



BROKEN ARROW

Where opportunity lives

Verdigris River Water Treatment Plant

Broken Arrow, Oklahoma

Engineer:

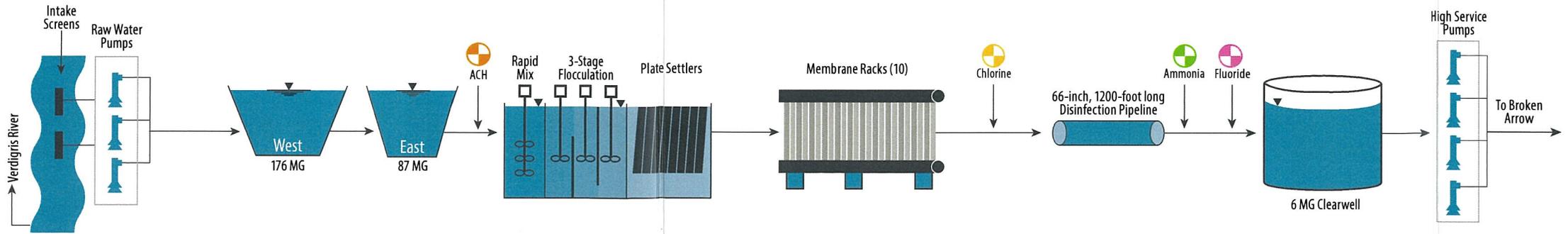


Contractor:



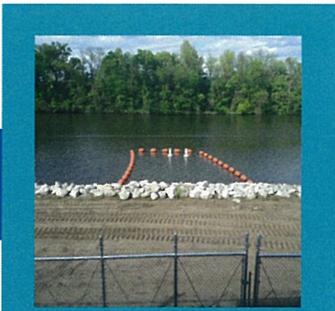
2014

Water Treatment Process



Intake & Raw Water Pump Station

Two intake screens located in the Verdigris River oxbow provide the entrance point for the raw water to be treated at the Verdigris River Water Treatment Plant (WTP). Each intake screen has a capacity of 20 million gallons per day (mgd). The raw water pump station has 3 (2 duty, 1 standby) vertical turbine pumps with 10-mgd capacity each. Each pump has a 250-hp motor. The raw water is pumped through a 3/4-mile, 42-inch diameter pipeline, overcoming 90 feet of total dynamic head. The water enters the West Pre-Sedimentation Basin under normal conditions or can be sent directly to the WTP.



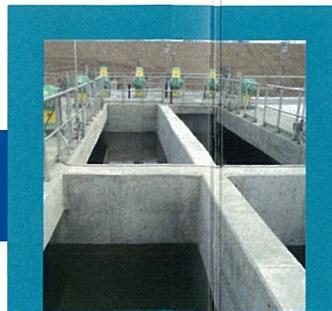
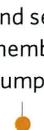
Pre-Sedimentation Basins

Over 260 million gallons (MG) of raw water storage capacity is provided by the two Pre-Sedimentation Basins. The West Pre-Sedimentation Basin holds 176 MG, while the East Pre-Sedimentation Basin holds 87 MG. This capacity is sufficient to furnish several days of raw water supply without the need to pump from the Verdigris River. Unforeseen raw water quality upsets on the Verdigris River (navigation channel) can be mitigated by using this storage volume. The basins also provide pre-sedimentation of the water to reduce and equalize the particle load to the treatment plant.



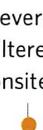
Pre-Treatment Basins

The Pre-Treatment Basins are the first step in the treatment process and consist of four parallel trains. Each train has a capacity to process up to 10 mgd and serves three purposes: rapid mix, flocculation, and sedimentation. In the rapid mix, aluminum chlorohydrate (ACH), a coagulant chemical, is added and mixed to the raw water to facilitate conglomeration of the small suspended particles in the water. In the flocculation basin, the raw water is gently mixed, helping the suspended coagulated particles to collide and form clusters. In sedimentation, plate settlers are used to separate the solids and send clarified water to the membranes. The solids are pumped to the onsite lagoons.



Membrane Filtration

The Verdigris River WTP uses low pressure microfiltration (MF) membranes to filter the water. MF is a hollow-fiber membrane system (looks like spaghetti-sized straws) that removes contaminants by physical straining (sieving) of particles that are larger than the nominal pore size of the membrane MF (approximately 0.1 micron). They can easily remove *Giardia* cysts and *Cryptosporidium* oocysts as well as other microorganisms, colloids, and high-molecular weight compounds. Four 200-hp pumps are used to "push" the water through the membranes and all the way to the clearwell. The membranes are backflushed several times a day with the filtered solids sent to the onsite lagoons.



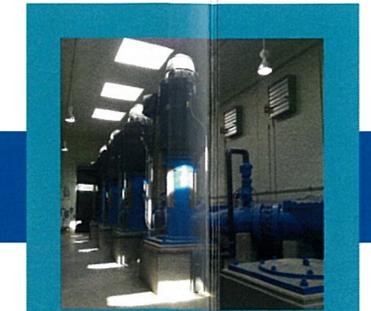
Disinfection

To accomplish primary disinfection, The Verdigris River WTP uses free chlorine. The chlorine contact takes place in a 1,200-foot long, 66-inch diameter contactor pipeline. The treatment plant also provides secondary disinfection to ensure the water quality does not degrade in the distribution system and remains safe all the way to the customer's tap. Chloramines are used to provide secondary disinfection as it is a more stable disinfectant than free chlorine and also produces less regulated disinfection by-products. Ammonia is added near the end of the 66-inch pipeline to form chloramines. Fluoride is also added for dental protection.



Finished Water Clearwell and High Service Pump Station

A 6-MG pre-stressed concrete clearwell is provided to store the finished water before delivery to the distribution system and storage tanks in the City. The clearwell is 80 feet in diameter and has a 40-foot sidewall height. High Service Pumps are provided to deliver the finished water from the clearwell all the way to the City's distribution system, a distance of around 15 miles. There are four vertical turbine pumps (3 duty, 1 standby) with 900-hp motors and variable frequency drives to match City water demand. Each pump is rated to deliver 11.5 mgd and to overcome more than 450 feet of total dynamic head.



Why Membranes?

Membranes have been used for water treatment for many years, primarily in industrial applications, but they are now cost competitive with conventional water treatment processes and are being used more frequently for municipal water treatment. The use of membrane filtration not only requires a much smaller footprint when compared to the area needed for conventional media filtration but also produces a finished water with better quality. Membranes provide an absolute physical barrier to all contaminants that are larger than the membrane pore size and prepare the City to meet future regulatory requirements.



Plate Settlers

Plate settlers enhance sedimentation by significantly minimizing the footprint of the sedimentation basin. State regulations require four hours of detention time in sedimentation basins. To seek a variance from this regulation, plate settlers were piloted for 90 days and showed that a detention time of 19 minutes was sufficient to achieve satisfactory effluent turbidity. This saved the City several million dollars and made the use of membranes cost-effective.

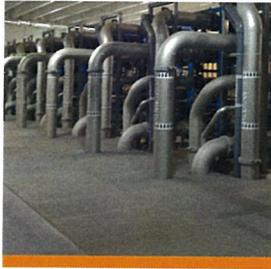


Onsite Chlorine Generation

All chlorine used at the WTP is generated on-site as sodium hypochlorite. It is the same chemical as household bleach, but at a lower concentration. Sodium hypochlorite provides the free chlorine that is required for primary disinfection and membrane cleaning. Typically, gas chlorine has been used by water plants for disinfection purposes. But, due to the very low concentration of chlorine in onsite sodium hypochlorite generation, it is significantly less dangerous to handle than chlorine gas and creates a much safer environment for staff. Moreover, very trivial ingredients are used to generate sodium hypochlorite: water, table salt, and electricity.



Project Highlights



- Largest Membrane WTP in Oklahoma and One of the Largest in the Nation
- \$65M Project Cost (Engineering and Construction)
- Largest Water Treatment Project Funded by the Oklahoma Water Resources Board
- 20-mgd Capacity; Readily Expandable to 40 mgd in Future
- 28-mgd Capacity in Warm Weather Due to Higher Flux Through Membranes
- All Chlorine Used at Plant is Generated On-Site as Sodium Hypochlorite; Much Safer Than Previous Use of Chlorine Gas
- Use of Plate Settlers for Sedimentation Greatly Reduces Plant Footprint and Cost
- Chloramines Used for Secondary Disinfection in Distribution System to Reduce Regulated Disinfection By-Products
- Advanced Laboratory for a Variety of Water Quality Testing and Analyses
- Large Conference/Training Room for City Staff
- Plant Processes are Fully Automated and are Controlled/Monitored Via Computerized SCADA System
- Constructed by Crossland Heavy Contractors, Columbus, KS
- Local Design Partners: BKL (Tulsa); Holloway Updike & Bellen (Broken Arrow); and Terracon (Tulsa)



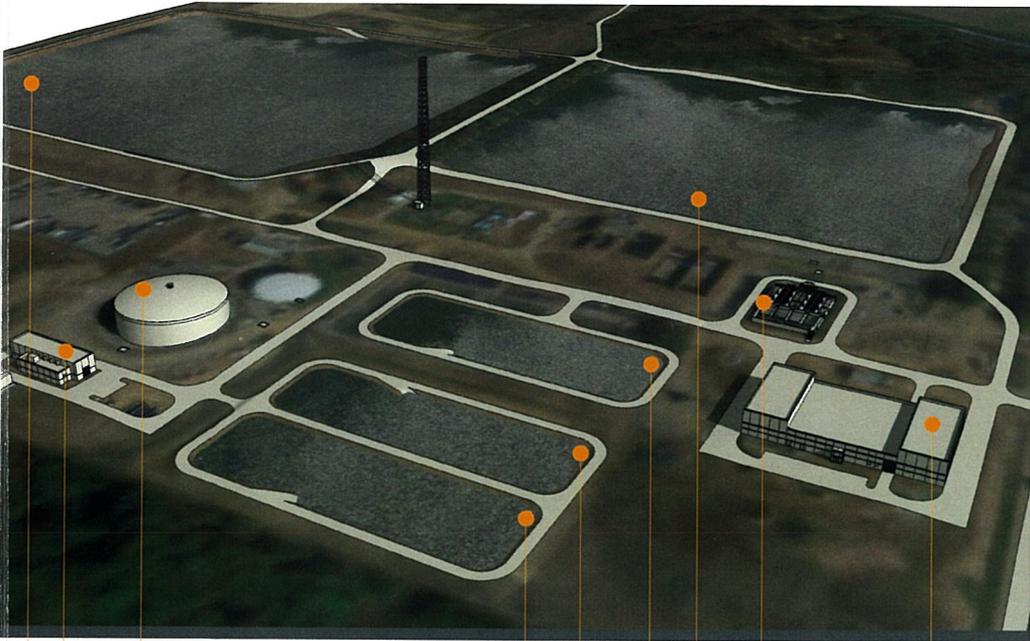


17111 Preston Road, Suite 200
Dallas, TX 75248
972.960.4400



BROKEN ARROW

220 South 1st Street
Broken Arrow, OK, 74012
918.259.2400



Clearwell
(6 MG)

High Service
Pump Station

West Pre-Sedimentation Basin
(176 MG)

Lagoon No. 3

Lagoon No. 2

Lagoon No. 1

Membrane /
Admin Building

Pre-Treatment Basins

East Pre-Sedimentation Basin
(87 MG)