4 The Standard System (Std)

4.1 *About LWW Standard Water Treatment Systems*

Every LWW Standard Clean Water System:

- Uses filtration, microfiltration, and disinfection (ozone or UV)
- Can be powered by AC power provided by a utility company or a generator, or
- DC power provided by a solar system with photovoltaic (PV) panels and batteries

4.1.1 Systems with Ozone Disinfection

By following the Decision Trees in Chapter 2, IPs in conjunction with their OPs can determine the appropriate disinfection technology for their clean water system.

- LWW suggests that Ozone disinfection is appropriate under the following circumstances:
    - If the hardness of the water will be greater than 120 ppm
    - If the Operating Partner rejects chlorine for residual disinfection because of taste
    - If the clean water is expected to be stored in a Clean Water Tank

Other Characteristics of systems with Ozone disinfection

- In all cases, Clean Water Systems with Ozone disinfection will require two passes through the disinfection section
    - The first pass filters the water as well as disinfecting it
    - The second pass bypasses the filters and provides a second disinfection pass for the water.
        - This provides sufficient contact time for disinfection

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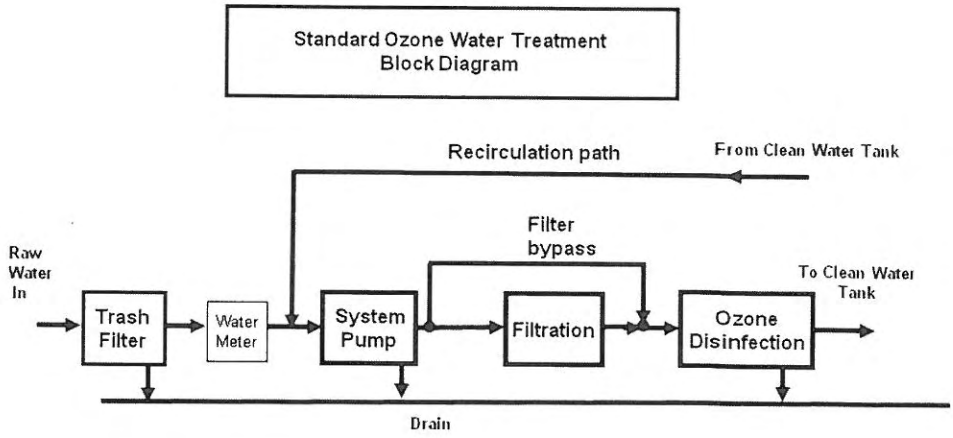

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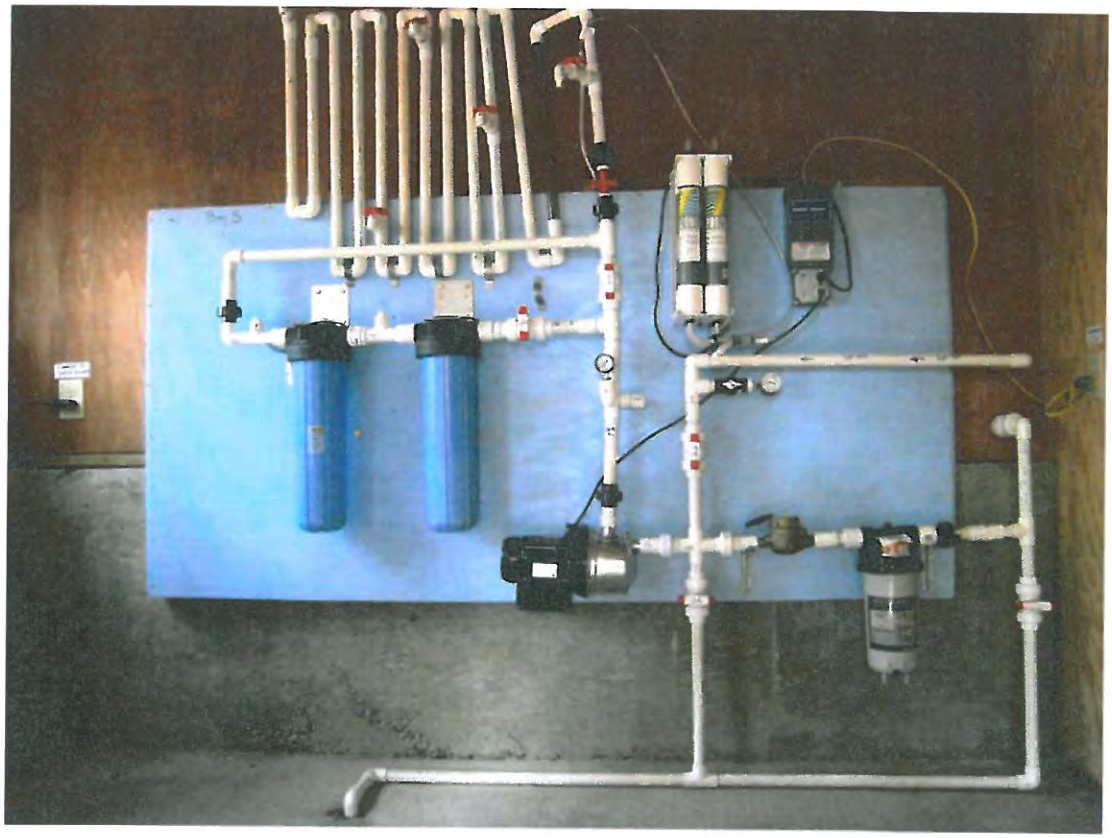

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4.1.2 Systems with UV Disinfection

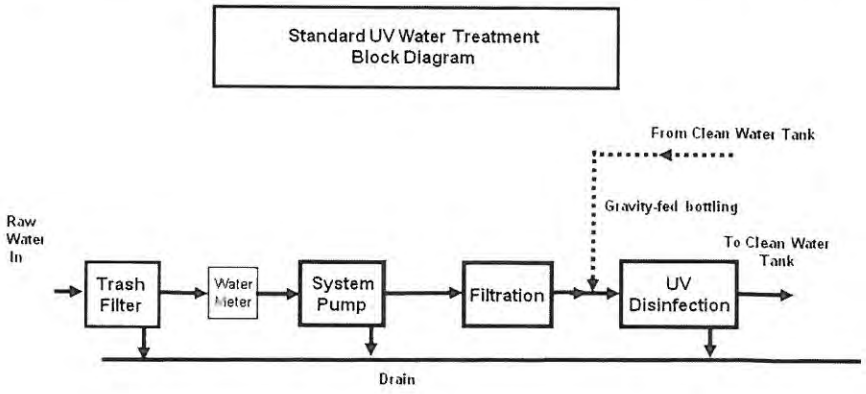
By following the Decision Trees in Chapter 2, IPs in conjunction with their OPs can determine the appropriate disinfection technology for their clean water system.

LWW suggests that UV disinfection is appropriate under the following circumstances:

- if water hardness is less than 120 mg $CaCO_3$ / L

Other Characteristics of systems with UV disinfection

- UV makes Clean Water in a single pass
- UV can be used for batch operation or on-demand operation
- An Elevated Clean Water Tank is recommended for the LWW Standard UV system as this allows gravity-fed bottling (water passes through the UV again during bottling)
- LWW recommends adding chlorine to the Clean Water Tank for residual disinfection in the tank
    - Alternatively, drops of bleach can be added to the bottles at bottling



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4.2 *Construction Considerations Common to all Systems*

4.2.1 Order of Construction

1. **Build and mount the Raw Water Entry Assembly (4.2.3).**
2. **Build and mount the Filtration Assembly (4.2.4).**
3. **Build and mount the Disinfection Assembly (4.2.5).**
4. **Build and connect the Drain Lines (4.2.6)**
5. **Build the Bottling and Rinsing Station, and/or other water use stations (4.2.8)**
6. **Build and connect the Electrical Systems (4.2.9).**

4.2.2 Important Considerations

- Threaded connections are done first, then the glued parts (except where noted).
- All threaded connections are first wrapped with Teflon tape – a minimum of 5 wraps – so that when the two parts are screwed together the Teflon will not unwrap. *(If you hold the male threaded piece in your left hand facing you, then wrapping the tape in a **clockwise** direction will prevent unwrapping.)*
- Do not glue drain lines
- All glued connections must be cleaned with an approved chemical cleaner - or sanded with fine sandpaper (very lightly) - to ensure a watertight joint.
- Be systematic as you glue or screw together each part to ensure all connections will be watertight. Marking each glued joint with a "dot" from a permanent marker helps ensure there will be no "surprises" when the system is first pressurized.
- With all unions and filters, pay attention that the "O" rings do not fall out during the installation and that the filters are properly seated on the center post in the bottom of the Big Blue canisters.
- Use K-Y Jelly or other water-based lubricant (i.e. silicone lubricant available from FCI) in installing "O" rings. DO NOT use petroleum-based lubricants, such as Vaseline.
- With all valves, pay attention during installation so that no glue gets onto the ball valve. Glue all ball valves with the valve opened.
- Pay attention to the water flow directional arrows on all filters, the meter connections, check valves, union ball valves, and the air backflow preventer on the line from the Ozonator.
- Mount the 4' x 8' plywood (or other mounting board) to the wall so that it is level and the bottom edge is 1 ½ feet from the floor. Secure plywood with 3/16" tapcon screws.
- !!!NOTE!!! If the tapcon screws do NOT hold in the masonry walls, it will be necessary to use toggle bolts and anchors.
- "L" brackets, or rigid aluminum supports are used to support the filters.

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- Strap hangers (1 ¼") are placed at critical points to ensure that all parts are secure and anchored to the board.
- The raw water intake line may need to come through a concrete wall. Use a star chisel or hammer drill with a concrete bit to make the hole. If connecting to a municipal water system, you must use an anti-siphon check valve on raw water intake pipe. Check valves are not included in the materials from FCI.
- The raw water intake line will need to have the valve installed in it before V-1 to ensure the raw water source can be isolated from the system during construction and prior to the line being placed under pressure.
- For an elevated tank, the lines going to and from the tank will need to run through the wall near the ceiling to make the connections. Do not make holes through the roof.
- The treatment board can be installed with the water intake line coming from the bottom right side of the board or from the bottom left. Sometimes it is best to run the raw water inlet piping from the right side of the board to left side to make the system look like the pictures in the Handbook.

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4.2.3 Raw Water Entry Assembly

The raw water entry assembly receives water from the source, filters out sediments, and measures the amount of water brought into the system.

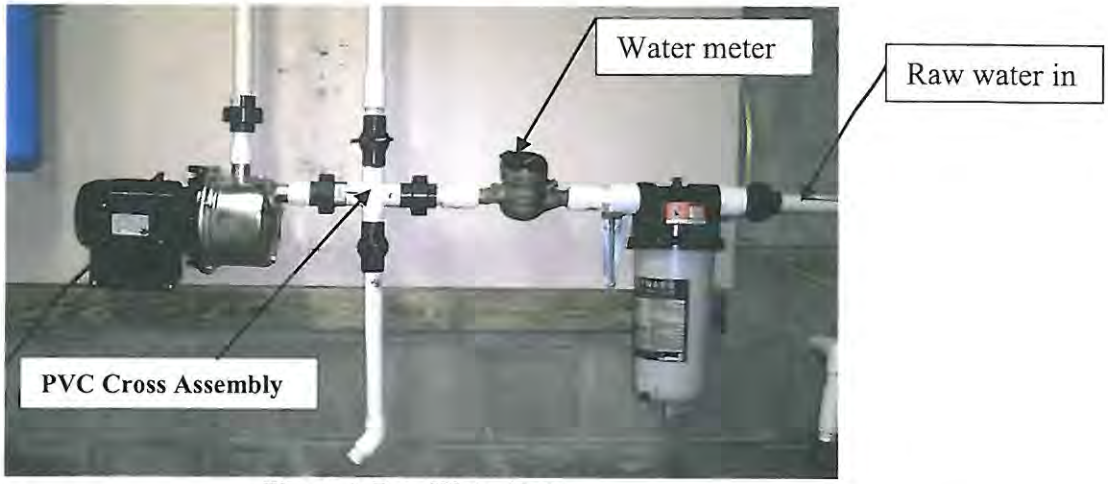

Figure 1 Raw Water Entry

- Water enters from right (mirror this photo for a left entry system)
- Passes through the sediment or trash filter
- Passes through the water meter
- The PVC Cross pipe component joins the raw water inlet, recirculation line (Ozone system only), drain line, and pump supply line.

Plumbing the Raw Water Entry Assembly

- Screw, glue and teflon tape the PVC fittings into the sediment filter head. Observe and follow the directional flow arrows on filter head.
- Build the water meter assembly and orient it so that the water flow arrow points downstream and the meter dial can be easily read.
- Glue the cross assembly pieces together, if a recirculation path is needed.
- Glue a union to the 1" male adaptor.
- Screw the 1" male adaptor into the pump. If the adapter can be tightened to touch the pump connection, add more wraps of Teflon tape to the threaded end.
- Connect all together using the 3 unions. In this case, pipe unions are used to make dismantling of the system for maintenance easier.
- Follow the manufacturer's recommendations regarding orientation of the pump head. Make sure the pump is secure.

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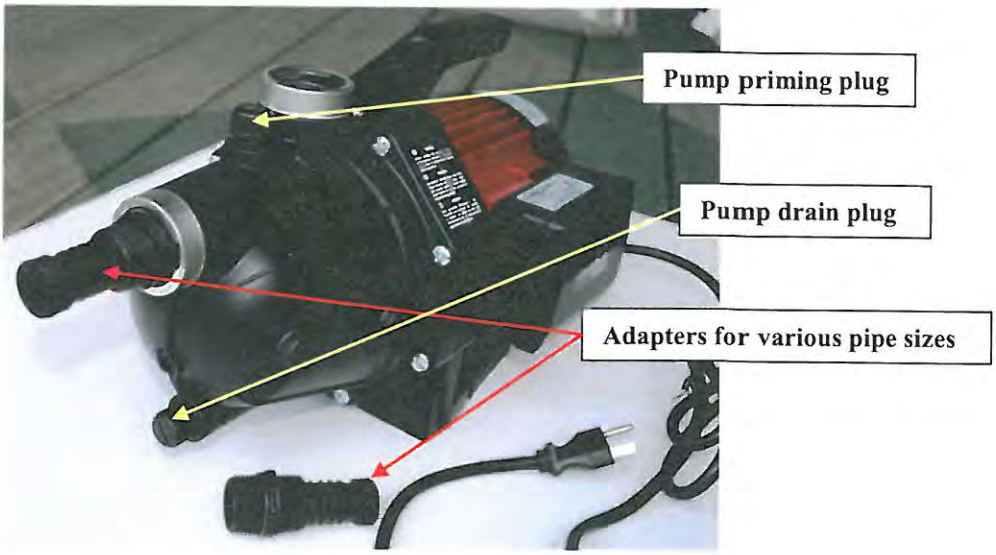
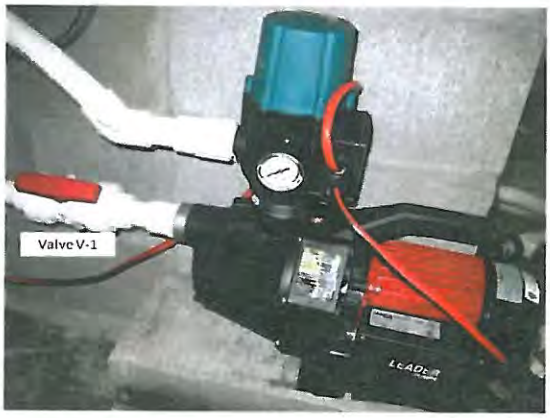
Pump Considerations

Pump information for solar-powered DC operation is provided at Solar School offered by Solar Under the Sun.

Shown below is the ½ hp Leader pump available from FCI. Note that it is prewired and has two adapters so the pump can be plumbed to match various suction and discharge fittings. Also note the drain and prime plugs in the head of the pump.



The picture below shows the ½ hp pump with a pump controller mounted on the discharge pipe side.



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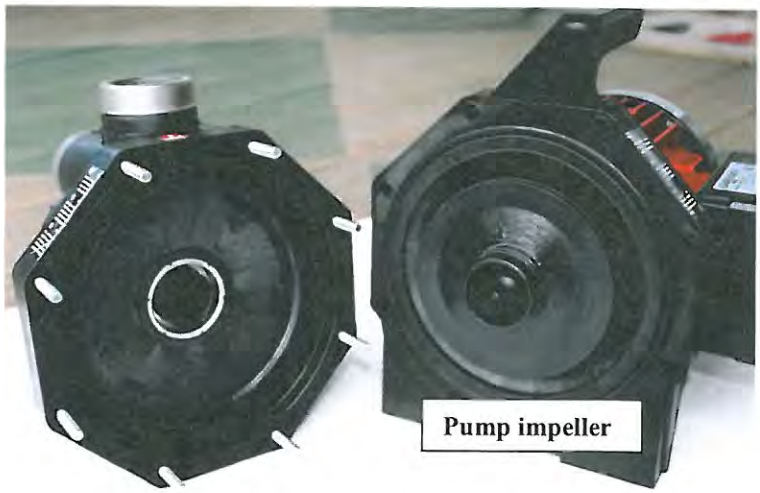
The pump head on the Leader pump can be adjusted to allow for the correct orientation of the intake and discharge lines. Use a Phillips head screwdriver to remove and reorient the head. The head on the pump shown below has been rotated 90 degrees so that the pump can be mounted on the board.

This picture shows the pump head removed and the configuration of the pump impeller.



It may be necessary to remove the pump head to check for free rotation of the impeller. Any foreign objects that enter the pump may possibly jam the impeller.

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4.2.4 Filtration Assembly

- Filtration and micro-filtration are part of every LWW clean water system , regardless of whether disinfection is with ozone or UV
- Water that has passed through the trash filter
    - First passes through a 5.0 micron filter
    - Then through a 0.5 micron filter
- The 0.5 micron filter is the "workhorse" of the system
- The filter units are referred to as "***Big Blues***" in this handbook
    - This should be clear from the photo below

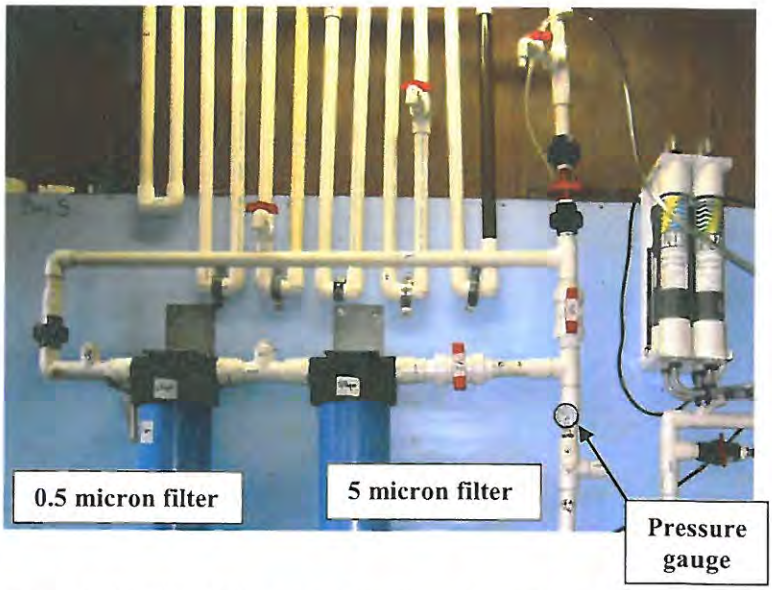

Figure 2 Big Blue Filters in a Standard Ozone System. Newer systems use a single pressure gauge before the 5 micron filter (to the right of the filter in this photo).

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Figure 3 Parts necessary to build the filtration assembly. A single Tee, adapter and pressure gauge are currently recommended.

Filter Assembly Construction

- Remove the two blue filter canisters from the black filter heads.
- Install 1½" male threaded adapters (MPT) first – use channel lock pliers. As with all threaded fittings, wrap each one with Teflon tape. Add 5 or more wraps, if the fittings can be tightened to touch the black filter heads. Some teams report having up to **10 wraps** on each BB male threaded adapter.
- **Note** – many of the new black filter heads have **1" male threaded adapters**.
- Glue all three Big Blue PVC sub-assemblies. Hand-tighten the center PVC sub-assembly into the first filter head. Make sure that all pressure gauge fittings are oriented so that the gauges can be read, then hand-tighten the other filter head into the unit.
- **!!!NOTES!!!**
- ***Pay attention to the water flow directional arrows.***
- ***To ensure the filter heads are level, place them on a flat surface and adjust accordingly.***

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4.2.5 Disinfection

Please see section 4.4 for details of ozone disinfection equipment and section 4.5 for details on UV disinfection equipment.

4.2.6 Drain Lines

- Drain valves should be installed at points in the system that will allow the system to be completely emptied of water.
- Drain lines should go to a common drain header pipe that carries water out of the water treatment building.
- Some teams recommend that OPs do not glue any drain pipe between the drain valve and the drain header pipe.
    - When draining, the only pressure is from the height of the water, so glue is not needed.
    - Leaving the parts unglued allows them to be easily disassembled when needed.
    - Each team should use their own judgment.

4.2.7 Check Valves

- LWW recommends that two check valves be considered to provide added protection against bad water backing up in lines and contaminating the clean water tank.
- One check valve should be placed above V-3 but below the WIKA gauge to measure the level in the tank.
- The other check valve should be placed in the bottling loop after the faucets to prevent overflow water from the clean water tank going back to bottling.

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4.2.8 Bottle Cleaning and Disinfecting Station

Most standard water systems are used to fill 5 gallon (19 to 20 liter) bottles for distribution to the community. See Appendix C for further details of the bottle rinsing station shown below.

Note: Local health department regulations may specify that bottle cleaning, rinsing, and disinfection stations must be segregated from bottle filling areas.

Figure 4

Bottle Cleaning and Disinfecting Station Operation

From right to left:

- Bottles are cleaned at right in sink
- Not shown is bottle sprayer with bleach solution for disinfecting the inside of each bottle
- Bottle rinsing station with an on/off spring valve
- Faucet at left fills bottles
- Not shown is the bottle cap and shrink-wrap cap sealing process

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4.2.9 Electrical Components

Shown here is the typical electrical panel for 110 VAC (Volts Alternating Current) Clean Water System. See Chapter 7, Electrical, for more information.

In the photo above, a single 20 amp circuit breaker feeds two switch-controlled outlets. One switch controls the pump, the other controls the disinfection, either UV or Ozone (O3).

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4.3 *Instructions Common to All Systems*

4.3.1 Routine Maintenance

Daily Maintenance

- Read the water meter and pressure gauge and record these in the Daily Log
- If a UV system, check all electrical connections and the green lights.
- If an ozone system, go through the Ozone checklist
- If the pressure gauge reads 10 psi or higher than its reading at initial installation, then
    - Change the 5.0 micron filter
    - If the pressure reading does not return to near its original reading, then change the 0.5 micron filter
- Run a pathoscreen test on the clean water, if required by local regulations
- Perform any other tests required by local regulations
- Check the condition of the clean water tank and any water in it

Weekly Maintenance

- Clean the trash filter
- Soak the trash filter in a strong chlorine solution for 30 minutes
- Rinse the filter and brush away any particulates noticed in the paper folds of the filter element
- Run a pathoscreen test on the clean water, if required by local regulations

Monthly Maintenance

- Run a pathoscreen test on the clean water

Quarterly Maintenance (every 3 months)

- Clean and disinfect the Clean Water Tank
- Shock the system
- If a UV system, clean the protective quartz glass sleeve around the UV lamp with Lime-Away or other Calcium sediment cleaner or vinegar.

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Annual Maintenance, or at 100,000 gallons

- If a UV system, replace the UV lamp and quartz-glass sleeve protecting the lamp
- Replace the 5.0 micron filter if it has not been replaced in last 9 months
- Replace the 0.5 micron filter if it has not been replaced in last 9 months

Maintenance as needed

- If the Clean Water Tank becomes contaminated
    - Clean and disinfect the Clean Water Tank
    - Shock the system

4.3.2 Operating Instructions Common to all Bottling Systems

See Chapter 8, Bottling, for instructions on bottling clean water.

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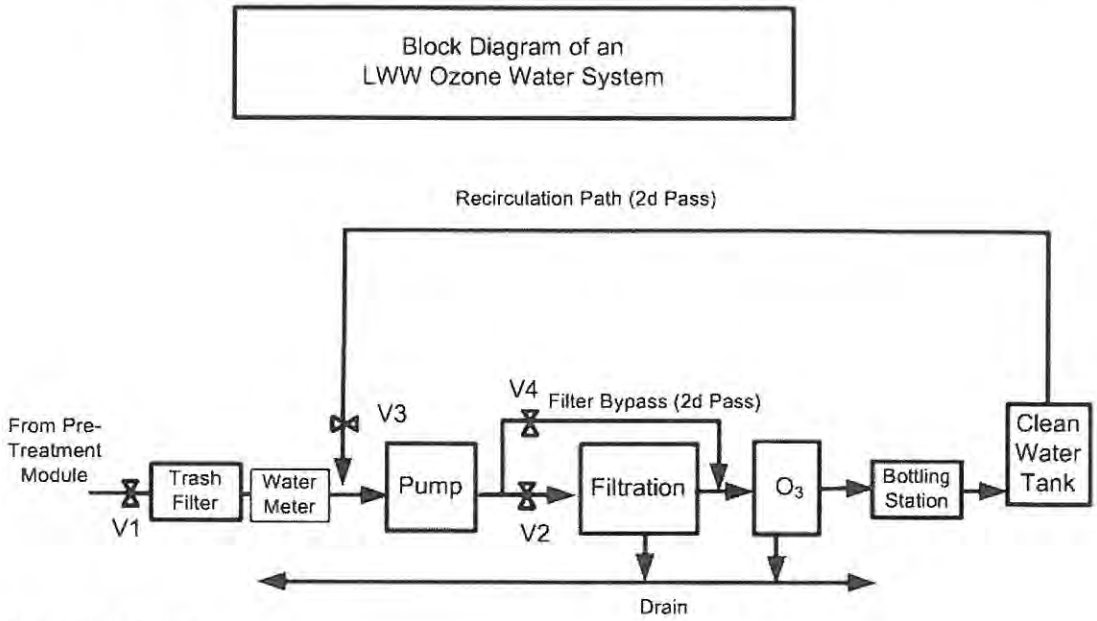
4.4 *Systems with Ozone Disinfection and a Clean Water Tank*



- More than 75% of all LWW installations use Ozone
- Systems using Ozone require a Clean Water Tank
    - The Clean Water Tank should be placed on a tank stand high enough that the bottom of the Clean Water Tank is above the inlet port of the pump
        - This avoids having to manually prime the pump
    - If the output of the Clean Water Tank is below the pump inlet, plumbing to prime the pump must be included and the operating instructions modified to include priming the pump. See Section 5.3 for instructions. A check valve can also be used to ensure the pump maintains prime.
    - If gravity fed continuous delivery is required, such as for water fountains at a school, the Clean Water Tank must be placed on an elevated stand at least 8 feet high
    - More information about Tank Stands and Elevated Stands for the Clean Water Tank is included in Section 6.2 of this handbook

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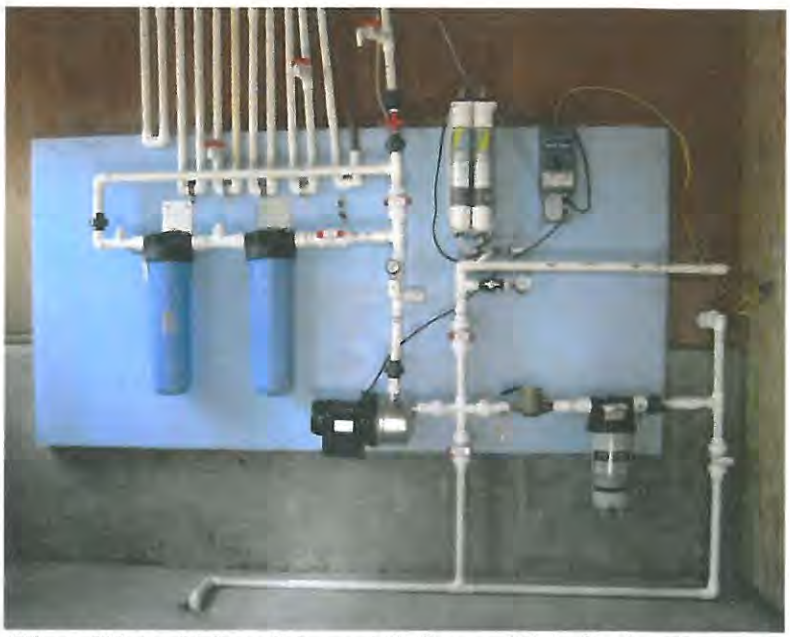
- Systems with ozone require that water be treated in batches to make clean water
    - The first pass through a batch of water (usually 300 gallons) is filtered and ozonated
    - On the second pass, filtration is bypassed and the water is ozonated and bottled
- Ozone has residual disinfecting strength in both the Clean Water Tank and bottled water.
- After the batch of water has been treated through 2 passes, this water can be used for gravity-fed operation for uses such as in kitchens or at water fountains.
- Power may be supplied as AC with generators or by a utility, or by DC from photovoltaic (PV) panels and batteries.
- Technical information about disinfection with Ozone can be found in the Appendix A "Technical Summary"

When purchasing an Ozone System from FCI, you should include the following kits:

- LWKit1 Board Fittings
- LWKit1A Churn Fittings for Ozone System
- LWKit2 Board to Tank Connections and Spare Parts
- LWKit3 Prozone PZ2-4 Ozonator Spare Parts
- LWKit4 Ozonator Kit w/ Ozonator, Venturi, Check valve, and tubing
- LWKit5 Electrical System



Clean Water U Bay 5 is an AC Ozone Disinfection System.

- Water enters from the bottom right and first encounters the "trash filter"
- The Bottling Station is on the other side of the building and not shown

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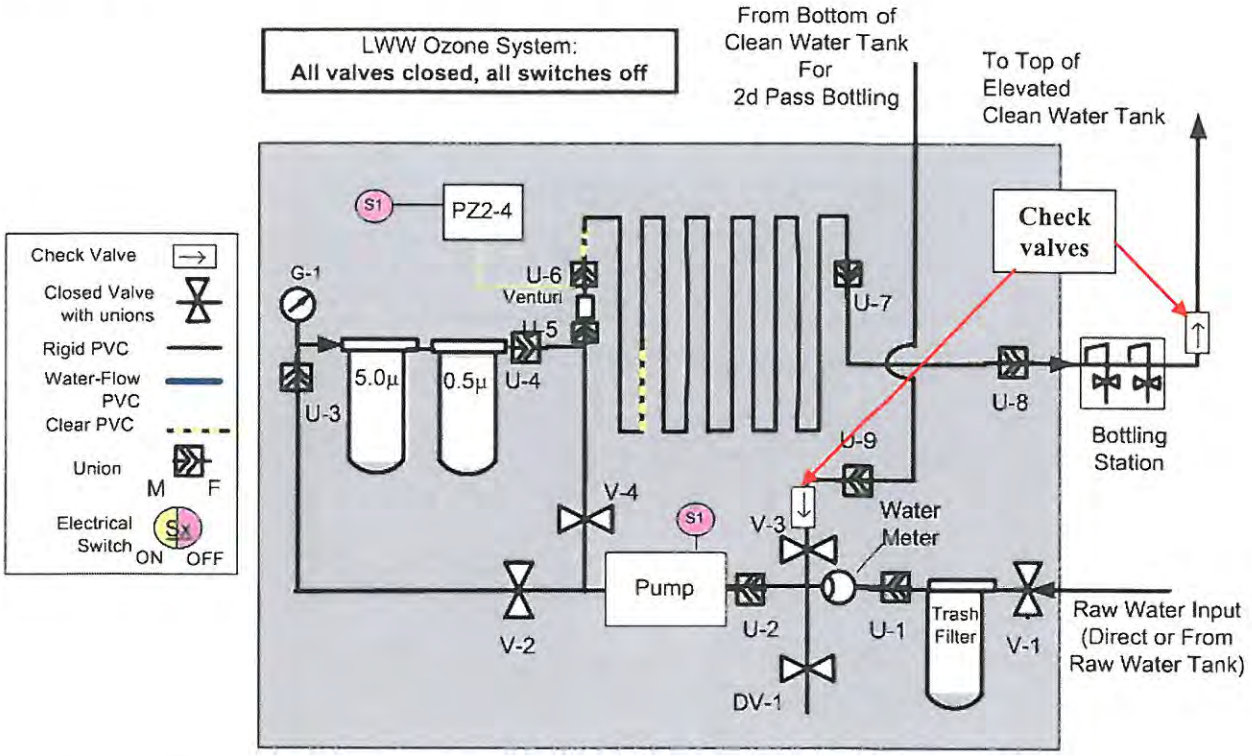
This drawing shows an Ozone clean water system. Union placements are suggestions for modular construction and maintenance of the system.



Revised January 3, 2011

4.4.1 Building the Standard Ozone System

Raw Water Entry Assembly

The Raw Water Entry Assembly for the Ozone System with a Clean Water Tank is shown in Section 4.2.3, under "Construction Considerations Common to All Systems"

Filtration Assembly

The Filtration Assembly for the Ozone System with a Clean Water Tank is shown in Section 4.2.4, under "Construction Considerations Common to All Systems"

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Ozone Disinfection/Churn Assembly

There are five components, in the order of the air flow:

- The inlet air filter
- The PZ 2-4, Ozonator
- The Kynar plastic check valve
- The Prozone PZ 684 Venturi Injector
- The churn, including the clear PVC pipe to observe mixing

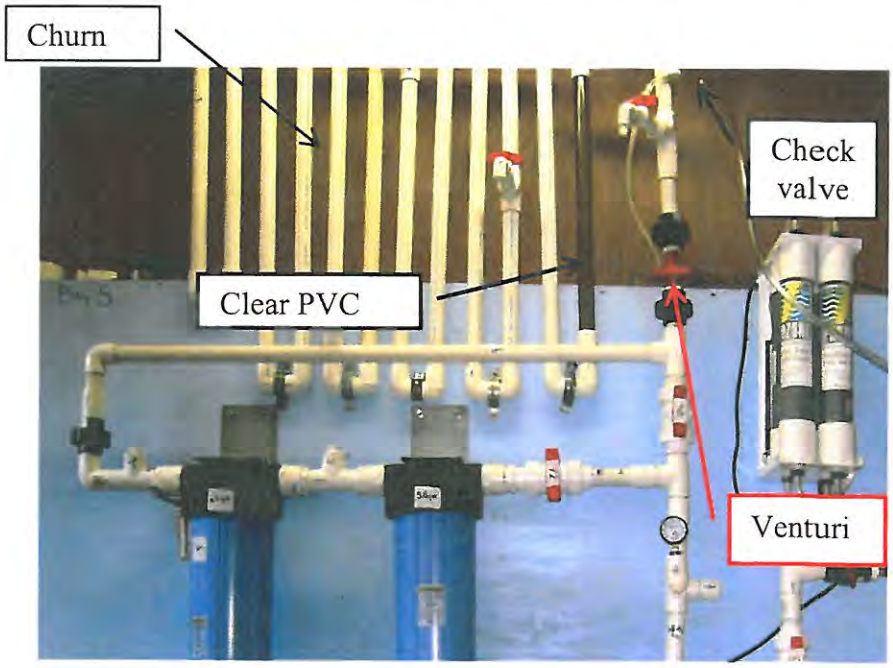

Figure 5 Here the clear PVC is in a down-flow section of the pipe. An up-flow section is preferred so that the water flow and the direction of bubble travel are the same

- **Important Note--**The effectiveness of ozone in the treatment of water is dependent on several factors, including:
- the quantity of ozone injected into the water
- the amount of mixing of the ozone into the water stream
- the amount of contact time between the ozone and water

- See Appendix A, *Technical Summary of Filtration, Microfiltration and Ozone Treatment* for a full discussion of the disinfecting power of ozone.
- See Appendix D, Ozonator Handbook (version 6.0) for detailed information on the PZ2-4 Ozonator.

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The Inlet Air Filter

The inlet air filter prevents debris and small insects from entering the ozonator

The Ozonator

- The Standard Board features the PZ2-4 Ozonator shown above.
- The PZ2-4 contains four lamp cartridges and produces about 2 grams/hr of ozone.
- Ozone is injected into the water through the vacuum created by the flow of water through the Venturi injector.

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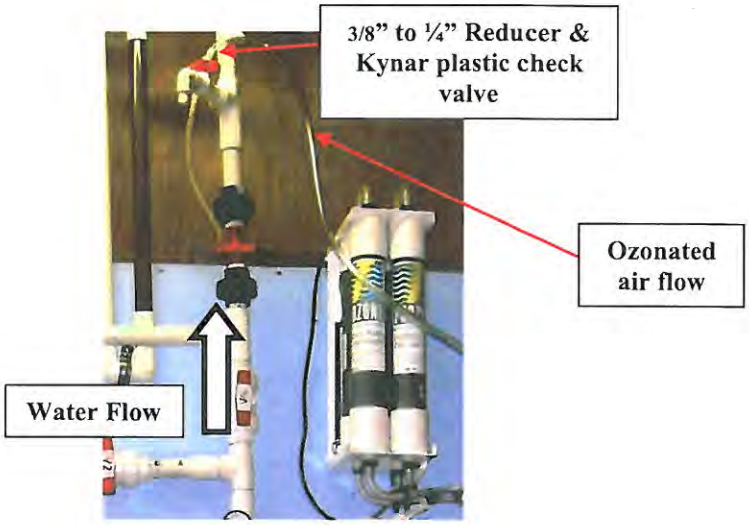
The Kynar Check Valve



- The Kynar check valve prevents water from flowing back in to the ozonator
- The check valve should be mounted at the high point in the tubing connection above the churn.
- The check valve is in the line from the Ozonator and must be directly above the venturi, as pictured above
- Blow through the check valve to ensure correct orientation.

Venturi

- Be careful NO glue gets into the venturi
- The venturi inlets must be facing downstream (i.e. UP)
- Use Union connections on each end of the Venturi and the Clear PVC Pipe sections to make it easier to remove them from the board for maintenance.
- The venturi contains an internal check valve in the body. If water leaks out the venturi port, then this check valve has failed. The system can still be operated by disconnecting the tubing from the port to prevent water from backing up into the tubing.

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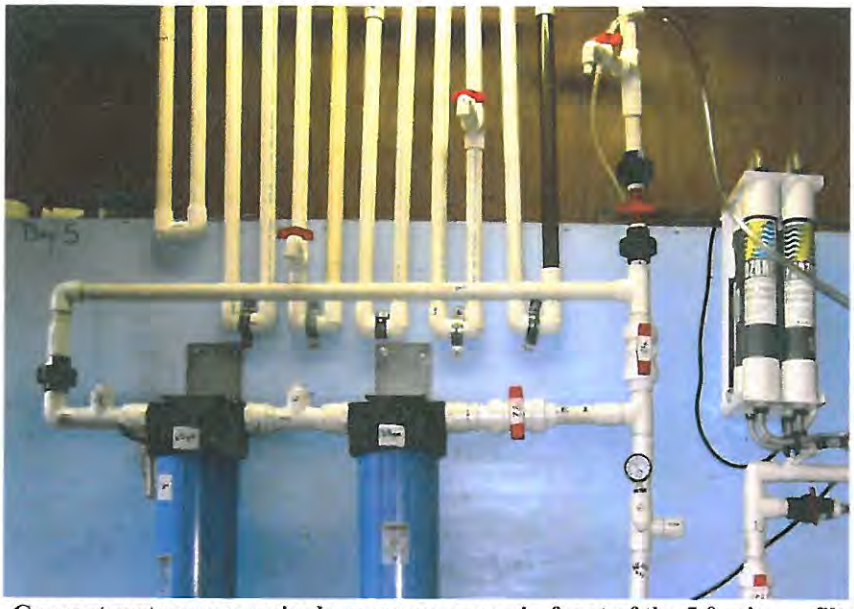
The Churn



Note: Current systems use a single pressure gauge in front of the 5.0 micron filter

- The total length of the Churn must be at least 30 feet
- All 1 inch PVC pipe MUST be vertical.
- The individual length of the pipe is not critical and may be adjusted to fit the height of the ceiling. In this picture, each pipe is 30" long and there are twelve sections. If each pipe is 24" long, it will require fifteen sections, if each pipe is 36" long, ten sections.

Clear PVC pipe

- This allows the operator to see the 'bubbling' of the ozone in the water

In monitoring venturi operation, the bubbles should be relatively small. The smaller the bubbles, the better the transfer of ozone and the better the disinfection of the water.

- Should be placed low enough for the operators to easily see the water flow
- Should be placed directly above the venturi. The drawing shows two possible placements
    - Directly above (downstream from) the venturi is preferred, or
    - In the first section of the churn where water is flowing upward
- By blocking the inlet to the venturi, the OP can check for proper operation of the venturi by observing the presence or absence of bubbles in the water

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Flow Meter

- If the team decides to install an optional flow meter in their system it should be placed after the pump discharge and before V-2 and V-4.

Electrical Components and PZ 2-4 Ozonator Assembly

(See Chapter 7 for electrical wiring details.)

- A single 20 amp circuit breaker feeds a switch that controls two outlets.
    - This switch is denoted S1
- The PZ2-4 Ozonator is supplied by one outlet, while the other outlet supplies the pump.
- In an ozone disinfection system, a single switch controls both the pump and the ozonator.

!!!NOTE!!!

The electronic ballasts in the PZ 2-4 Ozonator unit are rated for a range of operating voltages from 70 - 240 volts AC. Because the PZ 2-4 has no compressor or cooling fan, the unit can be powered from a 220 volt source by changing the plug on the power cord. Whether the AC current is 50 hertz or 60 hertz also will not make any difference to the operation of the Ozonator.

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4.4.2 Ozone System Start-up, Operation, and Shutdown

1 - Check for Leaks

!!!NOTE!!!

- ***Do not place either of the Big Blue cartridges in their canisters.***
- ***First, unplug ozonator so that it does not operate during this procedure.***

1. Remove the cartridges from the Big Blue Filters
2. Install the cases of the Big Blue Filters (without the cartridges), making sure that the O rings make a good seal to maintain pressure
3. Open V-1 and V2
4. Allow the system to fill as much as possible by gravity
5. Turn ON S1 (pump)
6. Press the pressure relief buttons at the top of the Big Blues to bleed air out of the system
7. Note the locations where leaks occur
8. Open V-4 and V-3. Close V-2.
9. Operate for a few minutes in the filter bypass/recirculation mode.
10. Note locations where leaks occur with all valves open.
11. Turn OFF S1 (pump)
12. Close V1. Open V-2, V-3, and V-4.
13. Open the drain valves and drain the system (water should remain in the churn and the Big Blue canisters)
14. Repair leaks as necessary
15. Go back to Step 3, above. Repeat as many times as necessary until all leaks have been fixed.
16. After all the leaks have been repaired, close all valves V-1, V-2, V-3, and V-4.
17. Close DV-1 and all other drain valves.

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2 - System Shocking

Before the initial start-up and at other times for preventative maintenance, it will be necessary to super-chlorinate or "shock" the tank, all hardware, and all plumbing to ensure the system is disinfected prior to use.

!!!NOTE!!!

- DO NOT INSTALL either of the Big Blue filter cartridges until after this procedure has been completed. Chlorine will degrade the activated carbon in the Big Blue filters.
- Verify that the Trash filter cartridge is installed.

Step 1 - Washing the Water Tank (These procedures apply to either tank.)

Wash the Water Tank whenever the Water Tank gets contaminated with dirt, mud, or other material that washes best with mild soap and water. This same procedure can be used for either the Clean Water Tank or the Raw Water Tank.

1. Prepare 5 gallons of a mild soap and water solution
2. Disconnect the tank at its unions and turn the tank on its side
3. Wash out the inside of the tank and lid with the soap solution using a sponge or mop.
4. Rinse the tank with water to get rid of soap residue.

Step 2 - Disinfecting the Clean Water Tank

Disinfect the Clean Water Tank at the initial startup and whenever the Clean Water Tank gets contaminated. This same procedure can be used for either the Clean Water Tank or the Raw Water Tank.

1. Add enough 10% bleach powder or liquid bleach (1/4 cup) to 2 gallons of water in the sprayer to make a 500 ppm – 800 ppm chlorine solution.
2. Spray the inside of the tank and lid.
3. Leave the bleach solution inside the tank and move the tank to its elevated position. This chlorine solution will be used to shock the rest of the system.

CAUTION: Be careful in moving a tank with chlorine water solution in it. The concentrated chlorine water can burn the skin or eyes on contact!

4. Reconnect the tank at its unions. Be careful not to spill or get any bleach solution on you.

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Step 3 - System Shocking

1. Record the reading on the water meter.
2. Remove the canister that holds the 5.0 micron filter. Empty the water from the canister.
3. Pour 1 cup of liquid bleach into the canister and replace the canister.
4. Open V-1 and V-2
5. Press the pressure relief buttons at the top of the big Blues to bleed air out of the system.
6. Turn ON S1 (pump)
7. Run the pump until water begins to enter the Clean Water Tank.
8. Open V-4. Close V-2. Run chlorinated water through the filter bypass.
9. Turn OFF S1 (pump)
10. Close V-1.
11. Open V-3 and the faucets at the bottling station.
12. Allow the chlorinated water to run into a bucket for about 10 seconds.
13. Close the faucets at the Bottling Station.
14. Close V-3 and V-4.
15. Let this super-chlorinated water sit in the tank and lines for 30 minutes.

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Step 4 - Transition from Shocking to making the system ready to make Clean Water

1. Open V-2 and V-4.
2. Open V-3 and open the faucets at the Bottling Station.
3. Allow all of the chlorinated water to drain from the Clean Water Tank. Save this water for bottle rinsing. ***Note that chlorinated water remains in the churn, in the Big Blue canisters, and in the pump.***
4. Close V-3 and the faucets at the Bottling Station.
5. Remove the Big Blue Canisters. Observe safety precautions about contact with chlorinated water. Save the chlorinated water to use to disinfect the bottles.
6. Break the unions at each end of the churn (U-6 & U-7) and take it off the board.
7. Drain the chlorinated water from the churn. You will have to remove it from the board in order to drain the chlorinated water.
8. Open DV-1 and allow all the water in the system to drain.
9. Close DV-1 after the system has been drained.
10. Insert the filters into the Big Blue canisters and install them. Do not forget to lubricate the O-rings and gaskets with KY Jelly.
11. Install the churn. Tighten all the unions.
12. All valves should be closed. All switches OFF.
13. Plug in the Ozonator.

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5 - Final System Flushing

1. The initial flush will be 50 gallons of water through the system.
2. Open V-1.
3. Open V-2 and keep V-4 closed.
4. Turn ON S1 (pump and ozonator)
5. Verify Ozone flow.
6. When 50 gals of water are in the Clean Water Tank, open V-4 and close V-2.
7. Run another 50 gals of water into the Clean Water Tank.
8. Close V-1 and open V-3. Circulate the water in the Clean Water Tank for 15 minutes.
9. Turn OFF S-1 (pump and ozonator)
10. Open DV-1, V-2, V-3, and V-4. Allow the system to drain.
11. Close all valves - V-1, V-2, V-3, V-4, and DV-1. Turn OFF all switches.

If there is still a strong chlorine odor from the system, perform a second flush of the system.

At the completion of flushing, the churn, Big Blue Filters, and pump should have clean water in them.

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