

Precision Hydromet Instrumentation



Presenters

- Michael Watt, Host
- Kerry Hubbard, YSI
 - Outdoor Water Monitoring Specialist
 - Decade of HydroMet monitoring experience
 - Passion for urban hydrology

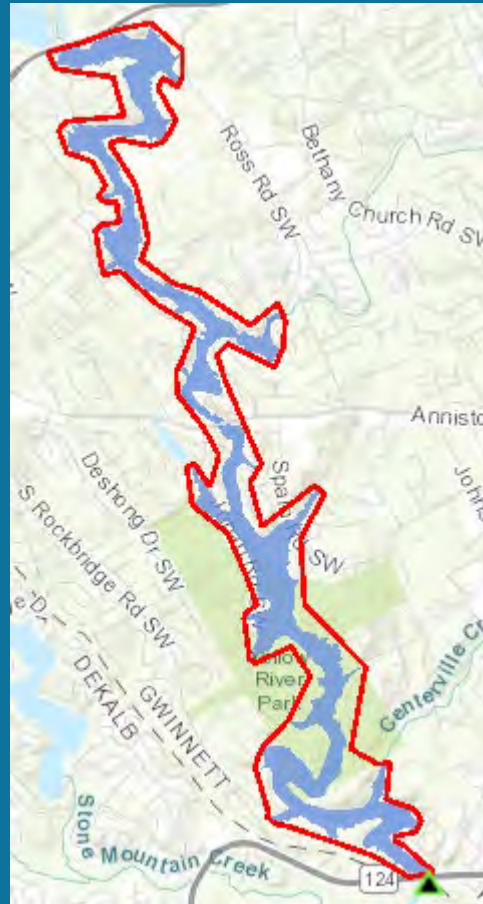
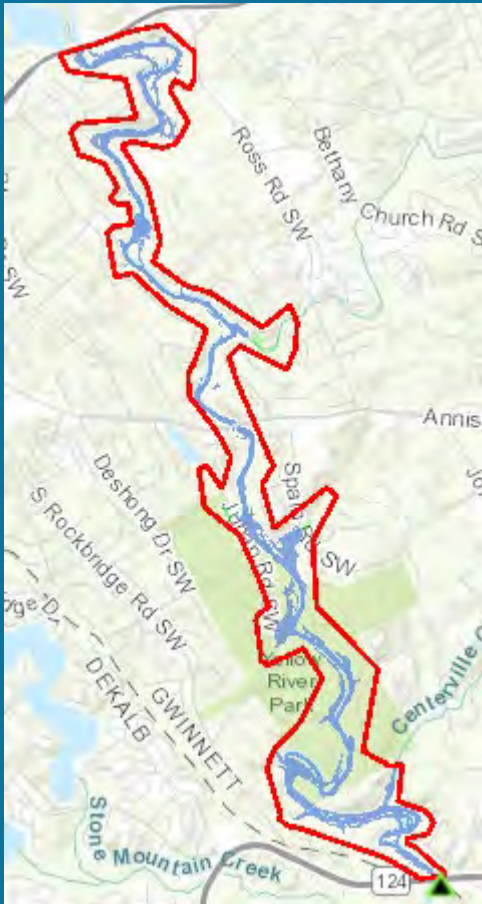


Transmission Order

- Submersible Pressure Transducers
- Shaft Encoders
- Amazon Bubbler
- Nile Radar
- Storm 3
- HydroSphere

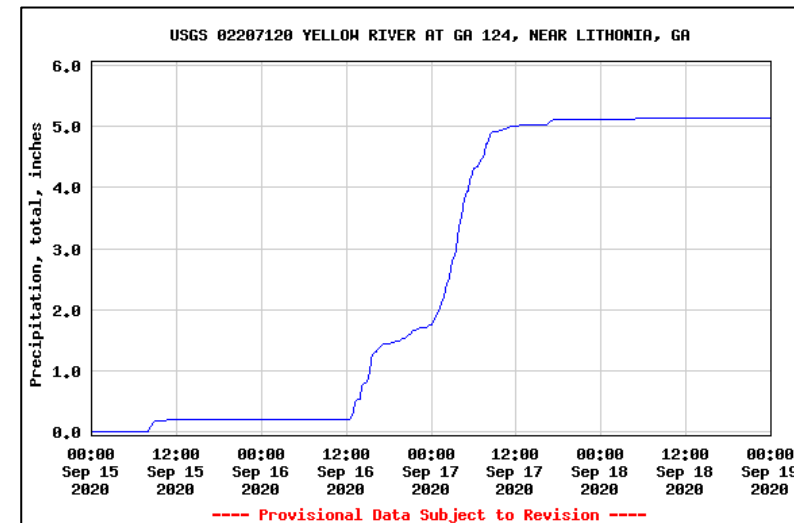


What is HydroMeteorology?



USGS

- Combines meteorology and hydrology
- Studies transfer of water between land and atmosphere
- Example:
 - Meteorologist forecasts 5" of rain
 - Hydrologists model impacts on rivers

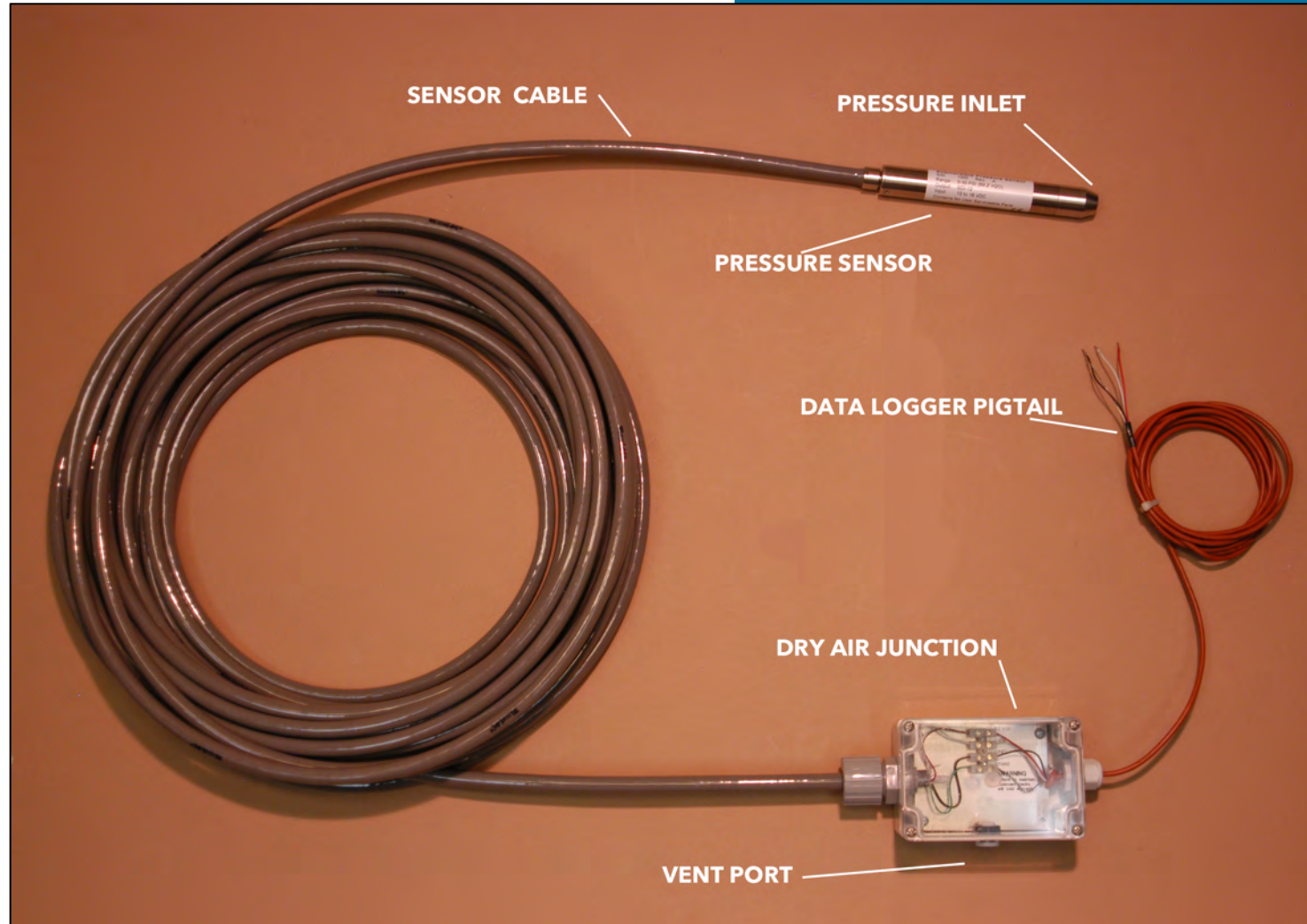


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Submersible Pressure Transducers



Pressure Transducer Anatomy



Pressure Transducer Advantages

- Vented cable provides on-site barometric compensation
- Very high accuracy
- Stainless steel design
- Dry air box to keep vent tube dry

- Must be deployed in a no-flow environment
 - “Stilling Well”
 - Groundwater wells
 - Stand pipes



How It Works

- Set up in stilling well/sand point/well
- Sensor measures water pressure
- Compensates using air pressure
- All calculations performed internally



Applications: Irrigation

- Image from deployment in Europe
- Transducer mounted in stilling well
- Very accurately measuring baseflow and flooding conditions
- Also able to monitor amount of water used by agriculture



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Sensors – Shaft Encoders

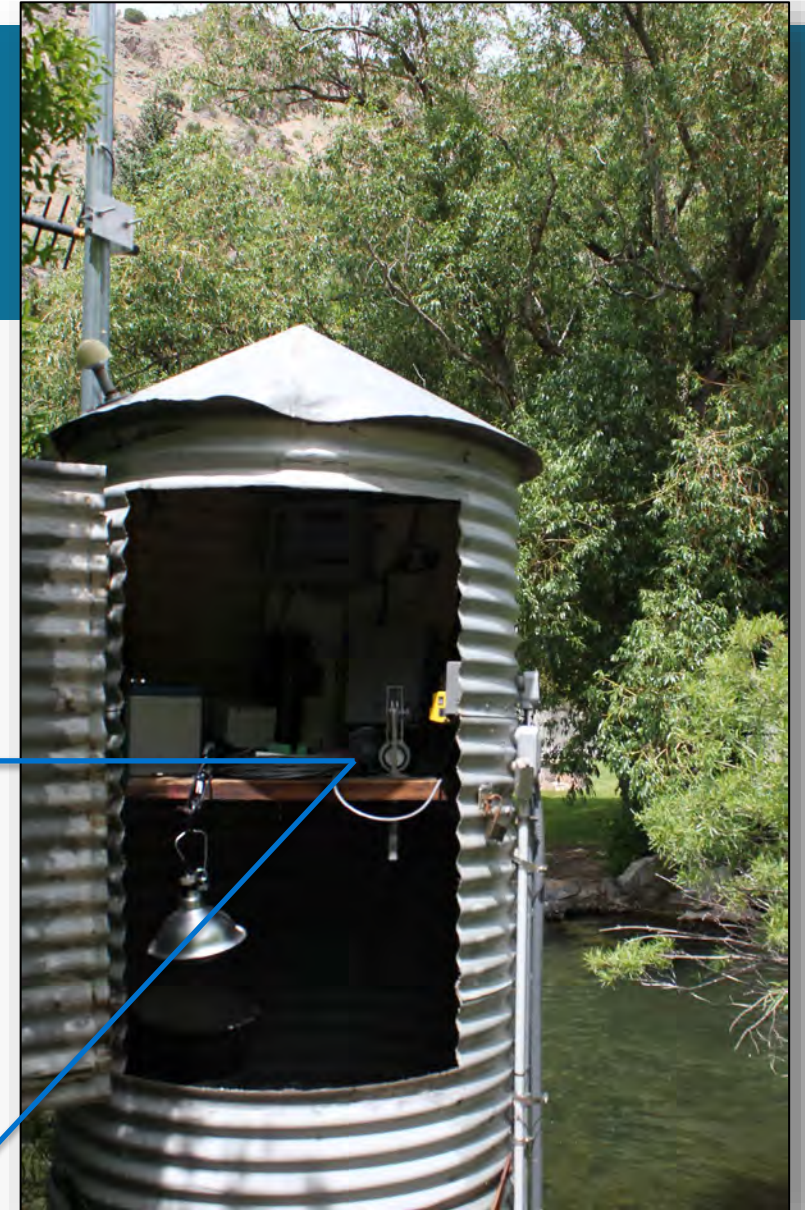


Shaft Encoder Anatomy



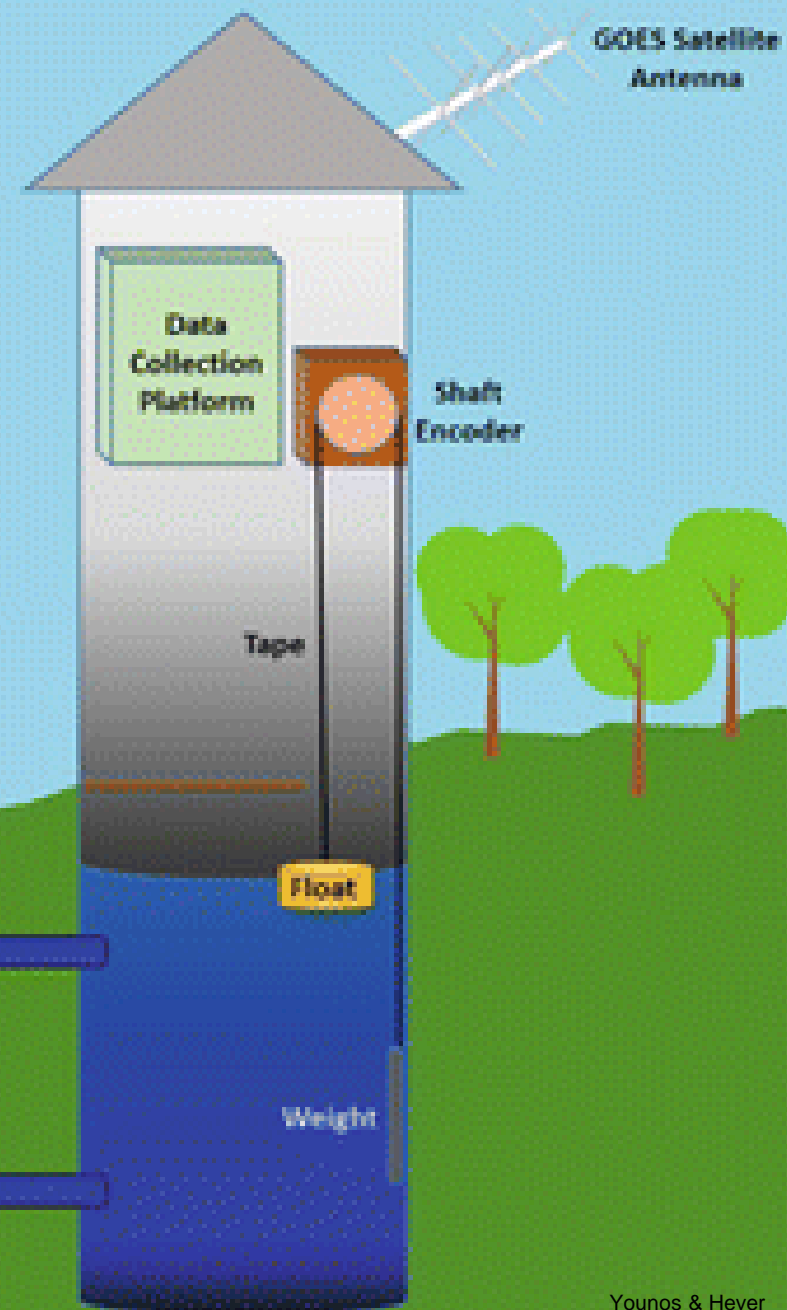
Shaft Encoder Advantages

- Non-Contact Optical Encoder
- Position Not Lost
- Threaded Shaft Compatible with Other Pulleys
- Ideal deployment in stilling wells
 - Not ideal for turbulent environments



How It Works

- Set up in stilling well
- Float rises, pulley turns
- Non-contact encoders determine angle
- Barcode read with optical encoder
- Turns counter counts revolutions



Applications: Irrigation Districts

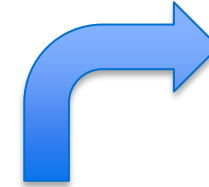
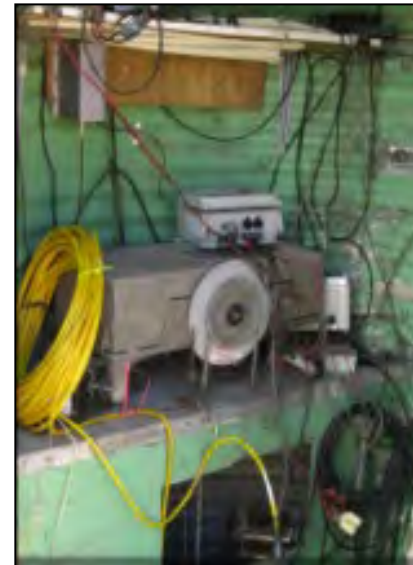
- Del Rio, Texas – Water Rights
- Water level correlated to rating
- Farmers cannot use more than their share
- More accurate than just measuring opening of a gate



Water Monitoring Solutions

Applications: Early Warning

- Alameda County, California
- Water rights, habitat sustainability, inflow/outflow of surface water, flood control management
- Old equipment made gage house cluttered! Hard to maintain equipment.
- New equipment = easier to maintain → BETTER DATA



3

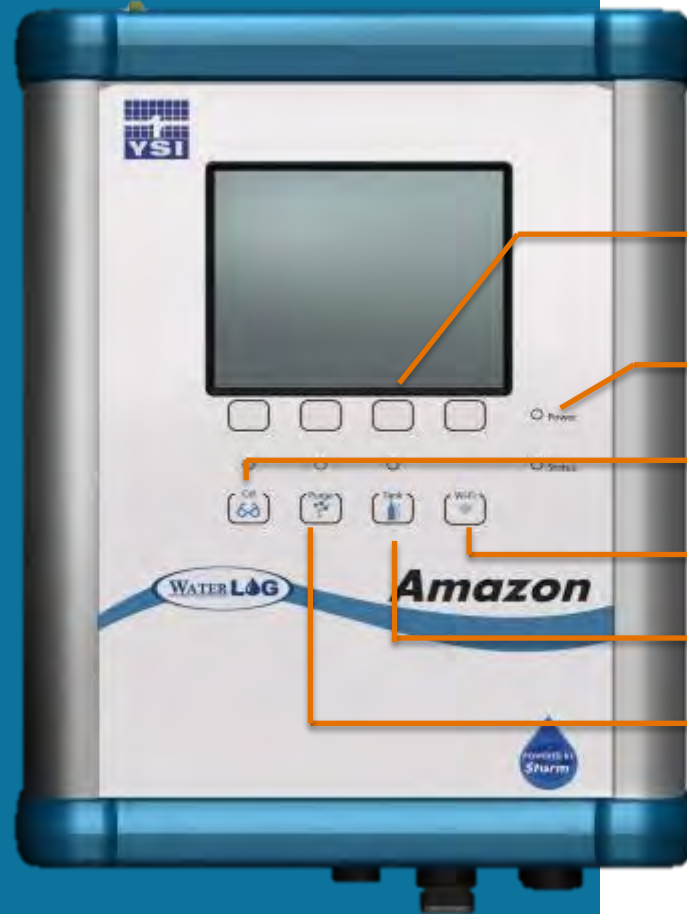
Sensors – Amazon Bubbler

Also known as a non-submersible pressure transducer!



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Amazon Bubbler Anatomy



Top Panel Connections

Display and Control Buttons

Diagnostic Lights

Cal Button

Wi-Fi Button

Tank Button

Purge Button

Amazon Bubbler Anatomy

I/O Panel Connections

USB

Inlet

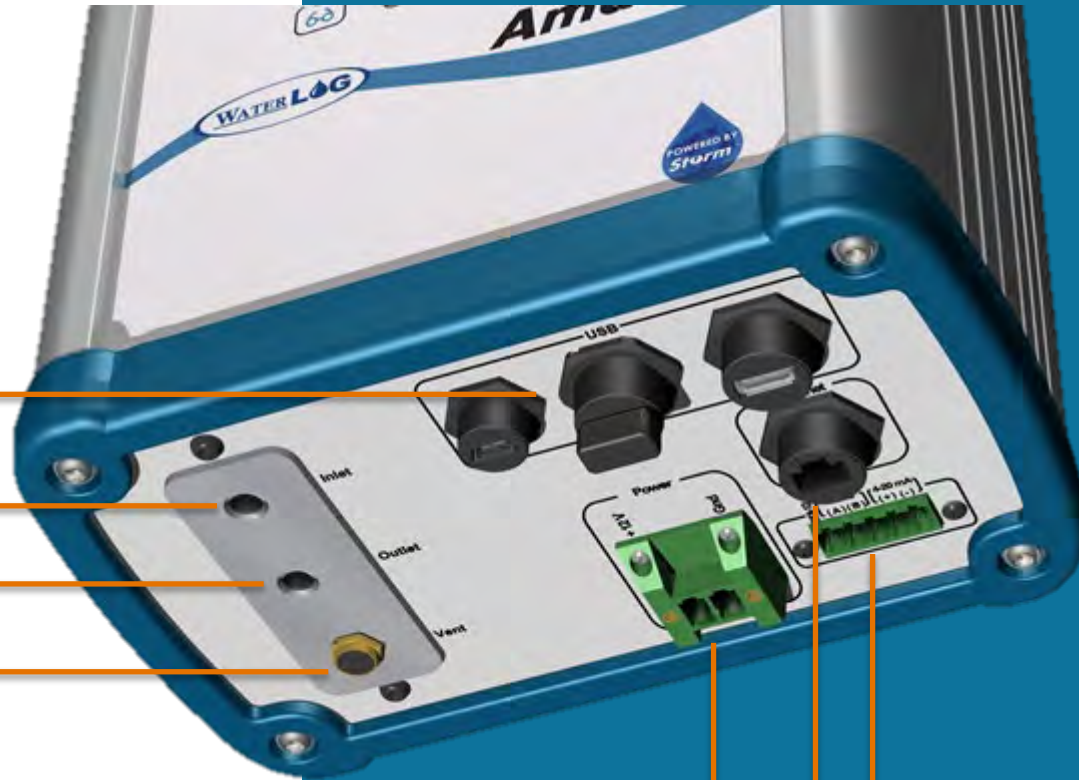
Outlet

Vent

Power

Ethernet

SDI-12/4-20 mA/RS-485(Modbus)



Amazon Bubbler Advantages

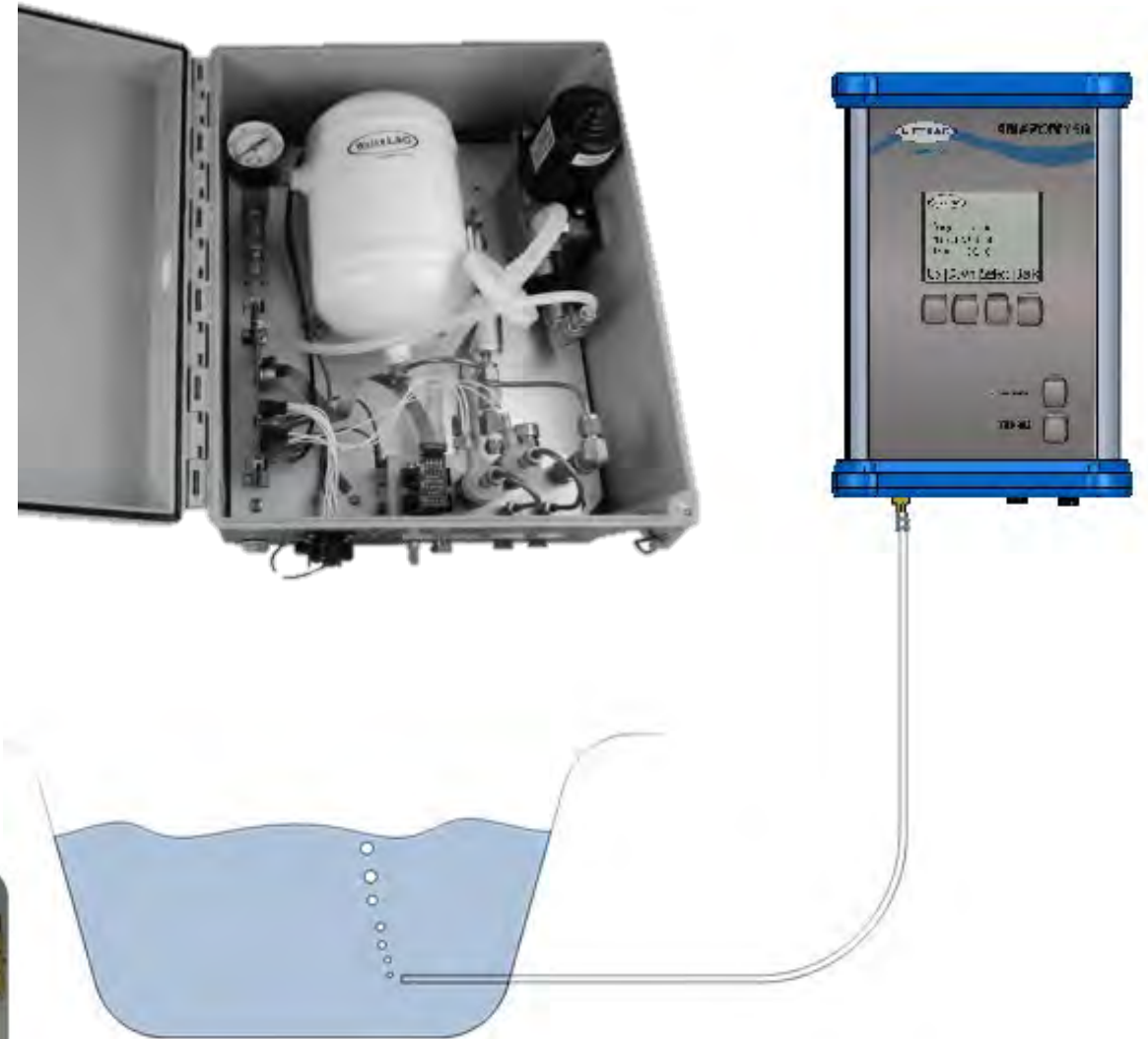
- Easy to use browser interface
- Communicates with *any* datalogger
- Internal data logging
- High accuracy
- Continuous bubble and automated purge
- No external pressure sensor required

- Great for use in streams, rivers, lakes
- Orifice line mounted along streambank or down culvert wall



How It Works

- Compressor and holding tank provide a continuous flow of gas bubbles
- Pressure required to maintain flow of bubbles determines depth:
 - $\text{Height} = \text{Pressure} / \text{Specific Gravity}$
- Don't forget the desiccant!!



Basic Setup - Web Interface

Amazon Menu Options →

WATERLOG **Amazon**

Home

Home
Bubbler
Data
SDI-12
4to20
Modbus
Cell Modem
Storm Central
System Setup
Ethernet

System Info

Site ID: Amaz20594
System Date: 01/21/2019
System Time: 15:38:19
Next Log At: 00:00:00
Next Log In: Disabled
Current Level: 5.00
Measure Level

System Status

Battery Voltage: 13.40
Battery Voltage (Min): 8.99
Battery Voltage (Max): 17.88
Firmware Version: 1.0.169 (01/24/2018 06:17:00)
System Serial #: 6J120594
Last Reboot: 01/21/2019 15:28:21
of Reboots: 15
Reset

Storm Central
Storm Central: Disabled

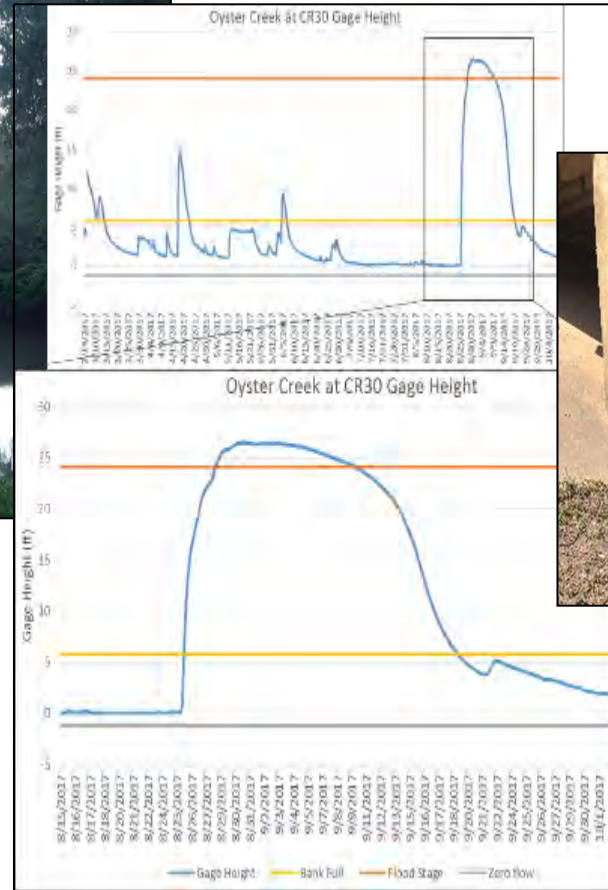
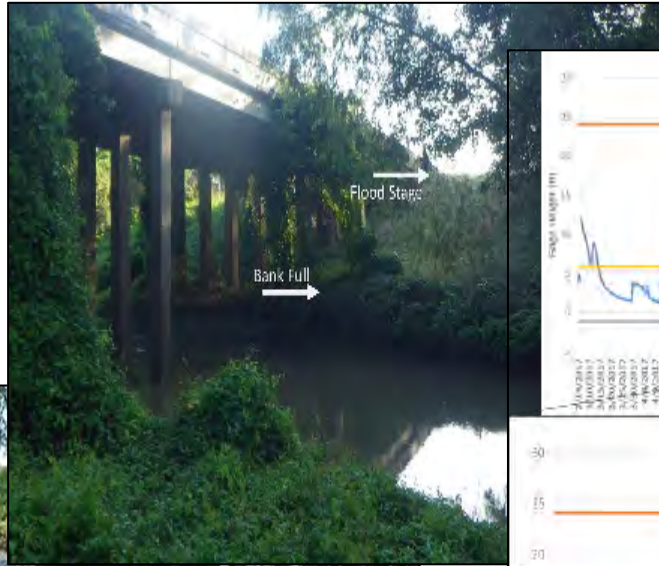
Site ID: Amaz20594 | Logging is Disabled | Connected

Applications: Flood Monitoring

- Contra Costa County in California
- Flood monitoring
- Upgraded from old WaterLOG bubblers due to new features
- Creeks are normally fairly dry
- Rain can quickly lead to floods



Applications: Hurricanes and Stream Changes



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Sensors – Nile Radar



Nile Anatomy



Nile Advantages

- Easy to install, use, maintain
- Heavy duty housing for outdoor installs
- Communicates with *any* datalogger
- High accuracy up to 70m

- Great for use in streams, rivers, lakes and turbulent environments
- Mount on overhead structures like bridges



Non-corrosive Construction



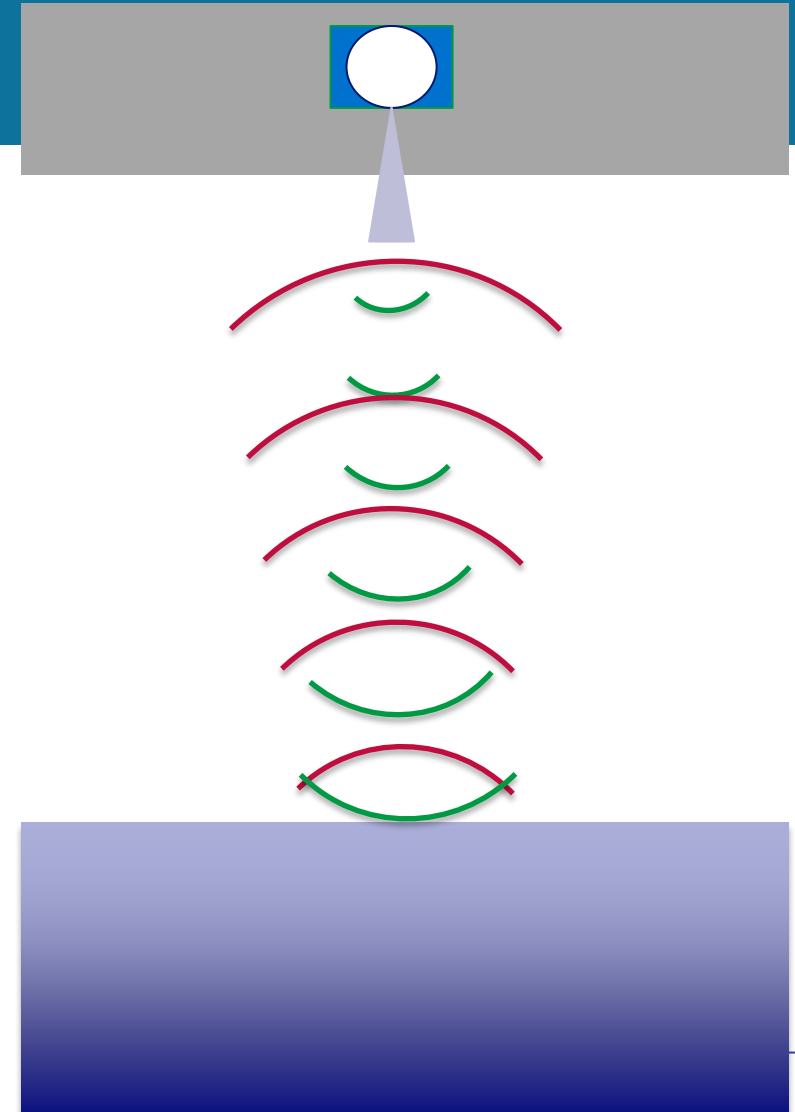
SALT MINE WEST AUSTRALIA



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How it Works

- Integrated microwave transmitter and sensor
- Distance to water is proportional to time of pulse
 - $D = c * t/2$
 - $D = \text{distance}$
 - $C = \text{speed of light}$
 - ~3 million m/s
 - $T = \text{time}$

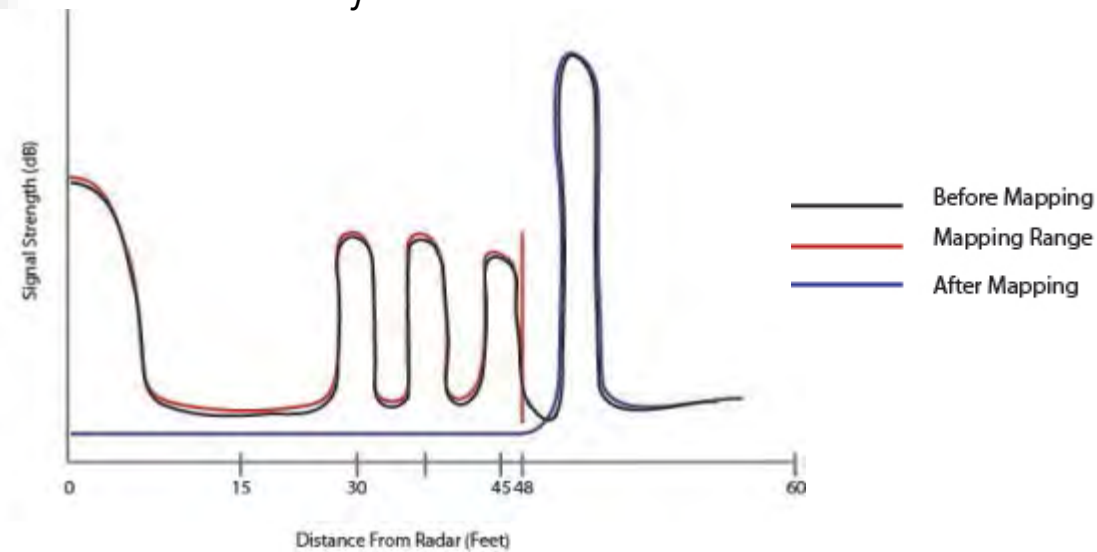


Echo Mapping

The signal from the Nile reflects off everything within its footprint



When adding a map to the instrument, you are creating a threshold that will tell the unit to ignore all false signals before this threshold. In the example below anything under 48' is mathematically eliminated

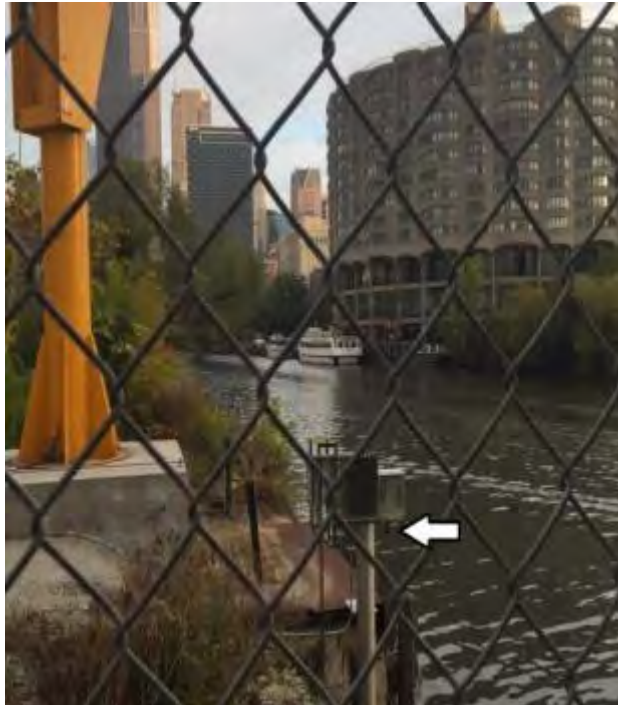


The Nile sensors provide *Mapping* and **Multi-Echo Tracking** to suppress false echoes

Applications: Water Level Measurements

Metropolitan Water Reclamation District of Chicago site along the Chicago River
Wanted to add a continuous level monitoring station to an existing DO gauge.

- Non contact
- Easy communication set-up (SDI-12)
- Minimal maintenance
- Real time data



Applications: Air Gap Measurements

In areas of commercial boat traffic the “Air Gap”, the distance from a bridge to the water’s surface, is a critical piece of information that captains need to safely navigate. The Nile is the perfect instrument to provide both (Air Gap) and water level data.



The radar is always measuring distance to water. The first two parameters from a standard SDI-12 measure command returns first Water Level and second Distance to Water (Air Gap).

In applications like the one pictured here the radar returns Water Level and Air Gap from one measurement. Combined with a data logger the radar becomes a non contact automated measuring solution.

Applications: Tide Measurement



One of The National Oceanography Centre Liverpool's tide gauging sites in St Lucia

In this application the Nile radar is always on using one of the NOAA mode measure commands that computes a standard deviation, removes outliers and returns an average.

"(context e.g. installation in St Lucia by) the National Oceanography Centre, UK, and delivered as part of the Commonwealth Marine Economies Programme".



What is NOAA Mode?

- 1. Makes 181 measurements at precise 1.0 second intervals
- 2. Computes the standard deviation for the data set as follows:
 - a. Compute the mean for the data set
 - b. Compute the deviation by subtracting the mean from each value
 - c. Square each individual deviation
 - d. Divide by one less than the sample size
 - e. Take the square root
- 3. Multiplies the standard deviation by 3 to obtain a High and Low outlier threshold.
- 4. Sifts through the data set and discards data points above and below the outlier threshold.
- 5. Computes the mean and standard deviation again for the data set with the outliers removed.

EACH SAMPLE OUTPUTS:

- 1) Mean Stage**
- 2) Number of Outliers**
- 3) Number of Good Values**
- 4) Standard Deviation**

Applications: Surface Height Measurement



Applications: Storm Surge Monitoring

One of NOAA's Mobile Bay Storm Surge Monitoring Network sites:



- NOAA's Center for Operational Oceanographic Products and Services in partnership with Mobile County Commission established 8 water level observatories for storm surge monitoring in Mobile Bay
- Data From the water level observatories combined Meteorological and Tidal data from existing sites provides critical information for coastal resource management and emergency management before, during, and after severe storm events.
- The radars can be mounted above category five storm surge heights without affecting measurements. Storm surge high flows also have no affect on the radar's measurements
- Telemetry at these sites provides near real time data

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Storm 3 Data Logger



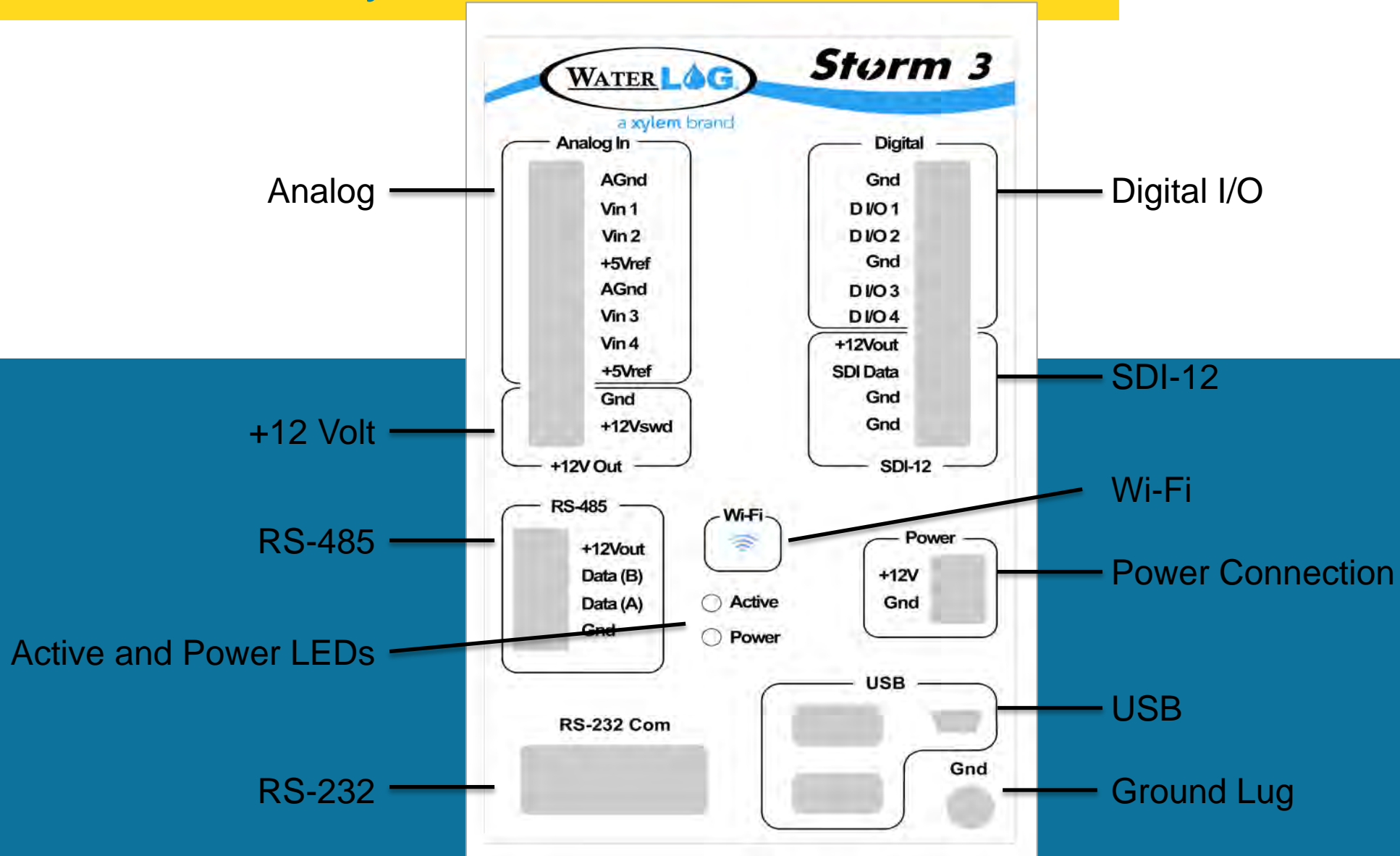
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Storm 3 – The Basics

- Mid-range Data Logger
- Supports External Cellular Modems
- Supports GOES Satellite Radios
- Built-in Sensor Library
- Built-in Help Menus
- Graphical User Interface
- USB Wifi or Device Cable Connection



Storm 3 Anatomy



Storm 3 User Interface

The screenshot displays the Storm 3 user interface. At the top left is the 'WATERLOG' logo, and at the top right is the 'Storm 3' title. A left-hand navigation menu includes 'Home', 'System Overview', 'Advanced Options', 'Quick Reference', 'Diagnostics', 'Hardware Tests', 'Sensors', 'Outputs', and 'Data'. The main content area is titled 'System Overview' and contains several sections:

- System Info:** Includes a small image of the device, 'Site ID' (input field: SiteID), 'System Date' (calendar icon: 03/05/2019), 'System Time' (input field: 13:54:41), 'Next Scan At' (button: Disabled), 'Next Scan In' (text: Disabled), and 'Scanning' (dropdown menu: Disabled).
- System Status:** A table of system parameters:

Battery Voltage:	8.373	Firmware Version:	1.4.8
Battery Voltage (Min):	8.158	System Serial #:	dotbob
Battery Voltage (Max):	13.31	Last Reboot:	03/05/2019 13:52:07
	<input type="button" value="Reset"/>	# of Reboots:	1 since 03/05/2019
- Logging Status:** Shows 'Log File: SiteID.csv' and a table with columns 'Date', 'Time', and 'Nile(Stage)'. There is a checkbox for 'Duplicate Log File to USB' which is currently unchecked.
- Communications Status:** Shows 'GOES Self-Timed: Disabled' and 'GOES Random: Disabled'.

At the bottom of the interface, a status bar displays 'Site ID: SiteID', 'Scanning is Disabled', and 'Connected'.

- Connect and open internet browser
- Navigate to 172.20.20.20

Storm 3 – User Interface

WATERLOG

Sensor Setup (Nile)

Configuration
Name: Nile
Type: WaterLOG Nile Radar Water Level

Settings
Address: 0

Available Parameters:

- Stage
- Distance_Feet
- Measure_Status
- Voltage
- CustomParameter

Schedule
Scan Rate: 00:15:00
Scan Order: 1

Site ID: SiteID

WATERLOG **Storm**

Sensor Setup (Nile)

Configuration
Name: Nile Enabled
Type: WaterLOG Nile Radar Water Level Sensor

Settings
Address: 0

Available Parameters:

- Stage
- Distance_Feet
- Measure_Status
- Voltage
- CustomParameter

Schedule
Scan Rate: 00:15:00
Scan Order: 1

Site ID: SiteID

Home

Sensors

- Add New Sensor
- Remove Sensors

Defined Sensors

- Nile (SDI-12)**
- Stage**

Support Options

- Basic Programming
- Digital Trigger Events
- SDI-12 Transparent Mode
- Modbus Master
- Modbus Slave

Outputs

Data

Adding a new Sensor to the Datalogger

WATERLOG Storm 3

Sensor Setup (Stage)

Configuration

Name: Enabled Source:
Type: WaterLOG Nile Radar Water Level Sensor Wiring Diagram:

Settings

Address:
Measure Cmd:
Parameter: 

Processing

Digits: Use Function: Raw Value:
Slope: Processed Value:
Offset:

Schedule

Scan Rate:
Scan Order:

Site ID: SiteID Scanning is Disabled | Connected

WATERLOG Storm 3

Output Tables

Log File Overview (SiteID.csv)

Column:	1	2	3
Source:	Date	Time	Nile(Stage)
Data Rate:			00:15:00
Last Log:	02/22/2019	12:30:00	

Storm Central Overview

Column:	1	2	3
Source:	Date	Time	Nile(Stage)
Data Rate:			00:15:00

Applications: Environmental Protection

- San Francisco Public Utilities Commission
- Reservoir serves over 1 million residents
- Fish and Game Refuge for wildlife
- Storm 3 transmits water quality data
- pH is biggest concern
- Data goes to HydroSphere



Applications: Improving Efficiency

- Zone 7 Water Agency in Alameda County
- Arroyo Del Valle Water Rights
- Habitat sustainability
- Modeling for flood control
- Better technology, less site visits
- Alarms for low/high flow
- Quicker quality control



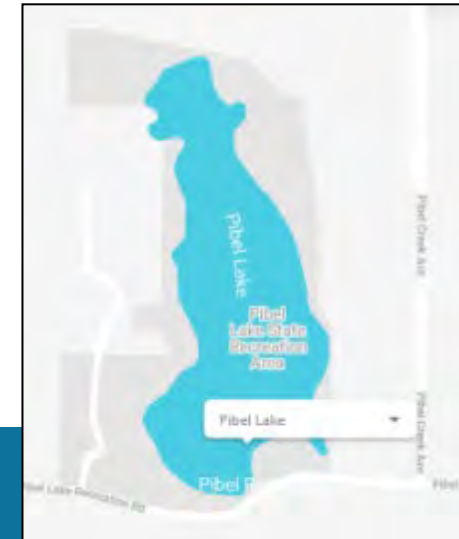
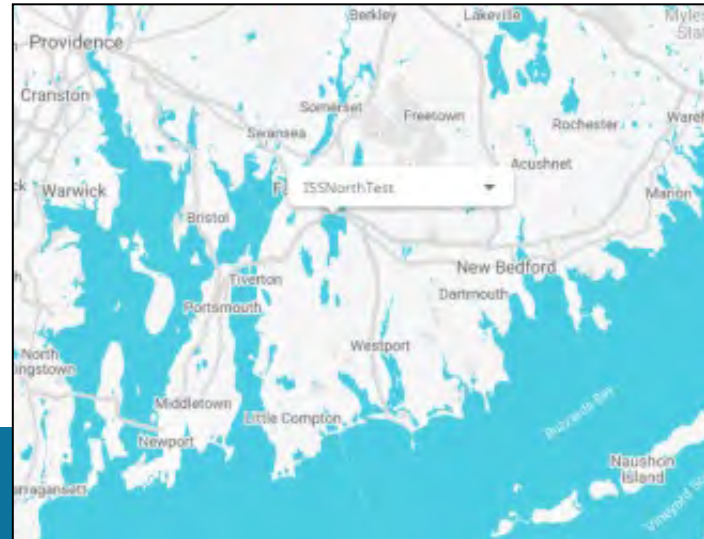
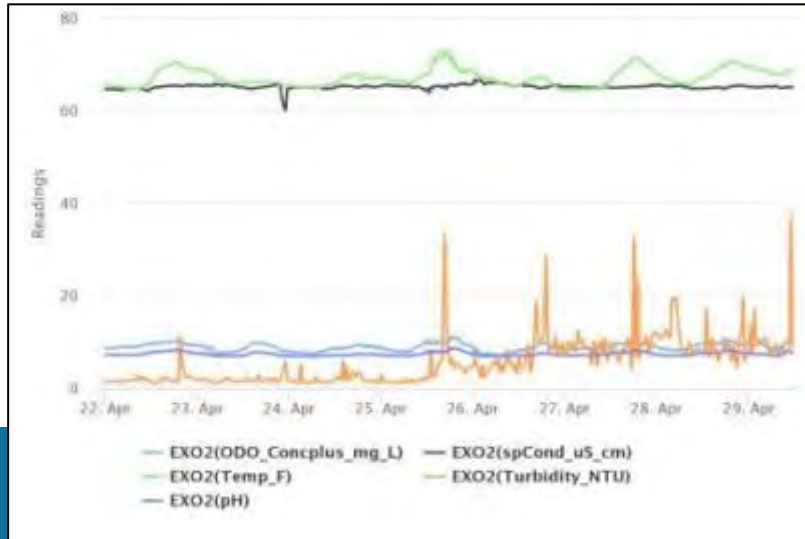
6

Software – HydroSphere



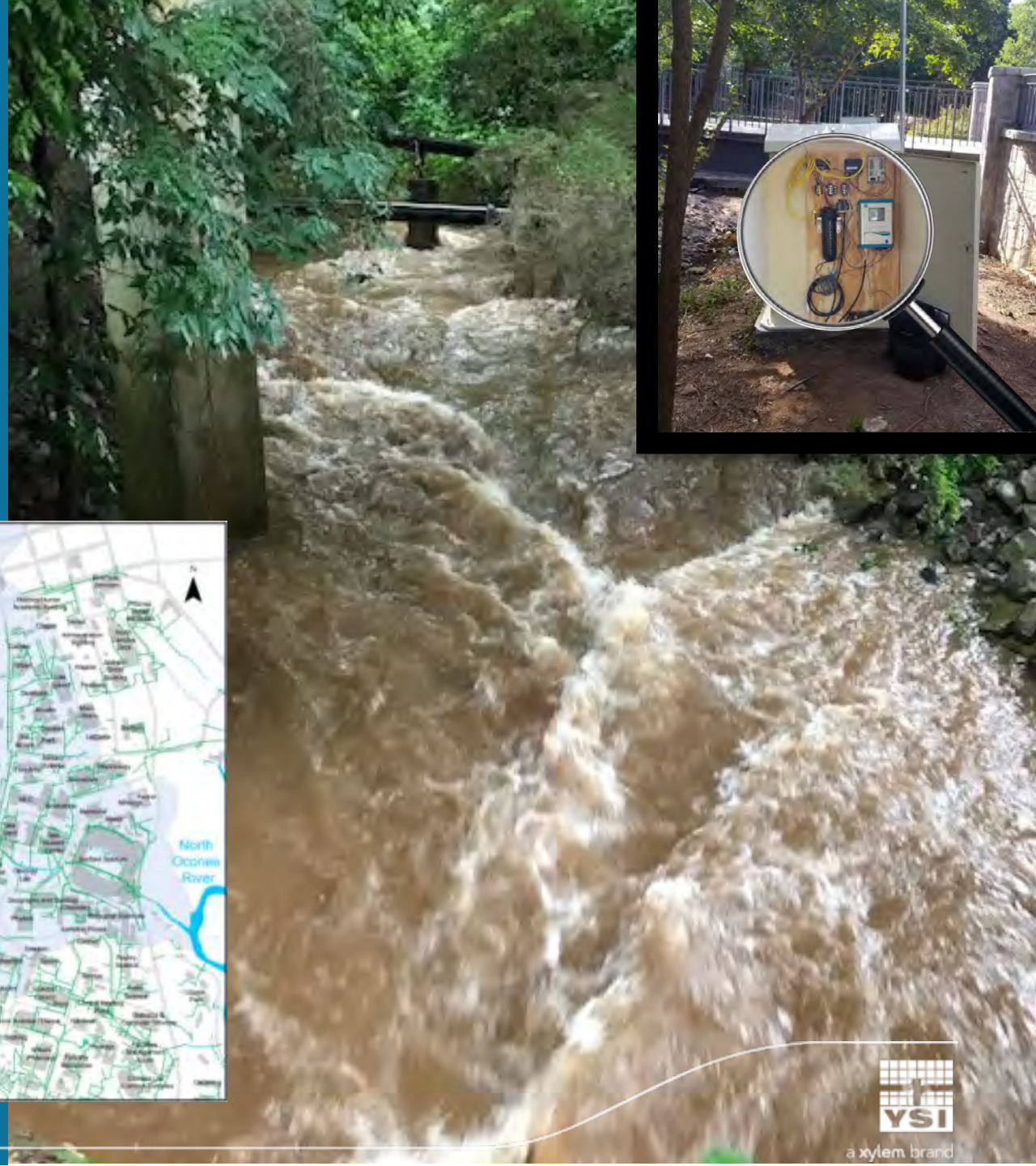
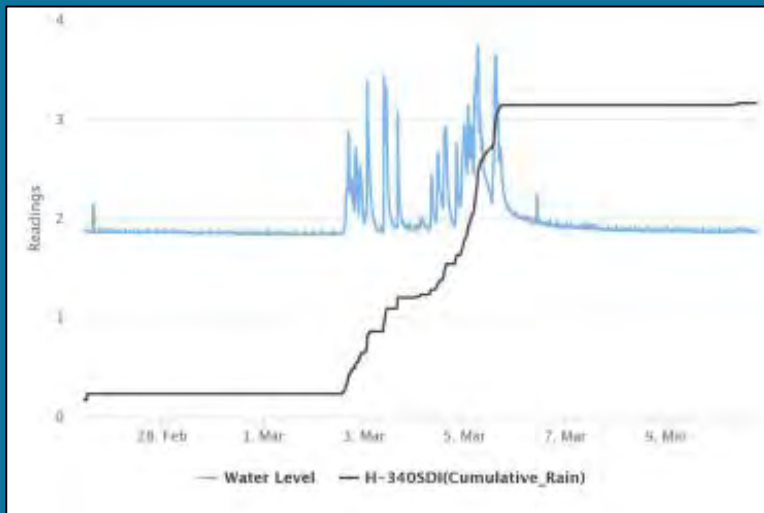
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Real-Time Monitoring Software: HydroSphere



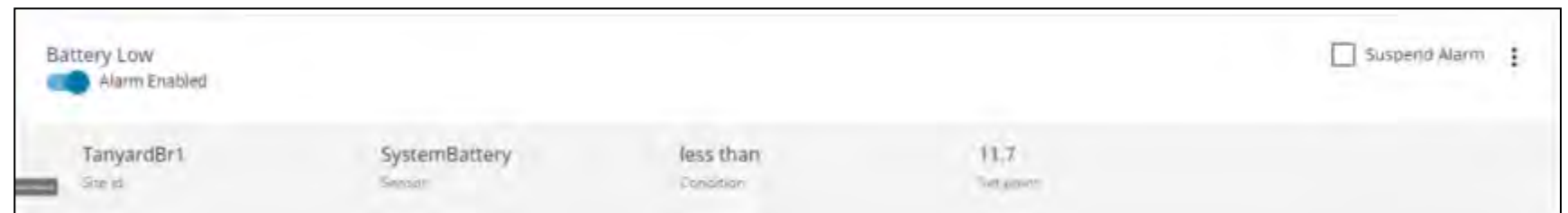
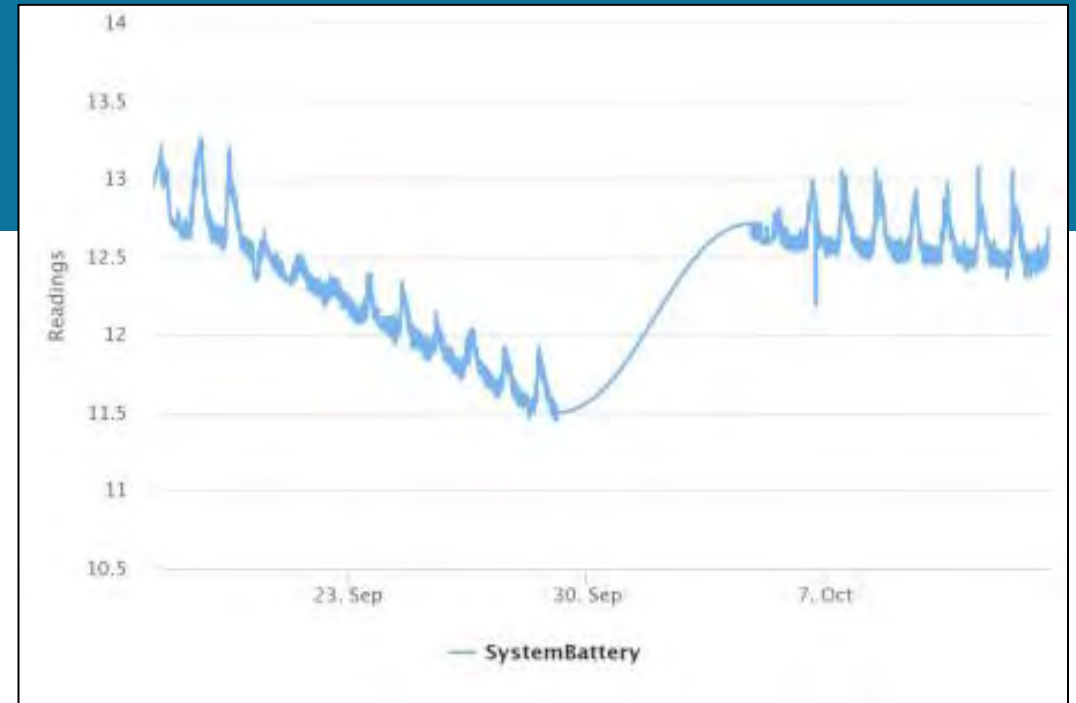
- Data available *anywhere* and *anytime*, 24/7
- Easy connection to telemetry system
- Real-time data assistance:
 - Alarms warn if a threshold is met
 - Alerts let you know if a site stops transmitting

- Tanyard Branch
 - YSI/UGA partnership began in 2019
 - 2.02 sq km watershed
 - 74% impervious surfaces
 - 50% of the stream runs through pipes
 - Storm 3 Data Logger
 - Amazon Bubblers
 - H-3401 Rain Gage



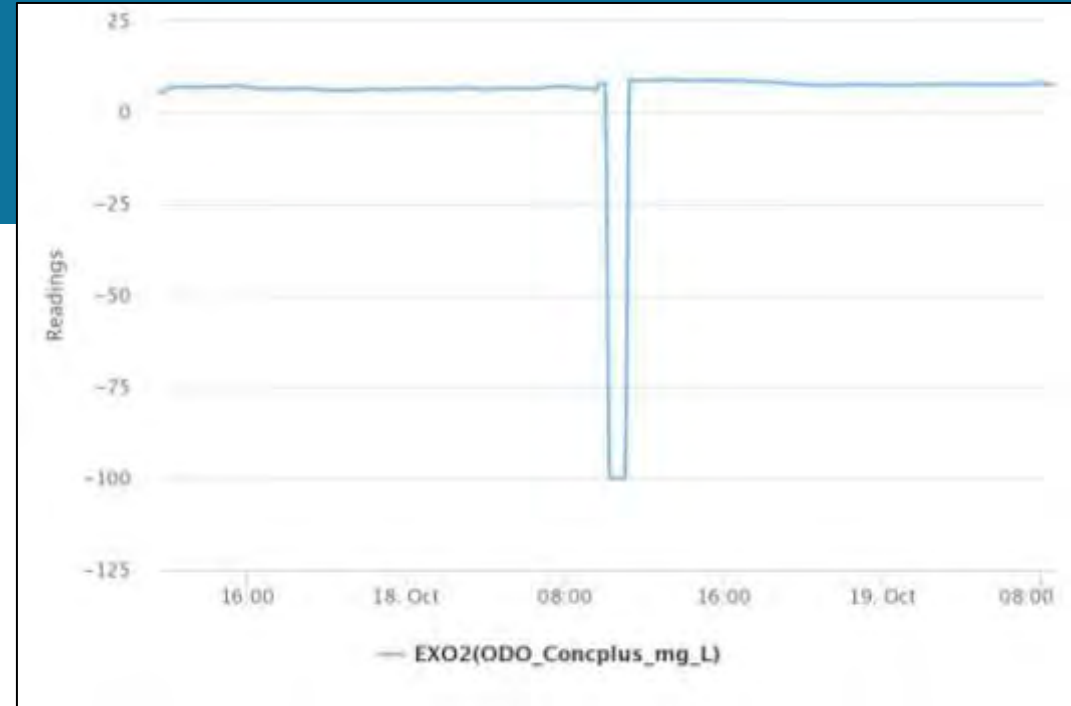
Alarm: Low Battery Voltage

- Battery voltage can drop over time and with clouds blocking sun for extended time
- Transmissions will stop if battery gets too low
 - Stops transmitting at 11.5V at UGA
- Set an alarm for:
 - Battery Voltage less than 11.7V



Alarm: Sensor Not Working

- Dissolved oxygen is monitored because stream is characterized as recreational.
- Need to monitor DO to ensure that there are no spills that will harm wildlife.
- Set an alarm for:
 - Dissolved oxygen less than 0



Dissolved Oxygen Sensor Down Suspend Alarm ⋮

Alarm Enabled

TanyardBr1 <small>Site id</small>	EXO2(ODO_Concplus_mg_L) <small>Sensor</small>	less than <small>Condition</small>	0 <small>Set point</small>
--------------------------------------	--	---------------------------------------	-------------------------------

Alerts: Missing Communication

- Need to keep sites as close to 100% uptime as possible
- Missing communication alerts allow a user to know in real-time if a site has stopped transmitting
- Allows for quick deployment of technicians to service equipment

Alert if missing communication

Enabled

Every change to the settings will change the alert timer

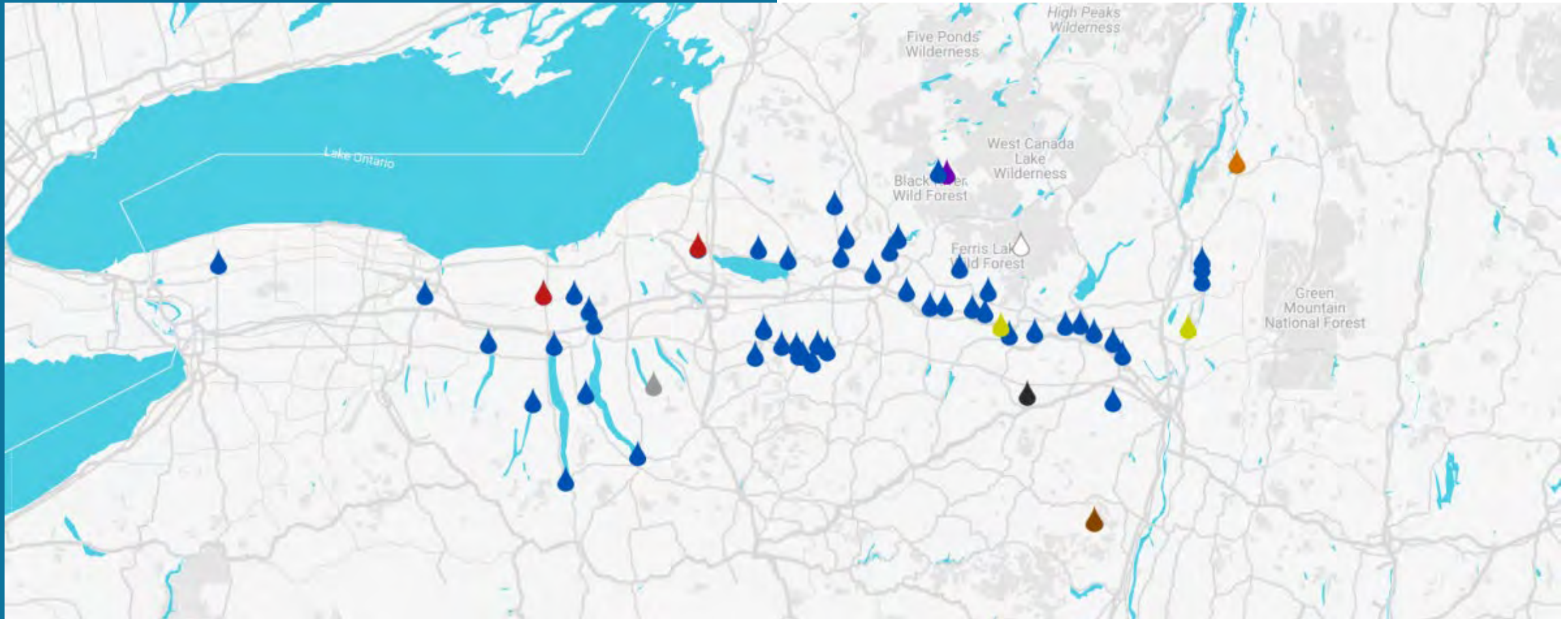
Alert if no data after *

67 minutes(s)

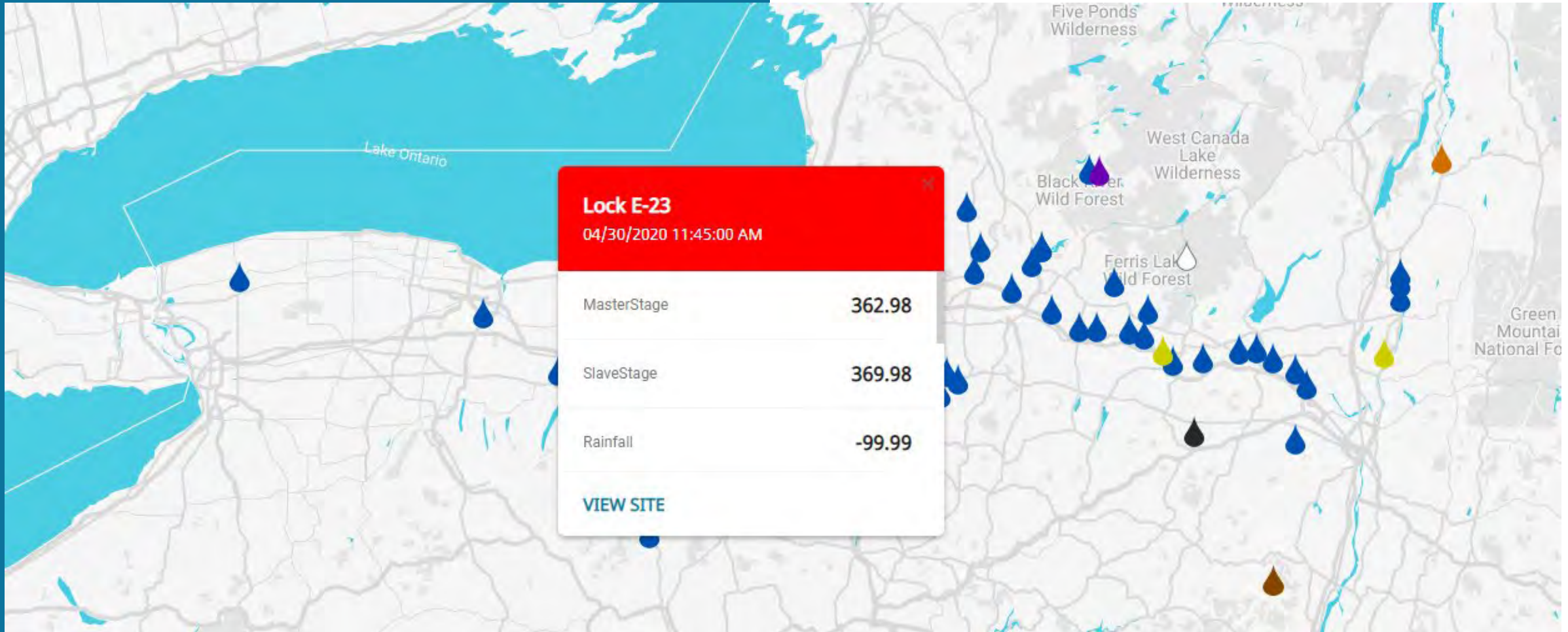
Stop alerting after *

5 attempts(s)

Alarms for Large Networks



Alarms for Large Networks



Contact us for more
information at:
info.apac@xyleminc.com

QUESTIONS?



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