Journal

of The New England Water Works Association

Volume 129 No. 4 December 2015

Our 134th Year

Granite Gate House at Penacook Lake
Concord, New Hampshire

New England Water Works Association
a Section of the American Water Works Association

ON THE COVER:

Granite Gate House at Penacook Lake Concord, New Hampshire

The photo on the cover shows Penacook Lake in Concord, NH. Penacook Lake was created in 1872 when a dam was constructed, combining Long Pond and Forge Pond. The Lake is 2.5 miles long, ¾ mile wide, and contains approximately 1.5 billion gallons when at capacity. This lake has been the primary source of supply to the City of Concord since 1872.

In the foreground, you see the granite gate house. This structure housed the first of three copper mesh screens that were used to filter the water prior to entering the distribution system and the City of Concord. The granite gate house had 2 sets of copper screens with ½-inch openings. These screens would stop anything larger than a ½ inch from entering the system. The water then travelled under the dam to a second screen house where two additional sets of screens would further "filter" the water as it had to pass through a ¼-inch copper screen, then an 1/8-inch copper screen. This screening process was in use until the Water Treatment Plant was constructed in 1974.

Concord has taken a very proactive approach to watershed protection. In the late 1800s, recreational access was allowed around the lake, which led to quality issues the directors needed to control. Concord was the State Capital and the protection of its water source was of the utmost importance. The City started purchasing shorefront property and now owns all property that touches the lake, as well as property that provides access to it. A local ordinance was put in place to restrict any and all access. Working with the State of New Hampshire Department of Environmental Services, water supply rules (ENV-Ws 386.21) specifically protect Penacook Lake from any recreational use. Concord also partners with NH Fish and Game to allow them to net fish from Penacook Lake and transport fish to their designated lakes and ponds if they have a difficult growing season at the State hatchery. This partnered commitment to protection of the source has been key in the consistent raw water quality and the class "A" designation of the Lake.

Information and photographs courtesy of:
Marco Philippon, Water Treatment Superintendent
General Services Department, Concord, New Hampshire

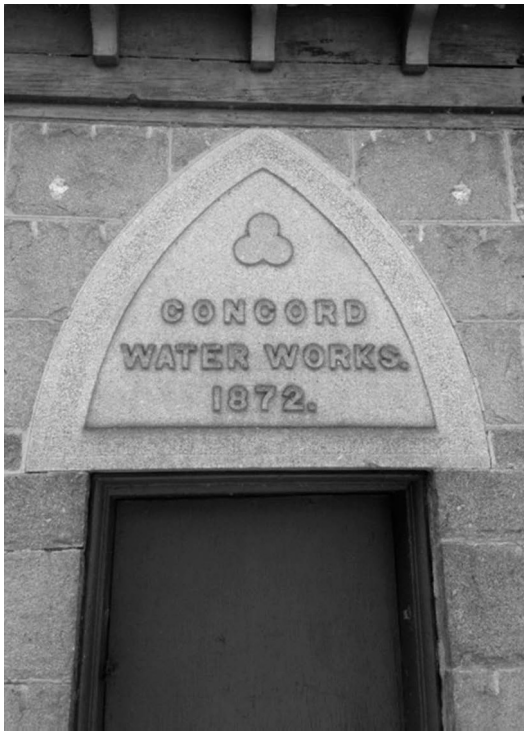
WATER SYSTEM PROFILE
City of Concord, New Hampshire

By Marco Philippon

Overview

The City of Concord, the state capital of New Hampshire, is a community of 64 square miles and a population of 45,000 located in central New Hampshire. The City was established in 1725 and granted as the Plantation of Penacook. It was a community which used the Merrimack and Contoocook Rivers to develop mill buildings and trade. Today, the City houses the state legislature, state offices, a law school, and a major hospital and health industry. The day population can reach 100,000 with the business, commercial, and professional commuters.

Water System Information	
System name	City of Concord N.H.
Service area	Concord & Penacook, New Hampshire
Population served	45,000
Sources	Penacook Lake, and Pembroke Well Field
Treatment processes	Traditional Filtration, Coagulation, Flocculation, Sedimentation, Filtration
Miles of pipe	172
Daily demand	4.0 MGD
Number of employees	23
Average Yearly Residential Water Bill	309.00



Water System History

Prior to 1872, the Concord Water System consisted of a series of buried reservoirs and surface water supplies. The City constructed the Penacook Lake dam in 1872, which combined Forge Pond and Long Pond into the new Penacook Lake. This new lake provided gravity flow of water to the city. In 1892, the first steam powered pumping station (Station 1) was constructed along with a series of mains

Concord WTP in background, original 1872 gate house, and screen house in foreground.

in 1893 to serve the elevated portions of the city. Station 1 would push water to the 2.0 million gallon reservoir constructed the prior year on Penacook Street. This open reservoir was built with horse and wagon and was completely lined with granite cobblestones. The City constructed major water mains between 1890 and 1915 to serve the core of the city. From 1935–1936, the system was further expanded with the construction of the West End pumping station and the 0.25 million gallon Columbus Avenue steel storage tank, which was needed to serve the elevated area. Two additional steel tanks were constructed to service the east side of Concord and the Penacook area. Looking for additional supplies, the City developed a 0.75 MGD groundwater supply adjacent to the Soucook River in nearby Pembroke. The well system consisted of 150, 2-1/2 inch well points. This groundwater supply is now referred to as the Pembroke Wellfield and Pump Station No. 2. It was reconfigured in the 1960s to include four 18-inch diameter gravel packed wells. These wells are still in use and have a yield of 1.0 MGD as an emergency supply. In 1949, the high lift station (Station 4) was constructed at Penacook Lake to increase capacity into the system rather than relying on gravity alone. This provided more capacity to the system and the ability to keep the tanks filled.

In 1974, the Water Treatment Plant was constructed. This traditional filtration plant was built on the North Shore of Penacook Lake adjacent to the dam.

Penacook Lake looking south from plant intake.

Penacook Lake

Penacook Lake is 2.5 miles long, ¾ of a mile wide at its widest point and contains approximately 1.5 billion gallons. The watershed covers 3.82 square miles, consisting mostly of forest and some agricultural land. The lake had been the primary water source to Concord since 1892. In the late 1970s to early 1980s, the central New Hampshire area experienced several serious droughts prompting the City to search for supplemental sources of supply. After careful analysis, the City constructed a pump station (station 5) on the shores of the Contoocook River to assure an adequate supply for the immediate future. Up to 7.5 MGD can be transferred between the Contoocook River and Penacook Lake. In 2004, Concord completed a Sustainable Yield and Drought Management study, which determined that under severe drought conditions, the safe yield of the lake is 2.5 MGD. This compares to an average day demand of 4.0 MGD. To protect the lake from potential contamination, the City owns all shorefront property and instituted local ordinances to eliminate any recreational activity in the watershed. This "no recreational access" has protected the lake from contamination and provides a class A status on the water quality.

Distribution Upgrades

The City maintains in excess of 172 miles of pipeline. Most of the system is made up of cast iron mains. Concord has been very aggressive in completing cleaning and lining projects. As of this writing, Concord has less than 6 miles of pipeline remaining to line. By the early 1980s, the City had grown to 35,000 residents. Many of the system's storage components needed to be replaced including all of the steel storage tanks. The steel tank in East Concord was replaced with a 2.1 million gallon concrete tank in 1984. In 1985, the 0.25 million gallon Columbus Avenue tank was replaced with the 2.0 million gallon West End concrete tank. The 0.4 million gallon Snow Pond tank and a new booster station

Recently painted Snow Pond Tank.

Partially buried Ed Young Tank.

(Station 6) was constructed in 1988 to provide service to a newly developed area in the City. In 1992, the Penacook Street Reservoir, originally constructed as an open 2.0 million gallon reservoir, then with a floating cover installed in 1975, was replaced with a 2.0 million gallon concrete tank inside of the original reservoir. This tank is mostly buried with only the dome visible from the road. All of these storage upgrades add up to 7.5 million gallons of finished storage in 5 concrete tanks.

Meter reading for the 12,000 accounts is completed via a combination of radio and telephone reads. Radio reads are completed with a drive-by system. Concord was one of the utilities that started reading remotely with telephone reads. There are still 400 accounts that use the telephone read system and are currently being phased out with the more flexible radio systems. Meter exchanging is handled in house with an aggressive replacement and testing program which ensures accurate reading and billing for metered ration calculations and customer billing. Concord also has the only full time Conservation Technician on staff in New Hampshire. This allows Concord to monitor metered ratios closely and continually as leaks come and go as the years pass.

Water Treatment Process

The treatment plant, constructed in 1974, has gone through several upgrades since it was put into service. The plant capacity is 10.0 MGD. The process is conventional with coagulation, flocculation, sedimentation, and filtration. The plant processes water in 2 stages, primary treatment/disinfection, and finished water treatment/disinfection. The primary treatment process starts with screening at the entrance to the plant at the bar rack. Any smaller debris that may travel through the screen then must go through the travelling screen and its finer ¼-inch mesh. Water then travels to the pumping chambers where the raw water pumps lift the water and push it through the process. The coagulant is introduced and the water then enters one of 4 treatment trains where it will get mixed thoroughly in the flocculation process, then slows through the sedimentation process where solids are dropped out, then to the final filtration process, where

Concord WTP main entrance.

Original Chemical Room constructed in 1974.

all water must travel through 1 of 4 mixed media rapid sand filters that contain silica sand and granular activated carbon to address any taste and odor components in the water. Prior to heading into the 4.7 million gallon clearwell, the water is given its primary disinfectant, sodium hypochlorite, the pH is adjusted with sodium hydroxide, and hydrofluorosilicic acid is added for fluoridation. The clearwell is where inactivation contact time takes place and also stores filtered water ready for the secondary treatment process at the high lift station. Once water leaves the clear well, ammonia in the form of ammonium sulfate is added to react with the free chlorine residual to form chloramines. A chlorine-ammonia ratio of 3:1 to 4:1 and a distribution system total combined chlorine residual of 1.7 to 2.2 mg/l are targeted. Carbon dioxide and caustic are added for pH and alkalinity adjustment to satisfy the optimized corrosion control treatment requirements of the Lead and Copper Rule. The target finished water conditions are a pH of 9.2-9.5, alkalinity of 35 mg/l, and dissolved inorganic carbonate of 10 mg/l.

Water Treatment Plant Upgrade

The chemical room that houses the primary treatment/disinfection chemicals which includes: coagulant (polyaluminum chloride), disinfectant (sodium hypochlorite), pH adjustment (sodium hydroxide), and fluoride (hydrofluorosilicic acid) has recently been completely rehabilitated. The original bulk storage tanks, motor control centers, switchgear, and older pumps were in working order, but were in need of upgrading. There was no containment for any individual chemical and there were no day tanks in place allowing for small batch pumping. This placed a considerable amount of risk in the

Upgraded Chemical Room in 2014.

event any chemical line would break, as it could spill all over the floor and into the floor drains, which all led to the City's sewer system. Daily chemical calculations were estimated by the operators based on the level of the bulk tanks or site gauges. This led to challenging daily dosage calculations, as the gradations on the tanks were in 50 gallon increments. Original conceptual design for the project was completed with City of Concord staff and Levy Engineering, Concord, NH. Final design was completed through Tighe & Bond of Westfield, MA. Plans were drawn up and after several revisions a final design was completed. The new design had containment for all 4 process chemicals, day tanks, scales under all day tanks for accurate usage readings, safety showers, new chemical process pumps, and plant process water pumps as it was determined the existing pumps were oversized, an inefficient use of electricity. The bid process was executed and the general contractor awarded the job was D&C Construction of Rockland, MA. The greatest challenge for this project was the need to keep the plant running with minimal interruptions and NO violations during this process. The project timeline was set at 360 days for substantial completion and 400 days for 100% completion. This meant that we would be going through the peak pumpage season as well as minimum pumpage in the cold months. After considerable planning between City of Concord staff and the general contractor, it was agreed that all temporary chemicals were going to be set up at the beginning of the project and stay that way until the new area was completed, then moved permanently. This allowed the contractor the room necessary to complete floor cuts and all other work without the risk of damaging an existing chemical process. The project was completed 63 days early! GREAT JOB TEAM!

What's Next?

The City of Concord Water Department joined the AWWA partnership for safe water in 2014. This voluntary program raises finished water quality goals to a higher level than EPA minimum standards. This commitment will guarantee that the residents of Concord are receiving the highest quality of water possible from their tap. Future projects include filter to waste, streaming current monitoring, and enhanced distribution system monitoring. Stay tuned!

Visit us at:

Web: www.concordnh.gov/generalservices

Facebook: www.facebook.com/ConcordNHGS

Twitter: https://twitter.com/ConcordNHGS

YouTube: https://www.youtube.com/channel/UCD2QJ9zZOgDXAavKlJRp5hg

Google+: https://plus.google.com/+ConcordGeneralServices/posts