

**BIRCH BAY WATER & SEWER DISTRICT**  
**Sanitary Sewer Lift (Pumping) Station 4**  
**Seametrics iMAG Installation**  
**by Mike Sowers, BBWSD Operations Manager**

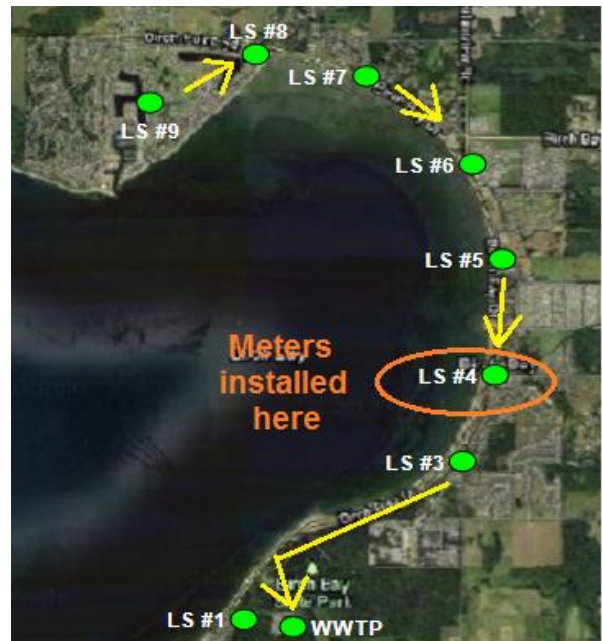
# BIRCH BAY WATER & SEWER DISTRICT

## Sanitary Sewer Lift (Pumping) Station 4 Seametrics iMAG Installation

### Background

Birch Bay Water & Sewer District is a special purpose district located in the northwest corner of Washington State. Located along the scenic shores of Birch Bay inlet, several sanitary sewer lift (pumping) stations safely convey wastewater several miles from the north end of Birch Bay around and down to the south end of the Bay to the Wastewater Treatment Plant (WWTP).

Lift Station #3 (LS #3) was the only existing pumping site with in-line flow meters. All other sites utilized volumetric calculations to determine influent and pumping flow rates. The problem with volumetric calculations is that they require many assumptions, accurate level sensors, and pump on/off cycles. (The most accurate calculations can be made when pumps are off and level/volume increases by X amount in Y time). During high flows, when pumps are on for indefinite periods of time, volumetric calculations are extremely inaccurate, yet this is exactly *when* the most accurate data is needed. Actual flow meters are the only viable option for good information.



### Purpose

The intent is to install permanent, accurate flow monitoring devices at each sanitary sewer lift station around the Bay. Accurate influent and pumping rates are important for several reasons:

1. **Pump performance monitoring** – One can monitor pumping rates to determine if wear, plugging, or other performance issues are occurring. This will allow the District to perform maintenance in a scheduled, predictable, cost-effective manner, before problems occur and it becomes an expensive emergency or public health event.
2. **Infiltration and Inflow (I&I), Basin Flow monitoring** – The WWTP is designed to handle a certain load and flow, based on expected wastewater flow from residents. All excessive flow above the expected amount as part of normal flushing and “down the sink drain” flow adds to the WWTP hydraulic load. If the flows exceed the WWTP NPDES permit rates, then the District must unnecessarily pay for expensive upgrades to the WWTP to accommodate the extra flow. High flows can also have detrimental impact on plant performance, with a potential for NPDES violation. Some residents have been known to plumb stormwater drains, rain gutters, and other illegal tie-ins into the sanitary sewer line.

There can also be some cracked joints, lines, manhole covers, and holes in lids that allow for water intrusion into the system. Thus, during heavy rain events, flows to/from each site and the WWTP jump dramatically, placing undue stress on individual sites and the WWTP. The District attempts to monitor flow into each area around the lift stations and where a particular basin area drains into a particular site. By monitoring “basin flows” and comparing to rain events and normal flows, the District can isolate high flow problems to certain areas and specifically target I&I reduction work in those areas. An example of the trending is shown in Figure 1. During a recent rain event (approximately 1” of rain), one can see that flows into basins 4, 5, and 6 increased significantly right at the time of the event. Thus, we know those three basins must be targeted to most efficiently utilize the money that is earmarked to make such repairs and improvements.

One estimate is that each \$1 spent on I&I reduction amounts to \$10 saved in capital/upgrade and maintenance costs: It’s well worth it to spend time and money on I&I reduction, and Seametrics iMAG meters are an important tool for the District’s arsenal.

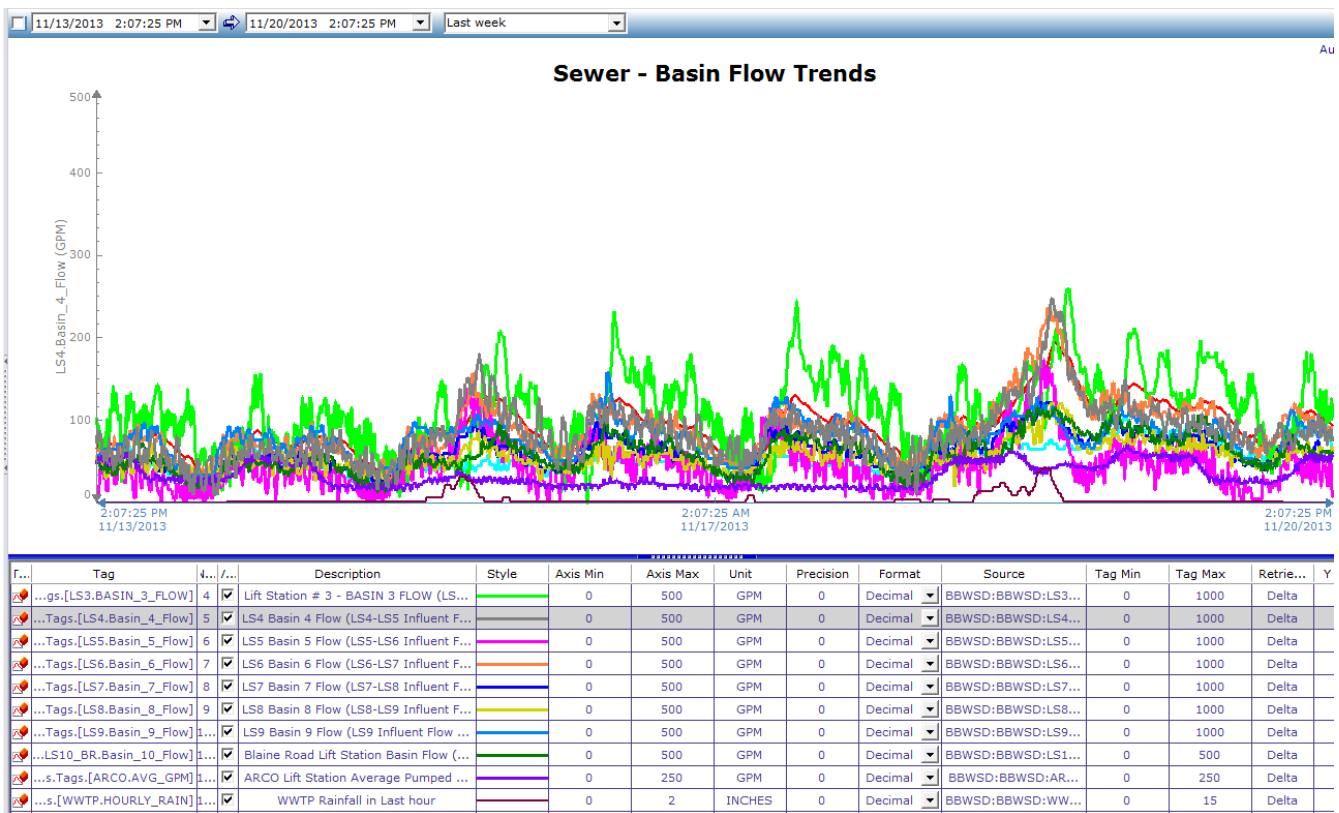


Figure 1 - Basin Influent Flow Trends

- Pump alarming/notification** – Similar to monitoring for maintenance and repairs, flow meters can be used as “proof” that the pumps are in operation and pumping. Taking it a bit further, alarms can be set at values at about 80% of expected flow rates, including those sites with variable speed pumps. When the alarm sounds, we know that we have an issue that requires immediate attention. Using the PLC and SCADA system, we can also plot the flow data in a real-time fashion on the actual pump curve on the computer screen. An example of one such site (a water pump station) is provided in Figure 2. The operator can click on the pump on the screen, and a pump curve pops up with the current point of operation (flow/pressure). It is very easy to identify exactly how the pump is performing against its design parameters.

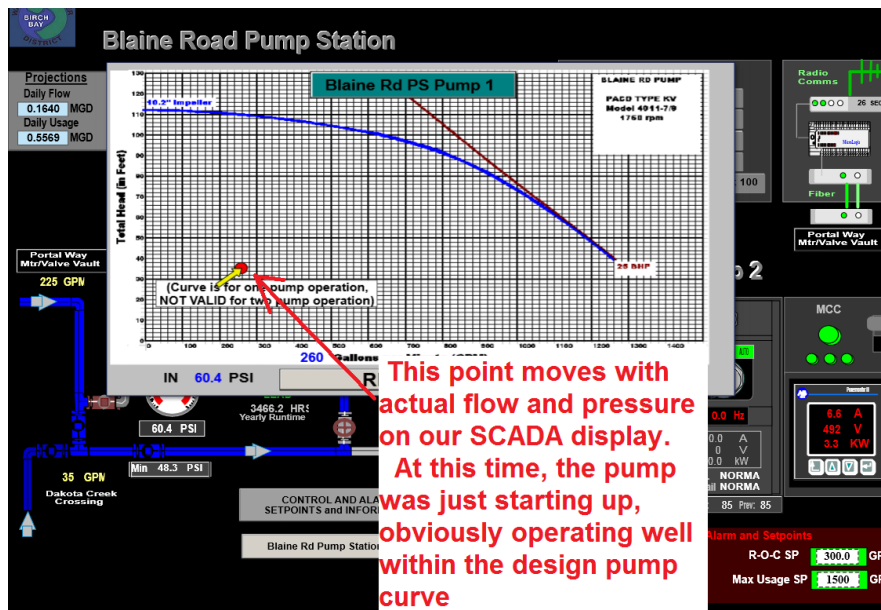


Figure 2 - SCADA screen with pump plotted real time against design curve

- Pump Control** – During extreme flow events or in situations during which downstream pumping capacity might be affected, we want the ability to clamp flow at a certain amount and utilize system “storage capacity.” For example, if we know that upstream sites are causing huge swings in flow into downstream sites (as they cycle on/off), we might clamp flow (put a flow limit) at a site that has a VFD (Variable Frequency Drive). In other words, instead of the pump now cycling from 600 to 1800 gpm on and off, we might “clamp” flow at 1200 gpm, and let the pump run at that flow for a longer period of time: this allows the wetwell level to cycle up and down a bit more than usual, keep flows smooth and consistent, and helps the rest of the system, particularly the process at the WWTP. An example is provided in Figure 3 (LS #3) below. This site has flow meters and VFDs. Using our SCADA system, we can monitor all events, clamp flow, and change the flow clamp as necessary, to provide for good, smooth, consistent flow into the WWTP.

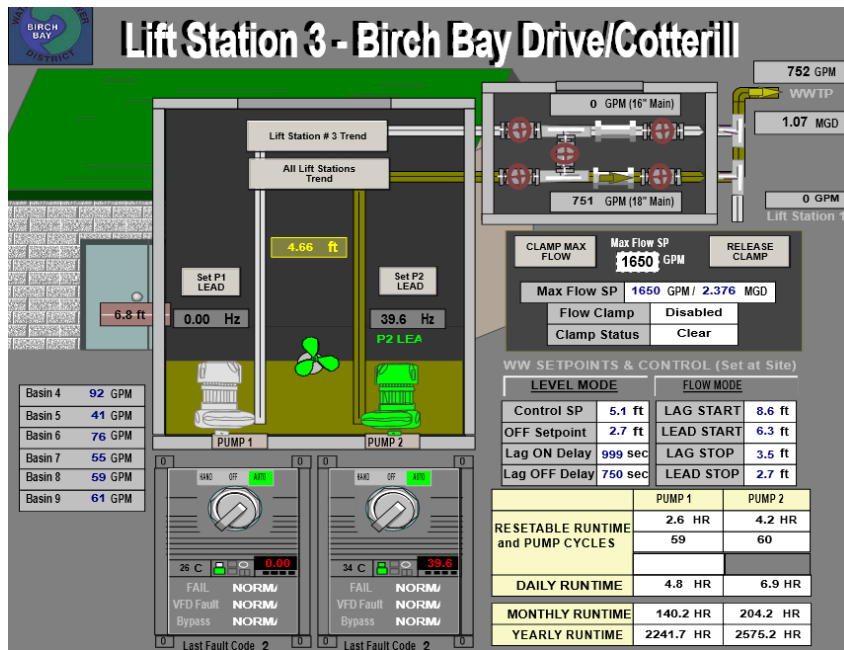


Figure 3 - Portion of LS#3 SCADA Screen to demonstrate Flow Clamp

Variable Speed Drives have already been purchased for the pumps at LS #4 (but not yet installed). Additionally, since LS #4 is the largest pump station without flow meters, it was chosen as the first location for flow meter installation. For the future, the plan is to move back from LS #4 to the site that feeds into it (LS #5), install the next flow meters there, and so on. If meters are installed at the rate of one to two sites per year, accurate flow data can be obtained at all sites within the next 5 years.

## Project

The original intent was to install an insertion type of magnetic meter that could be hot-tapped and that wouldn't extend so far into the piping as to collect strings and rags. It would be installed in a small vault at the point at which both lines from each pump merged into one line. By hot-tapping, there would be no issue with pumps being out of service for any length of time, and only one meter would be needed per site.

However, at LS #4 the piping is about 15 feet in the ground, which would require a significant pit. The fact that the site is right next to a stream, with associated environmental concerns and permitting, didn't help either. Therefore, we decide to go with the option of installing flow meters in each line (from each pump) at the site, within the valve vault. This does, of course, now require TWO flow meters per site.

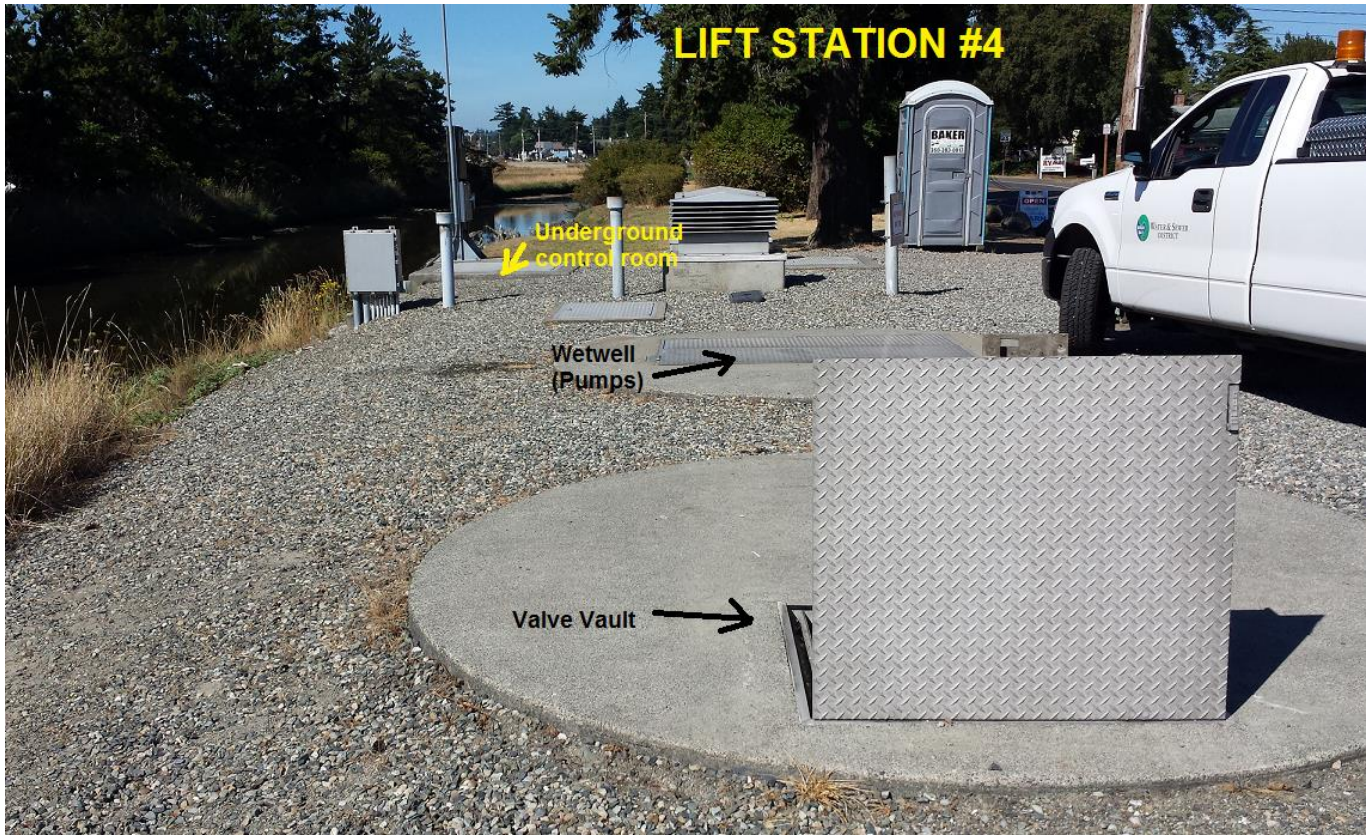


Figure 4 - Lift Station #4 above ground view

A discussion with Tom Philpot (Valin Corporation) revealed that Seametrics was offering a new line of iMAG flow meters and was anxious to get some units installed for testing, operational information, references, and field feedback. We eagerly agreed to install the meters as quickly as we could. A typical lift station drawing is shown below. The wetwell is on the right, the valve vault is on the left. The meters would be cut into the 8" ductile iron line between the check valve and the wall of the valve vault (between the pump and check valve.)

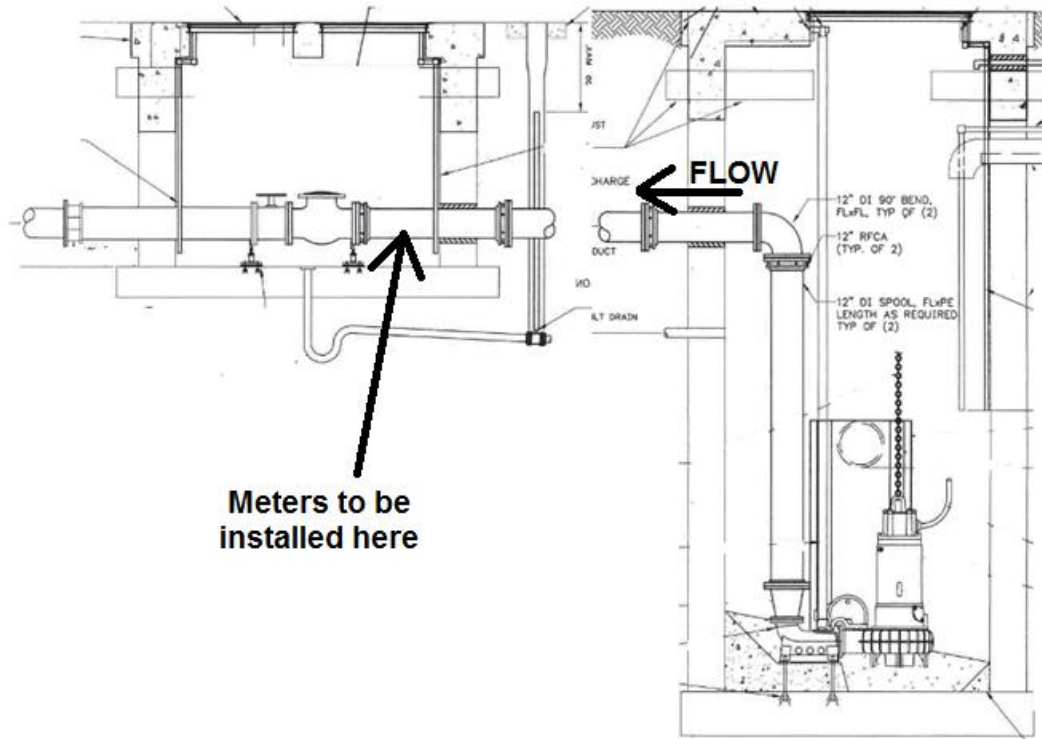


Figure 5 - Typical lift station



Figure 6 - Lift Station #4 Wetwell

There were some concerns about installing magnetic flow meters at this location:

1. They would be installed at one of the highest elevations in the pipe, so it might be susceptible to air bubbles.
2. We only had about 24" of piping in which to install the meters, so we could barely meet the minimum (1 pipe diameter) downstream pipe distance.
3. Check valves and isolation valves are immediately downstream: possible points of turbulence and potential flow meter inaccuracy sources.



Figure 7 - Valve vault piping BEFORE installation

Nonetheless, we were convinced that we could tune out potential issues and at least get a reasonably accurate flow indication which would be much better than our old method of volumetric calculations. We made the arrangements for the flow meters and necessary materials and launched into action as soon as the meters were received.

As there are about 30 feet between the control panel/room in which the indicators/transmitters would be mounted and the valve vault which would contain the flow meters, with ups and downs and twists and turns in between, the meters were requested with 60 feet of cable.





Figure 8 - Meters arrived

On their arrival, my first impression of the meters was that they were quite rugged. I served in the military for many years and the Seametrics equipment was similar in make and style to what I saw there. Definitely “mil-spec”: heavy duty cast metal, thick covers, very thick hard rubber lining; an overall beefy setup. It seemed as though one could drive over the top of the indicators or perhaps even bomb them and they would survive with hardly a scratch.



Figure 9 – Crew members installing Seametrics flow meters

Pipe cutting, fitting and flow tube installation itself only took about 6 hrs, in one day. Connecting, setting up, and programming the meters, PLC, and SCADA required a couple more days.



Figure 10 - Meters Installed

As one can see in the “Meters Installed” photo, the meters were installed and oriented as per the correct orientation shown in the manual: at a 45 degree angle (for proper electrode orientation).

The transmitter/indicator units were mounted in the control room area (we call it the “drywell”) next to the Main Control Panel. Programming was intuitive: It was no problem to just go through the front-panel menus to set it all up, one of the easiest-programming devices that I’ve ever dealt with.



Figure 11 - Indicator Displays

The control panel contains an Allen-Bradley ML1400 PLC, various terminal strips, SCADA radio, front panel switches. It was easy to utilize compression grip fittings to route the wiring into the panel and tie into the PLC via terminal strips in the panel. Both the analog output and the pulse output were connected to the PLC and scaled and programmed for rate and total. Pulse output for the totalizer was set at one pulse per 1000 gallons (based on the fact that the maximum pump output is about 2000 gpm). A 4.7Kohm resistor was used for pull down resistors for the PLC input.



Figure 12 - Control panel and Flow Indicators

The flow meters were specified to be 24VDC power as the Control panel utilize 24 VDC control power, backed up by two 100 AH batteries: Enough back-up power for over 30 hours during a power outage. Plus, the 24VDC set-up provides a secure buffer/power spike protection for the PLC, flow meters, accessories, inputs/outputs.

After programming the PLC, the touch panel on the control panel was then programmed for a visual rate and flow total, and, the values were transferred to SCADA for remote data and monitoring: Most personnel will never have to open the cover on the flow meter indicators as the front panel display is easier to read and is more accessible, but the Flow meter indicators are there, nearby, if we do need to see them. We can also compare the local display to the touch panel display to verify numbers: rate and total values should match up. If the numbers don't match up, then we have an issue somewhere and can troubleshoot accordingly.

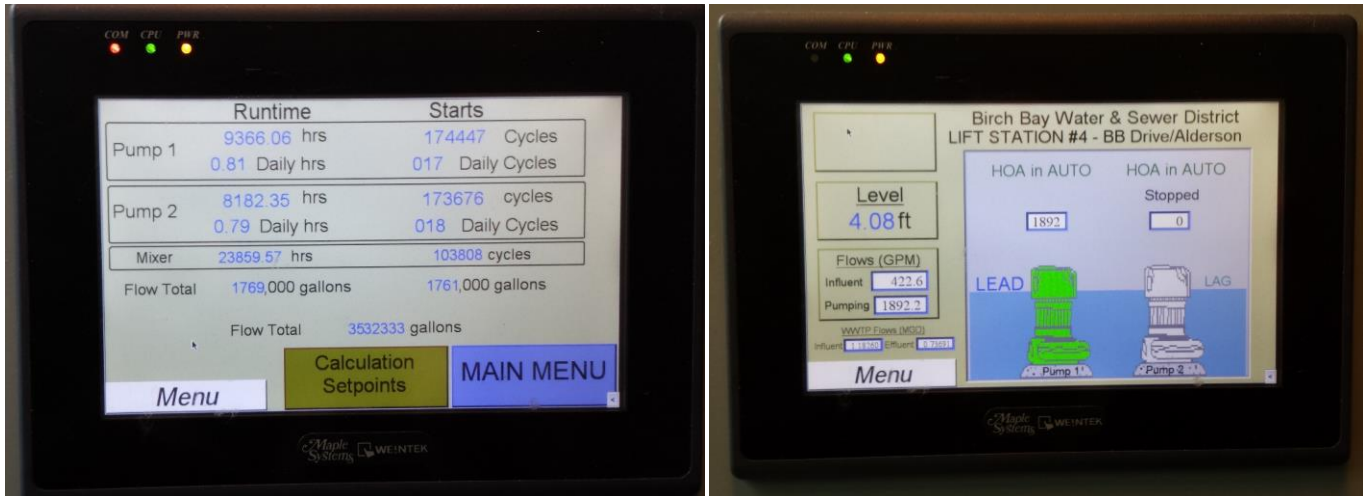


Figure 13 - Totalizer and Flow Values Displayed on Local Control Panel Touch Panel

After the local indications were set up and verified, SCADA was then programmed for the same points, with values now displayed on the graphic display for that site. Influent rates were also reprogrammed and re-calculated to include the actual pumped values, which makes the value more accurate than just the former simple volumetric calculation based on wetwell level increase/decrease by itself. (Influent flow is shown as “influent Rate” in the upper left side of the SCADA display, Figure 14)

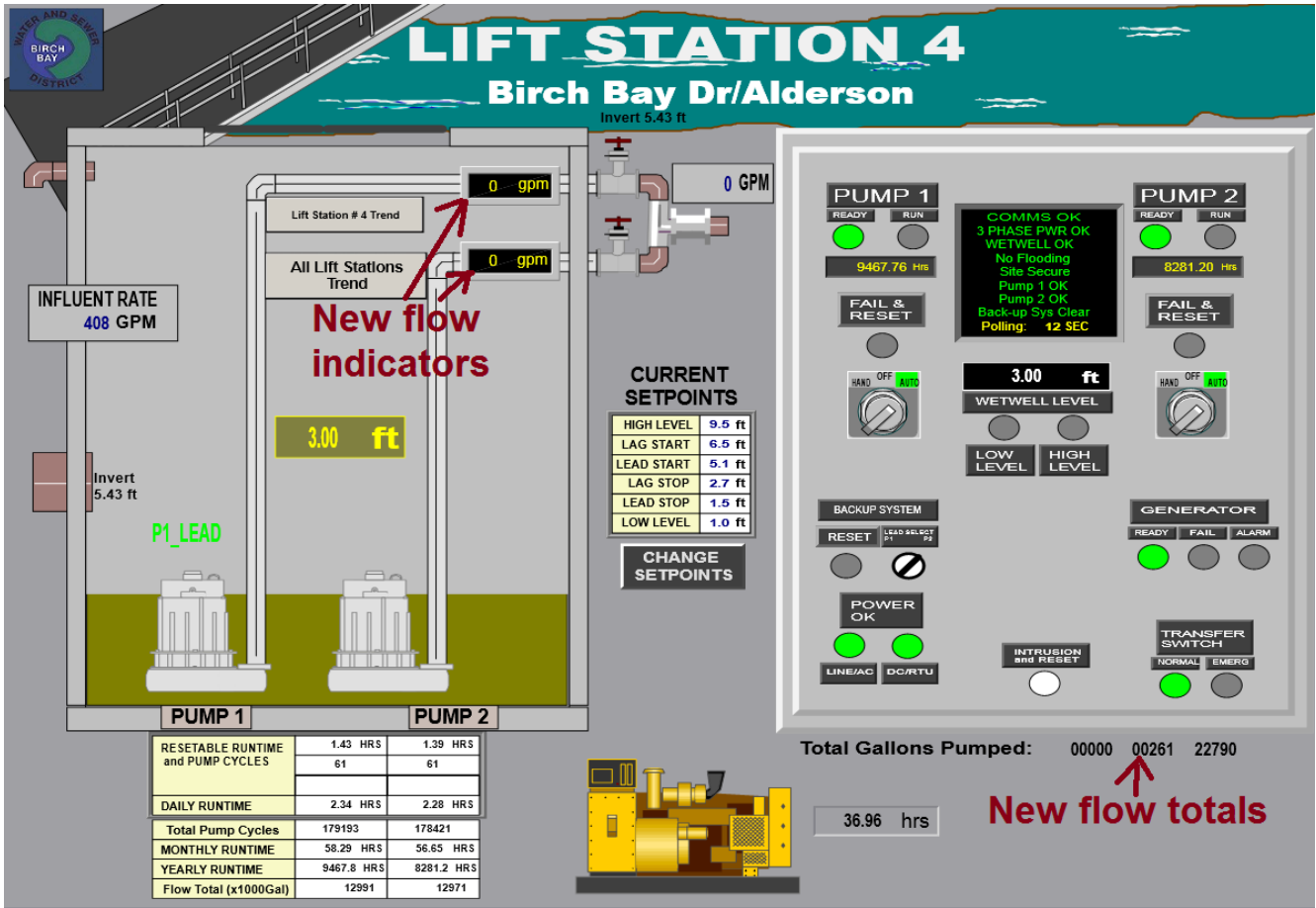


Figure 14 - SCADA Display with new Flow Rate and total indications

The points were also added to SCADA history for data collection and trending. In the history trend below, we can see that Pump #2 is not performing as well as pump #1 as its output is about 50 gpm less than Pump #1. Not a big issue right now, particularly when it's only about 2% of maximum capacity, and, the pump was verified to be clean (not plugged, no buildup). But if the situation degrades, we'll definitely have to look into it further.

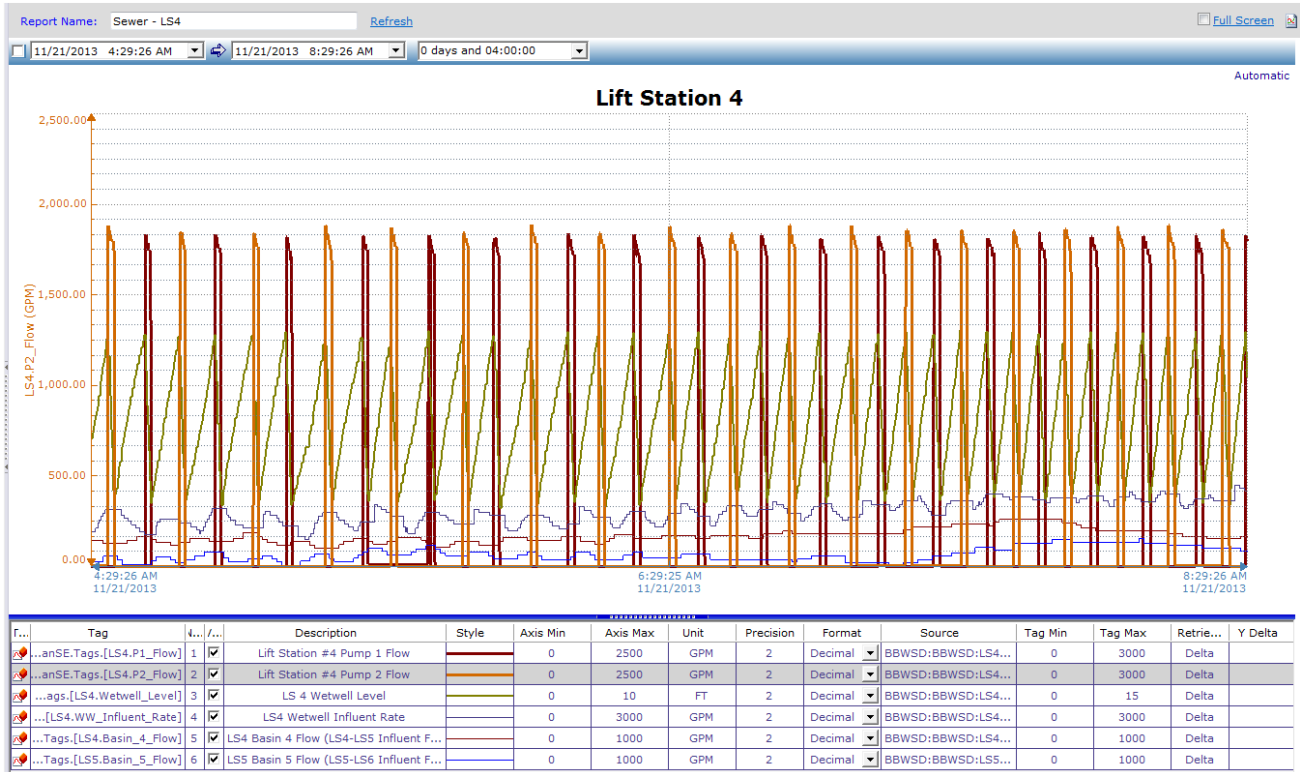


Figure 15 - Four hour SCADA trend of Lift Station 4

When zooming in on the SCADA trend for lift station #4 (going from 4hrs, down to 30 minutes) one can see how accurate and sensitive the meters really are: When the pump(s) start(s), wetwell level is high, thus pump inlet head is high and pumped flow rate is also high. As the level drops, inlet head drops, and thus pump output drops. By the time that the level drops to the shut-off setpoint, the pump output has dropped by about 200 gpm. This in itself is very useful information, as we now know that as the wetwell level increases, especially during heavy rain and flow events, we can expect much, much more flow from these pumps than what we normally observe. I would have estimated a hundred gpm difference or so (with wetwell level change between on/off setpoints), but based on these figures, if level goes up to and or above the wetwell high level, we can expect as much as 300 gpm more flow per pump.

Of course, during the high flow events, we can now monitor the pump output on a real-time basis and can quickly catch any pump performance degradation issues, before the issue becomes an emergency.

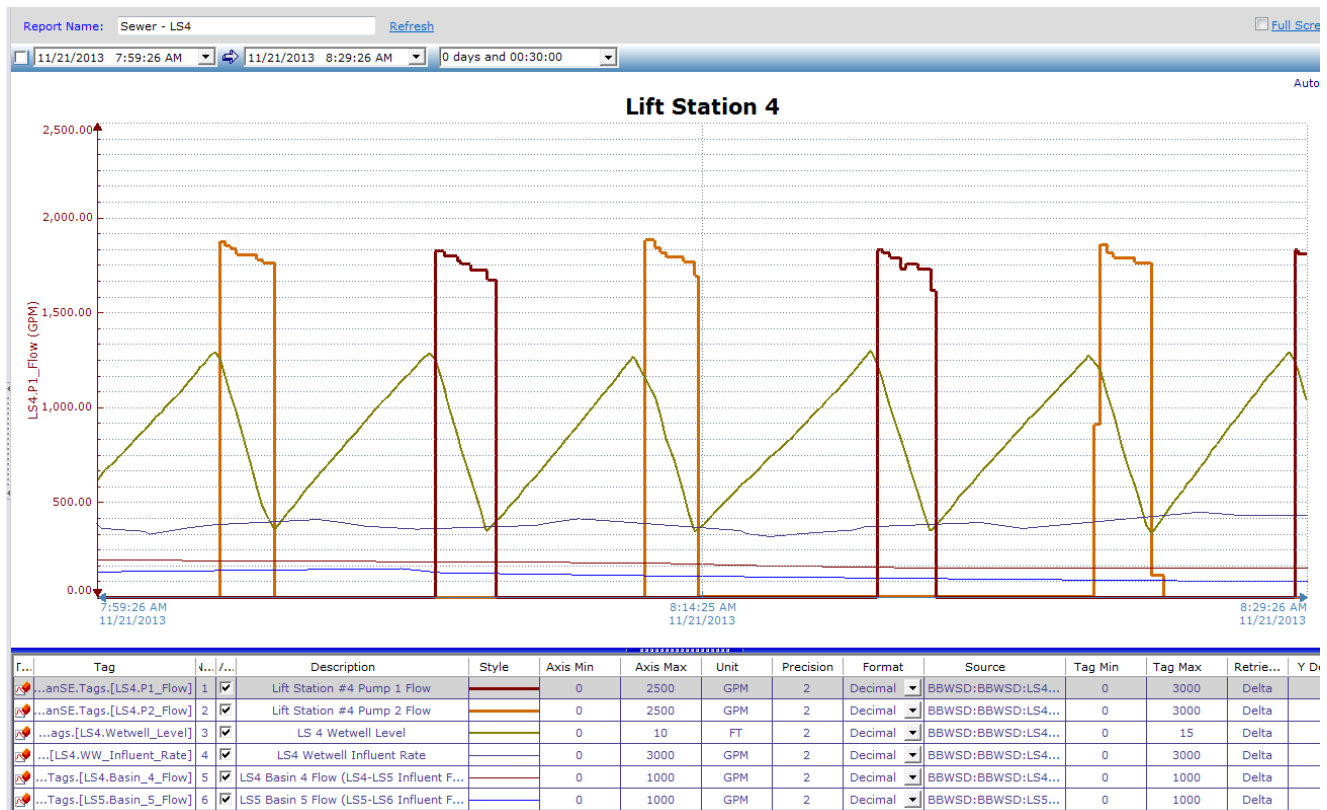
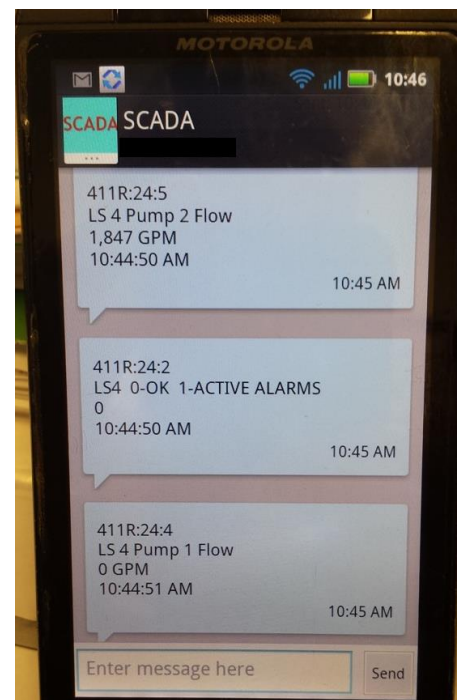


Figure 16 - 30 minute SCADA trend of Lift Station 4

Finally, the points were added to our remote alarming & texting software, such that we can access the data from anywhere, simply by texting. No matter where our personnel are in the field, and especially during emergency events, all they have to do is query the site and they receive operational information, including the level, flow, and alarms, via texts. With such a small staff, especially during bad weather, this information is critical.

As far as meter sensitivity is concerned, we're seeing flow rate changes in the order of 2-5 gpm at flow rates of 1800+ gpm; Very remarkable! In regards to concerns about air bubbles, I purposely left dampening on the next-to-lowest setting to see if we had any issues. Then if we did have issues, I would increase dampening to cover and average those dips/spikes. What I've found is that when flows are extremely low, and the pumps are off for 20 minutes or more, we do have some very rare, dips/spikes in flow as the pumps start: this indicates that the check valves might be leaking ever so slightly, or, that air is building up in the line. As I have only observed this 3 or 4 times in the last 4 weeks, it's obviously NOT an issue. And if it was, again, I would adjust dampening to cover & average those anomalies. So far.... So good, though! Very pleased!



# Summary

## **Impressions of the iMAG-Series:**

1. Rugged, "mil-spec," bomb-proof. Would expect this to last for a very, very long time.
2. Intuitive set-up. Easy to program!
3. No plastic button or switches that will wear out over time.
4. Accurate, sensitive: they work in an unforgiving location.
5. The flip-down metal cover over the top of the indicator displays for added protection is an excellent idea.
6. Easy to install and program with "in-house" personnel: saves money.
7. Would definitely recommend these meters.