

Passive Treatment System Monitoring Utilizing Solar Powered Telemetry, A Case Study.¹

Boise Idaho 2023

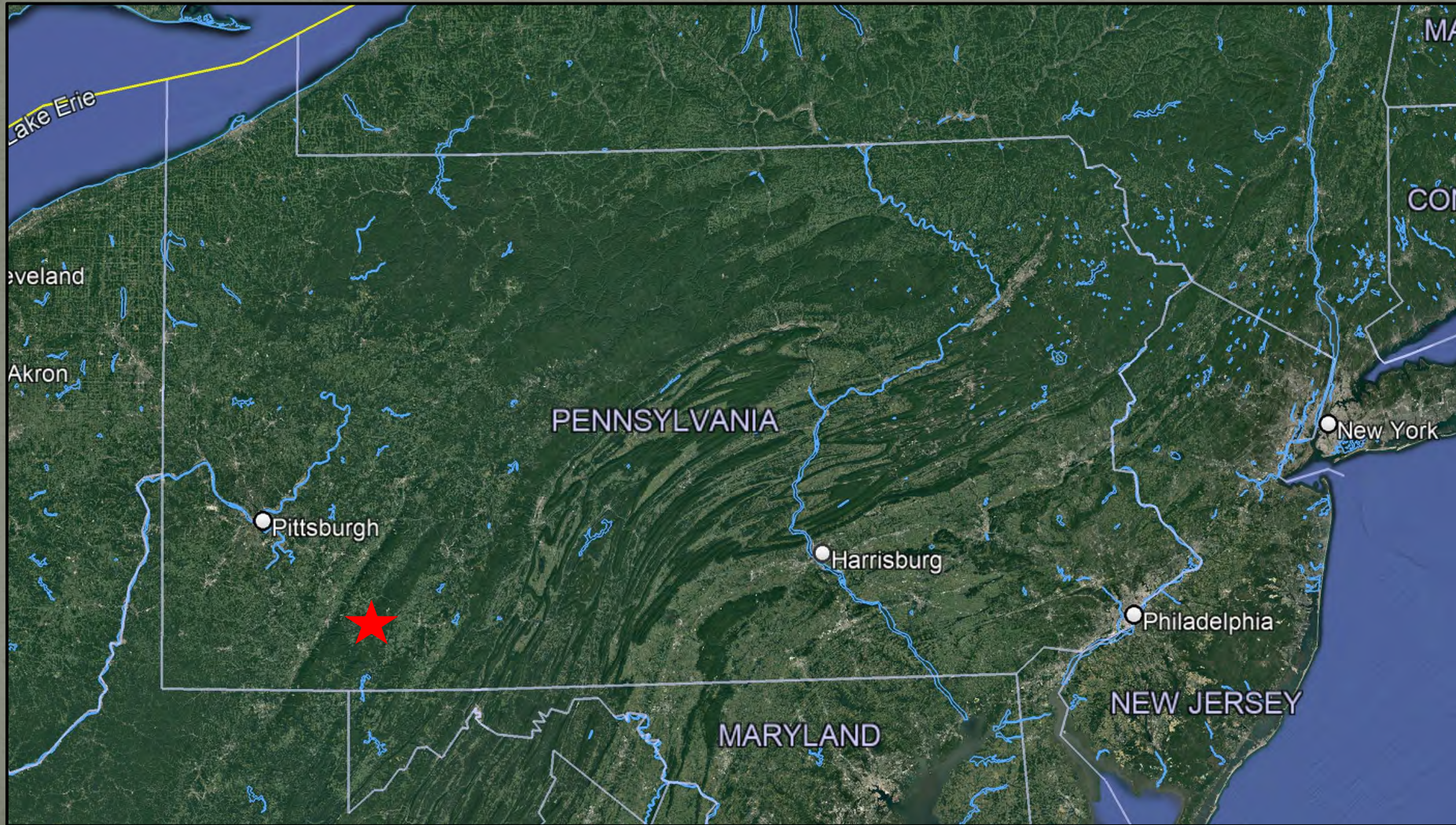
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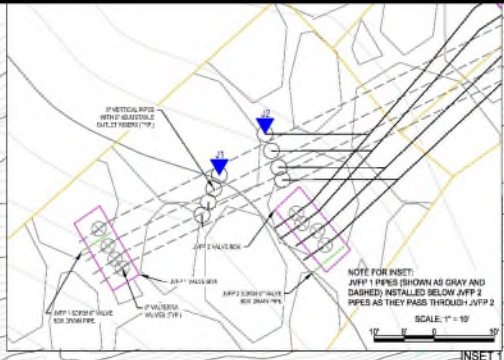
² Daniel A. Guy, (PG); Cody A. Neely, Environmental Engineer (PE); Tim P. Danehy, (QEP); BioMost Inc., 434 Spring Street Ext., Mars PA 16046.

Oven Run B – Stoystown, PA





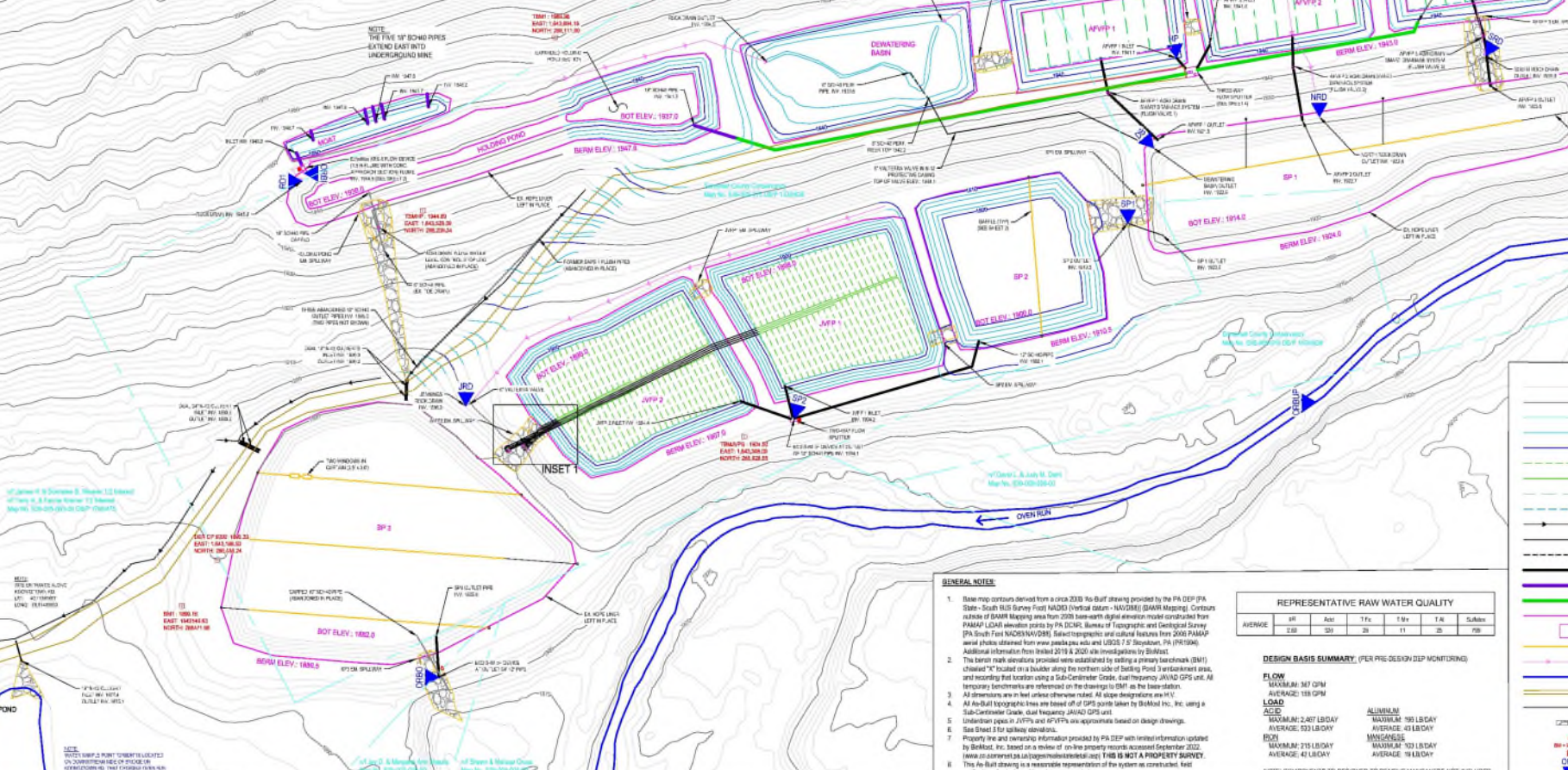
of Steven & Malgorzata
Map No. 03-020-00-01



NOTE FOR INSET:
JVPF 1 PIPES SHOWN AS GRAY AND
DASHED, INSTALLED BELOW JVPF 2
PIPES AS THEY PASS THROUGH JVPF 2

SCALE: 1" = 10'

INSET



LEGEND

- EXISTING INTERMEDIATE CONTOUR
- EXISTING INDEX CONTOUR
- PROPERTY LINE (APPROXIMATE)
- AS-BUILT INTERMEDIATE CONTOUR
- AS-BUILT INDEX CONTOUR
- 4" SCH40 PVC PIPE (PERFORATED)
- 6" SCH40 PVC PIPE (PERFORATED)
- 8" SCH40 PVC PIPE (PERFORATED)
- 12" SCH40 PVC PIPE (PERFORATED)
- SURFACE WATER DIVERSION DITCH
- 8" SCH40 PVC PIPE (SCLC)
- 8" SCH40 PVC PIPE (PERFORATED)
- 12" SCH40 PVC PIPE
- 18" SCH40 PVC PIPE
- 18" SCH40 PVC PIPE
- AS-BUILT TREATMENT COMPONENT
- STRUCTURE
- BATTLE CURTAIN
- ROCK DRAIN
- STREAM WATER BODY
- GRAVEL ROAD
- AMENDED-IN PLACE PIPE
- REBAR
- SOLAR POWERED MONITORING DEVICE
- GPS BENCHMARK
- WATER MONITORING LOCATION

GENERAL NOTES

1. Base map contours derived from a circa 2003 "No-Built" drawing provided by the PA DEP (PA State - South West Spruce Knob WADIS (vertical datum - NAVD83) (SWM) Mapping). Contours outside of SWM Mapping area from 2008 state-wide digital elevation model produced by PA DEP (PA State - South West Spruce Knob WADIS (vertical datum - NAVD83) (SWM) Mapping). Contours outside of SWM Mapping area from 2008 state-wide digital elevation model produced by PA DEP (PA State - South West Spruce Knob WADIS (vertical datum - NAVD83) (SWM) Mapping). Contours outside of SWM Mapping area from 2008 state-wide digital elevation model produced by PA DEP (PA State - South West Spruce Knob WADIS (vertical datum - NAVD83) (SWM) Mapping).
2. The storm mark elevations provided were established by setting a primary benchmark (BM1) checked "X" located on a boulder along the northern side of Pond 2 (setback area), and recording that location using a Sub-Centerline Grade. Dual frequency JAVAP GPS unit. All temporary benchmarks are referenced on the drawings to BM1 as the base elevation.
3. All dimensions are in feet unless otherwise noted. All slope designations are H:V.
4. All As-Built topographic lines are based off of GPS points taken by Bickford, Inc. using a Sub-Centerline Grade, dual frequency JAVAP GPS unit.
5. Underdrain spacings in JVPF's and APVFP's are approximate based on design drawings.
6. See Sheet 1 for building materials.
7. Property line and ownership information provided by PA DEP with limited information updated by Bickford, Inc. based on a review of on-line property records accessed September 2022. Basis on a general best information available. THIS IS NOT A PROPERTY SURVEY.
8. This As-Built drawing is a narrative representation of the system as constructed. Field verification of actual conditions is recommended.

REPRESENTATIVE RAW WATER QUALITY					
	PH	Alc	TSS	Fe	Mn
AVERAGE	7.00	250	20	11	26

DESIGN BASIS SUMMARY (PER PFC DESIGN/DEP MONITORING)					
FLOW	LOAD	ALUMINUM	MANGANESE	IRON	PHOSPHORUS
MAXIMUM: 167 GPM	MAXIMUM: 2.487 LB/DAY	MAXIMUM: 180 LB/DAY	MAXIMUM: 180 LB/DAY	MAXIMUM: 215 LB/DAY	MAXIMUM: 41 LB/DAY
AVERAGE: 118 GPM	AVERAGE: 1.733 LB/DAY	AVERAGE: 125 LB/DAY	AVERAGE: 125 LB/DAY	AVERAGE: 150 LB/DAY	AVERAGE: 29 LB/DAY

NOTE: COMPONENTS TO BE DESIGNED TO REMOVE MANGANESE NOT INCLUDED



BioMost, Inc.
Mining & Reclamation Services
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Mar, PA 16046
www.biomost.com

NO.	BY	DATE	DESCRIPTION

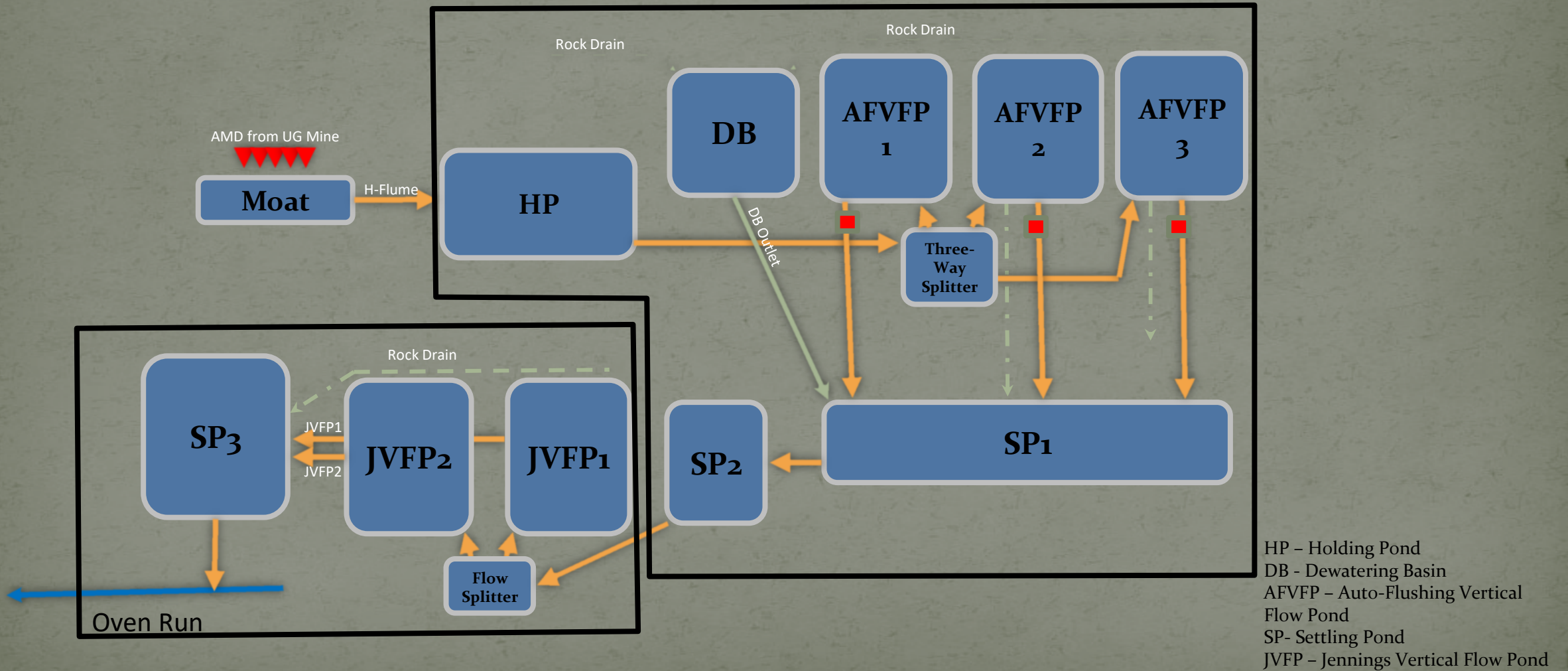


DATE: 09/30/2022
LATITUDE: 40.112275
LONGITUDE: -78.812004
SCALE: 1" = 10'
PROJECT: LWH
DRAWN BY: TPD
DATE: 09/30/2022
PROJECT ENGINEER: Cody A. Neely, P.E.

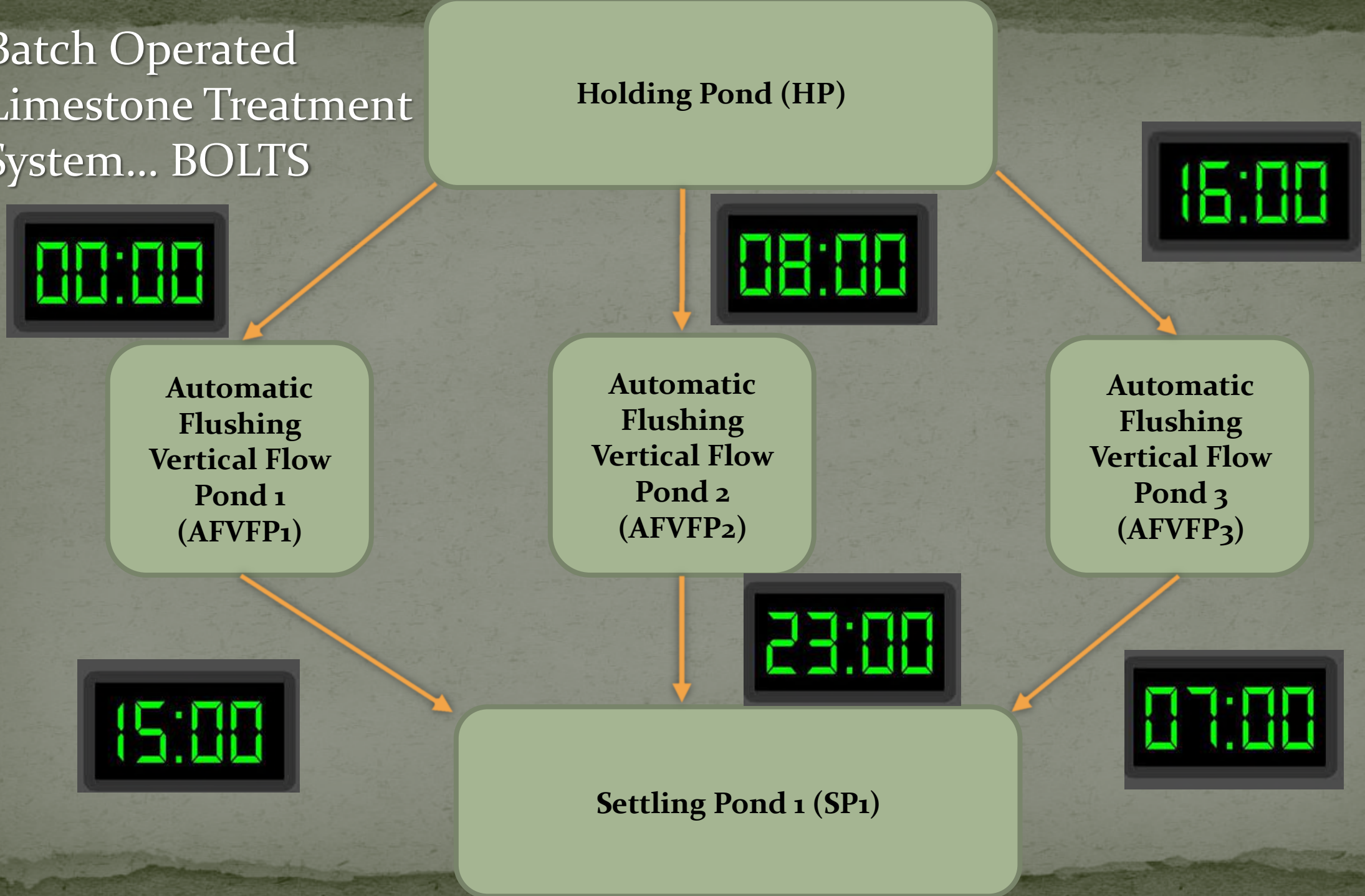
ALL CONDITIONS SHALL BE CHECKED AND VERIFIED AT THE SITE AS APPLICABLE PRIOR TO PERFORMING ANY MAINTENANCE WORK

AS BUILT DRAWING
OVEN RUN B
PASSIVE TREATMENT SYSTEM
REDESIGN AND CONSTRUCTION
PLAN VIEW
1 of 4

System Schematic



Batch Operated
Limestone Treatment
System... BOLTS



Telemetry...What's being monitored and why?

pH Monitoring

- System Performance (Effluent Monitoring)

- BOLTS Performance (Settling Pond 2 Monitoring)

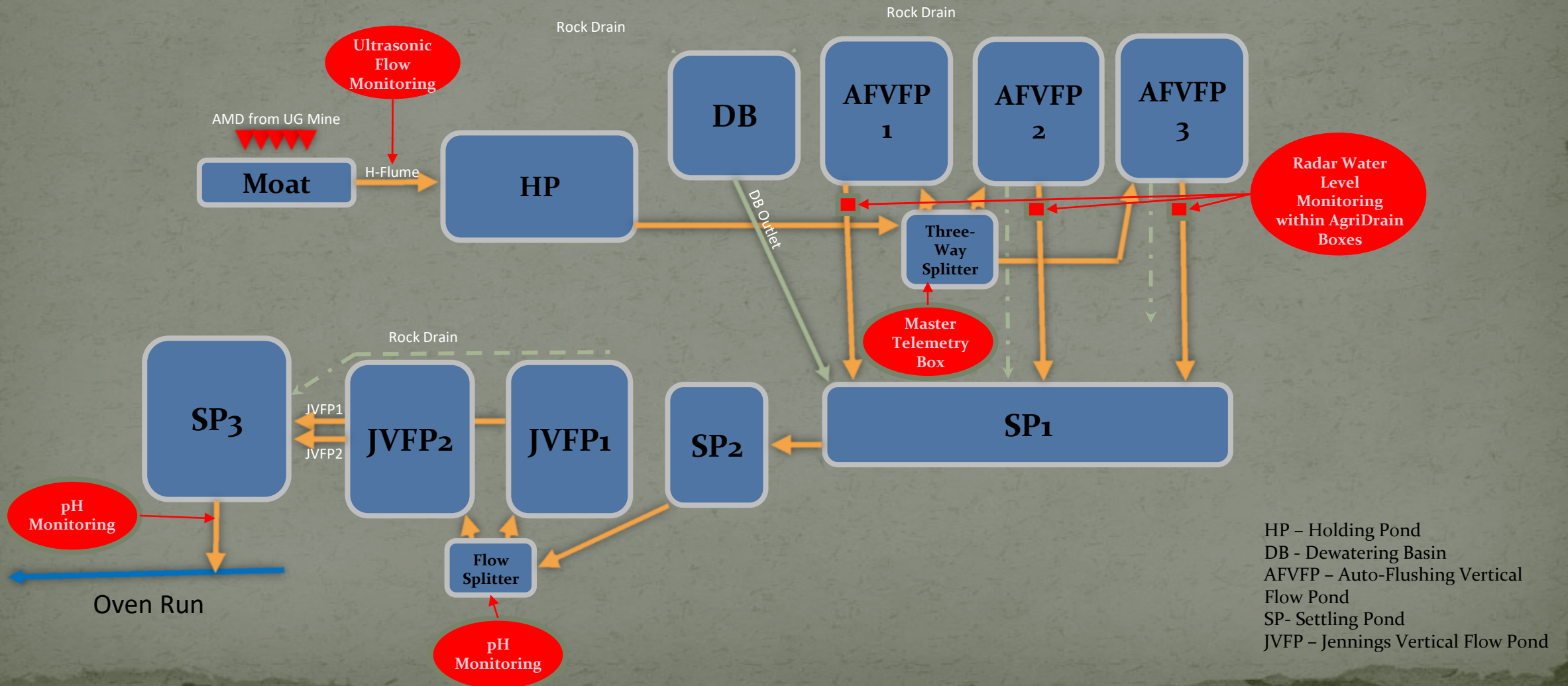
Flume Elevation Monitoring

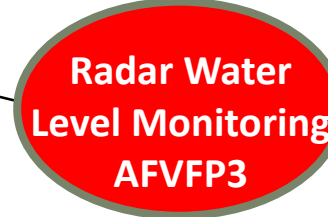
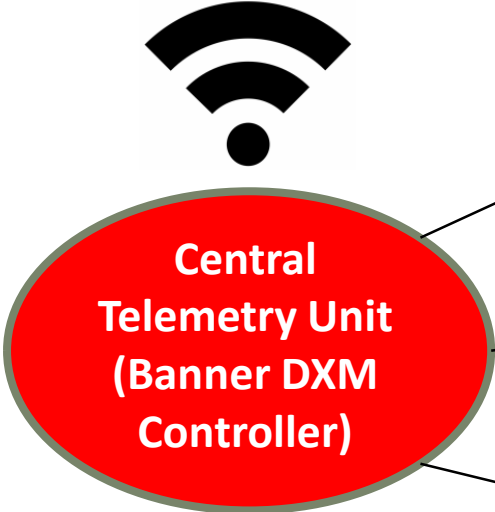
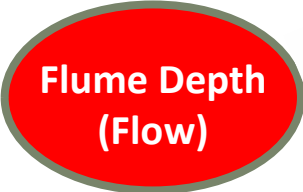
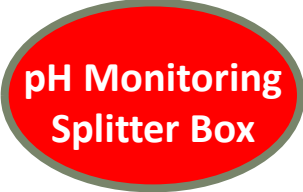
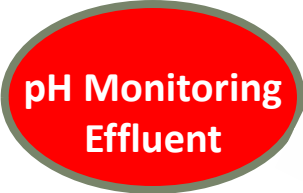
- Flow Must Be Taken Before BOLTS Components

Radar Monitoring of BOLTS

- Agri-Drain Drain Box 1,2,&3

System Schematic

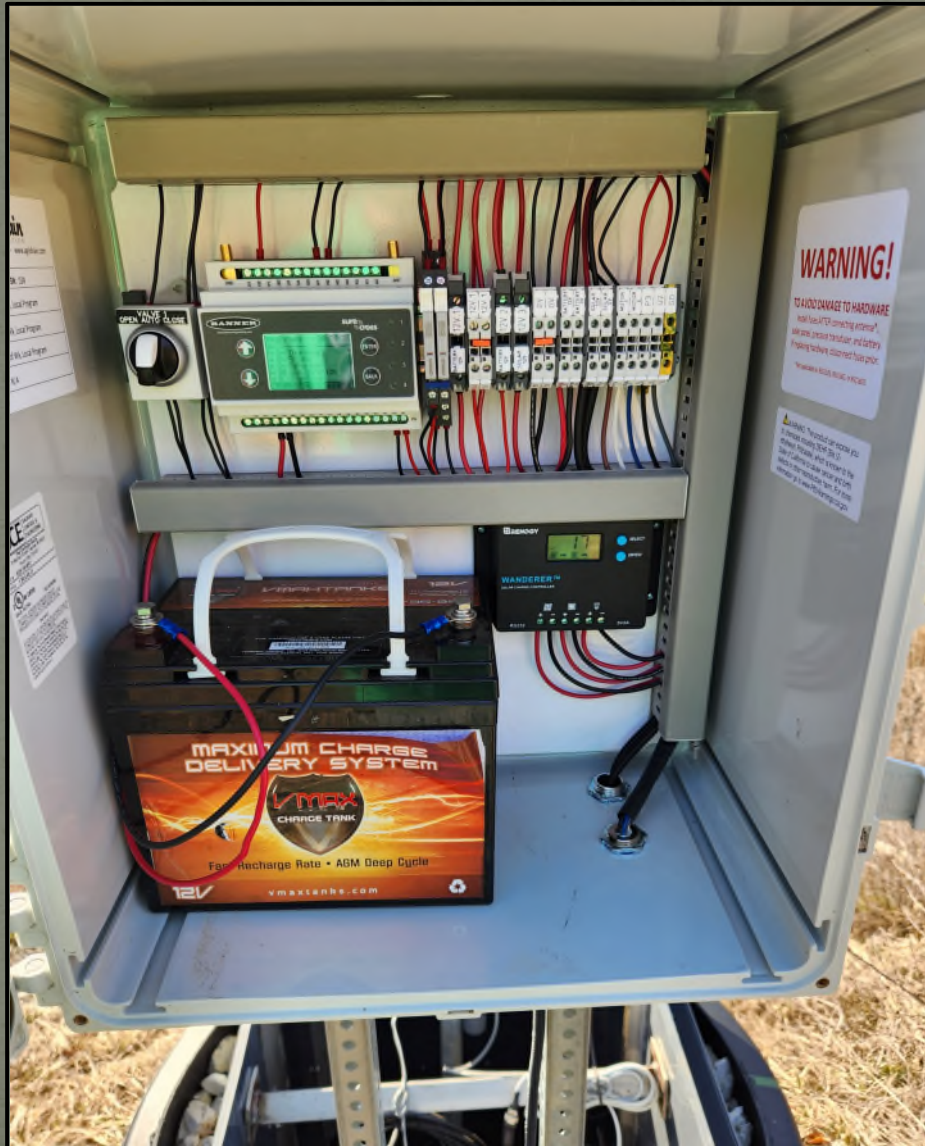




Programming the Telemetry

- Not Exactly Plug and Play For This Application...Yet
- All Metering Devices Work on a 4-20 mA Signal
 - Devices must be calibrated appropriately onsite
 - Powered by 12V solar
 - Transmitted signal must be scaled and offset
- Remote Devices Must Be Radio Connected or Hardwired to Central Telemetry Unit For Cellular Upload
- Input, Output, and Local Register Pathways Must be Created Within Central Telemetry Unit to Move Data Through the System
- Gateways Must Be Created On Banner Data Server Website To Connect Cellular Uploads

The Guts

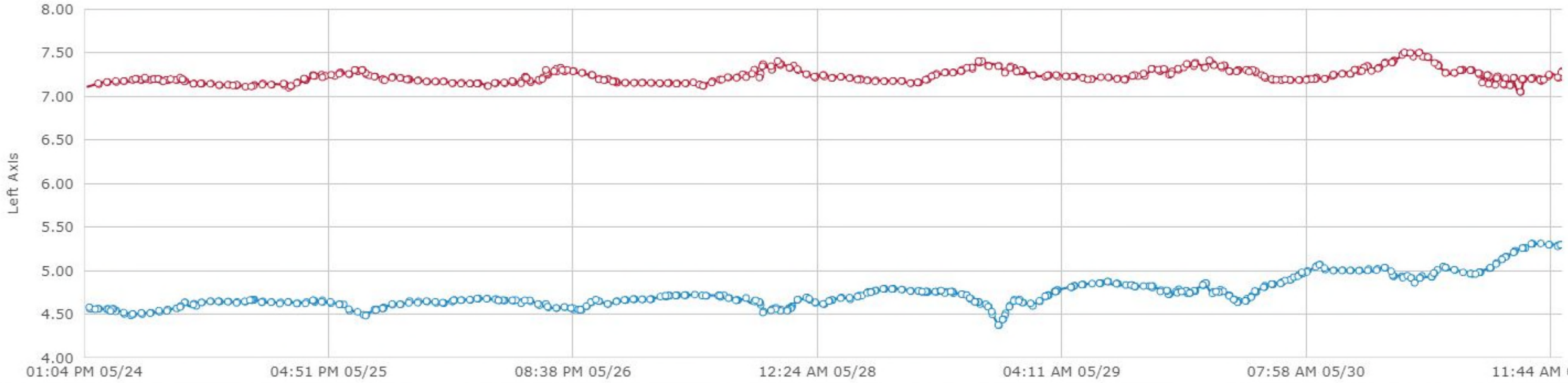
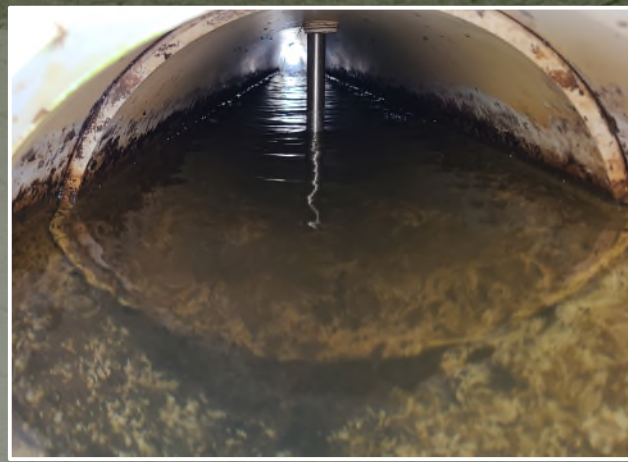


Agri-Drain Smart Drain Box



pH Telemetry

pH Effluent & Flow Splitter Box

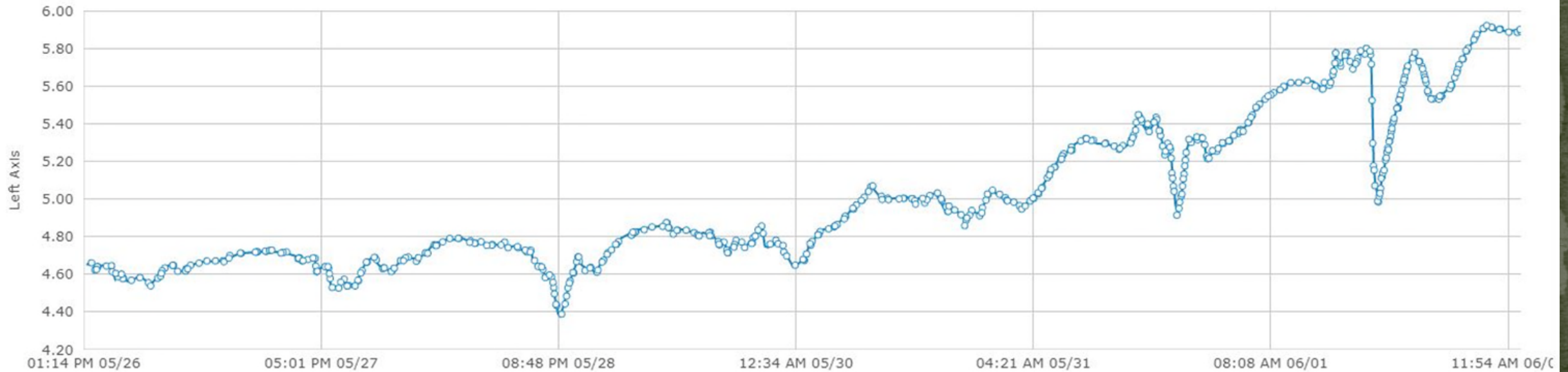


Color	Axis	Gateway	Register	Name	Type	Value	Min	Avg	Max	Unit	Remove
●	Left Axis	Oven Run	2	ORBSP2 pH (Flow Splitter Box)	Register	5.2947	4.3718	4.7389	5.3214		✕
●	Left Axis	Oven Run	3	ORBO pH (SP3)	Register	7.2857	7.032	7.2259	7.5001		✕

Flume Elevation Monitoring



Flume Telemetry Data



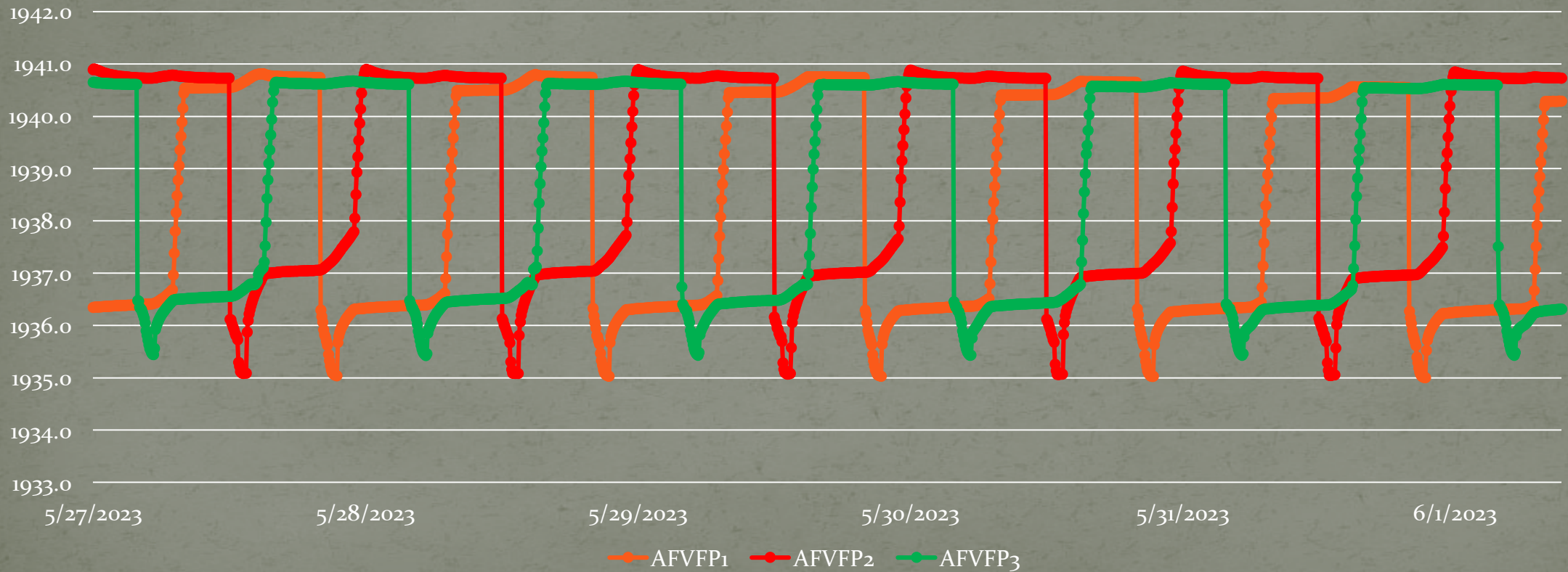
Color	Axis	Gateway	Register	Name	Type	Value	Min	Avg	Max	Unit	Remove
●	Left Axis	Oven Run	2	ORBSP2 pH (Flow Splitter Box)	Register	5.8886	4.3718	5.0027	5.9209		✕

BOLTS Utilizing Agri-Drain Smart Drains with Radar Monitoring

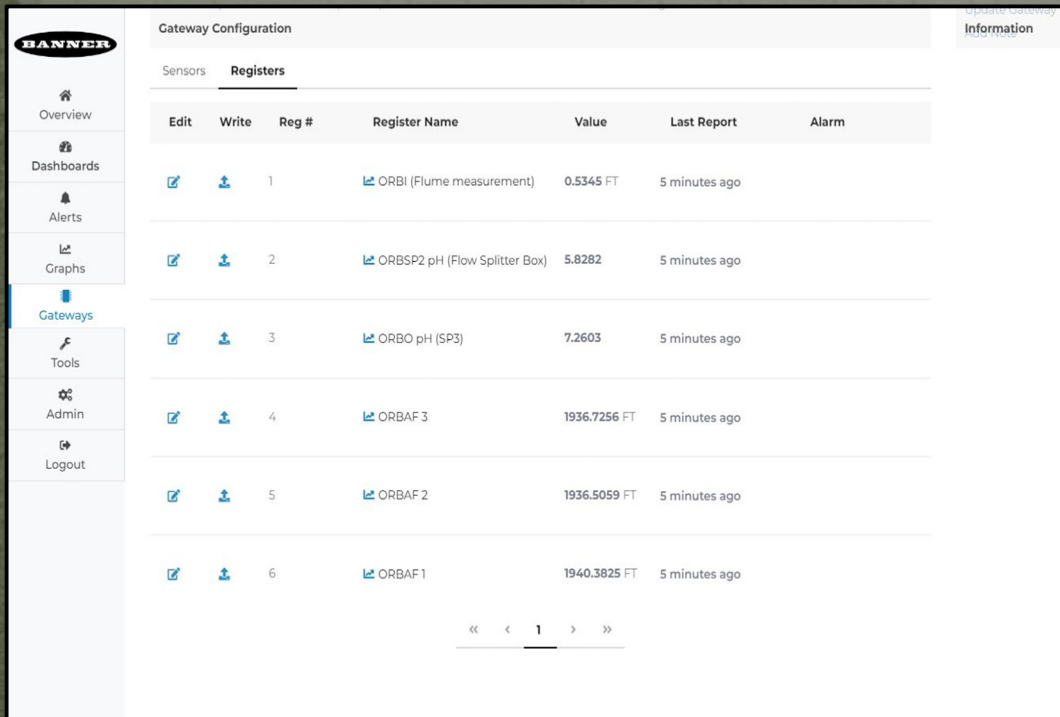


BOLTS Function

Water Elevation Within Auto-Flushing Vertical Flow Ponds (BOLTS)

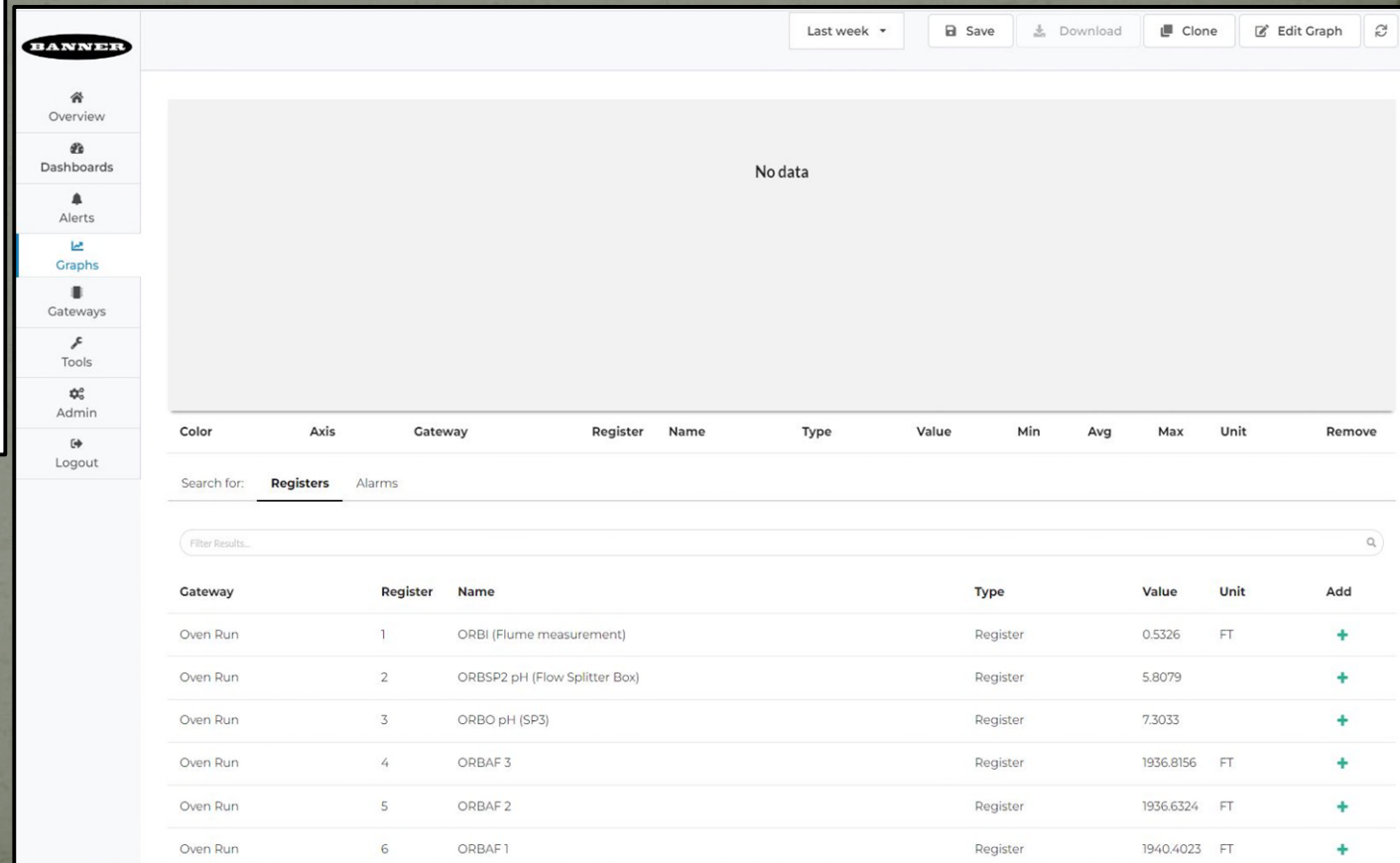


What Does Interface Look Like and What Does It Show



The screenshot shows the Banner Gateway Configuration interface. The left sidebar contains navigation options: Overview, Dashboards, Alerts, Graphs, Gateways (selected), Tools, Admin, and Logout. The main content area is titled "Gateway Configuration" and has tabs for "Sensors" and "Registers". The "Registers" tab is active, displaying a table of register data. At the top right, there is a "Refresh Gateway Information" button. At the bottom, there is a pagination control showing page 1 of 1.

Edit	Write	Reg #	Register Name	Value	Last Report	Alarm
✎	✎	1	📄 ORBI (Flume measurement)	0.5345 FT	5 minutes ago	
✎	✎	2	📄 ORBSP2 pH (Flow Splitter Box)	5.8282	5 minutes ago	
✎	✎	3	📄 ORBO pH (SP3)	7.2603	5 minutes ago	
✎	✎	4	📄 ORBAF 3	1936.7256 FT	5 minutes ago	
✎	✎	5	📄 ORBAF 2	1936.5059 FT	5 minutes ago	
✎	✎	6	📄 ORBAF 1	1940.3825 FT	5 minutes ago	



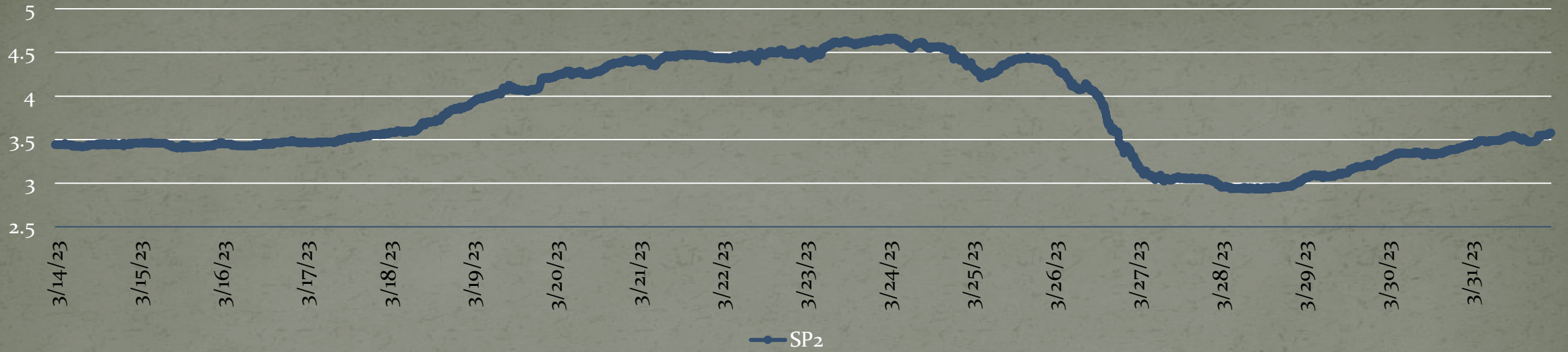
The screenshot shows the Banner Gateway Configuration interface with search and filter options. The left sidebar is the same as in the previous screenshot. The main content area has a "Last week" dropdown and buttons for "Save", "Download", "Clone", "Edit Graph", and "Refresh". A large grey box in the center contains the text "No data". Below this is a table with columns: Color, Axis, Gateway, Register, Name, Type, Value, Min, Avg, Max, Unit, and Remove. A search bar is present with "Registers" selected and "Alarms" as an option. Below the search bar is a "Filter Results..." input field. The table below shows the following data:

Gateway	Register	Name	Type	Value	Unit	Add
Oven Run	1	ORBI (Flume measurement)	Register	0.5326	FT	+
Oven Run	2	ORBSP2 pH (Flow Splitter Box)	Register	5.8079		+
Oven Run	3	ORBO pH (SP3)	Register	7.3033		+
Oven Run	4	ORBAF 3	Register	1936.8156	FT	+
Oven Run	5	ORBAF 2	Register	1936.6324	FT	+
Oven Run	6	ORBAF 1	Register	1940.4023	FT	+

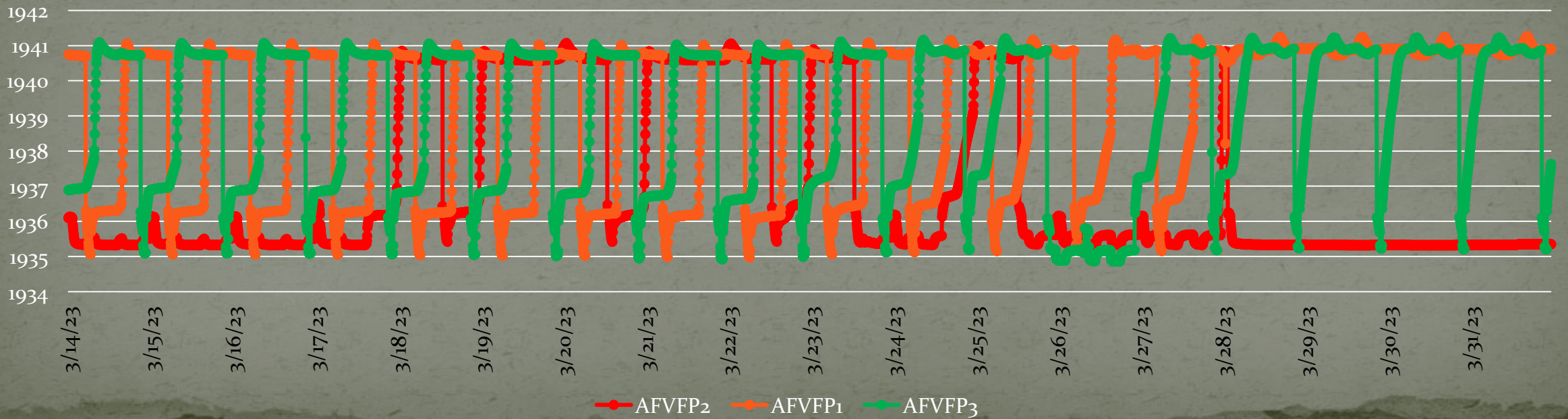
How to know when things go bad

- pH Below Pre-determined Set Point
 - Should Be Based on Pollutant Loading
- Erratic Flume Elevation Readings
 - Elevation Reading Too Low, Too High, or Static
- Radar Monitoring
 - Water Elevations Static (i.e. No Filling or Draining)

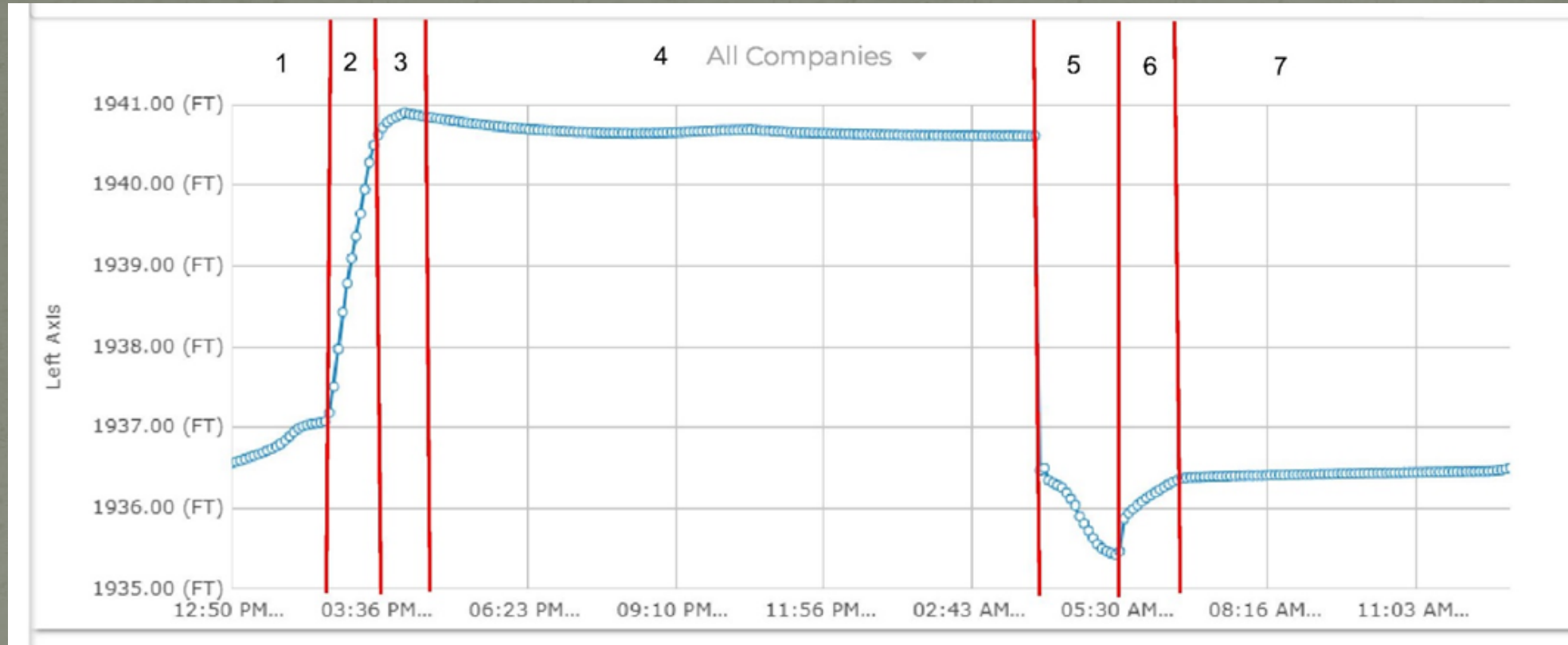
pH SP₂



BOLTS Monitoring



Analyzing the graphs to monitor hardware function

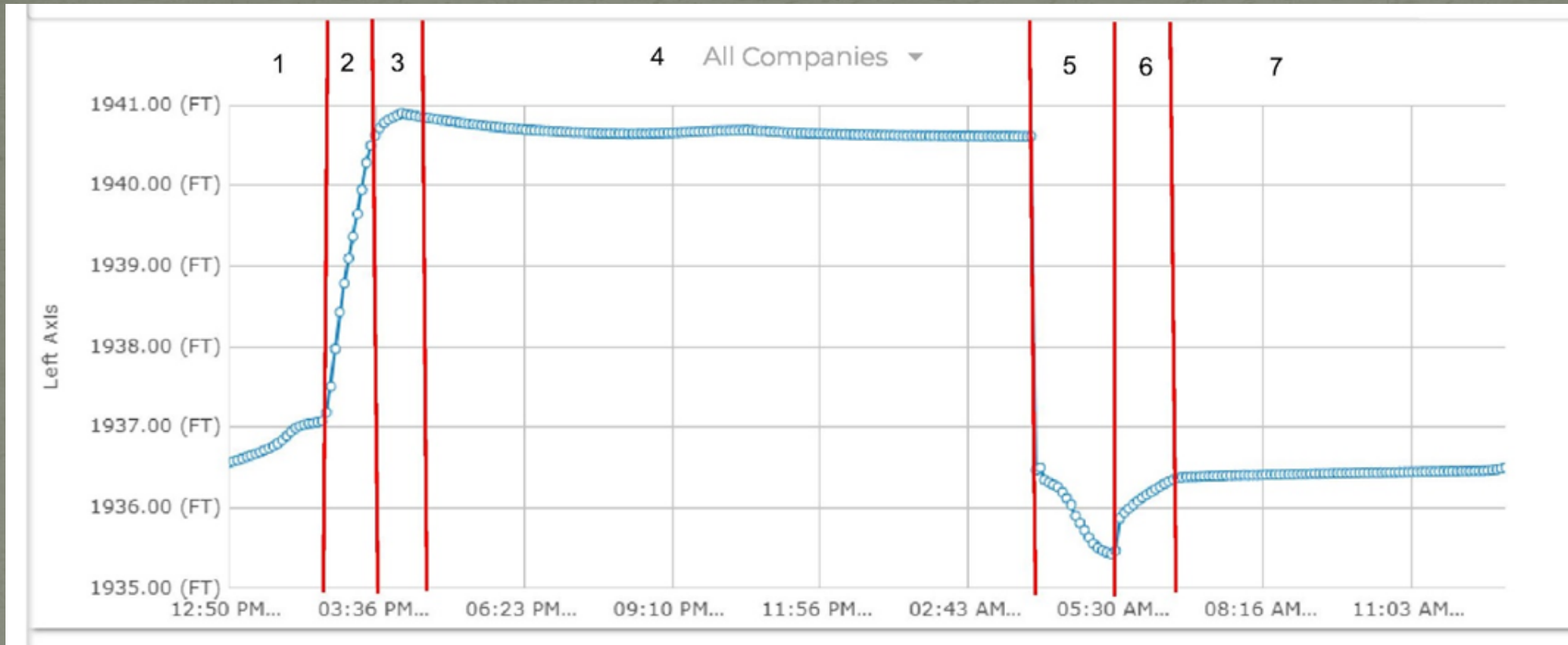


Zone 1 - The Holding Pond has reached capacity, it has begun overflowing the stop logs within the fill Agridrain box and flow into the empty Auto Flushing Vertical Flow Pond 2 (AFVFP2). This is shown by a slow gradual increase in water elevation within the Agridrain box before the quick inflow from the programmed flush.

Zone 2 - The quick increase in water elevation is shown in the graph indicating the fill valve has opened and the Holding Pond is filling AFVFP2.

Zone 3 - The elevation increases above what is seen in zone 4 indicates that the holding pond is still filling AFVFP2 and water is overflowing the stop logs within the flush Agridrain box. This can happen when flow rates are high, and the system can not fully contain all the flow from the Holding Pond. This zone will not be visible during times of lower flow.

Analyzing the graphs to monitor hardware function



Zone 4 – Steady state water level when water is being treated by the pond.

Zone 5 – A rapid drop in water elevation within the Agridrain box indicates that the flush valve has opened. The rapid water level drop drains the box until an equilibrium is achieved between the water coming into the box and the water flushing out of the box. Once equilibrium is achieved the elevation turns into a slower and more steady decline over the 90-minute flush period until the pond drains and water level reaches the bottom of the box.

Zone 6 – The small rapid increase in water level indicated the flush valve has closed and water is being contained within the Agridrain box. A brief slow but steady water level rise is seen before a steady state elevation is achieved. This brief water level rise is because the box invert is at a lower elevation than that of the pond, therefore the small amount of water still filtering through the stone will drain to the box until the box and associate drainpipe fill to an elevation equal to the bottom of the pond.

Zone 7 – Steady state water level during which the pond is empty and waiting for another fill cycle.

Cost Analysis (Installed Prices)

- Central Telemetry Unit – \$6,400
- Hardwired Radar Meters – 3 Units * \$2,600 = \$7,800
- Remote pH Meters – 2 Units * \$7,500 = \$15,000
- Ultrasonic Flow Monitoring – 1 Unit = \$8,500
- Annual Cost (year 2 and forward)- \$3,400
 - \$15/month Cellular Data Plan
 - Quarterly pH Calibrations - \$300/calibration = \$1,200
 - \$1,000/year/pH Meter = \$2,000
- Total Cost
 - ~\$50,000 (3% of total project cost)
 - 5 year - ~\$10,000 per year or \$850 per month
 - 20 year- ~\$5,000 per year or \$400 per month

Summary

- Remote Monitoring is Possible
- Useful on Passive Systems, Especially During Commissioning
- Is This an Economical Solution to Monitoring?
 - Does your system need frequent monitoring?
 - Site Location?
 - Ramifications from system malfunctions?
- Monitoring Can Help Facilitate Maintenance on These Systems
- Do You Want More Data to Do Cool Science?



Questions?

Thank You & Acknowledgements

PA DEP BAMR

Foundation for Pennsylvania Watersheds

Stream Restoration Incorporated

BioMost, Inc.

Earth Shapers, LLC

Saint Francis University

Landowners