DESCRIPTION OF PROCESS

WAUKESHA CLEAN WATER PLANT
600 SENTRY DRIVE
WAUKESHA, WI 53186
262-524-3625

Our mission is to protect public health and the environment by maintaining a high-quality effluent, biogas, and biosolids that meet or exceed our permit in an efficient, cost effective manner. The Waukesha Clean Water Plant is located southwest of downtown Waukesha and discharges to the Fox River in Accordance with a WPDES permit administered by the Wisconsin Department of Natural Resources.

The first wastewater plant in the city of Waukesha was a primary (or community septic tank) plant built on this site in 1890. That plant was upgraded in 1917. About 1928, a new secondary treatment plant was built. Upgrades and expansions were done in 1947 and 1968. In 1977, a major expansion built alongside the existing plant was started. This plant, completed in 1981 was an advanced (or tertiary) treatment facility. All of these plants from 1928 to 1977 used trickling filters as the secondary process.

The City of Waukesha Clean Water Plant (CWP) then underwent a major renovation project that should provide for the Community's water treatment needs well into the future. This construction project began in the fall of 1991 and lasted through early 1995. Approximately $42,000,000 was spent on the facility upgrade. This work incorporated the 1977 plant and a few structures from 1968. The other older portions were retired after many years of good service to the city.

Several important changes have taken place with the startup of the latest facility. The first, and most important, is the adoption of an "activated sludge" system for removal of dissolved wastes. By doing this, the new plant is much more capable of consistent treatment because the activated sludge process is less susceptible to weather extremes, is more adaptable to changing wastewater composition, and provides better ammonia and phosphorous removal.

The most recent facilities upgrade was completed in 2017 which included upgrades to solids processing and existing equipment that had surpassed their useful life expectancy. An egg-shaped digester was built to replace an existing digester along with the installation of a centrifuge to achieve better solids dewatering compared to the old belt filter presses.

The CWP gives plant management a wider selection of options in disposing of the solids that are removed from the wastewater. These "biosolids" (or "sludge") previously had been stored in ponds until farmland became available. The liquid sludge was then hauled to farmers' fields where it was injected into the soil as a fertilizer. Although this method of disposal has the most merit as reuse of a resource, it has several drawbacks. The ponds were determined to be leaking and the DNR ordered the CWP to discontinue their use. Land disposal is also highly dependent upon weather conditions, as illustrated by the above average rainfall in 1993 that kept trucks out of the fields. Land application of solids must also coincide with crop planting and harvesting cycles. Finding suitable land has proven to be difficult because the rules that determine soil type, slope, proximity to wells and homes, application rates, and climatic conditions are very restrictive. The new solids processing facility contains mechanical dewatering equipment, sludge drying areas, and storage for both liquid and dry sludge. This will allow the CWP to adapt more easily to changing conditions as well as provide the option of hauling the solids to landfills or composting facilities if farmland is unavailable.

The CWP uses several separate processes to treat the wastewater. Following is a description of each process. The number accompanying each description is the building where that process is performed, and corresponds to the number on the attached map.

Septage Receiving and Preliminary Treatment: Some wastewater is brought to the CWP by trucks from outlying areas. These trucks are owned by independent companies. They are issued permits from the CWP. They also pay fees to the City for each load hauled. This wastewater is from septic tanks and holding tanks. They can be residential, commercial, or industrial sources. These wastes are unloaded at the **Septage Receiving Station (100)**. The station was upgraded in 1999 to improve traffic flow through the plant. A truck scale was installed to allow measurement of the septage received and of the biosolids shipped out.

The **Preliminary Treatment (110)** process uses mechanical equipment to remove large objects such as boards (bar screens), rags and plastics (fine screens) and heavy settleable materials like sand, small rocks, seeds and corn kernels (grit removal). Also, located in Building 110 are the **Raw Wastewater** pumps. These five pumps lift the water into the primary settling basins. Each 165-horsepower pump can move 9400 gallons per minute. The control system limits the number of pumps in operation to only four at a time (one is a spare) but that still allows a combined flow of over ***54 million gallons per day*** during unusually heavy rainfall periods. Currently, average flows range from 10 to 12 million gallons per day. The plant is designed for 14 million gallon average daily flow.

Primary Settling and Trickling Filters: Primary settling removes solids that will settle from the wastewater over a certain predetermined period. These solids are primarily organic materials that are lighter than the inorganic solids removed in the preliminary treatment process. Floating materials such as greases and oils are also removed in these **Primary Clarifiers (120)** by skimming equipment. From the settling basins, the water flows by gravity into the **Roughing Filters (130)**. The traditional name for these units is not a very good description for them. They do not filter. The roughing filters are large tanks filled with fist-sized stones. After the wastewater is spread over the stones by rotating distributor arms, it then trickles over and through the rocks, finally draining away. This action causes a coating of microscopic plants and animals to grow on the stones. These organisms use the dissolved solids in the wastewater as a food source and as they grow, they clean the water. Trickling filters of this type were the only secondary process in the old facility but would not meet the increased treatment required today. The roughing filters remove some of the dissolved organic wastes and work as a buffer to protect the rest of the system from shock loads or momentary high strength wastewater. Due to low plant loading, these units are currently being bypassed.

Primary Effluent Pump Station (140): Water flows from the roughing filters into the primary effluent pump station. This building contains five 177 horsepower pumps with an available capacity of over ***60 million gallons per day*** from four pumps. These pumps were designed to be slightly larger than the raw wastewater pumps because they were installed in an existing building with no room for expansion. From this station, the water is pumped to a **Splitter Box (200)** that distributes the water to the aeration tanks.

Aeration Basins (210): These huge tanks are the heart of the activated sludge process. Microorganisms use the dissolved wastes (BOD, NH4, & Phosphorus) as a food source. By adding air to the tanks to provide oxygen and mixing, the microbes enjoy an almost perfect environment for growth. As they grow and multiply, the dissolved material is converted into larger particles which come together as a brown, fluffy-looking mass called **floc**. The floc settles very rapidly and is easily removed in settling basins. The inside of each aeration tank (6 tanks in total) is 50 feet wide by 250 feet long and has an average water depth of 18 feet. Each of the six tanks contains about ***1,683,000 gallons*** of activated sludge for a total of ***10,098,000*** gallons.

Equipment to operate and control the aeration process is located in the **Blower Building (220).** Oxygen is provided by huge air pumps called **blowers**. The blowers are powered by 3 - 300 HP and 2 – 350 HP, 4160 volt electric motors. The air supply is controlled by measuring the amount of **dissolved oxygen (DO)** in the aeration tanks, then adjusting the flow through the inlet valve of each blower. This can be done manually or by automatic control.

As the mixture flows through the aeration tanks, the microbes consume the dissolved materials and continue to reproduce. By the time they reach the discharge (effluent) end of the tanks there is an over abundance of hungry microbes and very little food for them. In addition to the organic wastes, organic and ammonia nitrogen are removed. From the aeration tanks the activated sludge flows into the final settling basins to floc together and settle out of the treatment system.
Final Settling Basins (230). The floc settles to the bottom of these tanks. This mass of concentrated microbes is known as "**Activated Sludge**". Most is sent back to the aeration tanks as "**Return Activated Sludge**" or "**RAS**" by pumping it to the splitter box ahead of the aeration tanks to be mixed with the incoming wastewater. Because biomass is constantly generated, the system would eventually become overloaded with sludge, so some is removed from the cycle. This removal is called "**Wasting**" and the material is known as "**Waste Activated Sludge**" or "**WAS**". The WAS is sent to other parts of the plant for further processing.

RAS and WAS are pumped through the "**RAS/WAS Building (240)**". The pumps in this building are adjusted to maintain a level (or blanket) of settled solids in the final settling basins while wasting rate is used to maintain a percentage of solids in the aeration tanks. Another factor taken into consideration is the flow coming into the CWP. The RAS/WAS pumps can be locked into the incoming flow signal and adjust to that signal to provide an optimum match between flow and RAS.

Coagulation Basins (300): The microbes do not always remove everything from the water and some material remains as the water passes through the final settling basins. Some phosphorous is removed in the biological processes but not enough to meet the plant discharge limits. The CWP adds coagulating chemicals (ferric chloride or polyaluminum chloride) as an aid for phosphorus removal. When added to the water, a phosphate precipitate (undissolved solid) is formed. This compound forms a **chemical floc** much like the biological floc created in the aeration tanks. The coagulating chemical handling equipment is located in the **chemical storage building (250).**

Mixed-Media Filtration (310): To further "polish" the wastewater the CWP uses anthracite/sand filters to remove any solids left from the other plant processes. These filters consist of various layers of materials, which range in size from three-inch stones at the bottom, up to fine sand grains and have a layer of anthracite on the top. The anthracite and sand removes fine particles. The chemical and filtration processes are considered advanced, or tertiary, treatment.

Ultraviolet Disinfection (350/320 - UV/Auxiliary Flow Basin): Bacteria in the water are reduced by exposure to **ultraviolet radiation.** Two banks of ultraviolet lamps are submerged in the flow stream. The radiant intensity of the lamps is varied with the flow rate and transmissivity of the effluent. This process is only operated during the “disinfection season” of May through September. The UV system was first brought on line in 2003, replacing the chlorination/dechlorination system. The replacement was done for both safety and permit compliance reasons. In 2016, the UV system was upgraded to a Trojan Sigma series which provides less energy and greater ultraviolet disinfecting power.

Sludge Thickening (400): The solids that are removed from the primary clarifiers and the activated sludge process still contain a great deal of water that must be reduced before further treatment. In the Sludge Thickening Building, water and air are added to the sludge under pressure to form a fizzy mixture that flows into two large, rectangular "**dissolved air flotation thickeners (DAFT)**". Because the solids entrap air they float to the top and are then skimmed off and pumped to the "**digesters**". The water then drains back to the beginning of the CWP to be treated as normal wastewater.

Digestion (410): The volume of solids produced at any wastewater plant is its biggest headache. The water flows through and finds its way into the world by way of a stream or lake. On the other hand, the solids must be transported somewhere for disposal. **Digestion** of the organics in the sludge by bacteriological action converts many of these organics into other forms, which can be more easily disposed of or have a useful purpose. In the digesters, some of the organics are converted into water and **methane gas.** The water can be sent to the head of the plant for treatment and the methane gas can be burned, either as a waste gas or to provide heat for the CWP. Digesters perform best when they are maintained at a constant temperature between 95°F and 100°F. The methane can provide enough heat to keep the system within that range. Waukesha's new facility has the capability of using some of the methane to provide supplemental heating for the other plant buildings also.

Sludge Storage Tank (450): In the past, sludge was sent to large ponds (called lagoons) for storage until it could be hauled to farm fields. This structure replaces those ponds as a temporary holding facility from which the sludge may be sent to fields as a liquid or to the sludge dewatering facility.

Dewatering building (430): The main component of any liquid sludge is water. In order to make wastewater solids economical to transport, the amount of water in it can be reduced drastically. Waukesha's digested sludge begins at about 2.5 to 3% solids before it is dewatered. The end product is about 18% to 25% solids. This means that we normally reduce the sludge to one-seventh of the original volume. The dewatered solids are stored in the attached **Cake storage building (440).** The most recent plant upgrades incorporated the replacement of Belt-Filter Presses (BFP's) to a centrifuge. Average cake solids from BFP's consisted of 18-20% cake, the new centrifuge can achieve cake solids in the range of 20-25%, significantly reducing land application costs to the treatment plants budget.

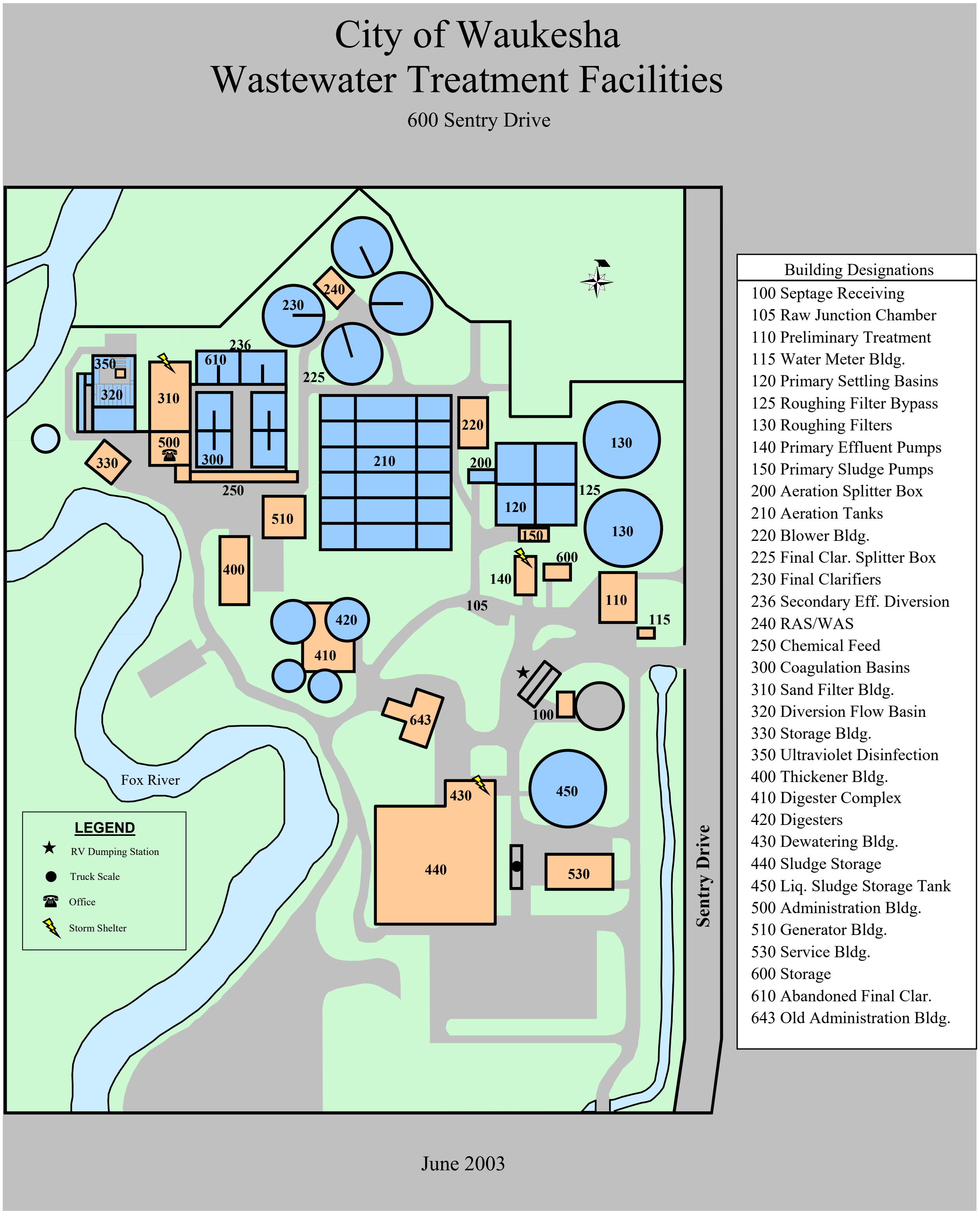
The CWP also has its own WI DNR Certified laboratory to monitor the treatment process and to make sure the plant is discharging at levels to meet plant discharge permit. The Industrial Pretreatment Program makes sure that local industries do not contaminate the water with chemicals that might damage the Plant, the processes, or pass through the system untreated. Plant personnel also monitor and maintain 38 pumping stations scattered throughout the city. As you can see, the Waukesha Wastewater Treatment Facility is very complex. There are presently twenty-three people at the plant working to keep our water resources clean, not only for today, but also for future generations.

Below is a table that lists the City of Waukesha Month Discharge Limits per our WPDES permit. Data shows that the last 3 years of data (2014 – 2016) the Wastewater Treatment Plant has exceeded our discharge permit levels by removing more than 97% of the influent toxins; providing some of the cleanest water available for all species to enjoy in the Fox River.

WPDES PERMIT

Parameter	Limit – Month Avg.	Influent	Effluent	Removal Rate
Flow Rate	MGD	9.10 MGD	9.03 MGD	N/A
BOD, Total mg/L	8.2 mg/L	262.18 mg/L	2.15 mg/L	99.18%
Suspended Solids, Total mg/L	10 mg/L	378.20 mg/L	1.57 mg/L	99.58%
NH_3-N	5.1 mg/L	8.55 mg/L	0.17 mg/L	98.06%
Dissolved Oxygen	6.7 mg/L	N/A	9.29 mg/L	N/A
Phosphorus, Total	0.7 mg/L	6.14 mg/L	0.14 mg/L	97.78%
Fecal Coliform	*** 400#/100 ml	N/A	2.69/100 ml	N/A

*** Fecal Coliform is based off a monthly geometric mean and is grab sampled 3X/week during the disinfection season of May – September, which is in accordance of the WPDES Permit


City of Waukesha
Wastewater Treatment Facilities
600 Sentry Drive
Fox River
Sentry Drive
LEGEND
RV Dumping Station
Truck Scale
Office
Storm Shelter
Building Designations
100 Septage Receiving
105 Raw Junction Chamber
110 Preliminary Treatment
115 Water Meter Bldg.
120 Primary Settling Basins
125 Roughing Filter Bypass
130 Roughing Filters
140 Primary Effluent Pumps
150 Primary Sludge Pumps
200 Aeration Splitter Box
210 Aeration Tanks
220 Blower Bldg.
225 Final Clar. Splitter Box
230 Final Clarifiers
236 Secondary Eff. Diversion
240 RAS/WAS
250 Chemical Feed
300 Coagulation Basins
310 Sand Filter Bldg.
320 Diversion Flow Basin
330 Storage Bldg.
350 Ultraviolet Disinfection
400 Thickener Bldg.
410 Digester Complex
420 Digesters
430 Dewatering Bldg.
440 Sludge Storage
450 Liq. Sludge Storage Tank
500 Administration Bldg.
510 Generator Bldg.
530 Service Bldg.
600 Storage
610 Abandoned Final Clar.
643 Old Administration Bldg.
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