal overflows. Such an overflow is called a Sanitary Sewer Overflow (SSO).

### **What happens after collection of the wastewater?**

The wastewater continues to flow through the collection system and eventually reaches the wastewater treatment plant. Upon reaching the plant, the flow first encounters preliminary treatment. Preliminary treatment is followed by primary treatment, then secondary treatment, and perhaps advanced or tertiary treatment. The solids or "sludge" removed from the wastewater stream also needs to be treated.

### **What is Preliminary Treatment?**

Preliminary treatment processes are the first processes that the wastewater encounters. This typically involves flow measurement so that the operator can quantify how much wastewater is being treated. Flow monitoring is commonly followed by screenings removal. Screenings are string like materials and large foreign objects like sticks or perhaps an errant golf ball. These materials need to be removed because they can damage machinery or clog processes. Screenings can be removed using bar screens and other devices designed for this purpose. The next process in preliminary treatment is grit removal. Grit is comprised of inorganic material such as sand, gravel, eggshells, etc. It is desirable to remove grit

to prevent wear and abrasion on pumps and other mechanical equipment. Grit can also plug lines and pipes. In this influent area, sampling equipment is often used to collect small portions of the wastewater for analysis. Sampling enables the operator to determine the pollutant loadings entering the plant (influent). Preliminary treatment commonly includes raw sewage pumps. Screening and grit removal are important to the proper operation of the raw sewage pumps. These materials will cause clogging and cause wear on the internal parts. These raw sewage pumps deliver the flow to the next phase of treatment: Primary Treatment.

### **What is Primary Treatment?**

Primary treatment is a physical settling process that removes solids. Wastewater that enters the primary settling tank (or clarifier) is slowed down to enable the heavier solids to settle to the bottom. Lighter materials, such as grease, will float to the top of the tank. Settling tanks are designed with mechanisms to remove both the settled solids, as well as the floating solids.

Primary clarifiers are either circular or rectangular. Both types work equally well when properly designed and maintained. Not all plants have primary treatment. Primary treatment generates primary sludge. The sludge is removed and pumped to the solids treatment process for ultimate disposal. What's left after we remove the pollutants that settle and float?

The wastewater still has solids remaining after primary treatment. These solids are either dissolved or suspended. Dissolved solids are very small solids (e.g., dissolving sugar in water). You cannot see the solids but they are there. Suspended solids can be likened to the same ends of a magnet. The solids repel each other. These solids are small, but are visible to the human eye. We remove these dissolved and suspended solids through the next phase of treatment: Secondary Treatment.

### **What is Secondary Treatment?**

Secondary treatment is a biological treatment process used to stabilize the dissolved solids. Microorganisms (i.e., bacteria and protozoa) feed on the organic solids (food) in the wastewater and convert the organics into a cellular or biological mass that can later be removed. These biological processes are aerobic processes.

Oxygen must be provided for these aerobic organisms to work properly and efficiently. An integral part of secondary treatment processes is another set of settling tanks or clarifiers. These secondary clarifiers (final clarifiers) remove the biological mass that has grown during biological treatment. There are many different kinds of secondary processes that can be employed. A very common secondary process is known as activated sludge.

In activated sludge treatment, the wastewater is mixed with organisms that are returned from the secondary clarifiers. There is a continuous return of organisms from the secondary clarifiers. This is

called return sludge or return activated sludge. Oxygen is provided in the aeration tank either by blowers and diffusers or by a mechanical mixing process. A variation of the activated sludge process that is becoming more popular is known as Sequential Batch Reactors (SBR's).

This process differs from the more conventional activated sludge systems in that it also uses the aeration tank as a settling tank. This is accomplished by turning off the air to the diffusers or the mixers and allowing the solids to separate from the wastewater. During this settling period, the flow is diverted into a second SBR tank for continuous treatment. Advantages of this SBR process include a relatively small footprint.

Lagoon systems are also a form of biological or secondary treatment. These lagoon systems are used where there is a lot of land available and/or the wastewater flows (quantities) are low. Lagoons are constructed with lined earthen bottoms and are less expensive to construct than are activated sludge processes that use concrete tanks. Lagoon systems in Michigan are allowed to discharge only for a few weeks in the spring and fall of the year. This means that the lagoons must be large enough to store all of the community's sewage for six months.

### **Other Common Secondary Treatment Processes**

Another type of secondary treatment is known as fixed film processes. Fixed film processes consist of two types: Trickling Filters or Rotating Biological Contactors (RBC's). Trickling filters are sometimes called BioTowers. Trickling filters are beds with a natural rock or a synthetic material (media). A distribution system applies the wastewater to the media.

Microorganisms form a thick growth attached to the rocks or synthetic media as opposed to liquid suspension in the activated sludge. The wastewater is trickled onto the media. As the wastewater flows over the media, it comes into contact with the microorganisms and picks up oxygen from the air. Consuming the food (pollutants) in the wastewater, the film of microorganisms grows thicker.

When the biological growth becomes too thick, it falls off the media and flows with the wastewater. The wastewater is collected by an under drain system and delivered to a secondary settling tank for solids removal. Many trickling filter plants that originally were designed with rock media have changed to the more efficient plastic media.

The RBC is similar to the trickling filter in that it uses an attached biological growth. An RBC has panels that are circular and mounted to a shaft. The wastewater flows into a basin beneath the media and the media rotates through the wastewater driven by the shaft. The microorganisms are contacted with the wastewater.

Since the RBC's expose the media to the air, oxygen is picked up and transferred into the growth. RBCs have low energy requirements. These systems need to be protected from cold weather by a building or cover. All of the secondary treatment processes produce sludge. The sludge is pumped to the solids treatment system for further processing.

## **What is Advanced Treatment?**

All treatment plants in Michigan are required to remove phosphorus and many are required to reduce ammonia due to the possible negative impacts on the receiving stream. Typically these advanced processes are accomplished concurrent with secondary treatment. When even higher degrees of treatment are required a tertiary (or third process) is utilized. These advanced treatment processes are used to remove additional solids and oxygen consuming substances. The tertiary step usually involves filtering the secondary effluent through a sand bed, but sometimes other methods are used.

## **Where do all the solids go?**

Solids that settle out in the primary and secondary clarifiers are referred to as sludge. Sludge that has been processed to reduce disease-causing organisms is referred to as biosolids. Sludge is the byproduct of treating the liquid wastewater. Proper solids handling is of paramount importance. If sludge is not removed, problems will occur in other areas of the plant.

Excess solids can also lead to permit violations and odor problems. There are many different options available for solids handling. Local conditions usually dictate which option is best for your particular facility. General categories of sludge handling include digestion processes, hauling of liquid sludge to a larger treatment plant, thickening, dewatering by mechanical means (belt filter presses, centrifuges), incineration, land filling, and land application.

In a typical wastewater treatment plant sludge may be pumped to a gravity thickener, treated to reduce odors, and dewatered using a belt filter press. The dewatered solids may be treated using dry lime for stabilization and loaded into a roll off container. The sludge may be landfilled or later land applied on crop fields. Another community may pump the sludge to a gravity thickener. Solids would then be dewatered using a belt filter press and then incinerated.

The remaining ash would be landfilled. Another option would be to pump the sludge into an anaerobic digester that stabilizes the sludge and produces useful methane gas. The stabilized sludge, now called biosolids, would be safe for farmers to use as fertilizer and soil conditioner. In summary, there are many options available for sludge treatment and handling.

## **Where does the water go after treatment?**

The treated wastewater is referred to as effluent. Before the effluent is discharged to a water body such as a lake, river, or stream it undergoes a process to reduce disease-causing organisms called disinfection. Two kinds of disinfection systems are common in Michigan: chlorination and UV. Chlorination involves injecting chlorine into the effluent then holding it in a contact tank for 20 to 40 minutes. The effluent would be dechlorinated before testing and discharge. UV systems utilize ultraviolet radiation to kill the microorganisms. This occurs quite rapidly so no contact tank is necessary. Since chlorine is not used, no

dechlorination is needed. Testing the effluent before discharge provides assurance that the wastewater has been properly treated.

A state-issued permit establishes the level of pollutants allowed that will be protective of the public health and the environment. Small streams and sensitive waters usually require more stringent limitations to be protective. These limitations are established in a public permit issuance process that allows anyone to comment on or object to the issuance of the permit.

### **What are common wastewater terms?**

In wastewater vernacular, there are acronyms for many processes. Some of the most common terms are listed below with a brief description.

*Aerobic:* A process that requires dissolved oxygen to operate properly. The microorganisms need the oxygen to “eat” the food properly.

*Anaerobic:* A process that can operate or needs to operate without oxygen being present. A good example is an anaerobic digester used for solids handling. *Biochemical Oxygen Demand (BOD5):* A test that measures the oxygen-consuming substances or the organic strength of a sample of wastewater. It provides information on the organic load or how much “food” there will be for organisms. The load can be either to a treatment plant unit or to a receiving water body.

*Clarifier or settling tank:* Tanks designed for the physical separation of wastewater floatable solids and settleable solids. These two terms are widely used interchangeably.

*Disinfection:* Killing disease-causing organisms, differing from sterilization, which kills all organisms.

*Dissolved Oxygen (DO):* A test usually performed by an electronic meter that measures the amount of oxygen dissolved in a sample of water. The sample may have been from natural waters or from a part of the sewage treatment process. It is important because many of the treatment processes require oxygen (aerobic) to operate properly. Too much oxygen can mean that money is wasted through excess energy consumption to provide the oxygen, which is relatively insoluble in water. It is important in natural waters because fish and other desirable aquatic life are just as dependent on oxygen as people.

*Effluent:* Wastewater or other liquid, partially or completely treated, flowing from a reservoir, basin, treatment process, or treatment plant.

*Influent:* Wastewater or other liquid flowing into a reservoir, basin, or treatment plant.

*Parts per million (ppm) or milligrams per liter (mg/L):* These terms refer to the results of analyses such as TSS, BOD5 or DO. These terms are used interchangeably and mean exactly the same thing.

*Total Suspended Solids (TSS):* Data from a test that measures by weight how much particulate material is contained in water samples by filtering the sample through a special filter.



**Focused since 1925 on being and creating  
stewards for Michigan's water environment**

**Our Mission:**

- Be and create stewards for Michigan's water environment.
- Provide high quality training.
- Educate and inform policy makers and the general public.
- Promote and advance the water quality profession.
- Promote scientifically sound environmental practices and regulation.
- Promote public and ecological health by preserving and enhancing Michigan's water environment.



Information developed by the  
New York State Department of Environmental Conservation, the  
US EPA Region 2, Environmental Finance Center at Syracuse University,  
And the New York Water Environment Association  
February 2007