Little St. James SWRO Service Report:

March 21, 2017

On March 15th through March 18th 2017, Jamaal Hodge conducted an onsite service visit at the seawater RO system on Little St. James Island. The goal of this service visit was to perform the necessary work to resolve the following issues;

1. Reduce the overall feed water pressure of the existing high pressure Wheatley pump.
2. Lower overall conductivity on the SWRO permeate water.
3. Install a new Pre Treatment chemical feed pump.
4. Resolve the post treatment water quality issues.

HP Pump PSI & Conductivity:

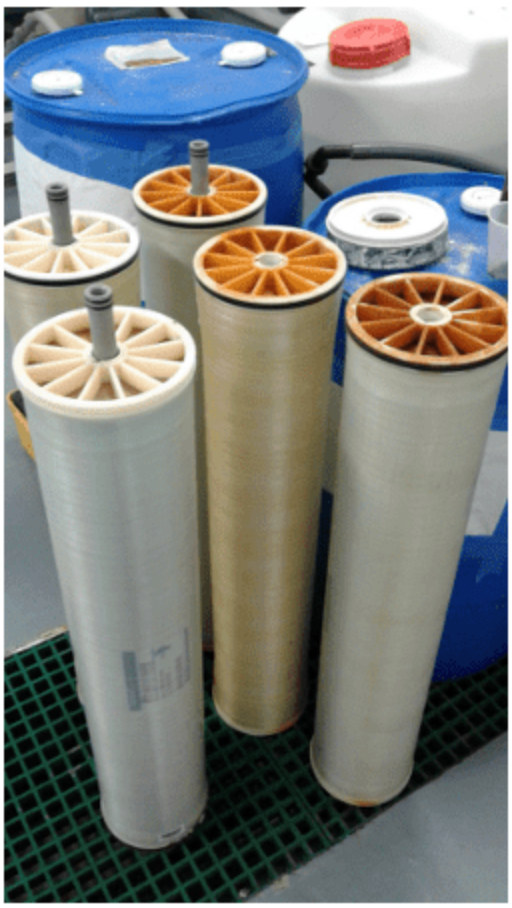
In order to lower overall conductivity and reduce the HP pump pressures, the lead membranes in each vessel needed to be inspected for foreign objects and debris (FOD). This has been an issue in the past at this plant due to improper backwashing of the Multi Media Filters using high flows which allows the filter media to enter the discharge lines of the filters. When the MMF filters are returned into service, this media travels and is trapped in the cartridge filters. Unfortunately if this occurs, the filter housing needs to be properly flushed out and cleaned when filter cartridges are changed in order to keep the FOD from entering the high pressure pump and membranes. Unfortunately, this cleaning of the Filter Cartridge Housing has not been done, and the result is irreversible damage to both the high pressure pump, and the membranes.

Upon arrival, the plant was operating at a membrane feed water pressure of 890 PSI with a concentrate pressure of 910 PSI. Please note that Maximum Operating Pressure of the membrane housings is 1,000 PSI. Jamaal changed out two of the lead membranes that were found to have FOD and mechanical damage cause by the FOD and installed new membranes into the final position of the vessels so as to insure the new membranes would not be overflowing permeate known as “Over Flux” when combining new membranes with older ones. This resulted in an overall pressure drop of 100 psi overall with membrane feed pressures now being 790 psi and concentrate pressure of 810 psi. This small change also resulted in permeate (product water) conductivity being lowered from 583 to 483. The photos below document the FOD, new membranes being installed, and the pressure and conductivity differences.

Other notes regarding this portion of the service: Jamaal brought his cousin over from St. Thomas to help him perform this portion of the service. He was assisted by Smiley’s brother or

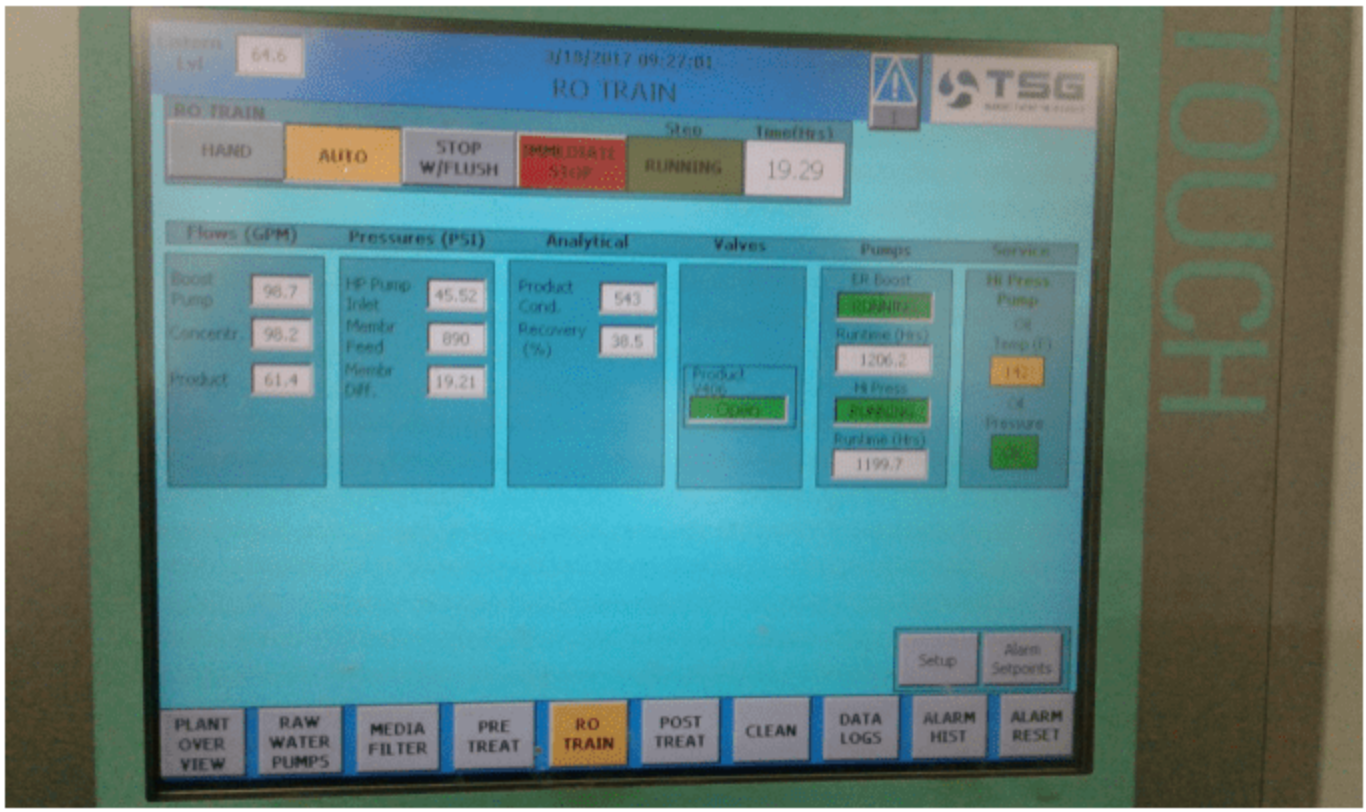
cousin and neither Smiley nor Danny were at the plant to assist with this procedure. Jamaal also had to fabricate a device to properly pull the end caps off of the membrane vessels in order not to damage them or the systems piping. The gentlemen in the repair shop below the plant assisted Jamaal in this fabrication. I highly suggest that a proper end cap membrane housing puller be either fabricated, or purchased from Pro-Tec.

Photos:

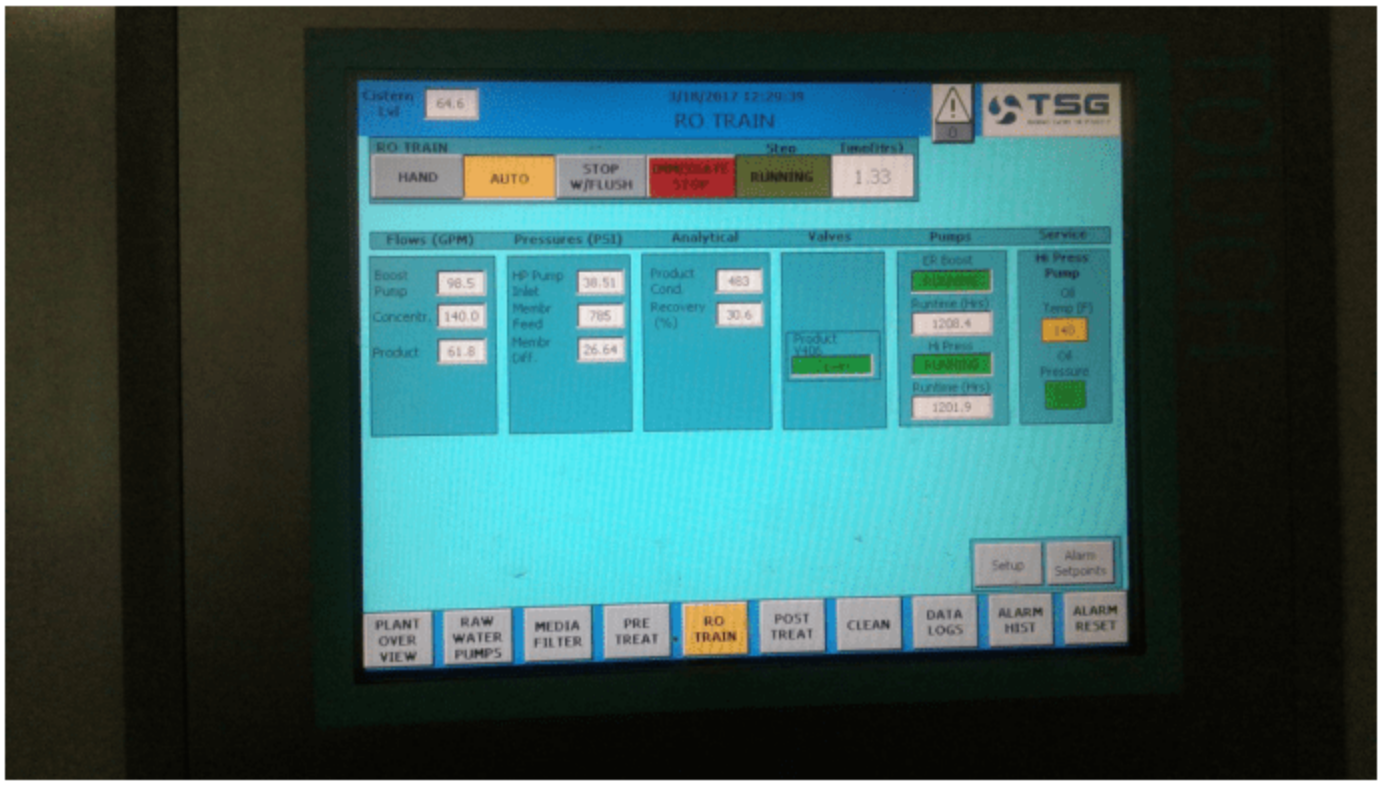


Please note on the Screen shot photos below the differences in Flows on the left portion of the screen. Jamaal found that the system was also out of balance which is important when using energy recovery devices and also set re-set the flows to original design condition. Also not that the screen shots are dated at the top.

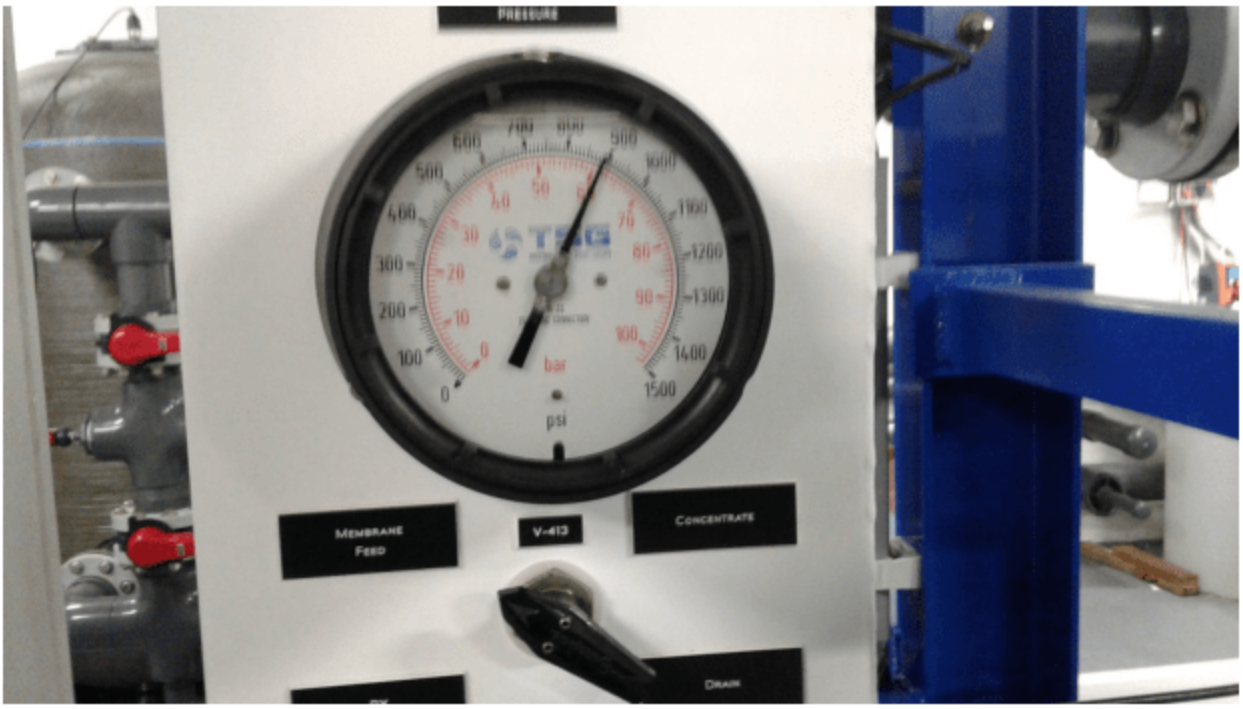
Pre Membrane service:

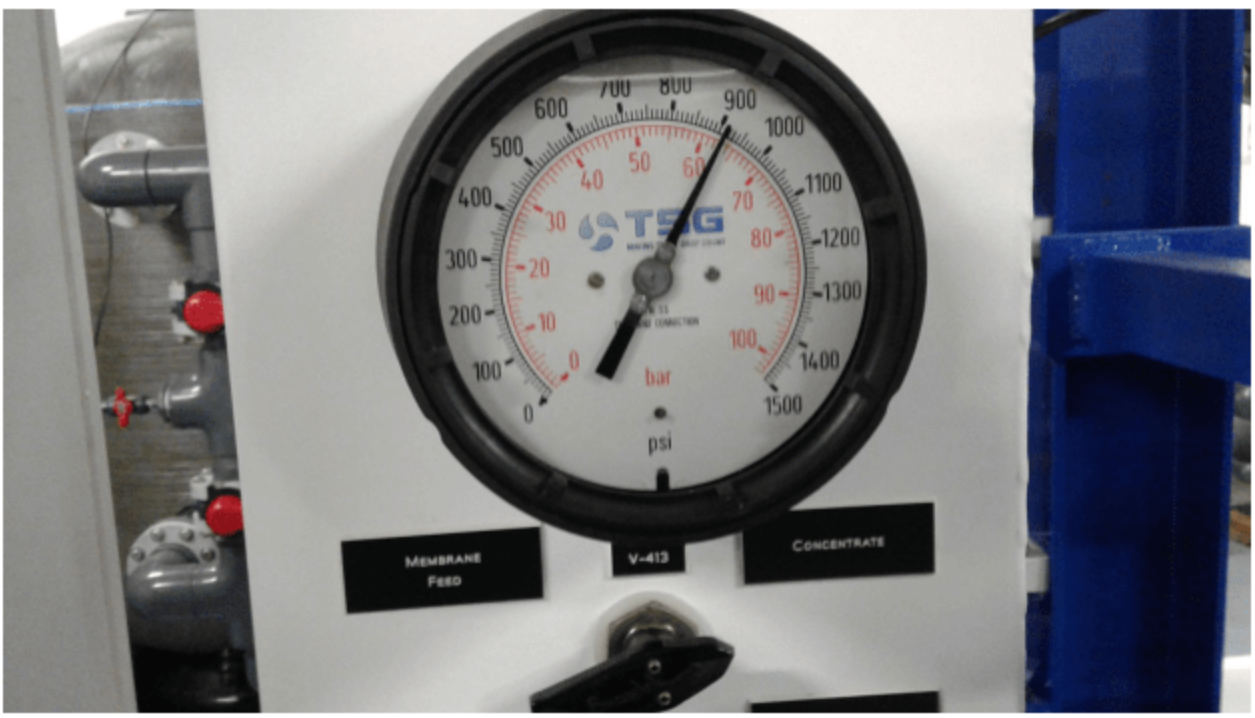


Post Membrane service:

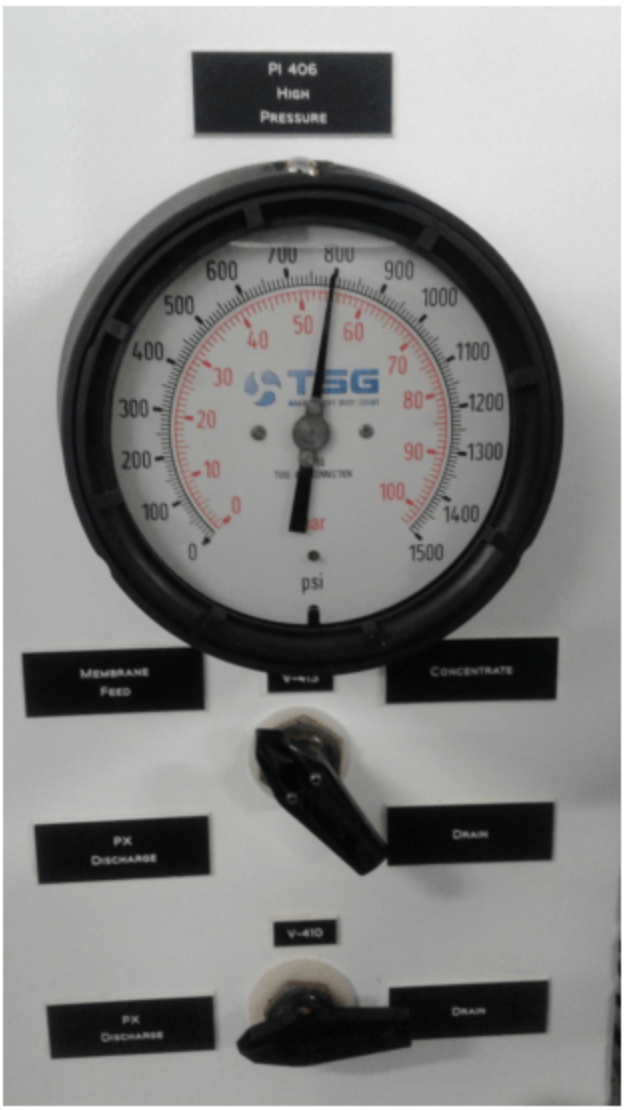


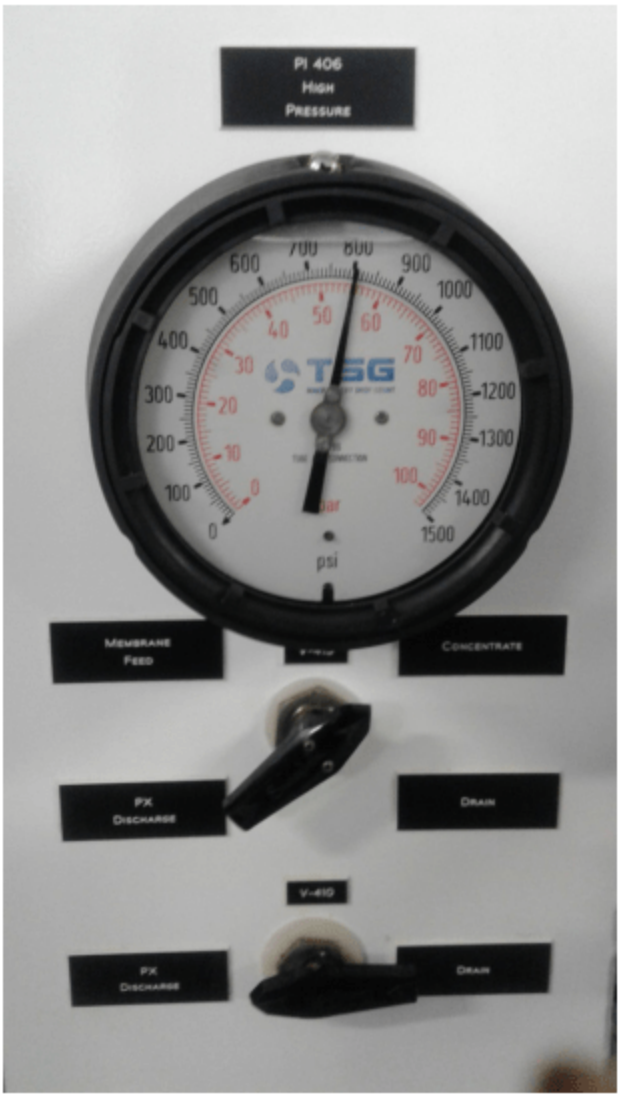
Pre service Pressure Gauges:





Post Service Pressure Gauges:





Pre-Treatment Chemical Pump:

Injecting proper amounts of Avista Vitec 5100 pre-treatment chemical is necessary to obtain maximum life from the SWRO membranes. The systems PLC controller insures that proper chemical dosages are delivered as well as turning on and off the chemical pump as the SWRO plant starts and stops. Jamaal found that the electrical box for the pre-treatment had been tampered with and the wiring had been changed to where the pre-treatment chemical pump will no longer operate in this fashion and must now be operated manually. Due to the fact that

this was an unknown issue prior to Jamaal's arrival, we did not have the necessary electrical drawings available to remedy this issue. It also needs to be noted that Danny told Jamaal that he was responsible for changing the electrical and that he would restore the electrical box back to its original configuration at a later date.

Given these circumstances, Jamaal had no choice but to install the newly purchased chemical pump, set it for manual operations, perform chemical drawdowns to insure proper chemical dosing, and leave the system running manually. I highly suggest that the electrical issues with the Pre-Treatment Chemical Station be remedied as soon as possible. Please see photo Documentation below:

Old Chem Pump:

New Chem Pump:

Pre-treat Elec Box:

New Chem pump in manual mode:

Pre-treatment draw down station:

Post Treatment

Post treatment is absolutely the most important part of the system given the fact that it is the final process in determining the overall quality of your distributed water. This portion of the SWRO plant requires more time than the rest of the plant in insuring proper water quality is being delivered. Permeate flow, changing calcium carbonate levels, and changing post treatment chemical levels all have an effect on how the post treatment system performs. My operators check post treatment water quality twice per day when the plant is running, and cistern water is checked daily when the plant is not running. Unfortunately, this does not seem to be happening on LSJ.

Jamaal worked on the post treatment portion of the plant on Saturday and found the chemical injection pump dosing over twice what it should be dosing which will cause an excessive amount of calcium carbonate to be consumed as well as poor water quality being delivered into the cistern. He also found the calcium carbonate reactor valve itself in the closed position probably due to the fact that with improper chemical dosing, the final product water was very high in calcium carbonate or hardness, so someone just figure that it would be best just to shut it off rather than properly adjusting the chemical feed. Unfortunately, this allowed for very low Ph water to be fed into the cistern which when one considers that the cisterns on LSJ are of concrete design, will cause damage through attrition of the cistern itself as well as cause a rise in hardness and conductivity of the treated water.

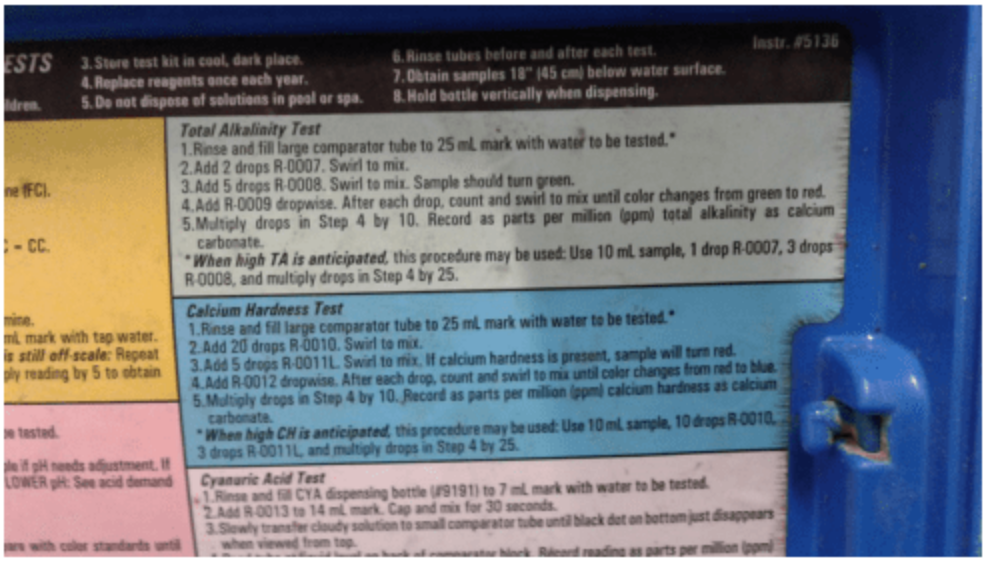
The first step in setting up the post treatment for Jamaal was to adjust the chemical feed pump with the calcium carbonate reactor in the by passed position until a Ph of 6 to 6.5 is achieved. Next he opened both inlet (bottom valve) and outlet (top valve) of the reactor and over the course of three hours slowly closed down the reactor by pass valve until an overall Ph at the post treatment sample port of 7.2 to 7.8 is reached. Then he checked the overall calcium carbonate level and found it to be 20 requiring only 2 drops of buffering solution to change the red solution to blue. We ordinarily look for 40 ppm of calcium in the post treatment water but because of the high amount of calcium currently in the cistern water, we opted to leave the level at 20 ppm.

There are also issues with the Shark post treatment conductivity / Ph monitor on the post treatment. The monitor would not calibrate properly and the readings from the device are incorrect. Jamaal used his hand held meter to test the final product water, and I would suggest that the LSJ staff do the same until this issue can be sorted out. Last, it should be noted that Jamaal was by himself on Saturday with Danny showing up later in the afternoon and having other duties to perform, so Jamaal had no one to show how to adjust the post treatment at the plant. Photos for documentation are below:

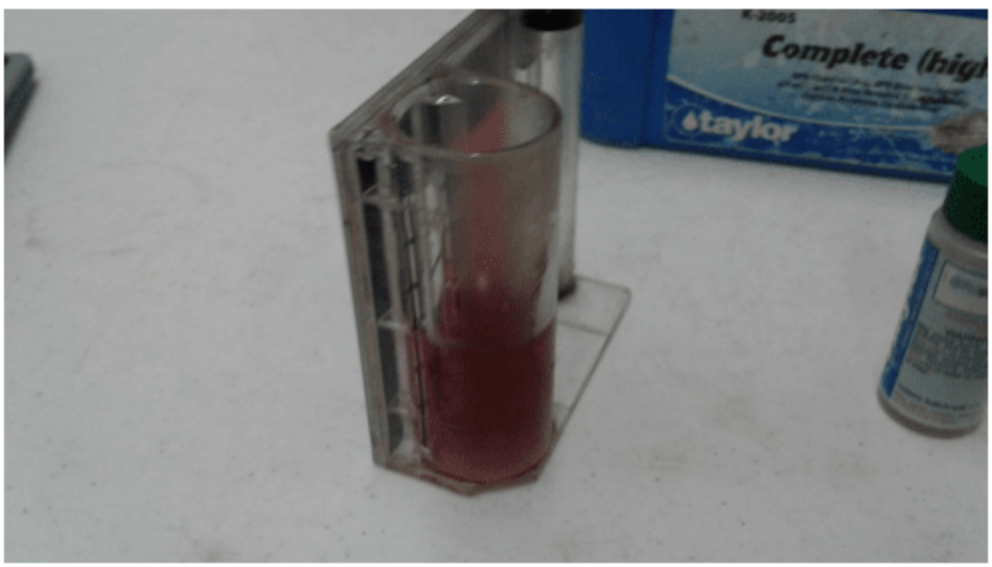
Post treatment Chemical Pump:

Post treatment chemical Pump at minimal setting:

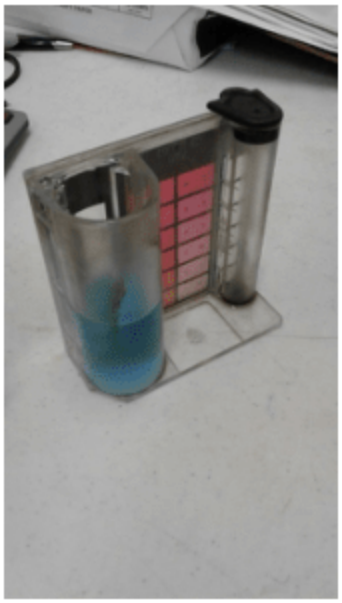
Calcium Test Instructions:



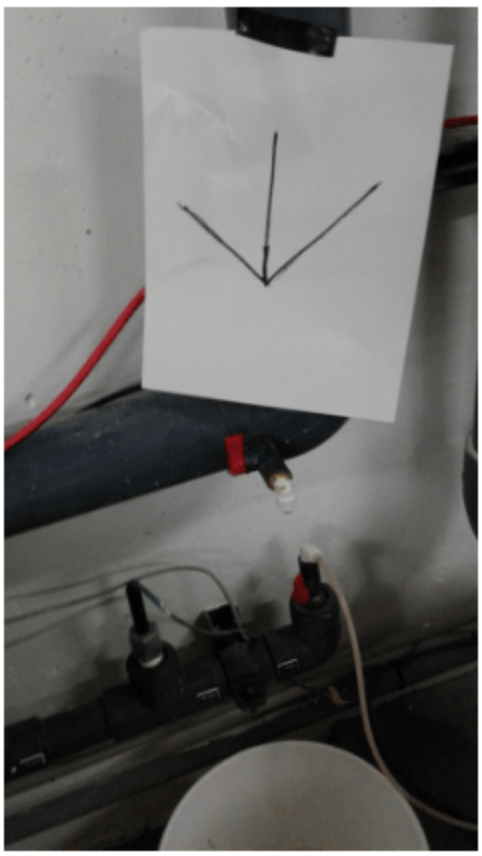
Calcium test steps 1-2:



Calcium test step 3: two drops = 20ppm as CaC03.



Post Treatment Sample Port:

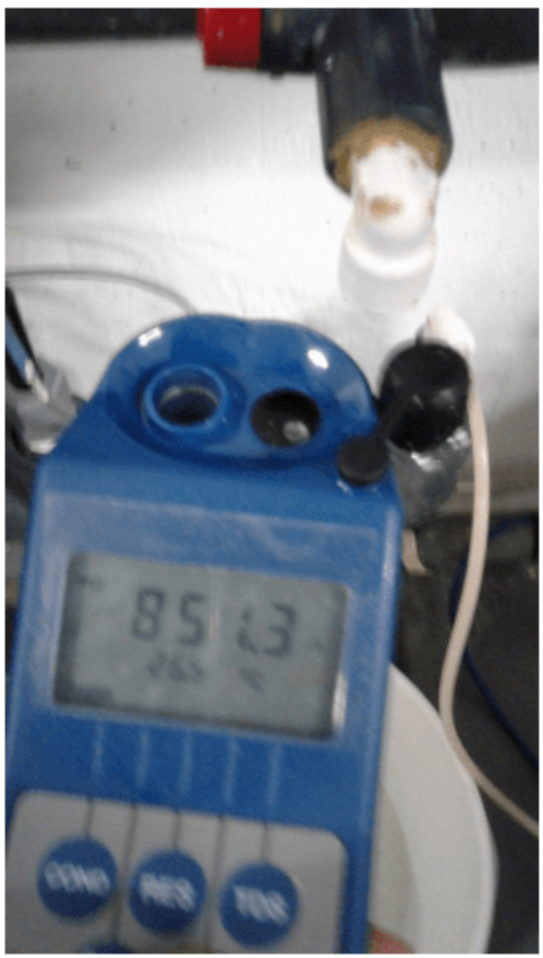


Ph Calibration solutions:

Trying to calibrate Post treatment Conductivity / Ph Monitor:

Post Treatment Ph final:

Post Treatment Conductivity Final:



In closing this service report, I highly suggest that steps be taken to hold the LSJ operators accountable for their actions. Data is being taken, but only when the plant runs. If the plant is off, nothing is tested. Post treatment water should be tested daily from the cisterns whether the plant runs or not. When the plant is running, Ph, and CaC03 should be tested twice daily with the results logged, dated, and signed. Water quality monitors throughout the plant should be calibrated monthly. The chemical solutions pictured above are from the plant, and were totally full. We were told that there were none at the plant but when Jamaal arrived, there was everything needed. It just had never been used before. Possibly set up a share point account online where the plant data can be monitored by the LSJ staff to insure what is necessary is actually being done. Preventative maintenance schedules need to be made up based upon manufacturer's recommendations and followed. Again with the operators being held accountable and documentation of the service being required. These items are absolutely necessary for the successful operation of a SWRO plant.

I will also at a later date submit items needed to be purchased by LSJ including a few tools, and testing equipment that is necessary for correct operations. We will also need to discuss what actions to take regarding the post treatment Cond. / Ph monitors.

Respectfully submitted,

Patrick Adams