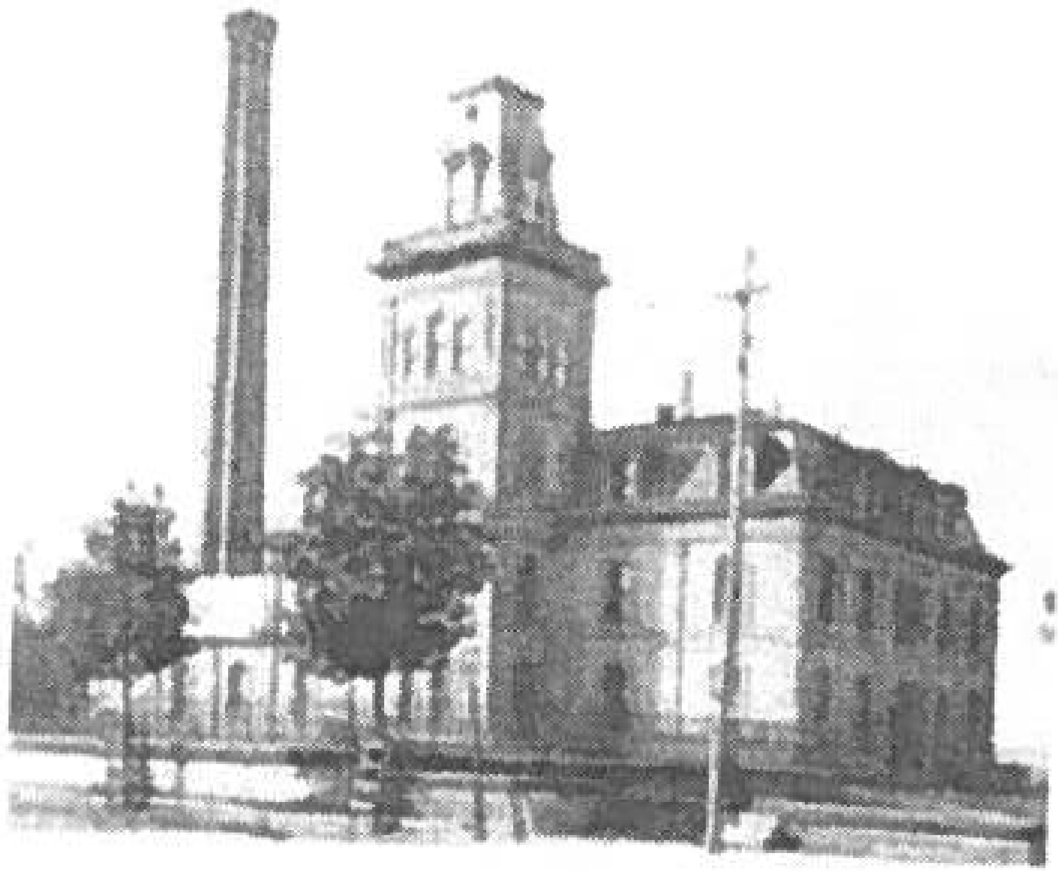

Photo 1.1 Original Waterworks Facility

Construction began on the original waterworks facility in 1870 and was completed in 1873. It was built at the intersection of Mulberry and Water Street which is now Riverside Drive. It sat on the North bank of the Ohio River southeast of the original town. The construction cost of the building was $300,000.

The original design consisted of a 17 foot diameter, 52 foot deep well that had brass strainer pipes driven though the bottom that allowed clear water to come through the pipes into the well. There were four 50 HP boilers that furnished the necessary steam to drive the two engines that delivered 3 MG of water per day (MGD) to the distribution system which served 200 customers.

This design did not work very well due to the varying stages of the river. When the river was extremely low, there was not a sufficient amount of water flowing into the well, so the pumps and filter plant was eventually abandoned. In 1881, a 30-inch intake pipe was ran to the river and two new pumps with compound jet condensing engines bought from the Holly Manufacturing Company were installed in the well to pump the river water to the city. These pumps, which had the capacity to pump 4 MGD, were the latest invention in pumping machinery at the time. The original boilers furnished the steam to run these pumps. By 1886, the customer base had grown to 1,544 and the plant was producing 5 MGD.

An additional 2 MGD pump was installed at Water Street and Fulton Avenue to help out on fire loads. In 1889, a 2MGD Worthington compound pump was added to the main pumping station to pump the water from the reservoir located in the front yard of the main station. The cost of the plant, including water mains, valves, and fire hydrants, was $1,300,000.

In 1892, a pumping station was built at Ninth Avenue and Pennsylvania Street to provide more water for the West Side. The station was equipped with two 50 HP boilers and a 2 MGD pump. The pump received its supply from a reservoir next to the station that was filled from the main station. The cost of the pumping station, pumps, and boilers cost $17,694.

In 1893, two more 3 MGD steam operated pumps were added to the main station to pump water directly to the city. The addition was put into operation in January 1894 at a cost of $21,639.

In 1895, the ground where the present plant stands was purchased. On December 10, 1895, the first contract was awarded to Delaney & Dawson for building the masonry wall and foundations for a sum of $84,500. A new well 50 feet in diameter and 60 feet deep was constructed and three 30" diameter cast iron pipes were extended 225 feet from this well, approximately 40 feet into the Ohio River. Delaney & Dawson was also awarded the contract for installing the three 30-inch intakes for a sum of $24,500. Each of these pipes was perforated with ½" diameter holes on 2-foot centers for about 20 feet from the outer ends to allow the water from the river to flow into the plant.

Photo 1.2 New Waterworks Facility built from 1895-1900

The building contract was awarded to George Seikel for $40,000. The plant was equipped with 10 MGD triple expansion condensing engines, built by the Holly Manufacturing Company at a cost of $48,000. The boiler house was equipped with three 225 HP Sterling Boilers, which cost $17,000. The towering smoke stack cost $7,000. When the plant was put into operation in 1900, it was pronounced one of the best water plants built. On December 24, 1903, the people of the city had learned that the three 30-inch intake pipes had broken and that a water famine was threatened. Mr. Hermany, who designed the station, was summoned. Upon his arrival, an effort was made to get to the broken intakes, without success. Mr. Ludington, an engineer, was hired to install a temporary intake.

On February 10th, during the construction of the temporary intake pipe, it became necessary to tear down the west wall of the building as it was badly cracked and ready to fall at any time. Pumps were placed along the river to supply the city. Mr. Ludington died and nothing was done to repair the intakes until August 22, 1904. A firm out of Chicago was awarded the job of repairing the intakes and after an unsuccessful attempt, quit. In December 1904, a contract was awarded to Kerns & Co. to make the repairs. They made several attempts and were successful in removing some the broken pipe but abandoned the job in the summer of 1905 due to high water. On March 1, 1906, Arch Hollerbach, an Evansville contractor, was hired to replace the three 30-inch pipes. This time, he placed them on a concrete foundation. The intakes were placed into operation in early 1907 at a cost of more than $135,000.

From 1906 to 1910 there were 786 officially reported cases of typhoid fever that resulted in 111 deaths. These conditions prompted Mayor J.W. Boehne to authorize the water works trustees to issue a contract for a complete water purification plant in 1908. In 1912, construction of the 12 new filters with a capacity of 1 MGD each was completed. The new filters and pumps cost $284,577.79

In 1912 & 1913 two more pumps were added and in 1924, four more filters were added. In 1928 the steam driven pumps were replaced with electric motor driven pumps and in 1929, a 20 MG underground reservoir was built on Stringtown Hill (now Campground Rd.) about 4 miles north of the city.

In 1938, four more filters were added. At this time the plant was rated at 24 MGD. In 1947-1949, four larger filters rated at 3 MGD each were added in a new structure just east of the original 12 filters. This brought the plant to a new filtering capacity of 36 MGD.

A diesel engine, power generating room was constructed at the same time. In 1950, the steam power plant and all steam related equipment was removed and the plant was converted entirely to an electrical operation. The plant then depended on purchased electric power but relied on the diesel generators, installed in 1949, for a backup power supply.

In 2011, work began to remove all of the piping, valves, pumps, and motors from the original 50 foot diameter, 60 foot deep well. Since the well had been abandoned for some time, the US Army Corps of Engineers considered the three 30 inch pipes running from the well to the river to be a risk during flood conditions. Those pipes could potentially allow water to flow from the river up into the well and pose a flooding threat to the protected side of the levee. At the time of this writing, in January 2012, all of the equipment within the well is being removed and the three 30 inch abandoned intake pipes will be capped with concrete down in the bottom of the well. The well will then be filled with a low strength flowable fill concrete to within 18 inches of the floor level. The remainder will be capped with a concrete slab to bring the elevation level with the surrounding floor.

FILTER PLANT

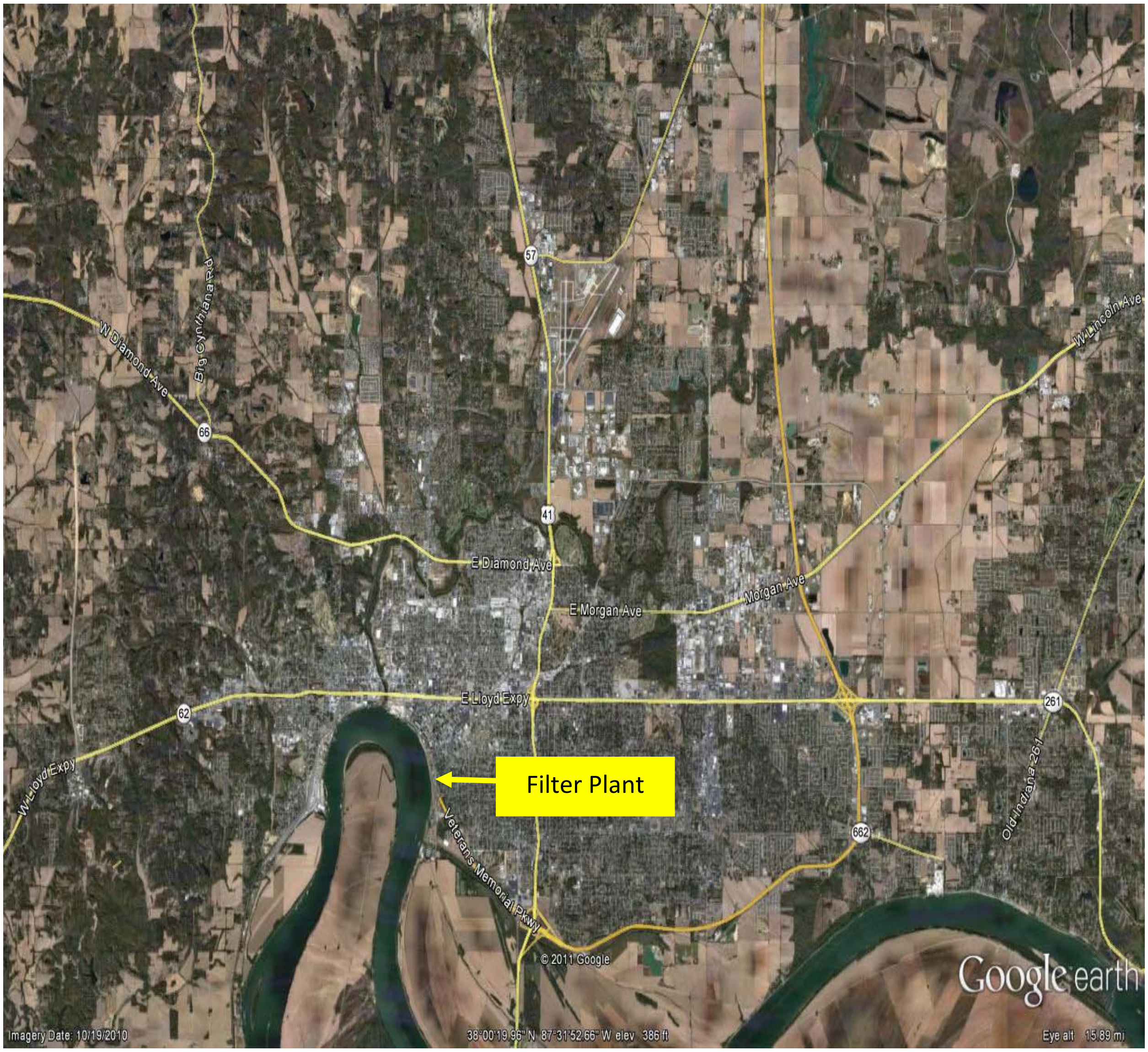

Photo 2.1 Location of Water Filtration Plant

Photo 2.2 Aerial View of Filter Plant

Photo 2.3 Front of Filter Plant

Low Service

The Ohio River serves as the City of Evansville's sole supply for its public drinking water system. The Evansville Water and Sewer Utility (EWSU) removes water from the river through a low service facility that sits in the river on the west side of the filter plant.

Photo 3.1 Low Service Facility

Photo 3.2 Interior of Low Service Facility

The water from the river flows into the low service building through three large openings on the west side of the structure. Each opening has a grate that prohibits large articles or driftwood from entering the structure. Each grate is attached to a chain that can be hoisted up on occasion to clear debris that may have accumulated on the grate. Under the floor shown in photo 3.2, are three reservoirs that are approximately 50 feet deep which contain the river water until it is pumped out to the filter plant.

After the water passes through the large grates that are located on the outside of the structure, it passes through one of three travelling screens, shown in photo 3.3, that are located on the inside of the building. There is one travelling screen in each of the three reservoirs. These screens remove much smaller debris that has been able to pass through the large grates on the outside of the structure.

Photo 3.3 Three travelling screens located inside the low service building

Located inside of the travelling screen as shown in photo 3.3 is a continuous loop chain that can be seen in photo 3.4 and 3.5 that runs on sprockets above the floor and down in the water. Attached to the chains are several screens that catch debris as the water is flowing through them. As the screens travel from the reservoir up above floor level, they are rinsed off with clean water. The debris that is rinsed off of the screen then travels through a drain and back to the river. Also located inside of the low service structure is dry feed chemical system where Potassium Permanganate ($KMnO_4$) can be added when needed. Potassium Permanganate is used for a variety of reasons including the control of the zebra mussel population in the raw water so they do not cling to and plug the openings in the screens.

Potassium Permanganate is also used to control some substances that may create taste and odor issues with the water, and it is used as the initial oxidant in the control of trihalomethanes (THMs). THMs are a group of compounds that form when decaying vegetation reacts with chlorine. The EPA has regulations that only allow a certain amount of THMs in the water.

Photo 3.4 Travelling Screen #2 Prior to Rehab in 2008

Photo 3.5 Travelling Screen #2 during rehab

Once the water within the reservoirs has passed through the travelling screen, it is then pumped up and out of the reservoir and is directed to one of two of the treatment “trains” at the filter plant. There are two pumps, rated at 14.41 million gallons per day (MGD) each, located within each of the three low service reservoirs that perform all of the pumping requirements for the low service facility.

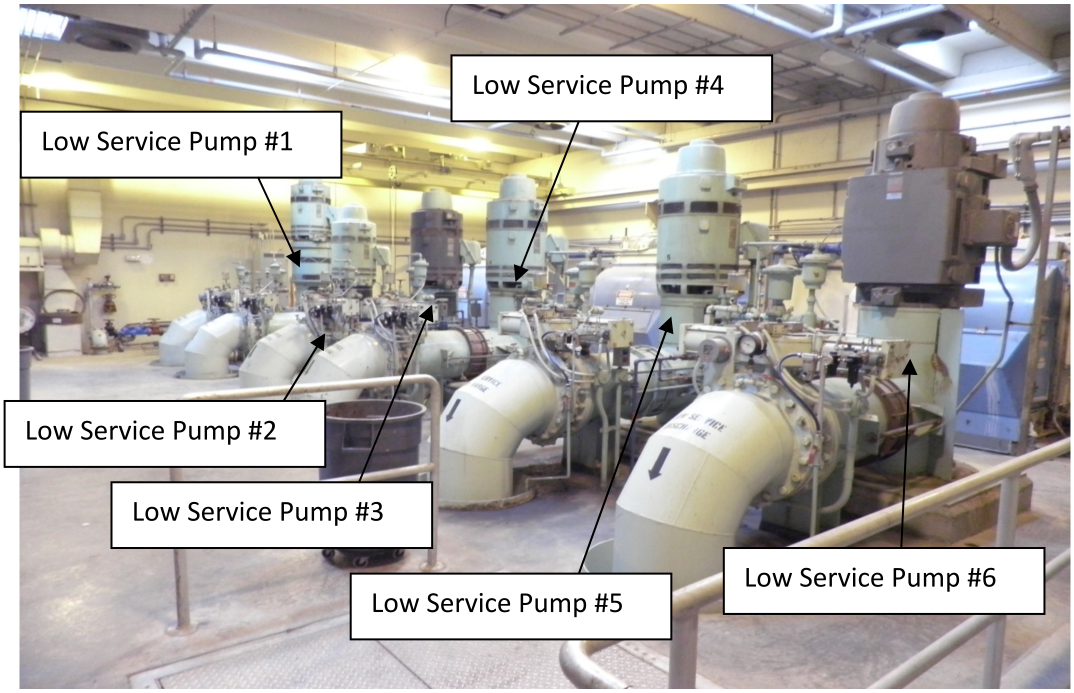

Photo 3.6 Low Service Pumps

North Plant

Even though Evansville only has one water treatment facility, referred to as the filter plant, many times there are references made to the North Plant and the South Plant. This refers to two separate treatment "trains" or paths that the water follows throughout the filter plant on its way from the river to the distribution system. Although most of the pictures and diagrams of the plant that are used are orientated so that the river is at the top of the picture as seen in photo 4.1, North would be to the right in those diagrams. Therefore, we have the South half and the North half even though they are left and right in most photos.

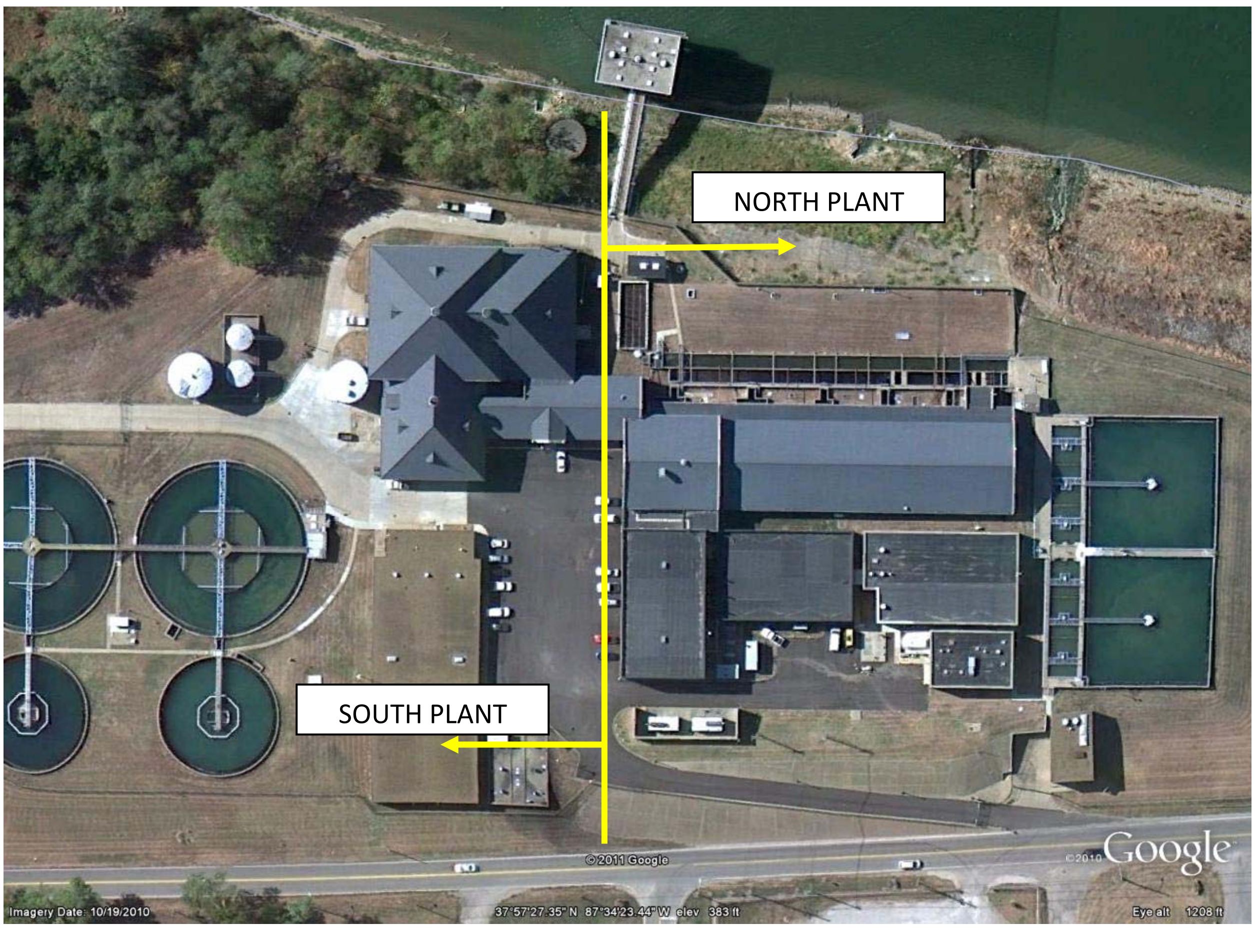

Photo 4.1 Aerial View of Filter Plant

After the water is discharged from the Low Service Pumps as shown in photo 4.2, it flows by gravity through the raw water flume, shown in photo 4.3. As the water is flowing in the raw water flume, the capability of adding powdered activated carbon (PAC) is available. PAC is a substance that is used as an absorbent if a spill were to occur on the river or if high levels of agricultural chemicals present themselves, typically during the heavy spring rain season. It is also has the capability of neutralizing some taste and odor issues that are present during periods of extreme heat and drought when the river levels may be low and slow moving creating ideal conditions for algae to bloom.

Photo 4.2 Discharge of Low Service Pumps

Photo 4.3 Raw Water Flume

The water flowing through the raw water flume is on its way to the coagulation and flocculation, or floc, chambers. There a coagulant, Aluminum Sulfate or more commonly referred to as Alum, is added to the water.

Coagulation – Flocculation

Photo 4.4 Empty flocculation chamber

The alum is mixed with the water in the floc chambers with large paddles similar to a ceiling fan, shown in photo 4.4. As the alum mixes with the raw water, any particles suspended in the water start to bond together into larger clumps of particles called floc. As the larger particles continue to bond together they begin to get heavier than the water they are suspended in and begin to sink to the bottom of the chambers.

Sedimentation

Photo 4.5 Empty primary clarifier

Photo 4.6 Primary clarifier weirs

The water leaves the floc chambers and travels to the primary sedimentation basins, or clarifiers, through channels and it enters the primary clarifier in the center. The North Plant has two identical primary clarifiers, referred to as North Plant primary #1 and primary #2. Photo 4.5 shows an empty clarifier. The water enters up through the tube in the center and flows slowly outward. Photo 4.6 shows the weirs that are located around the outside perimeter of the clarifier. Those weirs control the flow of water out of the clarifier allowing the floc particles the proper amount of time to settle out. As the water is moving outward, the floc particles are continuously sinking to the bottom of the clarifier. The solids that have settled out are then scraped towards the center of the clarifier by large scraper arms that continuously turn in a circular motion around the center tube. The solids, now referred to as sludge, enters drain pipes that carry it back towards the river and dump it out of one of four outfall structures located on the river bank.

After the water flows over the weirs, it travels through another set of channels towards the secondary clarifiers. The North Plant has three identical secondary clarifiers, referred to as secondary #1, 2, and 3. As the water is traveling from the primary clarifier to one of the secondary clarifiers, Chlorine is added as the primary disinfectant. In the North Plant, the secondary clarifiers are underground. These clarifiers are large reservoirs with baffles located throughout them to form a maze-like path for the water to flow through. As the water slowly makes its way through the path of concrete barriers, particles are continuing to settle out of the water and sink to the bottom. Again, the solids are collected and transported back to the river through a pipe and discharged out another one of the outfall structures located on the river bank.

Chloramine Formation

The water is now much cleaner than it was when it entered the plant but there are still particles and organisms present. As the water moves from the secondary clarifiers to the next step of the treatment process which is filtration, ammonia is added to the water. The ammonia combines with the chlorine that is present in the water to form chloramines. Evansville has used chloramine disinfection since the year 2000. Chloramine disinfection allows a residual chlorine level to remain in the water for a longer period of time before dissipating than chlorine allows. It is that residual chlorine level that kills the bacteria that may grow within the piping system and water storage facilities throughout the distribution system.

Prior to using the chloramine disinfection process, Evansville just used chlorine only, referred to as free chlorine. Even though chlorine is a stronger disinfectant than chloramines, it dissipates more quickly and does not offer the longer periods of maintaining a chlorine residual necessary to kill the bacteria. Every year, and sometimes two or even three times a year, depending on the heat and characteristics of the water, Evansville will temporarily switch from chloramine disinfection to free chlorine. This is done as a precautionary measure to “scrub” the distribution system with a stronger disinfectant and to prevent nitrification. Nitrification is the process where bacteria converts the ammonia contained within the water to nitrite and nitrate. This occurrence is typical during periods of warmer water temperatures. During nitrification, chlorine residuals drop and the potential exists for coliform bacteria to enter the system. When Evansville switches from chloramine disinfection to free chlorine, it is typically done for a period of about one month. Public notifications are sent out to alert customers that they may experience some differences in their water during the switch including a stronger chlorine smell, often compared to a swimming pool smell. Health care facilities are also notified in the event they need to make any adjustments to the water used for dialysis.

pH Adjustment

Prior to the water reaching the filter beds, caustic soda is added to the water to adjust the pH level to the optimum range for potable water so that it is not so low, or acidic, that it corrodes pipes within the distribution but yet not so high that excess scale deposits form within the piping and reduce capacity over time.

Filtration

Currently, the filter plant has 24 filter beds in service. They are more commonly referred to as filter beds #13 - #36. Filter beds #1 - #12 still exist but have been abandoned due to their obsolescence. Sixteen of the active beds are located in the North Plant and eight are located in the South Plant. Eight of them are capable of filtering 1.5 million gallons of water per day (MGD) each and the other sixteen are capable of filtering 3 MGD each for a total filtering capacity of 60 MGD.

Photo 5.1 Filter Bed #35 and #36

The water flows into one of the 24 filter beds from the secondary clarifiers. As the water enters the beds, it starts slowly seeping down through the different layers of anthracite, sand, and stone. Each bed contains approximately eight inches of anthracite, 22 inches of silica sand, four inches of larger diameter sand, and 12 inches of various size stone. A cutaway view of a filter bed is shown in photo 5.2. As the water passes down through the filter, the very small solids that did not settle out during the flocculation and sedimentation process are trapped and collected within the particles of sand. Other organisms or pathogens that may not have been removed through the coagulation and sedimentation process are also removed through the filters. The filtered water that has passed through all of the layers of the filter bed are collected in the drains located under the layers of sand and stone and is carried to one of three clearwells, or underground storage tanks, located at the filter plant.

Photo 5.2 Mock-up of the profile view of a filter bed

Photo 5.3 Filter Bed Gallery

Photo 5.3 shows one of the filter bed galleries located under the floor of the hallways in each of the filter buildings. These galleries contain the piping that carries the non-filtered water from the secondary clarifiers to the filter bed and the filtered water from the bed to the clearwell.

Photo 5.4 Water Quality Monitoring Equipment in Filter Gallery

Each filter gallery contains water quality monitoring equipment, shown in photo 5.4, which sends data back to the operator's control room indicating the condition of the water during and after the filtering process as well during the filter cleaning, or backwashing, process.

Photo 5.5 SCADA operated Valve in Filter Gallery

There are numerous valves in each filter gallery that have remote actuators, as shown in photo 5.5, attached to them so that the operators are able to monitor and control the position of each valve through the SCADA system. The valves, like the one shown in photo 5.5, have digital displays that indicate the current position, or percentage of flow allowed through. Operators are able to precisely open and close each valve to achieve the desired flow through the filters so that optimum water quality is maintained while producing the necessary amount of finished water to meet the current demand of the system.

Clearwell Storage

The filter plant has three clearwells with capacities of 0.5 million gallons (MG), 1.5 MG, and 6.0 MG. Water from both sides, the North Plant and the South Plant, can free flow to any one of the three clearwells at any given time. The water is temporarily stored in these underground reservoirs until it is needed in the system. The water is continuously monitored throughout all of the processes and in the clearwells to ensure the finished product meets or exceeds all of the criteria for safe drinking water.

South Plant

All of the processes are the same for the South Plant as they are for the North Plant but there are differences in the location of each process. Both, the primary and secondary clarifiers, are round in the South Plant. Photo 6.1 shows one of the two primary clarifiers empty during a recent cleaning.

Photo 6.1 South Primary #2 During Cleaning

Photo 6.2 South Primary #2 During Cleaning

As shown in the two photos, each of the two primary clarifiers is composed of a large diameter concrete structure with a smaller metal ring supported in the center of clarifier. As in the North Plant, the water enters the clarifier in the middle. The difference between the North and the South is that on the North Plant, the coagulation and flocculation process was completed in a separate chamber before the water entered the primary clarifier. On the South Plant clarifiers, the coagulation and flocculation is performed in the inner circle and the clarification is performed in the outer circle of each clarifier. The alum is added to the water just prior to entering the primary clarifier.

After the water flows over the outer weir of the primary clarifier it enters a channel to flow towards the secondary clarifier, which is also round. Chlorine is added to the water between the primary and secondary clarifiers. After most of the floc particles settle out in the clarifiers, the water is transported towards the filters through a large diameter underground pipe. Located in the pipe is a static mixer, shown in photo 6.3, where ammonia, fluoride, and caustic are injected into the water. As the water flows through this mixer, the baffles protruding from the sides cause extreme turbulence in the water which allows the chemicals to be thoroughly mixed into the water without any type of mechanical power equipment. After those chemicals are added, the water completes the same filtration process as the South Plant. Like the North Plant, after filtration, the water flows into one of the clearwells.

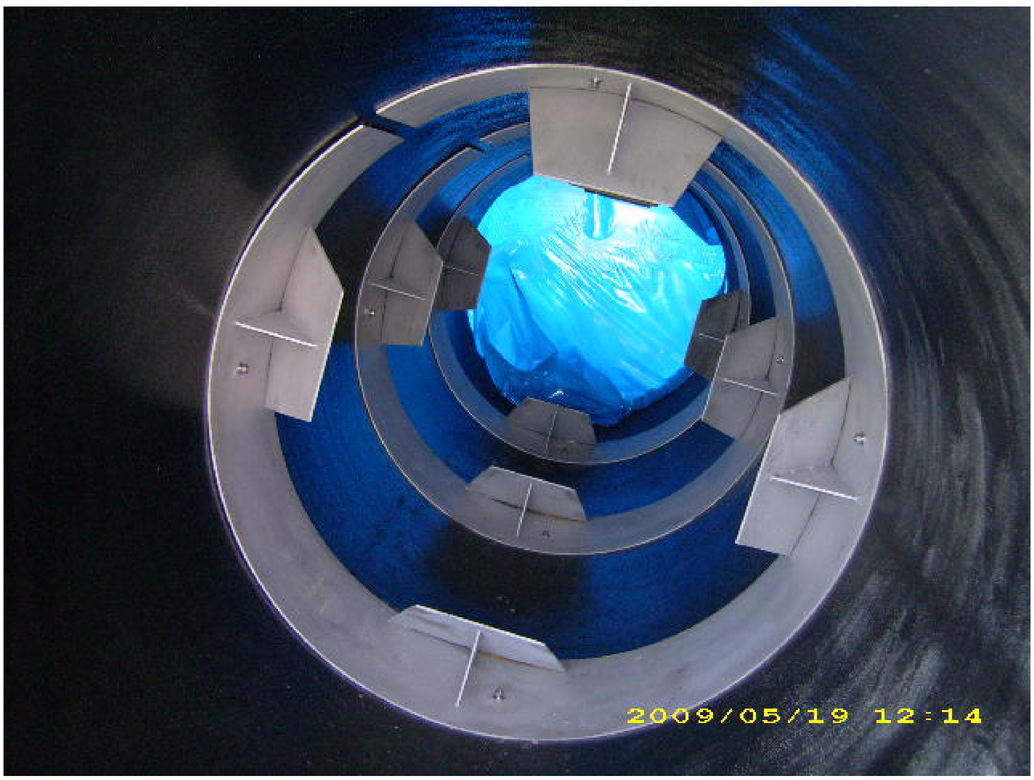

Photo 6.3 Inside view of Static Mixer

High Service

Water flows out of the clearwells to one of seven high service pumps that pump the water from the plant out into the distribution system. As a last step in the treatment process in the North Plant, Fluoride is injected into the pipe prior to entering the inlet of the high service pumps.

Photo 7.1 High Service Pump Station #2

Each of the seven pumps, like the one shown in photo 7.1 is capable of pumping 14.41 MGD. Pump use is rotated on a continuous basis to prolong the life and allow for periodic maintenance. The number of pumps running at any one time is dependent on the current demand of the system. The water exits the plant at a pressure of approximately 70 psi.

Filter Plant Laboratory

Located inside of the filter plant is a state certified laboratory where thousands of water samples are analyzed throughout the year. The laboratory is staffed seven days a week. Not only do the laboratory technicians process samples from throughout each step of the treatment process, they also collect and analyze hundreds of samples a month from various locations throughout the distribution system to ensure a very high quality product is produced and maintained. The lab staff responds to customer requests for water sampling as well as processes water samples for surrounding municipalities that do not have their own laboratory. Any time work is completed throughout the distribution system that results in a water line being turned off or line pressure dropped below 20 psi, a precautionary boil advisory is issued by the lab to the affected customers. Lab staff members then collect and analyze water samples from the affected area until two consecutive sample results have shown the water is free from any type of contamination. After two consecutive samples are contaminant free, the lab issues a notice to customers that the precautionary boil advisory has been lifted.

Photo 7.1 – 7.4 Analytical Lab Equipment

The filter plant lab is equipped with several pieces of analytical equipment that are used on a daily basis to ensure the water produced by the Evansville Water and Sewer Utility meets or exceeds all of the standards set forth by the Environmental Protection Agency, the Department of Health, and Indiana Department of Environmental Management which is the state's agency that oversees the production and distribution of drinking water. The water department also voluntarily participates in the Partnership for Safe Water. Members of the partnership produce and distribute water that exceeds all of the required standards for safe drinking water. The laboratory is also responsible for submitting all of the state and federal reports that are required by various agencies.

Operators

The filter plant is staffed 24 hours a day, 7 days a week. There are four full-time operators whose primary responsibility is to produce high quality drinking water for the city. There are seven maintenance employees who are also certified as operators that primarily perform maintenance activities but fill in and assist the operators whenever needed. All four laboratory technicians are also certified operators.

Photo 8.1 Operator's Control Room

Photo 8.2 Screen Shot of SCADA controlled Chemical Delivery Equipment

Photo 8.3 View of Water Storage Facility Monitor

With the use of supervisory controls and data acquisition (SCADA) controlled equipment, the operators are able to control most of the pumps, valves, and pieces of equipment throughout the plant from the operator’s control room. Monitors display the current status of the equipment, as shown in Photo 8.2, including the levels of water towers, shown in photo 8.3, chemical tanks, and pump pressures. Several locations throughout the plant and distribution system have water quality monitoring equipment that continuously reports various water quality parameters to the operators through the SCADA system.