LIVING WATER™ TREATMENT SYSTEM (LWTS™) OPERATING INSTRUCTIONS

The Living Water™ Treatment System (LWTS™) is essentially a miniature water treatment plant. Like many municipal treatment facilities in developed countries, this unit relies on filtration and chemical disinfection for production of safe drinking water. Filtration physically removes particulate and bacteriological contaminants, while chemical disinfection neutralizes any remaining pathogens and ensures the treated water is safe to drink. This method is very effective, and, when operated properly, the LWTS™ will provide a community with safe drinking water for many years.

The LWTS™ requires an operator to manually adjust the water flow through the unit by opening and closing various valves. The operation of the system is discussed in the following sections:

1. Raw Water Filtration

When the LWTS™ is started, water flows through piping, the filters, the chlorinator, and into the treated water storage tanks. Valves in the Valve Assembly control flow rates and directions of flow. To operate the valves in the Valve Assembly simply push the handle, V2, to the left or right.

At startup, the valves should be set as shown in Figure 1 and Table 1.

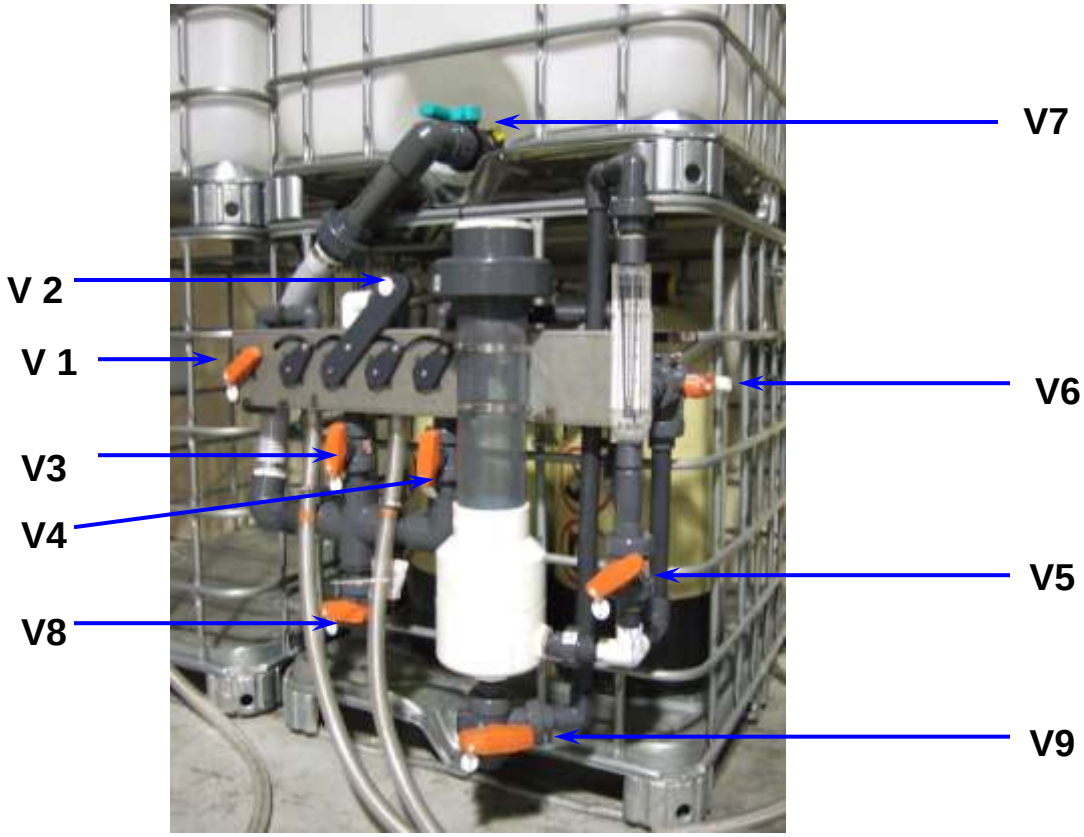

Figure 1: Valve settings at startup

Table 1: Startup Valve Positions

No.	Name	Position
V1	Main Flow Control Valve	1/2 Open
V2	Valve Assembly	To the Right
V3	F1 Backwash Flow Control Valve	Open
V4	F2 Backwash Flow Control Valve	Open
V5	Chemical Feed Bypass Valve	1/2 Open
V6	Sample Port/Tank 1 Fill Valve	Position 1
V7	Backwash Water Feed Valve	Open
V8	Tank 1 Drain Valve	Closed
V9	Tablet Chlorinator Drain Valve	Postion 1

V1 is used to control the total flowrate of water through the LWTS™. Settings for V1 are discussed in Section 3. At startup, V1 should be half open. V2 has two positions left and right. During normal operation V2 is positioned to the right "WATER PRODUCTION" position. V3 and V4 are used to control the backwash flowrates when backwashing Filters F1 and F2. V3 and V4 should be open during startup. V5 is the Chemical Feed Bypass Valve which is used to adjust the chlorine concentration in the treated drinking water. V5 settings are discussed in further detail in Section 4. V5 should be half open at startup. V6 is the Sample Port/Tank 1 Fill Valve. It is a 3-way valve and has two positions (see Figures 2 and 3).

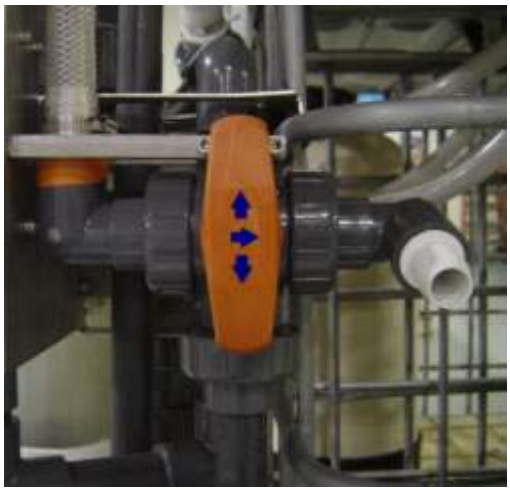

Figure 2: V6 in Position 1

Figure 3: V6 in Position 2

During startup, V6 should remain in Position 1, discharging water from the LWTS™ until the water is determined to be safe. (Attach a section of 1" braided hose to the outlet of the sample port valve to direct water away from the LWTS™ while the system settings are being adjusted.) V7 is the backwash water feed valve and should be open during normal operation. V8 is the Tank 1 Drain Valve and should be closed during normal operation. V9 is the Tablet Chlorinator Drain Valve. Like V6 it is also a 3-way valve and has two positions (see Figures 4 and 5).

Figure 4: V9 in Position 1

Figure 5: V9 in Position 2

During startup, V9 should be in Position 1.

Filter Air Vent Valves

At startup the multimedia filters will have air in them. As the system is started up, water flowing into the filters will displace the air, which will automatically vent through the air vent valves located on the tops of the filters (See Figure 6).

Figure 6: Filter Air Vent Valve

2. Pump Operation

The LWTS™ can treat water from a variety of sources, including wells, rivers, lakes, lagoons, etc. Raw water is transferred from the source to the LWTS™ by the

electric powered pump. The pump must be located no more than 15 feet above the water source.

Ensure that the foot-valve on the 1.5 inch intake hose is submerged in the water source. When possible, the foot valve should be at least 1.5 feet below the water surface, 1.5 feet above the bottom, and away from the sides of the water source to minimize the amount of dirt and debris that enters the intake hose.

Prime the pump by pouring water into the pump casing through the fill plug. If problems priming the pump occur, check for air leaks in the suction hoses or connections.

With the Main Flow Control Valve, V1, half open, flip the switch to turn on the electric pump.

3. Water Flowrate Adjustment

Once the pump is started, water will begin to flow into the filters, displacing any air in them, as discussed in Section 1. Once both filters are full, the water will then begin to exit the Sample Port/Tank 1 Fill Valve, V6, and the flowrate can be measured and adjusted to the desired 10 gpm if this has not yet been done.

Adjust the Main Flow Control Valve, V1, to the desired flowrate of 10 gallons per minute (gpm). The flowrate can be measured by timing how long it takes to fill a five-gallon bucket. (Note: multiple five-gallon buckets are supplied with the LWTS™.) At 10 gpm, a five-gallon bucket should take 30 seconds to fill. The total flowrate can also be measured by closing the Chemical Feed Bypass Valve, V5, and taking a direct reading from the flow meter.

If the water exiting the Sample Port/Tank 1 Fill Valve, V6, is not clear, reduce the flow incrementally. If the water remains cloudy over incremental decreases in flow, then pre-treatment with alum is necessary. See the Alum Addition Manual for instructions. Water clarity can be measured with a turbidimeter, if available. Turbidity readings of less than 5 NTU are acceptable, according to the World Health Organization. If the LWTS™ is being used properly, turbidity measurements should read less than 1 NTU.

4. Chlorine Adjustment

Raw water may contain pathogens, particularly certain viruses, bacteria, protozoal cysts and worm eggs, which cause many illnesses, including diarrhea, dysentery, cholera,

and infectious hepatitis. The multi media filter system of the LWTS™ removes suspended particulates, including most of these pathogens, and improves the aesthetics of the water. After filtration, chlorine is added to the water to kill any pathogens remaining and to ensure that the water remains safe after it leaves the LWTS™.

The LWTS™ uses 3" chlorine tablets, which are stacked in a column inside the Tablet Chlorinator. At startup, the operator should visually check the Tablet Chlorinator and add chlorine tablets if necessary. Under normal operation the chlorine in a fully loaded Tablet Chlorinator should last many weeks. Tablets should be added when needed as follows:

1. Shutdown the LWTS™ as described in Section 6.

2. Place a bucket under the Tablet Chlorinator Drain Valve, V9, and adjust V9 to Position 2 to drain the Chlorinator.

3. Unscrew the cap on the top of the Tablet Chlorinator and remove it.

4. Load the Tablet Chlorinator with 3-inch tablets. Lower the tablets into the Chlorinator as far as possible one at time to ensure that they lay flat on top of each other. Do not drop the tablets, as it can cause them to break.

   Note: When finished, wash hands thoroughly as prolonged chlorine contact can cause mild burns.

5. Ensure that the "O" ring is clean and in place, and screw the cap securely onto the top of the Chlorinator.

6. Adjust V9 to Position 1.

Note: During normal operation the water level in the Tablet Chlorinator should not be visible unless the system is under significant backpressure. This is normal. The water level will drop when the pressure is released. On the other hand, if the "O" ring does not seal properly, the Tablet Chlorinator will fill with water. In this case repeat Steps 1, 2, 3, 5, and 6.

Note: Chlorine is a very powerful disinfectant and must be handled carefully. When removing the Tablet Chlorinator top or opening the container storing the chlorine source, concentrated chlorine fumes may be present. Ensure the area is well ventilated and do not inhale the concentrated fumes.

With the flowrate set at approximately 10 gpm and treated water exiting Valve V6, the Chemical Feed Bypass Valve, V5, should now be adjusted.

When V5 is closed, all filtered water is forced through the Tablet Chlorinator adding a residual amount of chlorine to the filtered water. The amount of chlorine added to the filtered water exiting V6 increases as the flowrate of raw water through the tablet chlorinator increases. Filtered water flow through the tablet chlorinator increases as V5 is closed (See Figure 7) and decreases as V5 is opened (See Figure 8). Thus, the amount of chlorine added increases as V5 is closed, and decreases as V5 is opened.

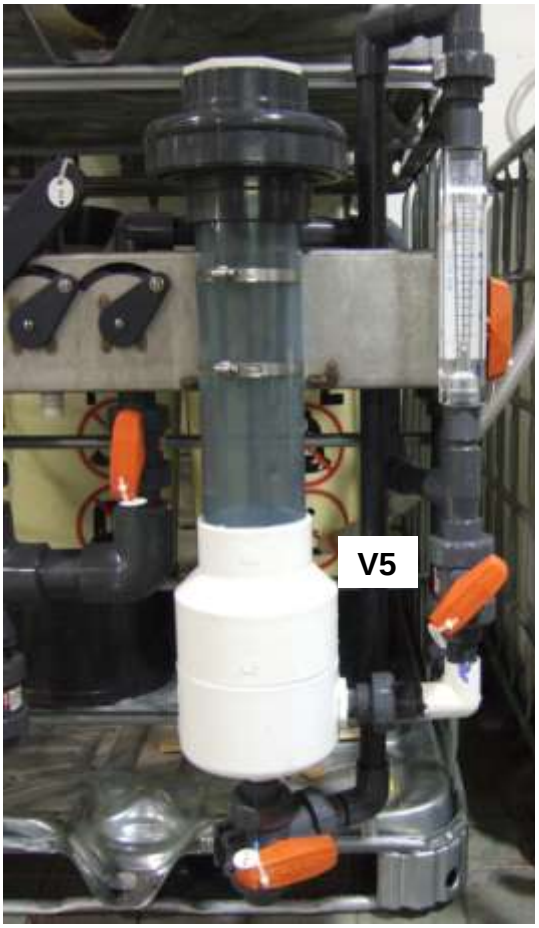

Figure 7: Chemical Feed Bypass Valve, V5, partially open

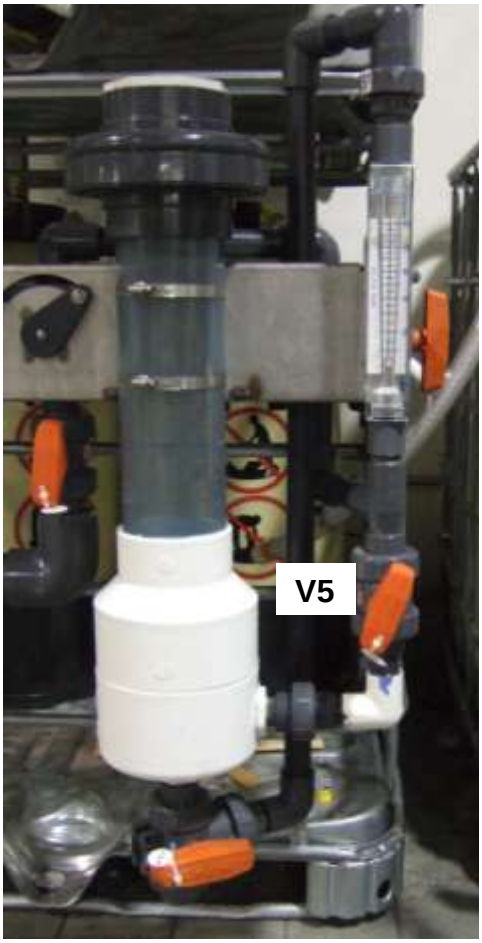

Figure 8: V5 more open resulting in more water flowing through the bypass, and less water flowing through the Tablet Chlorinator

At startup, set V5 as follows:

1. Adjust V5 until the flow meter reads 4 gpm (this assumes 3-inch trichlor tablets are being used. Refer to Table 2 if using an alternate chlorine tablet).

2. The water flowrate from the Sample Port/Tank 1 Fill Valve, V6, should now be checked to ensure it is still 10 gpm. After the first measurement, total flow can be increased or decreased as necessary by adjusting V1.

3. Check the chlorine concentration. To ensure proper chlorine addition, chlorine test strips are provided to check the chlorine concentration in the treated drinking water. These strips will turn darker shades of blue as the amount of chlorine in the water increases. To check the chlorine concentration, gently move a test strip back and forth in a 20 ml sample of water for 5 seconds. Remove the test strip from the water and, after waiting 30 seconds, match the color on the test strip to the color chart on the test strip bottle to determine the chlorine concentration. As a general rule of thumb, the chlorine concentration should be 2 ppm (2 mg/L). A bypass flow setting of 4 gpm should result in a concentration of approximately 2 ppm of chlorine. Chlorine concentrations of 2 ppm ensure a kill rate of 99.99% of waterborne pathogens in the filtered water after a residence time of 15 minutes. If the chlorine concentration appears lower or higher than 2 ppm then the bypass flow rate can be adjusted to achieve the desired chlorine concentration

Table 2: Various Chlorine Tablets

Type	Suggested Bypass Flow Rate	Comments
ACL 90 TRICHLORO ISOCYANURIC ACID 90% Chlorine	4 gpm	Follow detailed instructions as noted above.
Generic Tablet TRICHLORO ISOCYANURIC ACID ~90% Chlorine	4 gpm	There are a variety of trichlor tablets available on the market. Trichlor is recognized as a very stable, slow dissolving tablet. Use will be similar to the ACL 90 tablets provided with the LWTS™.
Calcium Hypochlorite (CalHypo) 65% Chlorine (Also known as HTH)	~1.25 gpm	CalHypo 3" tablets are a suitable alternative. However, the physical characteristics are not as desirable. CalHypo has a 1 year half life and is not nearly as stable as Trichlor. CalHypo also dissolves rapidly when wet, releasing much more chlorine in the water. For this reason a lower bypass flowrate is recommended so the water is not over chlorinated. CalHypo also contains a lower percentage of chlorine. For this reason, it is usually a more costly alternative. **Warning!** **CalHypo should never be used simultaneously with trichlor tablets. Combining the two products could result in an explosion. If CalHypo tablets are to be used, ensure that the Tablet Chlorinator is thoroughly cleaned before adding tablets.**

5. Potable Water Storage

Once the desired drinking water quality has been achieved, the treated drinking water should be sent to storage. Adjust V6 to Position 2 (See Figure 3). Tank T1 will now fill from the top. Once T1 is full, Tank T2 will automatically begin filling.

Tank T1, located above the filters, should be kept full so there will be sufficient clean water to backwash the filters. If necessary, water can be discharged from Tank T1 by opening the Tank 1 Drain Valve, V8 (see Figure 1.)

6. System Shutdown and Filter Backwashing

After extended operation, the water flow through the LWTS™ will decrease as contaminants accumulate in the filters. Eventually, the filters must be cleaned by backwashing them with treated water from Tank T1. The frequency of backwashing may vary from twice a day to once a week depending on the raw water quality. A good practice is to backwash the filters at the end of each day or when water production reaches half of the initial production rate. This will help maintain the filters in good condition. It will also help the operators remember the correct valve settings. Approximately 50 to 100 gallons of treated water should be used for backwashing each filter.

Before backwashing, the system must be shut down.

System Shutdown

1. Refer to Figure 9 and Table 3 for shutdown and backwash valve settings
2. Turn off the pump
3. Close Valve V1

System Backwash

1. Push Valve V2 to the left position “BACKWASH”
2. Open Valve V7 (Located on Tank 1) if not already open
3. Adjust Valve V3 to full open
4. Adjust Valve V4 to 1/2 open

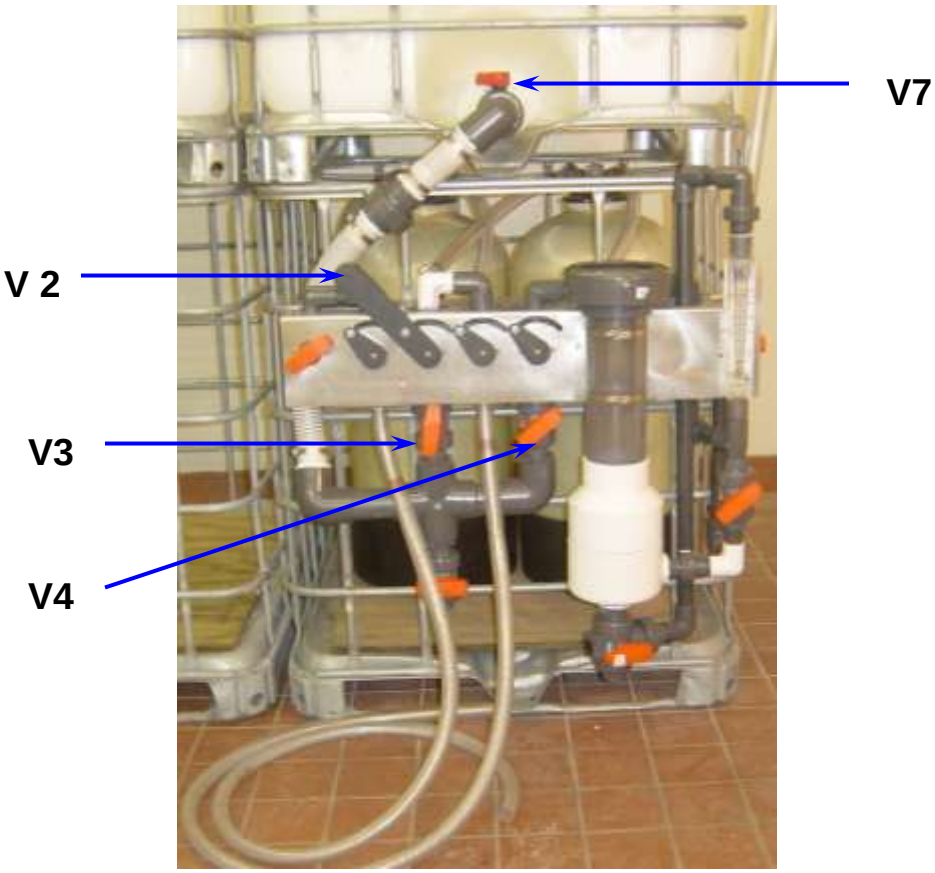

Figure 9: Valve Settings to Backwash Filters

Table 3: Shutdown and Backwash Valve Settings

No.	Name	Position
V2	Valve Assembly	To the Left
V3	F1 Backwash Flow Control Valve	Open
V4	F2 Backwash Flow Control Valve	1/2 Open
V7	Backwash Water Feed Valve	Open

Water should now flow through Valves V3, V4, and V7 and out of the discharge hoses. Use the hoses to direct the backwash water away from the LWTS™. Allow between 50 and 100 gallons of water to flow though each filter to ensure the filters are clean. The unit is ready to operate again.

Note: During backwashing, if there is little or no initial flow it may be necessary to use the hand pump to start the backwashing process. To do this, attach the inlet side of

the hand pump to the discharge end of the discharge hose. Then, with the valves set as described above, pump the handle several times until the water flow rate increases. Remove the hand pump from the discharge line.

It may be desirable to increase or decrease backwash rates through the filters to improve the backwash process. Backwash rates may be increased or decreased by opening or closing V3 and V4 (see Figure 10). V3 controls the backwash rate of the Primary Filter F1. V4 Controls the backwash rate of the Polishing Filter F2. If F1 requires additional flow, close V4 to increase flow through F1. Likewise if F2 requires additional flow, close V3 to increase flow through F2.

It is important to note that if the backwash rates are too high, filter media may be washed out of the filters. While backwashing, pay attention to what is being discharged. If sandy material begins to flow out of the discharge lines, reduce flow immediately.

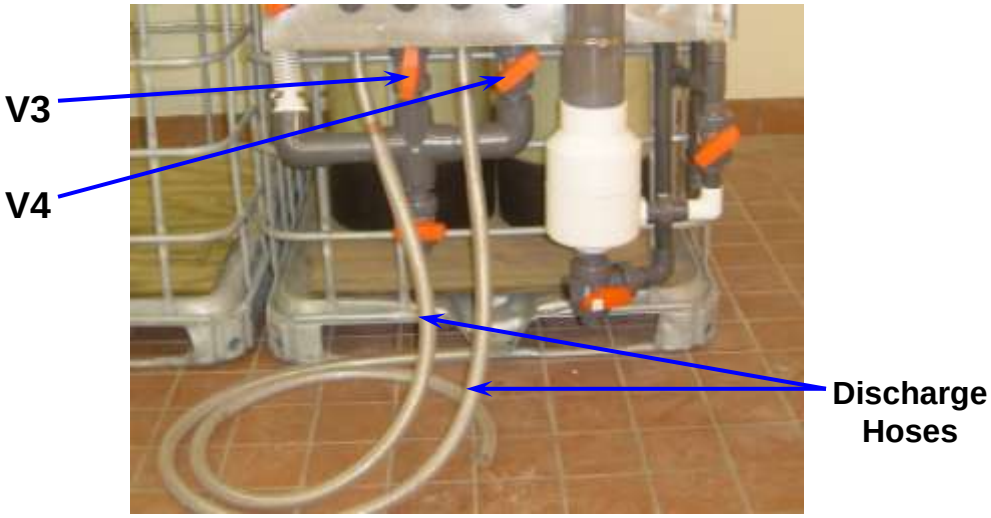

Figure 10: Discharge Hoses