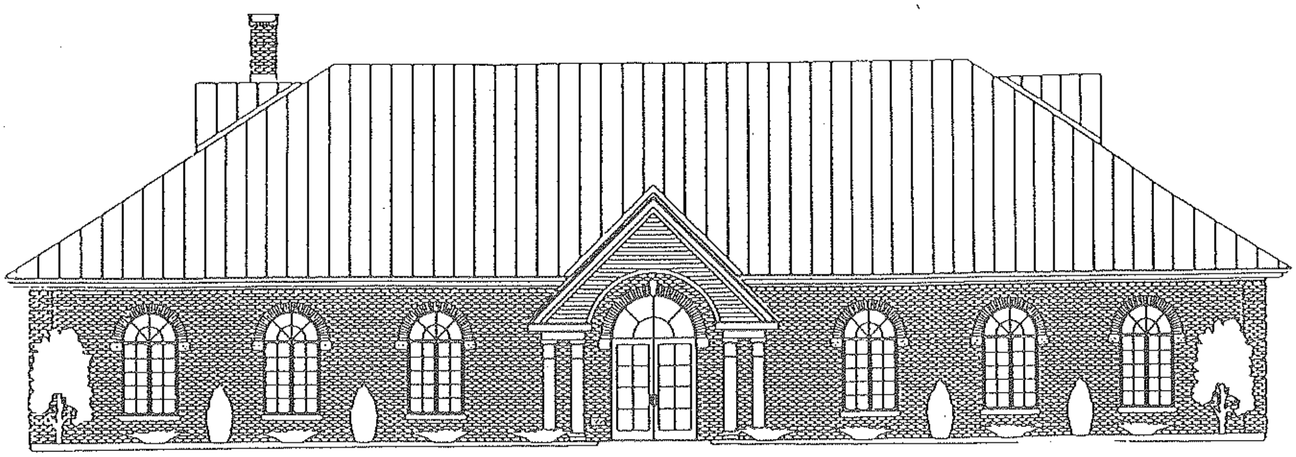


Rutland City Water Filtration Plant

Constructed in 1995

Slow Sand Means Safe Water

by Jeffrey N. Wennberg,
Mayor of the City of Rutland
(1987 -1999)

Long before the federal government mandated filtration of drinking water drawn from streams, the voters of Rutland approved a bond issue to construct a water filtration plant. Rutlanders have long been concerned about both the taste and safety of our water.

Many years of study, planning and experimentation resulted in the selection of the slow sand filtration process and the construction of Rutland's new Slow Sand Filtration Plant.

After interviewing several engineering firms, Wright Engineering, Ltd. of Rutland was selected as the design engineer for this project.

They were given the following goals for the facility:

1. It must be simple to operate.

2. It must be run entirely by gravity with no expensive pumps to operate and maintain.

3. It must not require any additional operational staff.

4. It must be built to last at least 100 years.

This facility elegantly combines centuries-old technology with the latest scientific knowledge and techniques to meet all these goals.

Most important, however, is that this facility dramatically reduces the risk of contamination and puts Rutland in complete compliance with the Surface Water Treatment Rule of the Federal Safe Drinking Water Act .

I deeply appreciate the hard work of the engineers, contractors and tradespeople who have constructed this wonderful facility. Special thanks to the Board of Aldermen for their support and to all the employees of the Department of Public Works who have managed this project and will from this day forward operate this remarkable facility.

Rutland City's Slow Sand Filtration Plant

by Mark P. Youngstrom, P.E.
Project Engineer
Wright Engineering, Ltd.

Since the late 1700's clear mountain streams have provided drinking water to the residents, businesses and industries of Rutland City and portions of Rutland Town.

Flowing by gravity from source to tap, Rutland's water has never needed pumping. Routine monitoring of stream "cleanliness" and monitoring of watershed activity has kept raw water quality high. This simple, low maintenance system has operated much the same way for 150 years.

With the advent of the 1977 Safe Drinking Water Act and the Surface Water Treatment Rule, it became apparent that filtration would have to be added to the system. The purpose of this Federal legislation was to address the significant incidences of waterborne pathogens and viruses. Some of these new concerns, such as Giardia and Cryptosporidium, had achieved epidemic status in several U.S. cities.

Cryptosporidium in the drinking water was responsible for the highly publicized 1993 disease outbreak in Milwaukee which affected 400,000 people. Vermont is not isolated from these organisms because of the constant movement of streams, animals and people. Because of these concerns, and the Federal regulations, the City decided to construct a water filtration facility.

After several years of studies and pilot testing slow sand filtration was selected, an old technology almost forgotten since the advent of electricity, pumps and more complex chemical treatment.

An Old Technology Revisited

Used extensively throughout Europe since 1829, century old sand filters still effectively serve London, Aberdeen, Paris and many other European cities.

Slow sand filtration first made it's appearance in this country in 1872, when it was used in Poughkeepsie, NY. From there sand filtration spread throughout the northern latitudes, but by the mid-20th century it had lost favor to the more compact, versatile rapid rate processes involving chemical coagulation.

By the 1950's, engineering textbooks referenced slow sand only in a historical light. However, in the last decade, researchers began to discover that slow sand filtration performed more effectively than previously realized, especially for removing the 'new' pathogens of concern such as Giardia, Cryptosporidium and viruses.

By the 1980's all water systems using a surface water supply began planning for some type of filtration. Many of those water systems had high quality supplies which had previously escaped the need for filtration because the water was "clean" in the public's perception. Cost-effective filtration methods were needed to filter these water supplies which did not need complex multi-stage treatment processes. As a result, slow sand filtration has enjoyed somewhat of a renaissance during the past decade, especially in the northeast and northwest regions of the U.S. Several new facilities have been constructed, merging old and new technology, to create cost effective, energy efficient facilities.

Slow Sand Basics

Research has proven that slow sand can provide very effective removal of bacteria, viruses, Giardia lamblia cysts, and Cryptosporidium oocysts from low turbidity surface water without the use of chemical coagulants. Removal of these contaminants occurs primarily on the filter sand surface, a biologically active layer called the "schmutzdecke" (dirty skin).

Contrary to common thinking, slow sand filters do little filtering by "straining" contaminates from the water. Even though the sand grains are very small, most all disease causing organisms will easily flow through the raw sand. Instead the sand collects a biofilm of living organisms within the schmutzdecke layer. Organic contaminants are digested and attached in this layer through many biological and physical processes, effectively achieving 99.9% removal of these pathogens. This is a very natural process, allowing organisms which occur naturally in streams to consume other organic material and organisms. Only the top 3" or 4" supports the schmutzdecke layer so when the sand becomes clogged, it can be cleaned in place quickly and put back into service.

Overview of Rutland's New Facility

Rutland's Slow Sand Filtration Plant is the largest of it's type in the State of Vermont.

Highlights of it's design include the following:

* Maximum design flow of 3.6 to 4.8 million gallons per day (MGD). Present average daily demand is 2.5 MGD.

* Minimal staffing requirements. The facility can be operated by a single operator, one shift per day.

* Three filter units comprising a total of 50,400 square feet, allowing 2 filters to be in operation while the third is being cleaned.

* Structurally designed for zone 2 earthquake forces estimated for New England.

* 100% gravity flow with no pumping. Electrical service is only slightly larger than that for a typical residence.

* Automatic computer based data collection system saves time consuming manual data entry.

* Use of old discontinued open reservoir for washwater settling basin eliminated construction of lagoon.

* 2.5 million gallon filtered water storage tank sufficient for fire protection and emergency storage.
* Emergency connection to East Creek, a separate watershed, for use in the event primary storage becomes contaminated.

The project required 5,000 cubic yards (350 truckloads) of sand to be sized, washed and transported from Holliston Sand Company, Inc. in Slatersville, Rhode Island. The effectiveness of treatment is entirely dependent of the size and uniformity of the sand. Therefore, very extensive testing and quality control was performed on the sand during construction.

Filter cleaning is accomplished by flowing raw water over the sand surface (approximately 6 inches deep) while scarifying the sand with a tractor mounted harrow. Loosened organic material floats off to a wastewater trough without removing the sand. This quick method of cleaning eliminates the shovel and wheelbarrow technique of typical slow sand filters while retaining some of the schmutzdecke organisms in the sand, "ripening" the filter for use in a shorter period of time. Washwater will settle in the previously abandoned 5 million gallon open reservoir downhill of the facility.

The Rutland filters are linked by a 4,000 square foot control building which houses access ramps to the filters, chemical feed control systems, office, laboratory, and a conference room.

All process functions and water quality parameters are continuously monitored electronically.

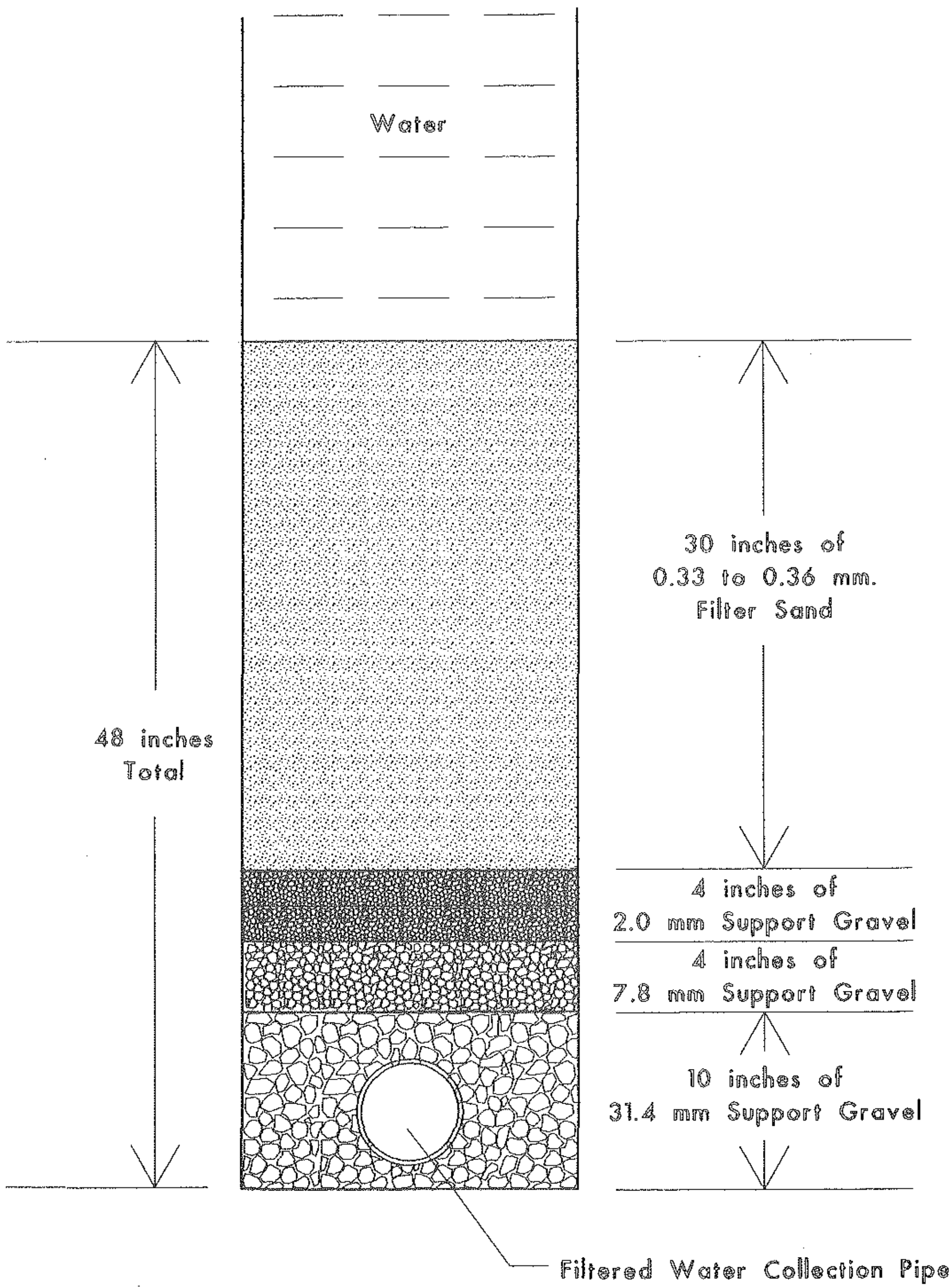
If a process parameter falls out of range, an automatic dialer notifies an operator who responds to the incident. Filtered water storage is proved by a single 2.5 million gallon prestressed concrete tank. In the unfortunate event of severe contamination in the watershed the emergency connection to East Creek can be activated in just a few hours.

The facility operates 24 hours per day at an operator selected flow rate equal to the City's daily water use. Slow sand facilities are biologically active and operate efficiently when the flow rates are not adjusted frequently.

The plant can be operated entirely by manual valves, but normal operation is through a process control system which adjusts flow valves and monitors the system. The system continuously gathers data such as filter flow, filter headloss (clogging), turbidity (the clarity of the water), storage tank water level, chlorine concentration, flow rate to the City and other process variables.

The facility was constructed by T. Buck Construction, Inc. of Lewiston, ME. Wright Engineering, Ltd. designed the facility and provided full engineering services during the nearly two year construction phase.

The construction cost was $6.1 million with the State of Vermont providing a 35% grant.



CROSS SECTION OF SLOW SAND FILTER

A Short History of The Rutland City Water Supply

by Alan J. Shelvey, P.E., L.S. Assistant City Engineer

As early as the 1790's, parts of Rutland were served by a piped water system. The first supply of water to the Village of Rutland was provided by Gershom Cheney proprietor of the Franklin House, who laid wooden pipes from a large spring in Mendon 2 1/2 miles to the Village.

The wooden pipes, called "pump logs", were actually logs with a three inch hole bored lengthwise through the center. With a taper on one end fitting into an enlargement of the bore hole on the next log, the pipes were joined together and secured with a metal band.

The water was not piped into the houses. A "water post" tapped by a spigot was installed in front of each subscriber's home. A trip outside to the spigot was required to draw water.
In November of 1800, the Rutland Aqueduct Company was incorporated to run the water system. At that time there were forty two subscribers.

The system continued for many years under the control of the Aqueduct Company. However, by the 1850's, the aging system was in need of major repairs. Leaks and the inefficiencies of the wooden pipes combined with the growing demand for water (there were 250 families connected in 1856) to result in an inadequate supply. Complaints from the subscribers were mounting.

A disastrous fire in May of 1857 further pointed out the deficiencies of the system. Several homes and businesses on West Street were destroyed in that blaze.

A decision was made to negotiate a contract with the Village to take over the operation of the water system.

In August of 1857 the Aqueduct Company did "demise, lease and farm let to...the Village of Rutland ...all the aqueduct...for and during the term of one thousand years." Soon afterwards, a small dam was constructed at the spring, creating what is known as the "Gleason Reservoir".

A storage reservoir was also built on Woodstock Avenue near Deer Street at the present site of the Godnick Senior Center.

In 1858, the Village replaced the old wooden pipeline with a new cast iron pipe.

Even with these improvements, the supply of water was still not really sufficient for the growing Village.

On April 3, 1868, another major fire occurred in Rutland destroying the Franklin House, The Owen Block, Court House and three other buildings. This tragedy revealed the inadequacy of the water supply and ultimately resulted in Rutland turning to East Creek as a more plentiful water source.
In 1878, a gravel and stone "infiltration galley" was constructed in the bank of East Creek near the junction of Mendon Stream.

The principle of the operation of the infiltration galley was similar to that of the new slow sand filter plant. Water flowed through the bed of the creek into a buried collection galley. Some filtering of the water was provided by the natural sand and gravel.

A twelve inch pipe cast iron was laid from this galley to the reservoir on Woodstock Avenue. (This pipe is still in use today as one of the main water supply lines to the City.)

Evidently, the infiltration galley was too small, as it could not provide a sufficient flow of water. Instead of improving the galley, a decision was made to abandon it and draw water directly from East Creek.

The water quality of East Creek was inferior to that of Mendon Stream. Without the filtering effects of the infiltration gallery, the purity of the water became a concern.

The use of East Creek was discontinued in 1881 when a channel was dug from Mendon Stream to two small storage reservoirs.

In 1891, a larger reservoir of approximately 5 1/2 million gallons capacity was built southeast of and at a higher elevation than the old reservoirs. A 16 inch cast iron water pipe was laid from that reservoir to the city. After completion of the pipeline, the use of the Woodstock Avenue reservoir was discontinued.

The citizens enjoyed having plenty of water for everyday use and slept more soundly knowing that if a fire broke out, an ample supply of water would be available to fight it.

However, they were soon to discover that a big supply of water did not necessary mean a good supply of water.

The typhoid outbreak began in August of 1909. Before it ended in November of 1910, 146 cases were reported, eight resulted in death.

In a letter dated October, 1909, Mr. Henry D. Holton of the Vermont State Board of Health told the Rutland Aldermen that he believed that the "....present outbreak of typhoid fever and other water borne diseases.." was a result of "...pollution in Mendon Stream."

The City responded quickly. Inspections were made of the watershed and the water tested.

Mr. Holton was proven to be correct. The worst of the pollution was traced to the many farms and homes along Mendon Stream in the area called Wheelerville.

The City began a program of buying these properties and, once acquired, destroying the farms and homes.

Between 1911 and 1920, 22 parcels totaling 1,700 acres were purchased.

Disinfection of the water supply with "bleaching powder" began in the fall of 1910. By December the outbreak had ended. The Rutland Board of Health reported in 1910: "...in no other way can this sudden drop be explained than that it was the direct result of the action of the 'bleaching powder.'"

Disinfection with chlorine gas began in July of 1916 and continued until 1995. Liquid chlorine is used at the new Slow Sand Filtration Plant since it is just as effective as the gas but much safer for the operators to handle.

On June 3, 1947, the East Pittsford dam on East Creek burst. The resulting rush of water severely eroded the earth just down from the reservoir and washed out sections of the main water pipes leaving the City without water for many days. Emergency measures included pumping water out of Tenney Brook and into the water system through a fire hydrant on North Main Street.

At the time of the flood, the City had been considering constructing a larger reservoir at a site 120 feet higher and about 1,200 southeast of the 1891 reservoir. In response to the flood damage, moving the water mains out of the flood area was added to the project..

The 13 acre, 90 million gallon "Davis Reservoir" was constructed in 1954.

The Davis Reservoir, fed by a pipe from Mendon Stream is now the primary source of water for the City water system. The City's use of the Gleason Reservoir and the other old reservoirs was discontinued years ago.

A Description of

Rutland's Water Supply

by Alan J. Shelvey, P.E., L.S.
Assistant City Engineer

Today, the water supply for Rutland City consists of a 90 million gallon reservoir located off Post Road in Rutland Town, near the Mendon Town line.

Mr. George C. Whipple, Consulting Engineer, was apparently the first to consider the present reservoir site. In his "Report on the Water Supply of Rutland, Vermont" dated December 10, 1908, he considered that location: "the most feasible site for storage".

He envisioned an earthen dam impounding 64 million gallons with a water surface area of 10 acres.

An investigation of the site was performed, after which Mr. Whipple reported "Unfortunately, this naturally advantageous site for a reservoir cannot be utilized , as the earth in the hills that would form the side of the reservoir is too porous to hold water. Test pits...show that the entire region is composed of sand, some coarse and some fine, but all porous. To make a large reservoir here would be impossible..."

The 1912 "Barrows and Breed Report" suggested a concrete lined reservoir at the site but apparently the cost was such that the plan was rejected.

The present reservoir, constructed in the fall of 1954, uses a special layer of asphalt to line the bottom and prevent leakage. the pond has a buried asphalt membrane, about 1/4 inch thick, covered with 12 inches of sand and gravel. The construction was sufficiently unusual to be featured in an article in the "Journal of the New England Water Works Association " and is referred to in the Asphalt Institute's "Asphalt in Hydraulic Structures" handbook.

Water is supplied to the reservoir from Mendon Stream through an intake located just down from Meadow Lake Drive in Mendon. The water then flows through 1,900 feet of 20 inch and 1,500 feet of 16 inch pipe into the reservoir.

The intake itself consists of a small concrete dam and a building housing a trash rack, leave screen, turbidity meter (which measures how "dirty" the water is), chlorinating equipment and a manually operated valve.

An electrically operated valve is located in a manhole over the pipeline just downstream of the intake building. The controls for this valve are wired so that, in the event of a water quality problem, the valve can be closed by two different methods: (1) In the case of an emergency, such as an accident or chemical spill in the watershed, the valve can be closed by a dialing a certain telephone number. The treatment plant operator, police and other emergency response officials are provided with that number. (2) The turbidity meter is wired to the valve and programmed to close it if the water in the stream becomes too turbid or "dirty" due to a rainstorm or any other cause. This prevents dirty water from entering the reservoir.

Before the installation of the electric valve in the early 1980's, keeping dirty water out of the reservoir depended entirely upon the alertness, responsiveness, and weather forecasting abilities of the Water Treatment Manager.

Divers were hired by the City to perform a thorough inspection of the reservoir in 1988. Except for a mound of heavy sand and gravel near the inlet pipe, they found the sediment accumulation over the preceding 34 years to be minor, about 3 inches overall. The mound of debris was removed by divers in 1989. Since that time, diver inspections of the reservoir are performed each year at which time all pipes and screens are cleaned and adjusted as necessary.

The City is fortunate in having it's reservoir located and constructed in such a way as to be protected from flood damage and excessive siltation.

Even though the inlet building on Mendon Brook was destroyed during the severe flooding of 1973, the reservoir was unharmed. Water stored in the reservoir allowed us to maintain normal water service and gave us time to complete emergency repairs to the intake.

Before the completion of the water filtration project, there was a serious disadvantage to the water system. If the reservoir became polluted, there was no other source of water available.

Several safeguards were designed into the new filtration facility to address this problem.

- A 2 1/2 million gallon storage tank was constructed.

- If there is a problem with the reservoir, water from Mendon stream can be piped directly to the filtration plant.

- If Mendon Stream becomes polluted, water can be pumped from East Creek to the Filter plant.

A Slow Sand Glossary

CHEMICAL COAGULATION

Adding chemicals to the raw water to cause the smaller particles to clump together, making them easier filter out.

PILOT TESTING - Experimentation with water treatment methods through the use of smale scale models of the treatment system.

RAPID SAND FILTRATION- Sand filtration using chemical coagulation. Removal of pathogens is by physical straining. Rapid sand filters operate at a much faster rate (100 times or more faster) than slow sand filtration.

SCHMUTZDECKE - A biologically active layer that forms on the surface of a slow sand filter, seldom extending more than 3 inches deep.

SLOW SAND FILTRATION -

Sand filtration without the use of chemicals. Larger particles are filtered out and pathogens are captured or destroyed by biological activity in the schmutzdecke. The filtration is by gravity and very slow, requiring a larger area than rapid sand filtration.

Some Facts About The Rutland City Water System

- The Rutland City Water System serves nearly 18,000 people. There are about 4,950 service connections on the system's 71 miles of pipe.
- There are 444 public fire hydrants ranging in age from new to 117 years old.
- Rutland City is a member of the Ductile Iron Research Institutes "Cast Iron Pipe Century Club", an organization whose members have cast iron pipes over 100 years old in their water systems.
- The oldest known pipe still in use in Rutland is a cast iron pipe on Woodstock Avenue that was installed before the Civil War, in 1858.
- The water distribution system is entirely gravity. There are no pumps on the system. Water (and sewer) service continues even when the electrical power is off. During a power outage an emergency generator at the water filtration plant runs the small chlorine pumps to continue to provide disinfection of the water.
- The first "wet tapping machine" that allowed connecting a new pipe to an existing water main without shutting down the main was purchased by the City in 1895.
- The first water meter was installed in Rutland in 1898.
- The City began using copper pipe for water service connections in 1922. Before that the services were galvanized iron.
- The City had an early start in water quality testing. In 1896 samples were sent to the "Museum of Hygiene" in Washington D.C. for analysis. Their no-nonsense report said simply : "This is a potable water". In 1899 the lab reported that the water was "...of good quality and chemically and bacterially beyond suspicion."
- Taken together, water and sewer bills are historically (and more accurately) called "Water Rent." The water is collected, treated and delivered to your home or business 24 hours a day, seven days a week. After use, it is collected, removed from your premises, transported to the wastewater treatment facility, cleaned and returned to the environment.
- No Property Tax money is used to operate the water system.