CITY OF PUEBLO RECLAMATION

TRUSENSE S330 TEST SITE

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Overview:

The City of Pueblo, Colorado is located at the confluence of the Arkansas River and Fountain Creek, 112 miles south of Denver, Colorado. With a population of over 160,000 people in its Metropolitan Statistical Area, it ranks ninth among Colorado cities.

The Test Site location is at the Nature & Wildlife Discovery Center, located in Rock Canyon along the banks of the Arkansas River. The mission of the Center is to provide unique experiences in education, conservation and recreation in environmental stewardship. In 2016, the Raptor Center admitted 372 raptors and released 100 back into the wild.

The test site selected at Pueblo Nature and Raptor Center is a Wet-Well (Lift Station). The wet-well contains two digester pumps (Lead and Lag pumps) to maintain levels in the wet-well from 2.2 feet to 3.2 feet. The current controller (DigiGauge 2300) uses a problematic Bubbler system (Differential Pressure) for level feed back used to control the pumps to maintain programed levels. Since this site is designed to run autonomously, for redundancy, a mechanical float system is in place at over alarm height and low well alarm levels that will send an alarm to the office if they are detected.

The current controller in addition to the bubbler system has a 4-20mA input. A S330 will be used to replace the bubbler system for level measurement input.

There are 4 objectives for this beta site: 1) integration to existing standalone controllers, 2) ease of setup, 3) sensor data collection for later evaluation, and 4) environmental operation.

Integration of the S330 into the control system

System Components

The reason for this system is to collect waste water from the park and park restaurant, then lift the waste water to be processed. Current system components are two digester pumps, DigiGage controller (Bubbler system feedback), remote cellular system, and a mechanical float system as backup level control.

The Wet-Well dimensions are approximately 8 feet in diameter and 10.5 feet deep. There are three pipes that drain into the Wet-Well from the park's facilities. See photo 1

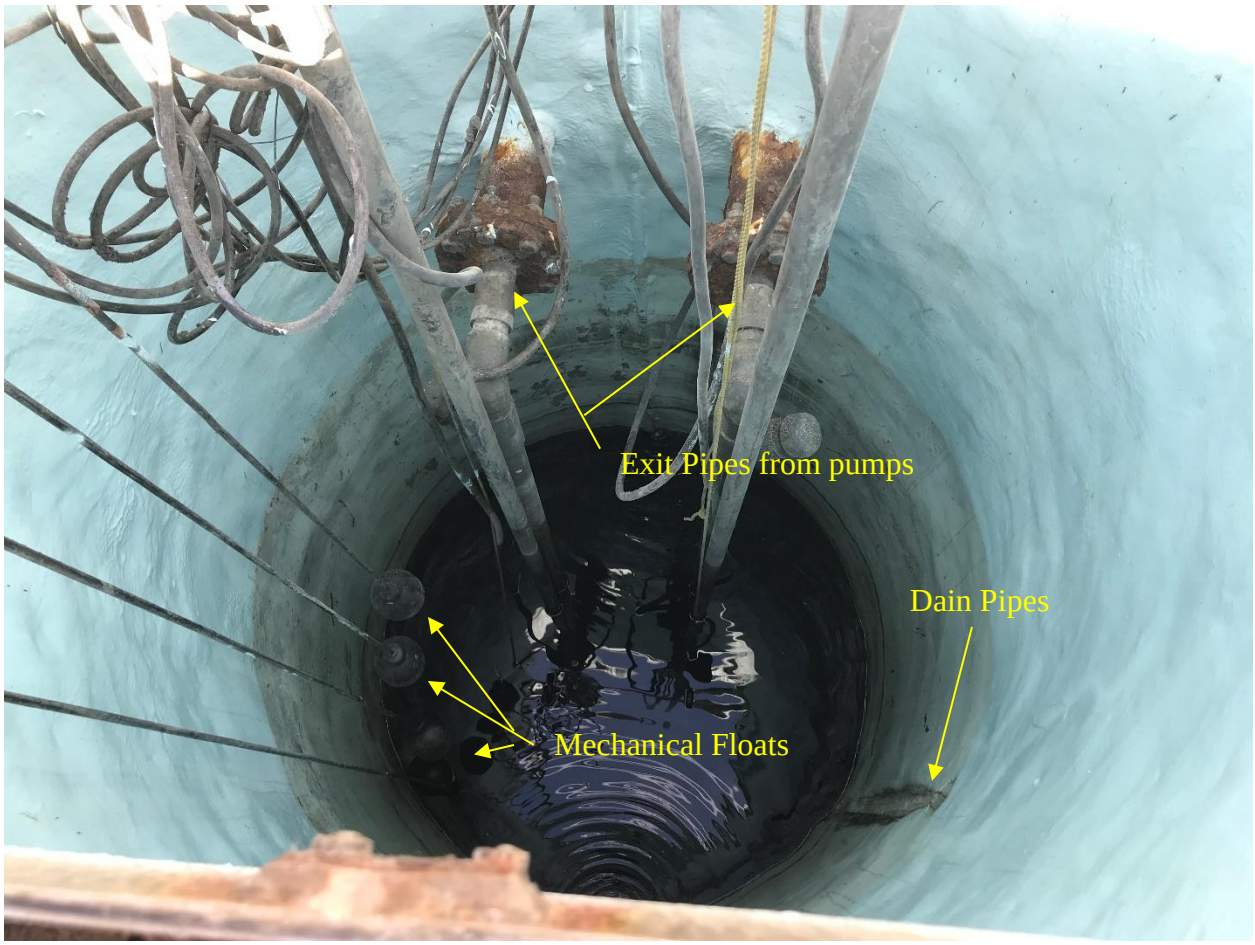


Photo 1

Critical Set Points

The objective is to allow the wet-well to fill to a predefined height and then lift the waste water from the wet-well to be processed. To prevent the pump(s) from running dry, when the level gets down to a predefined level the pump(s) should turn off. During normal pump-down operations only one pump (Lead pump) is required. The second pump (Lag Pump) is used during high demand effluence filling.

If the system moves out of bounds of the control levels for any reason, there are Over and Under alarm points. Once a critical alarm level been detected, the cellular system will phone home to alert that a critical level has been met.

- Lead pump on = 3.2 feet
- Lag pump on = 4.2 feet
- Lead & Lag pump off = 2.2 feet
- Over height alarm = 4.5 feet
- Low well alarm = 1 foot

Integration Considerations

To integrate the S330 into the system a bracket was made for mounting the sensor in the Wet-Well on an existing angle iron support (See photo 2). The shielded cable that comes with the S330 was used to connect the sensor to the control panel via an existing pipe leading from the Wet-Well into the control panel. See Appendix A for detailed setup.

Setup in System

Setup was made quick and easy using the 4-20mA Setup software provided by Laser Technology.

The next step was to reprogram the DigiGage to use the 4-20mA loop input to replace the bubbler system input.

After the sensor and DigiGage were configured, a data collector was attached to capture the RS-232 measurement data for later evaluation.

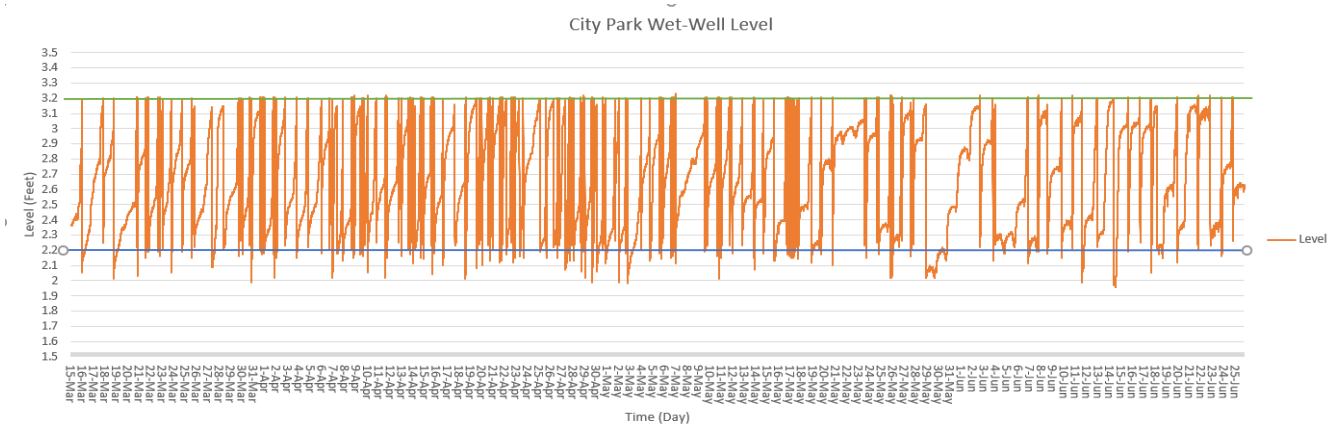
The final step, after verification of the system operation, was to allow the DigiGage control of the system. The system has been currently running since March 5, 2019 and as of the printing of this paper in October 2019, has continued to run without any alarms of failures.


S330 and mounting bracket.
Note: Customer recently replaced the vise-grips shown in photo with mounting screws, as the vise-grips had significant corrosion; the S330 showed no signs of corrosion.

Photo 2

Sensor Data Evaluation

The below graph's (Graph 1) time line is from March 15th through June 25th .

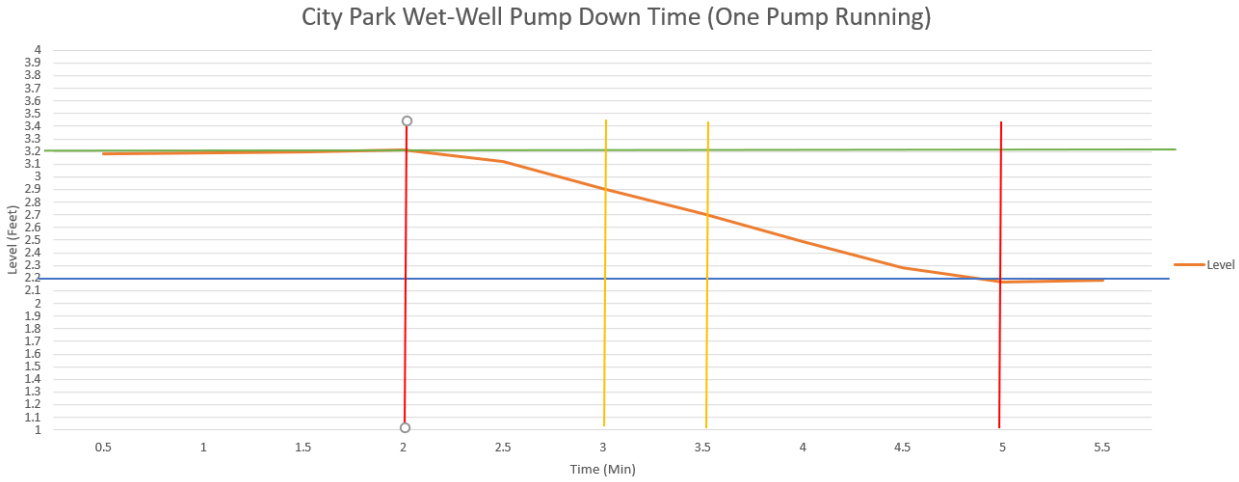


Graph 1

The green horizonal line is the lead pump turn on point (3.2 feet). The blue horizontal line is the lead/lag pump turn off point (2.2 feet). The orange line is the distance output of the S330.

First two things to note is at no time the system was out of control (Alarm point met) and only the lead pump was used during this time period.

Inflow into the Wet-Well is controlled by park usage and outflow (pump-down) is controlled by the Lead/Lag pump volume. Since the difference of inflow is much less then outflow, the outflow time does not noticeably vary from pump-down cycle to pump-down cycle. The below graph shows one pump-down cycle (Graph 2).

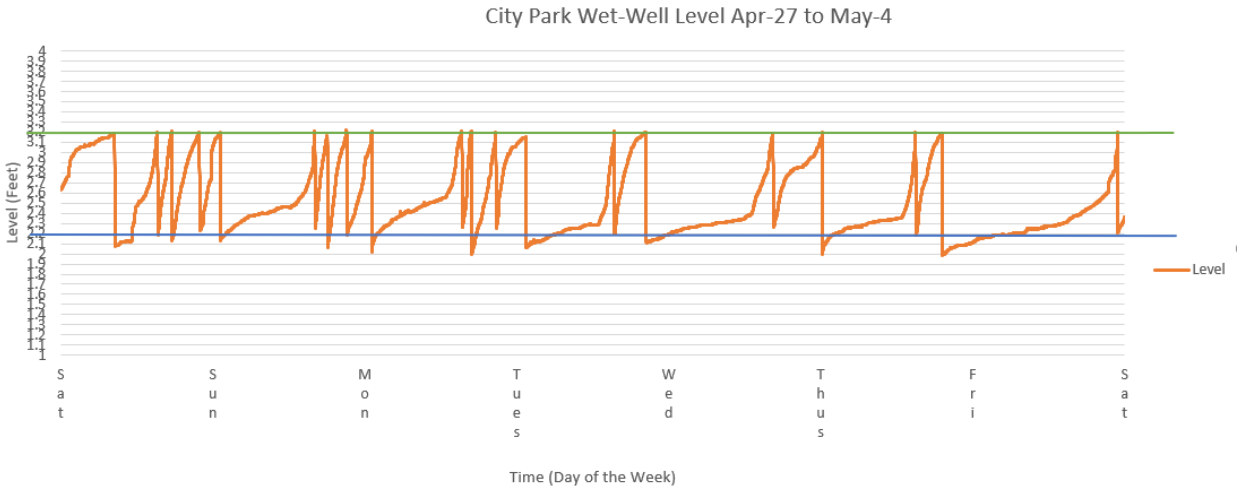


Graph 2

The green line represents the lead pump turn-on and the blue horizontal line represents the pump turn-off . Between red vertical lines is one period the pump is on which is about 3 minutes (Pump-down from 3.2 feet to 2.2 feet = one pump-down cycle). Where the yellow vertical line intersects the orange measurement line defines one 30-second interval. The level rate of change is about .2 feet every 30 seconds.

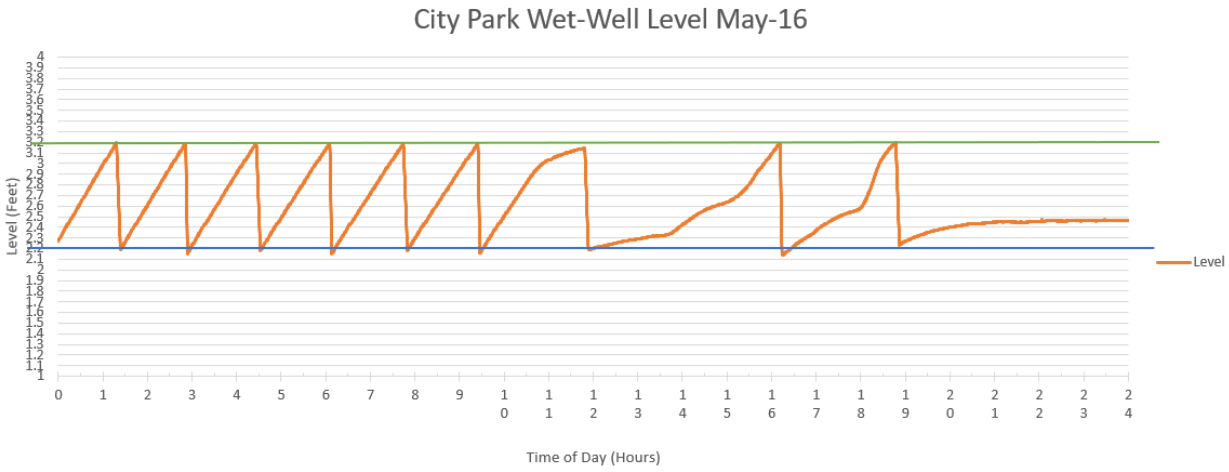
During setup, the 4-20 loop update was set to a 30 second update interval per the customer request.

In both Graphs 1 and 3, the pump turn-on points (green horizontal line) are very repeatable, and the pump turn-off points (blue horizontal line) vary up to .2 of a foot. This is directly attributed to the slow rise time and fast fall time in relationship to the loop update period. Since the rise time is slow, in 30 seconds the level does not change much. During a pump-down, a 30 second delay can equate up to a .2 of a foot variance in levels before the pump turn-off.



Graph 3

A closer look at May 16th was a high usage day. Graph 4 show the day starting with a fast fill rate from 12am to 7pm, followed by a slow fill rate.



Graph 4

Environmental Operation

The sensor was installed about 6" under an aluminum lid that covered the wet-well. It is exposed to Hydrogen Sulfide (H_2S) gas which is very corrosive.

During the testing the sensor was exposed to temperatures ranging from about 32° F to 105° F. This is based on the open-air temperatures during the testing period.

After continued operation from March 10 to August , the sensor showed no signs of corrosion and continues to work fine as of the printing of this document in October 2019.

Summary

This beta testing has proven the S330 is a very capable non-contact level sensor in an enclosed environment. The best advantages the sensor has are ease of setup, ease to maintain with minimal downtime, and able to work in corrosive liquids environments.

In the waste water industry, the S330 would integrate well since it is non-contact and not subject to failure in contaminated water like Bubbler systems or pressure sensors.

In conclusion, the S330 has proven that the sensor can hold up in a corrosive environment and provide to be a reliable level measurements sensor for information and/or control of a system. The sensor also proved to be very repeatable over time.

Leveraging the 4-20mA loop, the S330 can directly replace aging unreliable measurement systems currently using the 4-20mA communication loop.

Appendix A: Wet-Well Site specifications:

S330 recommended setup parameters and hardware LTI to provide customer site testing:

- TruSense S330 in case Serial number DS005693 Firmware 1.14-113.
- LTI to manufacture custom fixture(s) for sensor location.
- $MM,4 HighSpeed measurement mode
- $DM,5 First Target
- MU,f Measurement units in feet
- $OS,2,1,0,30 Median filter, 1 second block,0, 30 sec per measurement output to loop.
- $FT,10.5,0,0,240,1 4mA=10.5 feet, 20mA=0 feet, Update =0, Error current 3.5mA @4mA and 24mA @20mA, Number of measurements=1
- $UO User offset to be calculated to account for floor thickness and LTI fixture
- Power to sensor:
    - Provide 19.5 VDC Loop power
    - 12VDC power supply for sensor power.
- Attach data collector to capture the RS-232 data for later review.

City of Pueblo to supply for setup of Site testing.

- Required tools for Calibration of Digigauge 2300 Loop calibration.
- 110 AC for loop power and sensor power hookups.
- Make available a loop receiver on the control panel for the beta testing period.
- Critical Set Points
    - Lead Pump on = 3.2 feet
    - Lag Pump on = 4.2 feet
    - Lea & Lag pump off = 2.2 feet
    - Over height alarm = 4.5 feet
    - Low Well alarm = 1 foot (Panel will phone home with a low-level alarm)
    - Sensor 4 mA = 10.5 feet (Panel will phone home with a high-level alarm)