Graywater Recycling System

The CT Graywater Recycling System utilizes advanced membrane bio-reactor technology to remove virtually all contaminants from graywater with a simple low-maintenance, energy-efficient process. The filtration membranes have a pore size of 0.04 micron which is small enough to block 100% of bacteria and more than 99.99% of viruses, eliminating the need for disinfection. The membranes also extract soaps and dissolved organic compounds, preventing plumbing problems with reuse.

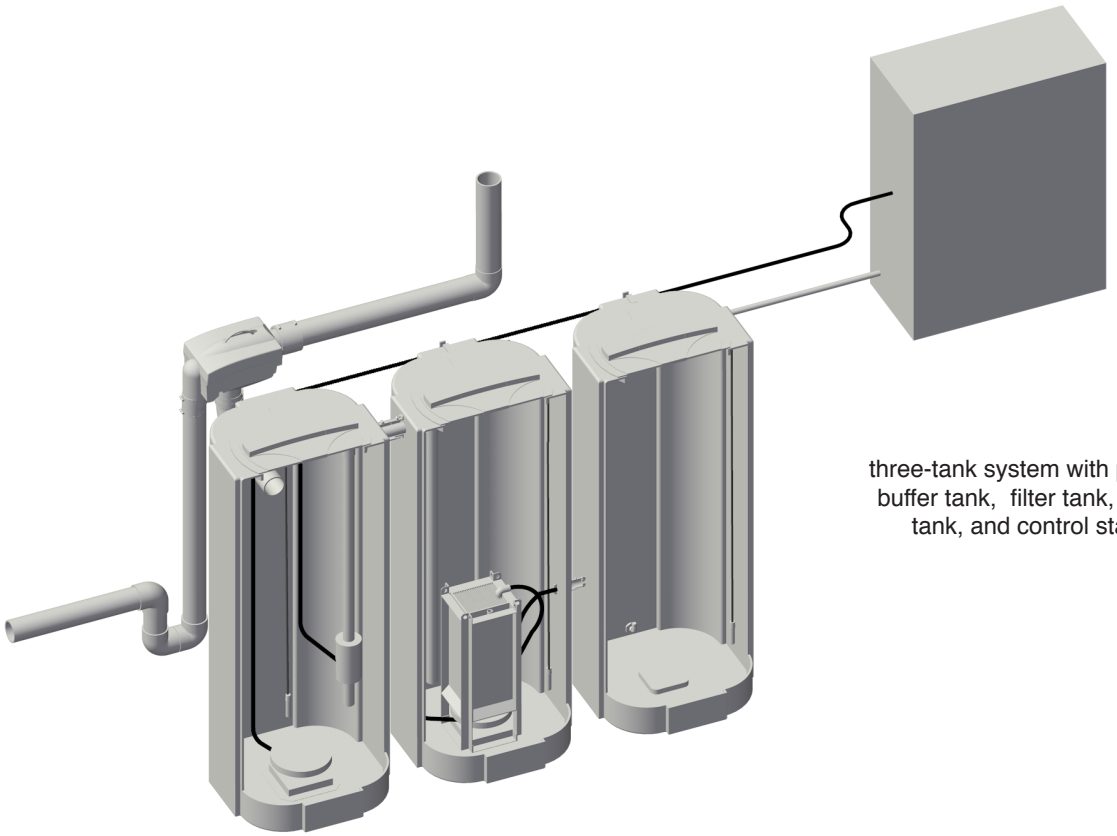
Air bubbles mechanically scour the filtration membranes, simultaneously supporting aerobic biological activity that breaks down trapped organics and biofilms on the membrane surface. This eliminates the need for backwashing and reduces maintenance to once per year.

filter element

filter assembly

BASIC OPERATION

The graywater recycling system is based on a three-tank concept. First, graywater from sinks and showers flows through a self-cleaning prefilter that extracts large particles and hair. Then the screened water flows into a *buffer tank* which contains a diffuser assembly that generates bubbles to aerate and de-stratify the graywater, promoting aerobic biological treatment while eliminating odors and anaerobic slimes. A clog-resistant, air-powered pump transfers the graywater from the buffer tank into the *filter tank* which contains a filter housing with the membrane filter cassette. An air diffuser at the base of the filter housing generates air bubbles that lift the graywater up through the filter cassette. Water is filtered by the cassette and the clean water is transported to the *storage tank* from where it is pumped for reuse.

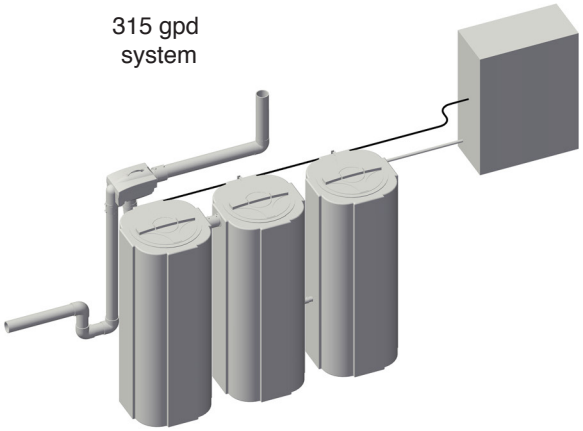


three-tank system with pre-filter, buffer tank, filter tank, storage tank, and control station

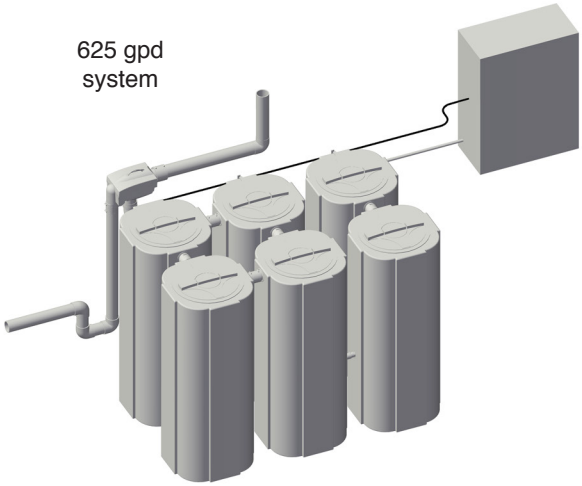
SURFACE SYSTEMS

Surface systems are created from sets of three custom-designed polyethyene tanks with large threaded lids that provide full access to the tank interior. Each tank holds a net volume of 200 gallons, measures 29” x 29” x 72” (fits through a 30” doorway), and requires a minimum of 96” ceiling height for access. Each set can treat approximately 315 gpd (gallons per day), so six-tank systems can treat 625 gpd, twelve-tank systems can treat 1250 gpd, and twenty-four tank systems can treat 2500 gpd. It is not necessary to install surface systems under occupied space where they can collect graywater by gravity: graywater can be collected in an undergound sump inside or outside the structure and pumped into the buffer tank.

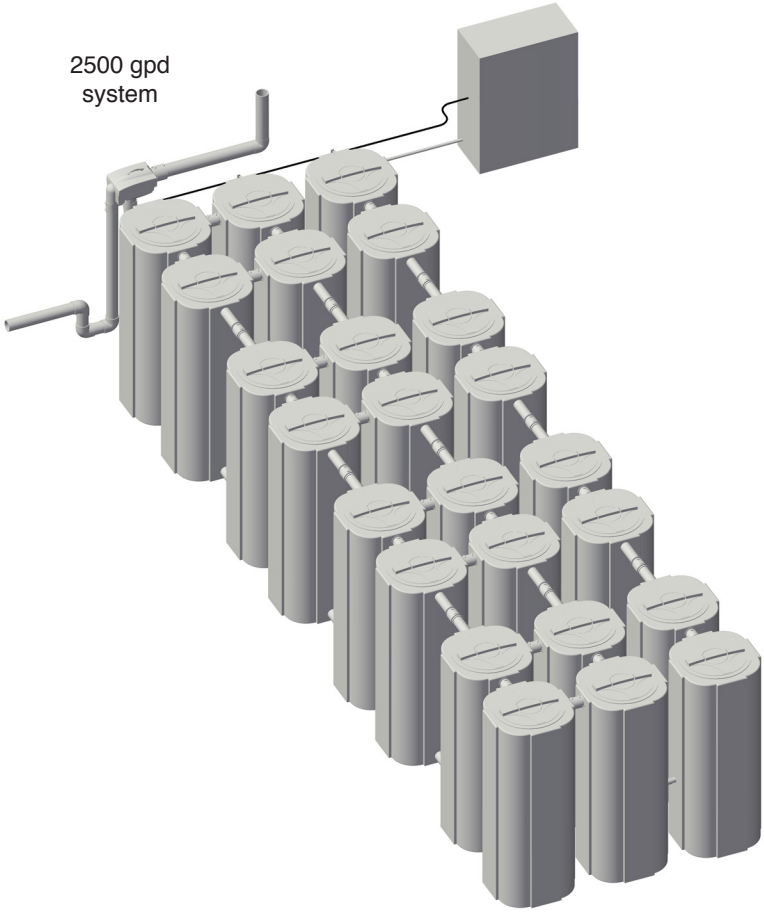
315 gpd system



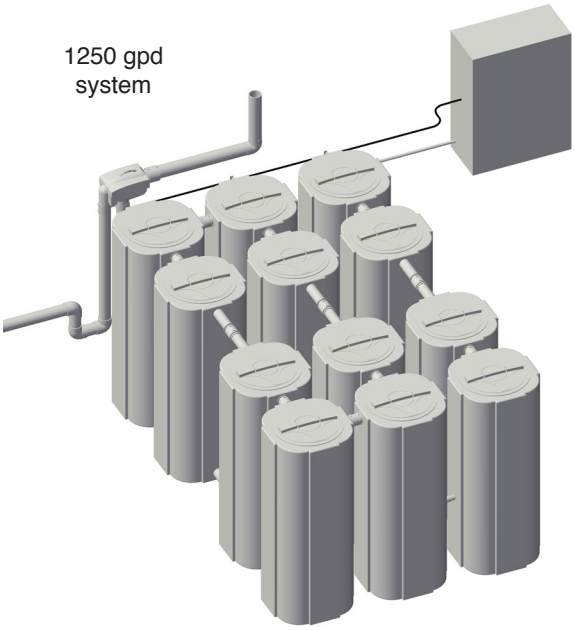
625 gpd system



2500 gpd system



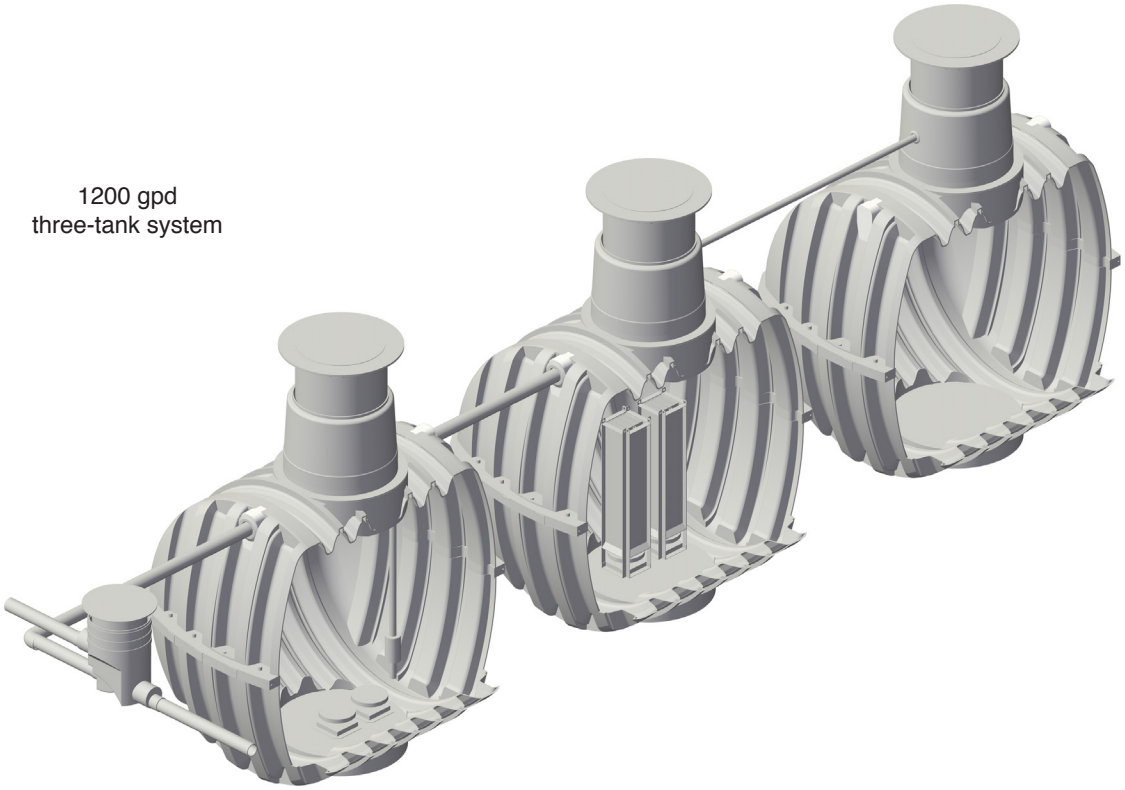
1250 gpd system



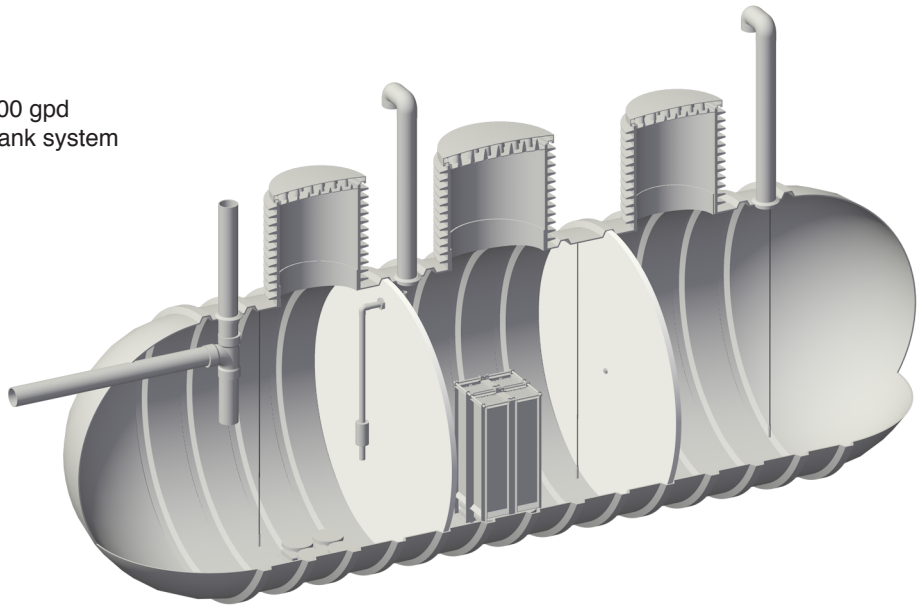
UNDERGROUND SYSTEMS

Where interior space is not available, part or all of the system can be installed underground. Underground systems can use the same three-tank concept, the buffer and filter tank can be combined into a two-chamber tank, or all three tanks can be combined into one tank.

1200 gpd
three-tank system



2500 gpd
single-tank system



FILTER CASSETTE

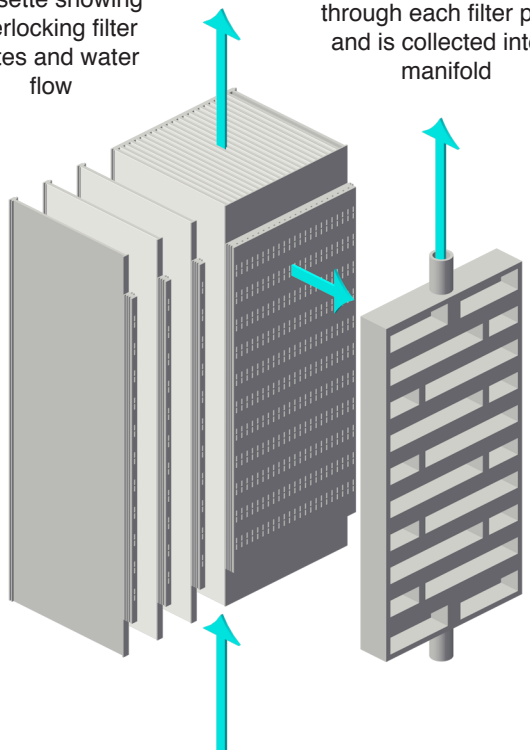
The key technology that makes this system work is a German-made filter cassette that has been used in thousands of sewage treatment plants worldwide. It consists of a series of filter plates that lock together and connect to a collection manifold. Each filter plate consists of a dimpled plastic core with porous plastic filtration membranes laser-welded to both sides. The filter cassette fits into the filter housing which is submerged in the filter tank.

During operation, an air diffuser mounted below the filter cassette generates small air bubbles that push graywater into the bottom of the cassette. Both the water and air bubbles flow upward between the filter plates and out of the top of the cassette. While graywater is flowing vertically between the plates, it is driven through the filtration membranes on the surface of the plates by water pressure, often supplemented by a small water or air suction pump. The resulting clean water flows through the space created by the plastic dimples, out the edge of the filter plates, into a collection manifold, out of the top of the collection manifold, and into the clean water storage tank.

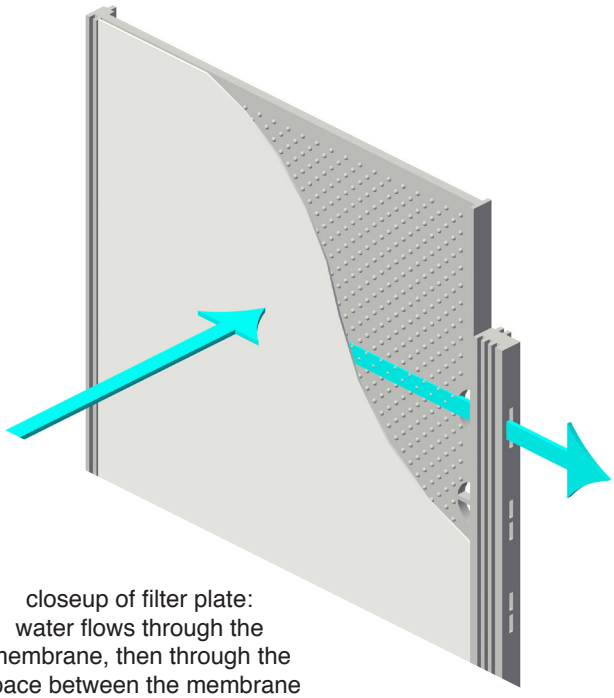
assembled filter cassette

exploded filter cassette showing interlocking filter plates and water flow

filtered water flows through each filter plate and is collected into a manifold



air bubbles and graywater flow upward through the filter cassette

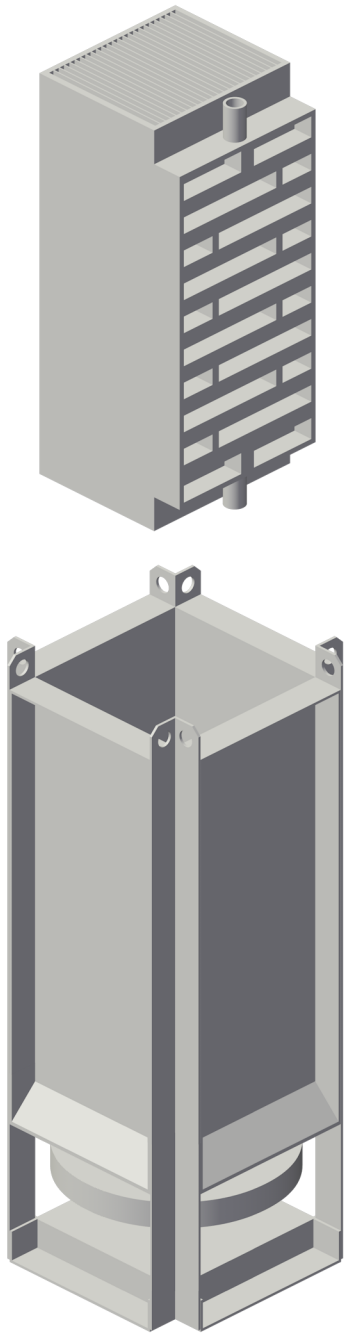


closeup of filter plate: water flows through the membrane, then through the space between the membrane and dimpled support plate

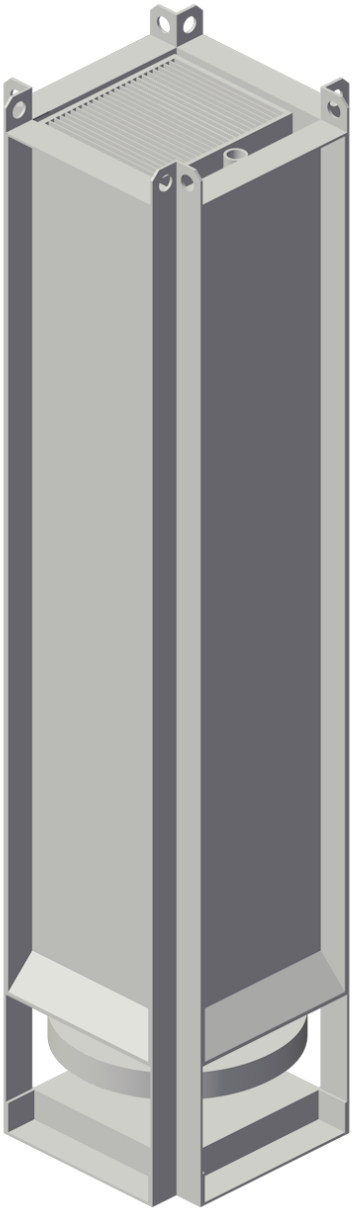
FILTER HOUSING

The filter cassette drops into a thick-wall stainless-steel filter housing with an air diffuser built into the bottom. Two housings are available: a single-cassette housing that filters 315 gpd and a double-cassette housing that filters 625 gpd. Since both require the same diffuser and air pump, the double-cassette housing will provide optimal energy efficiency for larger systems. However, the double-cassette housing requires three feet minimum clearance over the top of the filter tank to extract the housing, so for surface systems it can only be used where ceiling heights exceed nine feet.

single-cassette housing



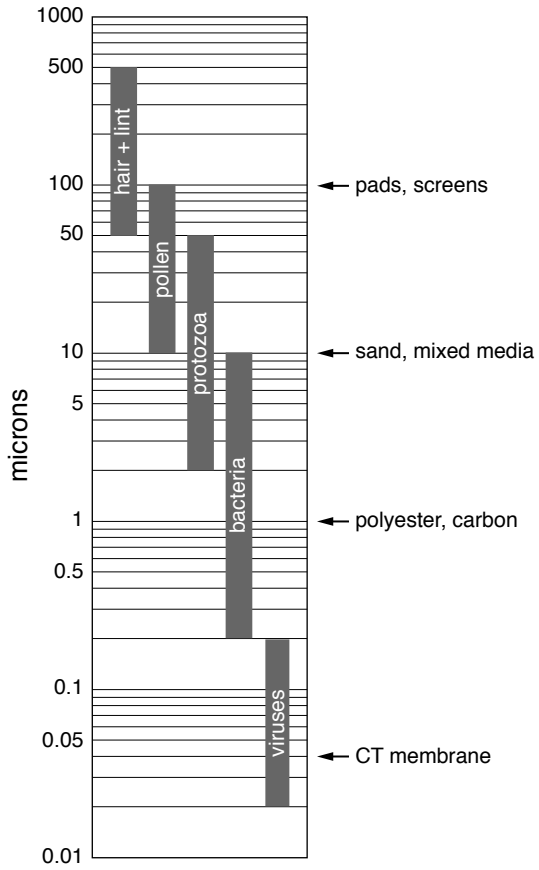
double-cassette housing
with stacked cassettes inside



PERFORMANCE

The filtration membranes used in this system block passage of all particulate matter larger than 0.04 microns (0.0000015”). This includes not only visible solids such as hair, lint, and pollen, but also virtually all microorganisms including protozoa, bacteria, and viruses. The membranes also block large dissolved organic compounds reponsible for odor and color. Unlike hollow-fiber membranes commonly used in other membrane bioreacter systems, our membranes trap contaminants on the surface of the membrane where they can be mechancally scoured or can be broken down by aerobic microorganisms.

Filtered Water Quality	
Parameter	Value
BOD	< 5 mg/l
TSS	< 1 mg/l
TKN	< 5 mg/l
Turbidity	<1 NTU
E.Coli	< 1
virus retention	> 99.99%
odor	none
color	none



OPERATION AND MAINTENANCE

All system functions are managed by a microprocessor control system which can be monitored remotely via the internet, GSM modem, or SMS text messaging. Industrial-quality level sensors in each tank and a flow sensor in the outgoing pumped water line enable the control system to precisely monitor the system status as well as to resolve problems such as reduced flow caused by excess accumulation of organics on the filter membranes. In the unlikely event the membrane fails, the control system will quickly detect the change in flow rates and shut down the system, preventing re-use of potentially contaminated water. The control system can also log historic data.

Normally it is sufficient to service the system once per year. The buffer and filter tanks are drained of accumulated solids by opening a bottom valve. Then the filter cassettes are chemically cleaned in place with a bleach solution followed by a citric acid solution. If it becomes necessary to remove the filter element for additional cleaning or replacement, the filter housing can be lifted and supported on the tank access opening, permitting easy access to the filter element. Where on-site cleaning is not feasible, we can ship clean, tested elements to be field exchanged for dirty elements.

The system uses medical-quality linear piston air pumps that do not fail catastrophically like diaphragm pumps - instead they gradually lose pressure and can be periodically re-built. Lifetimes of the filter elements, air pumps, and diffusers are expected to be 5-10 years. The filter housing is made of one-eighth-inch thick 316 stainless-steel plate which should last indefinitely.