Revealing Natural and Unnatural Phenomena on Water Quality in our Surface Waters

Sierra Club – PA Chapter, Lehigh Valley Group
Matt MacConnell

Unseen Science in the Lehigh Valley
January 11, 2018

Charlie Brown Ice House, Bethlehem, PA
January 11, 2018

Impacts in the Lehigh River Watershed

- Abandoned Mine Drainage –
  - Metals – Iron, Aluminum, Manganese,
  - Low pH
  - Yellow boy – coating of bottom rocks with iron and smothering benthic organism habitat.
- Cement Plants, Chemical and Industry or Agricultural Point Sources –
  - Potential for high pH, calcium and aluminum discharge – toxic to aquatic life
- Waste Water Treatment Plants –
  - Plant upgrades have helped
  - Combined sewer overflow
- Dam Flow Control at Headwaters
  - FEW Dam controls minimum and maximum flows primarily for flood control but also for conservation, white water boating.
- Palmerton Zinc Superfund Site – Zinc impairment at Aquashicola Creek
- Non-point Sources
  - Storm water run-off
  - Agricultural areas
  - Residential Areas

Lehigh Valley Group Main Water Programs

- Water Quality Monitoring
  - 24/7 at points in the Lehigh or other surface waters
  - Point basis or 24/7 in selected tributaries
  - Conduct annual surveys of water quality conditions in tributaries

- Metals and Nitrate Portable Field Testing
  - Iron, Aluminum and Nitrate

- Abandoned Mine Drainage (AMD) Remediation
  - Lausanne Tunnel in Jim Thorpe
  - Buck Mountain in Weatherly

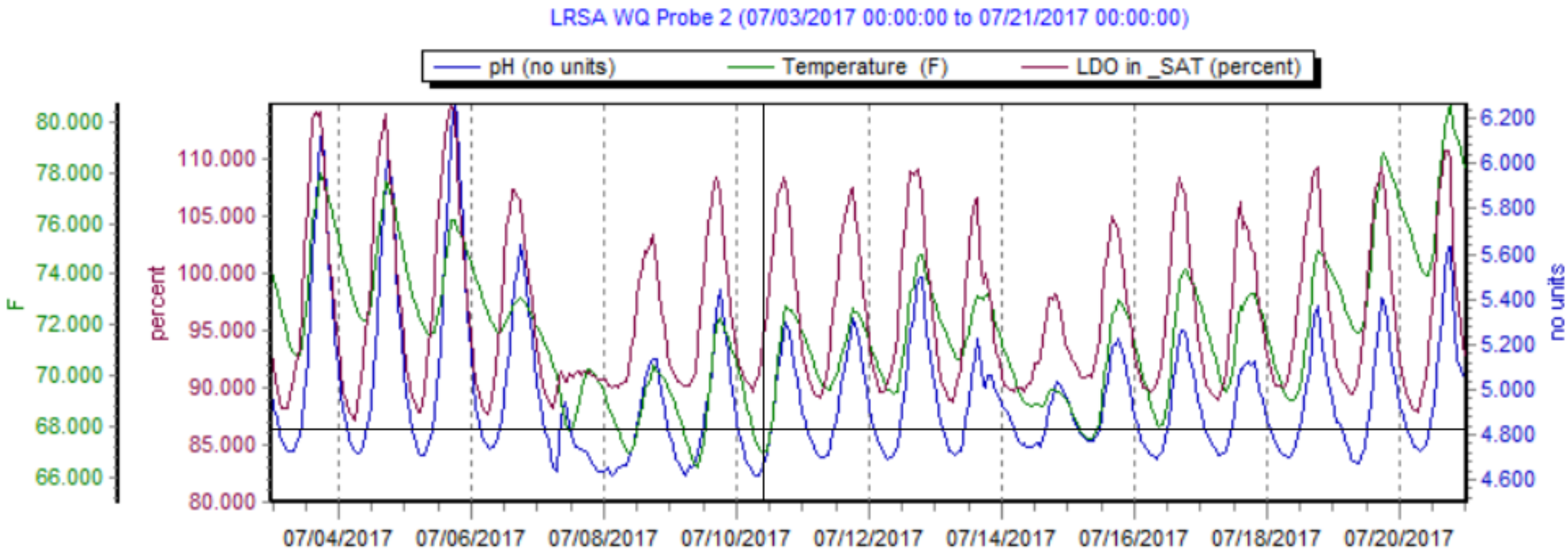
- Trout Fishway for Parryville Dam
  - Project proposals made to benefit trout populations in Lehigh and Pohopoco Creek

2017 Tributary Survey Results

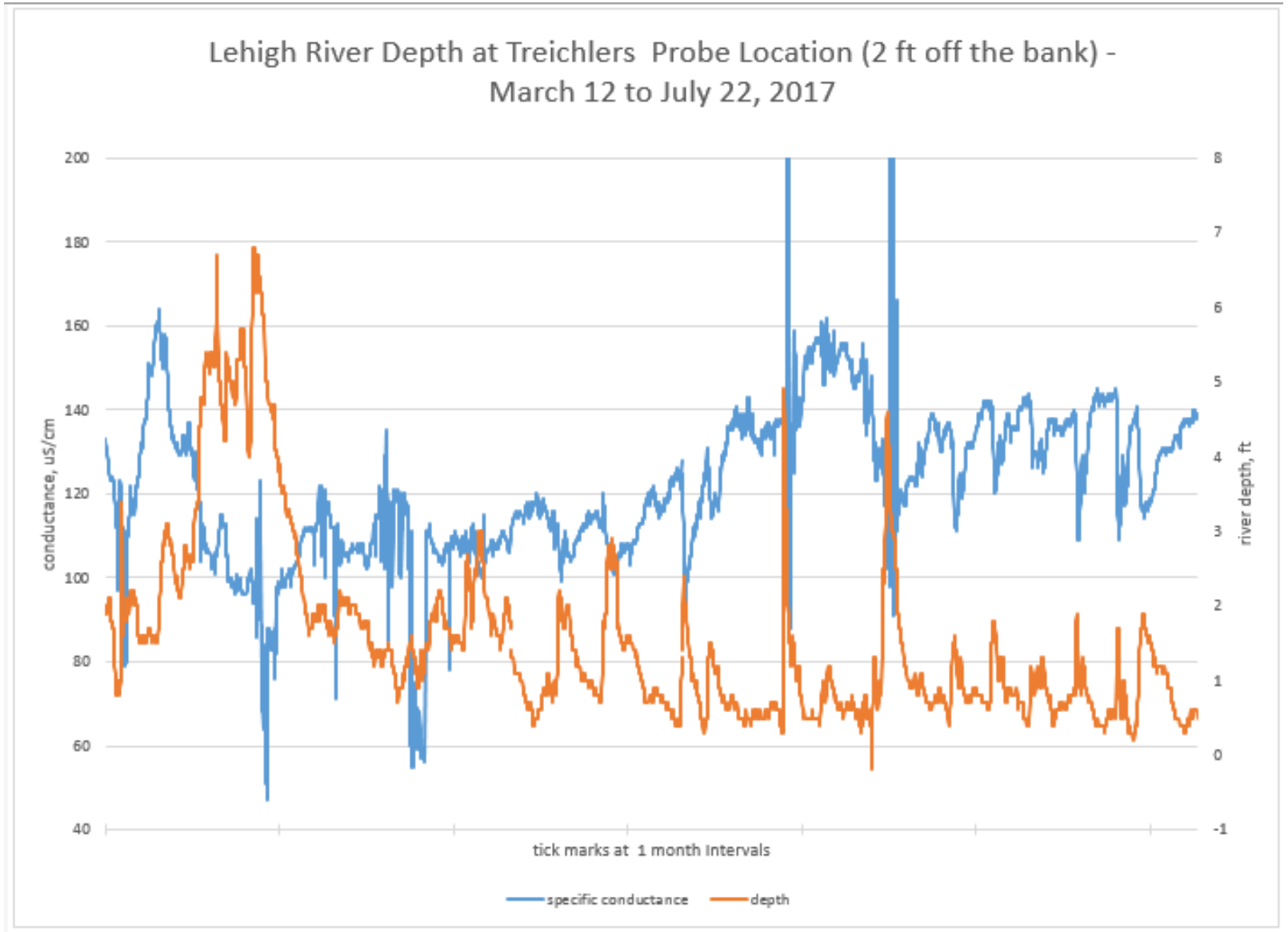
- 15 tributaries
- The tributary survey has been done for 5 years running
- pH, Conductivity and Nitrates all tend to increase as you head south

Creek	Time	Temp, F	Sp. Cond.	pH	Ni-trate	DO, %Sat
Lausanne Tunnel Outflow	13:03	58.9	833	6.38	0.17	79.6
Nesquehoning	13:11	58.9	102	7.54	0.82	100.9
Mauch Chunk	12:16	49.4	99	7.49	0.62	109
Mahoning	11:22	61.3	100	7.76	2.5	107.4
Pohopoco	11:03	56	109	7.34	1.4	99.4
Aquashicola	10:46	59.9	191	7.75	1.58	109.1
Lizard	11:46	62.1	104	7.73	2.26	101.5
Trout	10:22	60.4	279	7.95	2.08	100.7
Bertsch	10:09	59.7	231	8.03	2.42	101.1
Hockendau-	9:31	62	413	7.93	3.64	102.4
Fells	9:58	58.4	279	7.69	6.38	98.6
Spring	9:50	62.7	457	8.21	4.84	91.6
Coplay	9:06	62.4	608	8.16	4.23	95.6
Catasauqua	8:52	55.7	507	7.79	7.66	80.3
Jordan	8:39	59.3	337	7.89	4.47	99.5

Temperature, pH and Dissolved Oxygen All Cycle Each Day – This is normal photosynthesis with River Algae

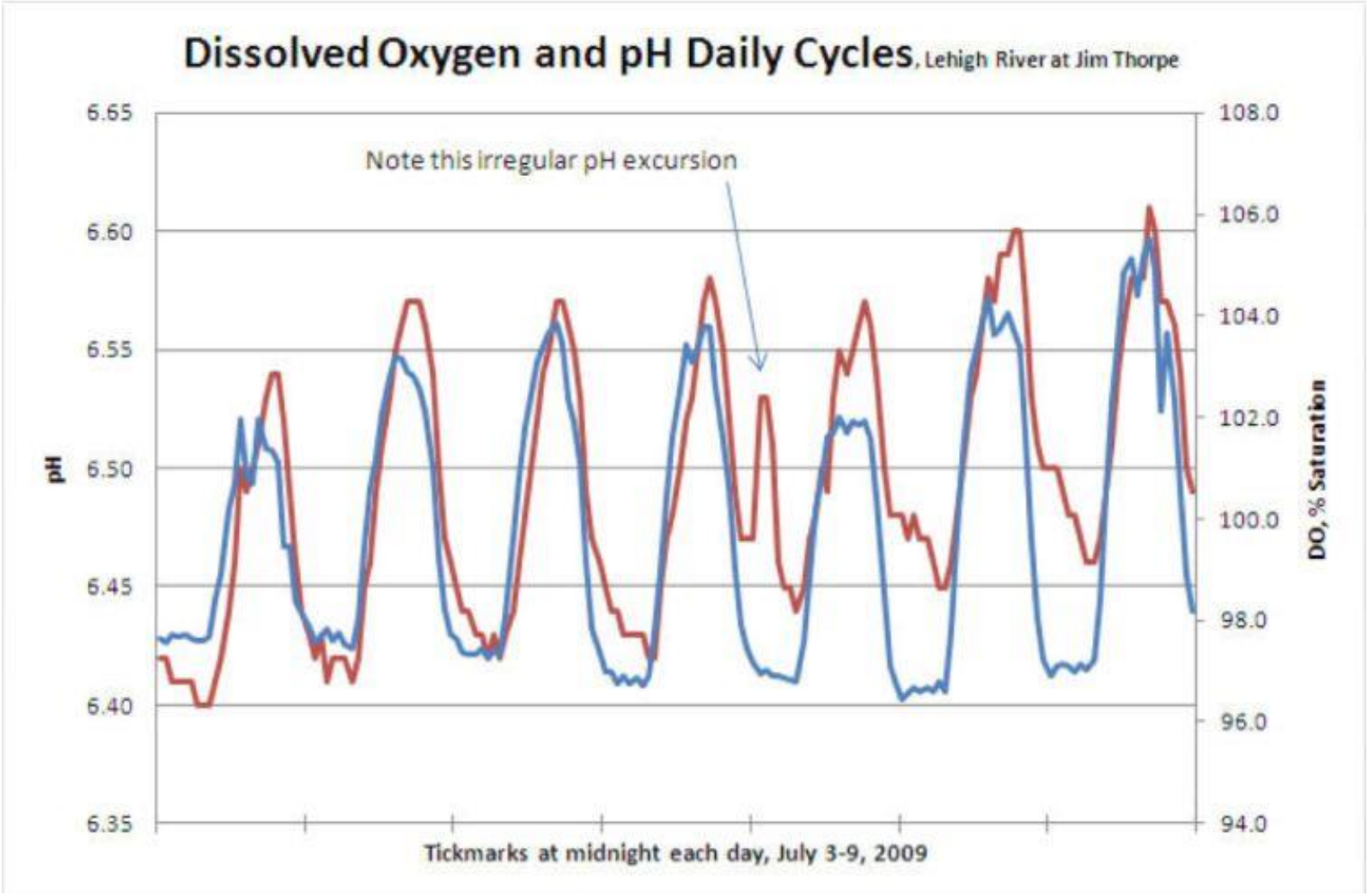


Depth vs Specific Conductance - Treichlers

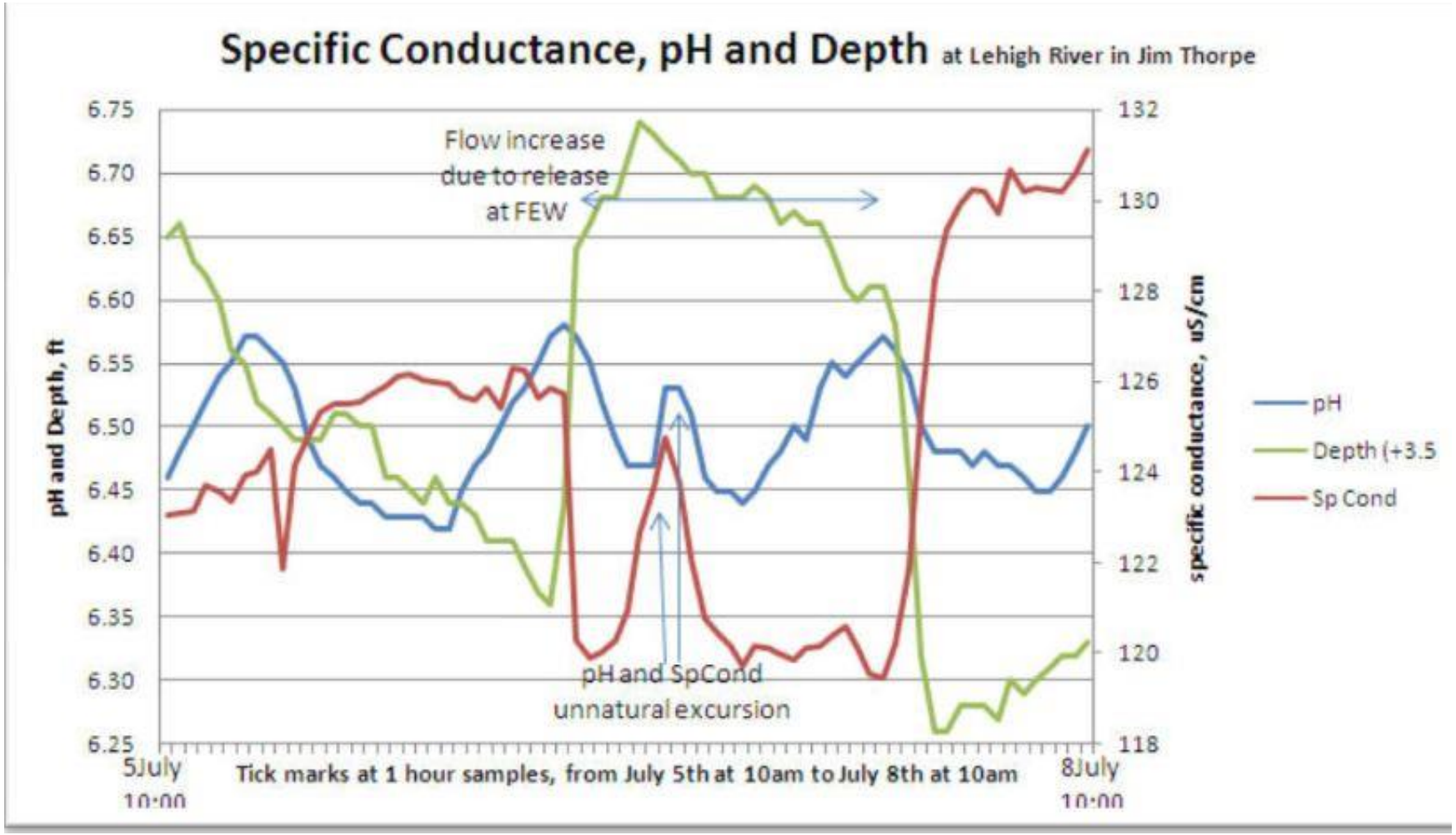


Pollution Event Captured!

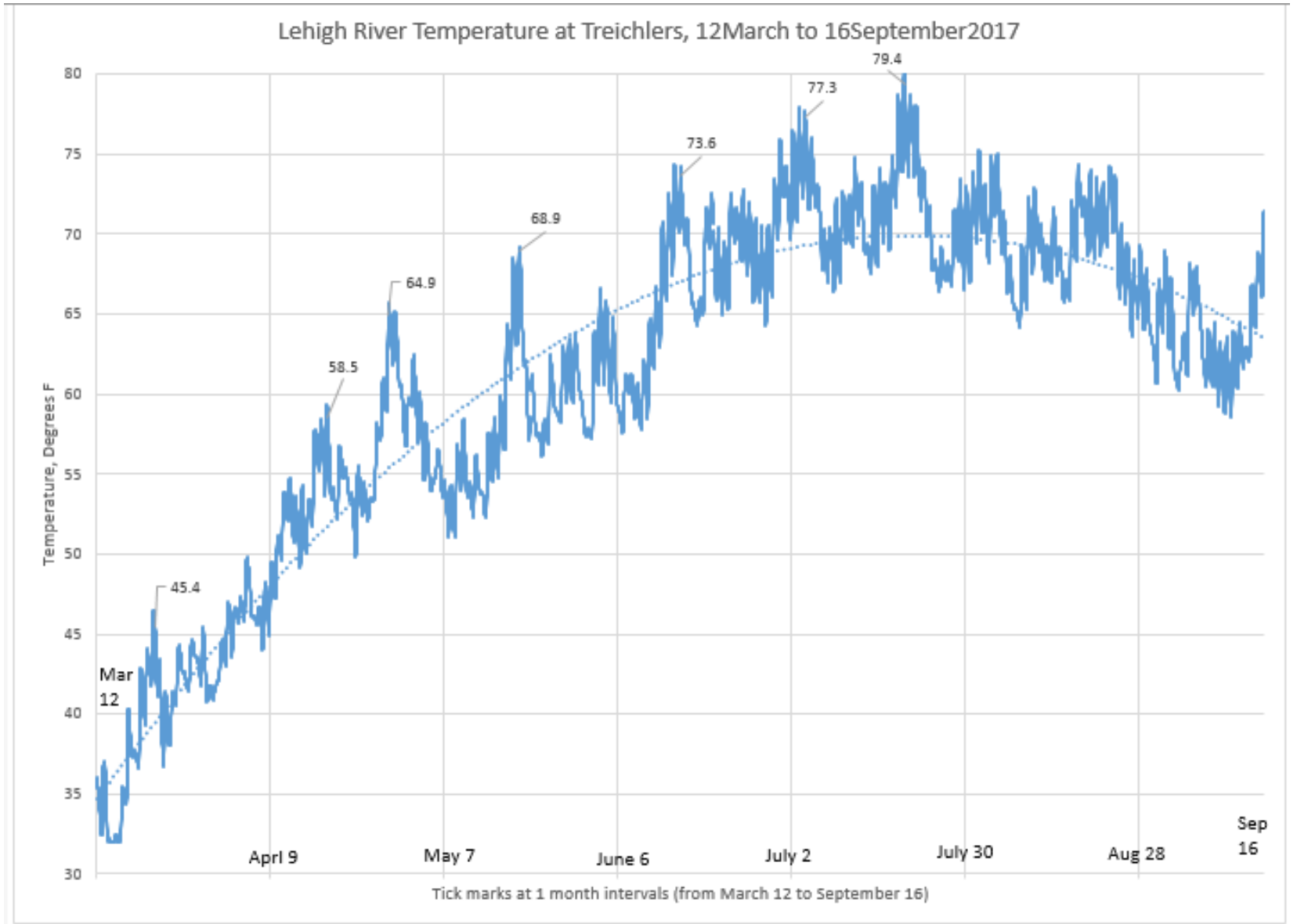
In the graph below, the natural diurnal cycle of pH with dissolved oxygen is clearly evident. This natural pH cycle is caused by photosynthesis of algae and other plant life. The plants extract CO2, thereby reducing carbonic acid in the water, which raises pH, while producing pure oxygen, which in this case drives dissolved oxygen levels above the air-saturation level.



The specific conductance also spiked at the same time the pH excursion occurred. This implies that something entered the river that added to the dissolved "salt" content and drove the pH high. Given the high volume of water, it would take a large amount of material to cause the Lehigh main stem to register the effect given the huge amount of dilution. It is noteworthy also that during this specific event, the river depth increased by 3 inches allowing even more dilution, but still the pH and specific conductance event is clearly evident. Using Standard Methods of Analysis, calculated about 400 lbs of dissolved solids were dumped into the river/stream.

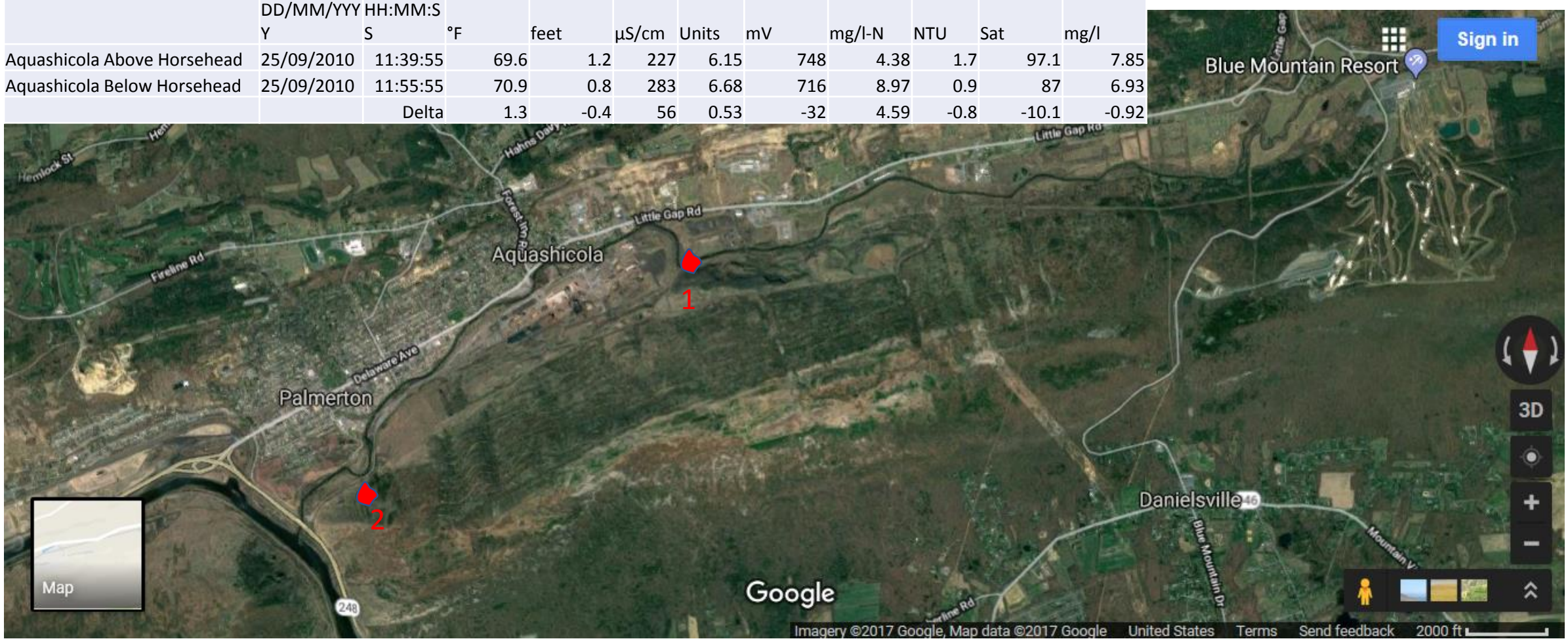


Lehigh Temperature Profile at Treichlers Area



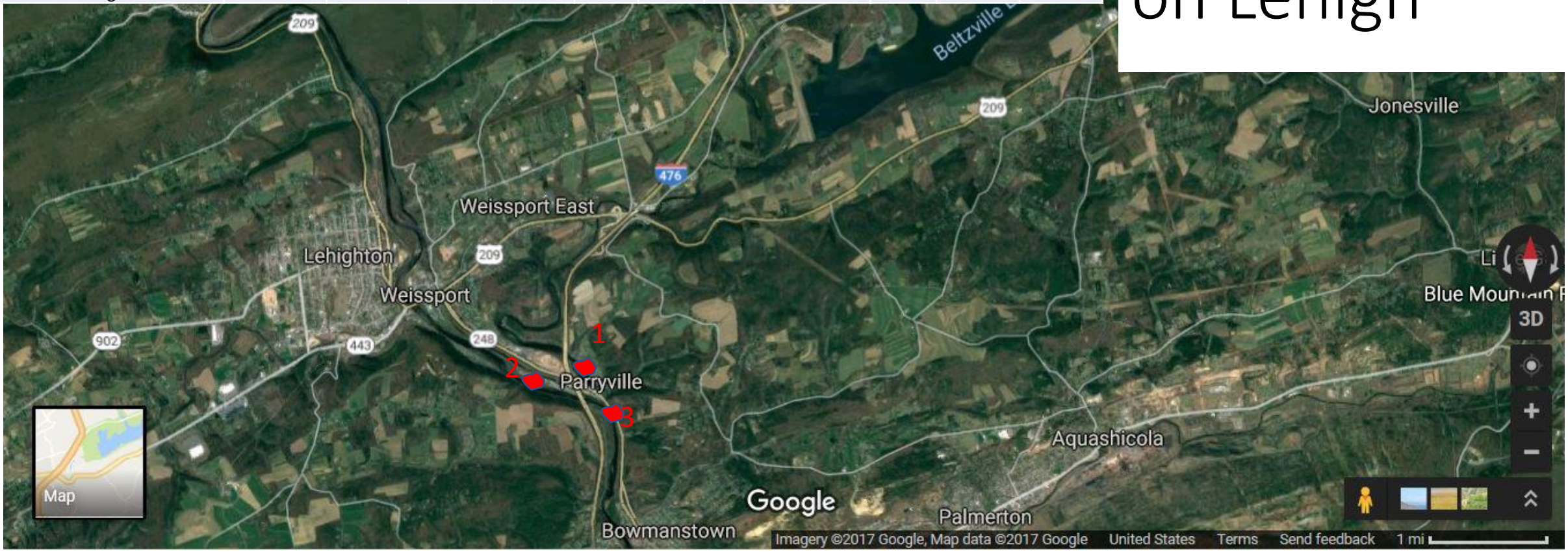
Horsehead Industrial Impacts on Aquashicola Creek, Palmerton

	Date	Time	Temp	Dep100	SpCond	pH	ORP	NO3-	TurbSC	LDO%	LDO
	DD/MM/YYYY	HH:MM:SS	°F	feet	µS/cm	Units	mV	mg/l-N	NTU	Sat	mg/l
Aquashicola Above Horsehead	25/09/2010	11:39:55	69.6	1.2	227	6.15	748	4.38	1.7	97.1	7.85
Aquashicola Below Horsehead	25/09/2010	11:55:55	70.9	0.8	283	6.68	716	8.97	0.9	87	6.93
		Delta	1.3	-0.4	56	0.53	-32	4.59	-0.8	-10.1	-0.92

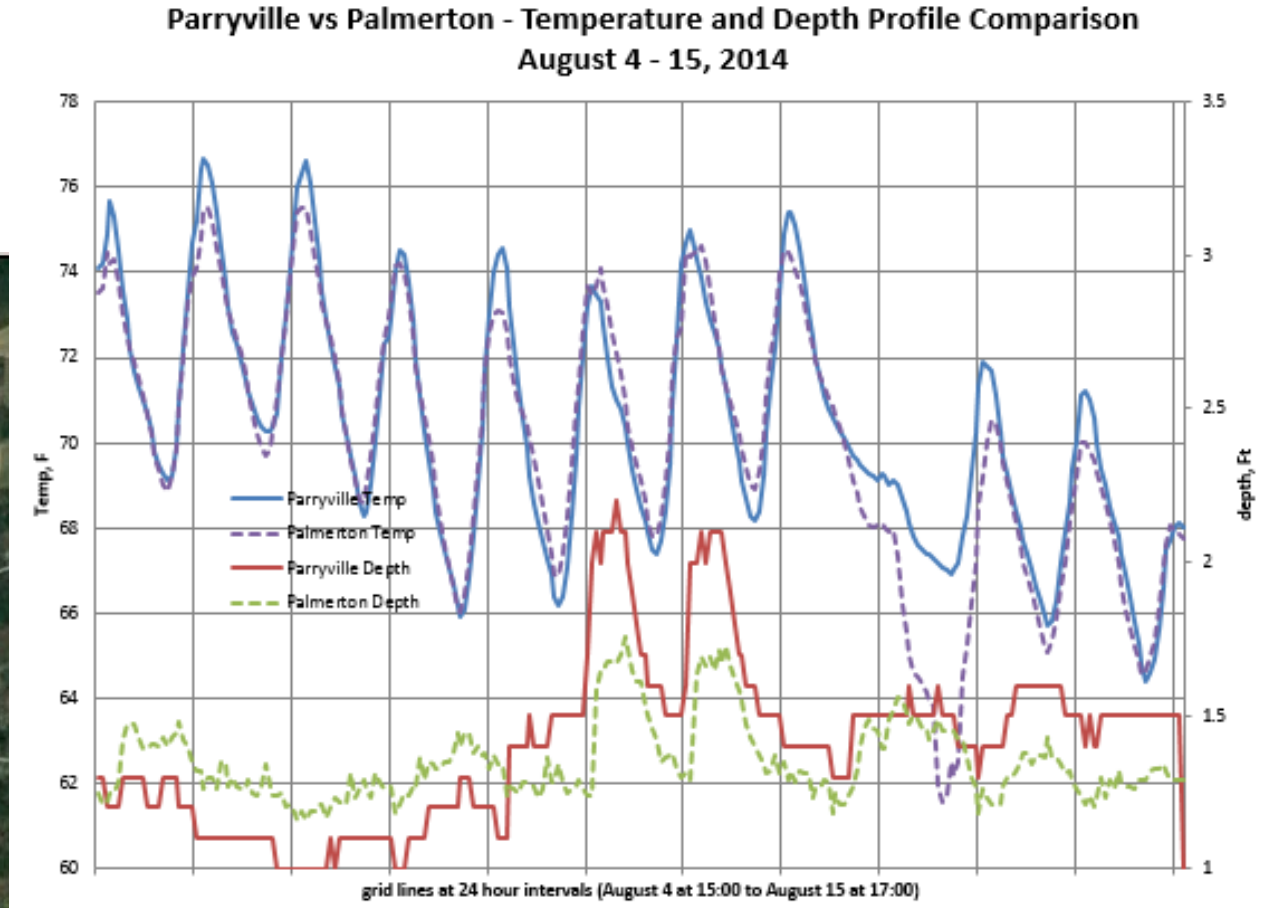


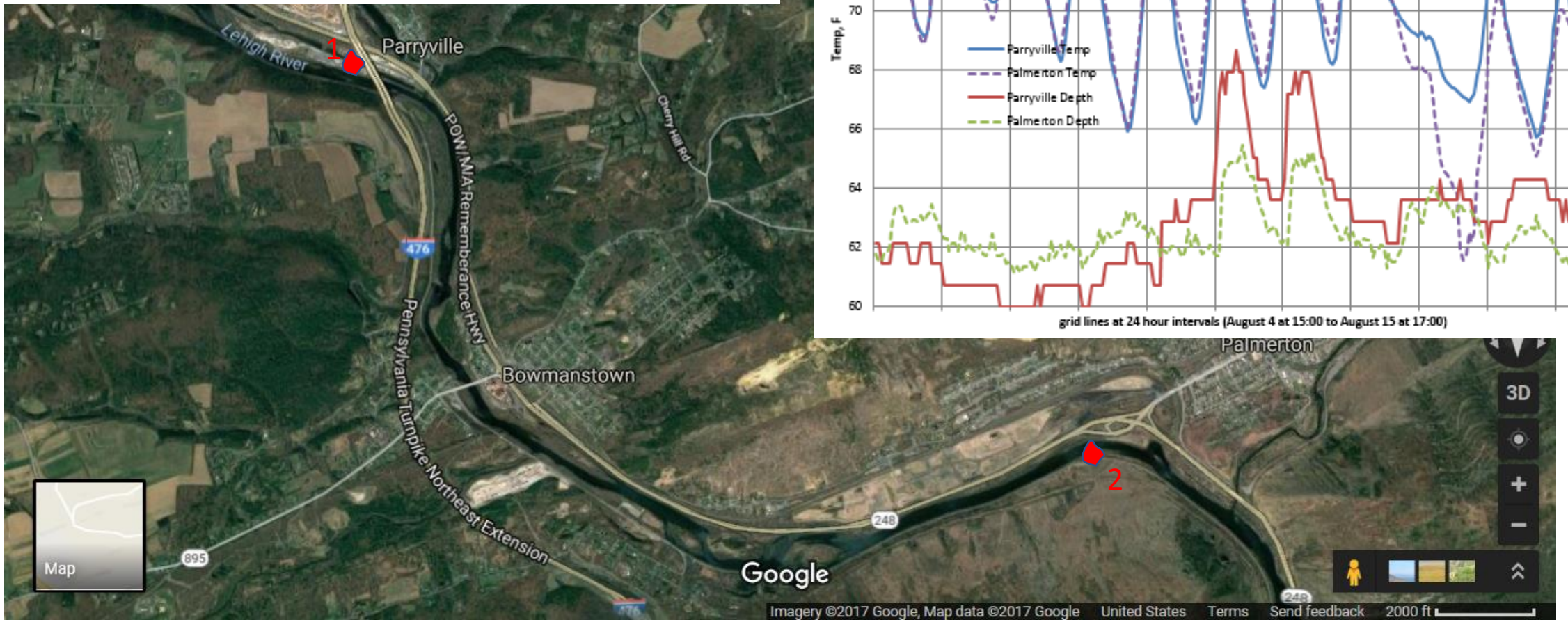
Pohopoco Creek Tail Water Impact on Lehigh

	Date	Time	Temp	Dep100	SpCond	pH	ORP	NO3-	TurbSC	LDO%	LDO
	DD/MM/YYYY	HH:MM:SS	°F	feet	µS/cm	Units	mV	mg/l-N	NTU	Sat	mg/l
Po at Beltzvill Outflow	25/09/2010	10:45:35	58.5	0.2	86	6.45	723	3.39	1.2	94.2	8.66
Po at Crest of Parryville dam	25/09/2010	11:06:50	60.2	1.7	95	5.87	754	2.08	6.8	85.3	7.69
		Delta	1.7	1.5	9	-0.58	31	-1.31	5.6	-8.9	-0.97
Lehigh Above the Po Confl	25/09/2010	12:12:25	72.4	1.6	137	6.79	700	6.58	0.3	115.1	9.03
Po at Confluence	25/09/2010	12:16:55	62.1	1.3	96	6.84	694	4.44	3.7	94.3	8.31
avg below Po Conflence			69	0.95	122.5	6.92	690	5.83	2.3	107.4	8.74
Effect of Po on Lehigh			-3.4	-0.65	-14.5	0.13	-10	-0.75	2.0	-7.7	-0.29
Delta Po and Lehigh			-10.3	-0.3	-41	0.05	-6	-2.14	3.4	-20.8	-0.72



Lehigh Comparison – Parryville vs Palmerton





Lausanne Tunnel AMD Site in Jim Thorpe

- Issues are channeling, need of dredging and overgrowth, flow distribution

Raw AMD confluence with Nesquehoning Creek – Bypassing Passive Wetland AMR

Macroinvertebrate Study of AMD Impact

Clean Stream

- Mayfly, stonefly, caddis, many…

AMD Impacted

- Only two cranefly

Milestone Dates Along the Way at Lausanne Tunnel Remediation Site

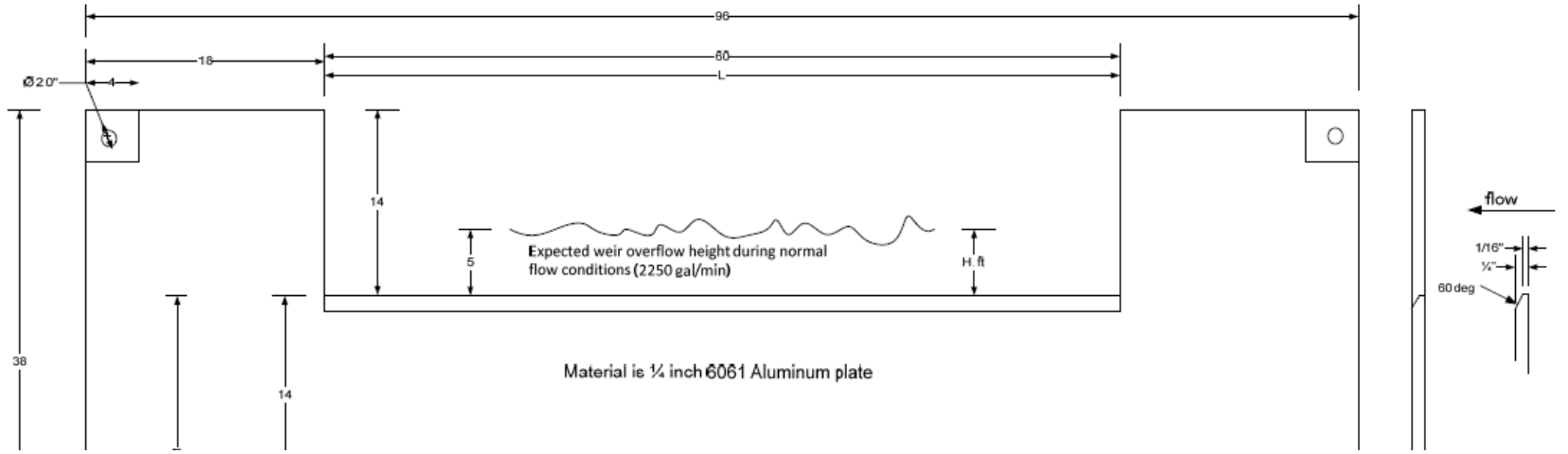
- Wetland put into Operation 2004

<u>Sierra Club Funded Projects</u>:

- Flow Weirs Installed 2007
  - Upgraded instruments 2009
- Installed Artesian Aerators 2011
- Designed Bypass Settling Concept and Installed 3rd Feeder pipe 2014
- Installed solar powered air compressor aeration 2016

Open Channel Flow Monitors Installed

Measure and Read Flow from Tables



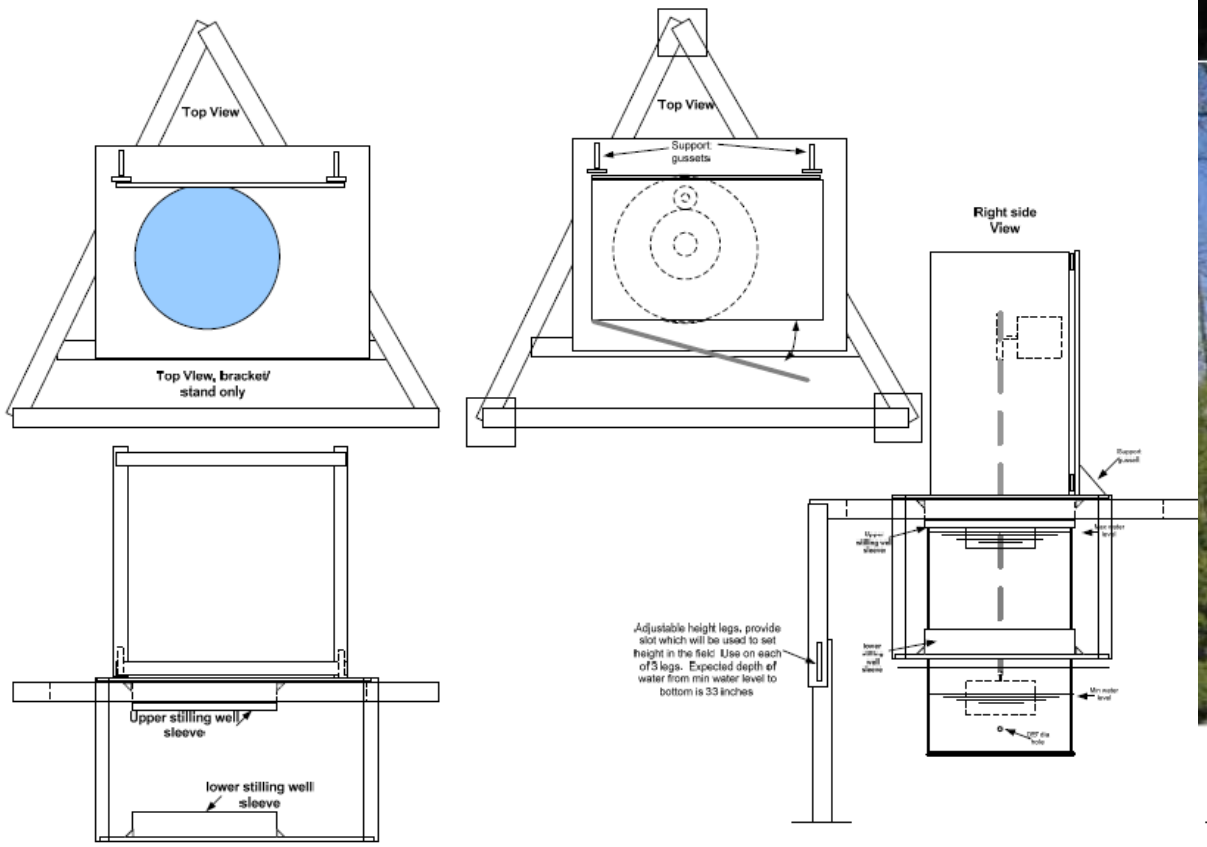
11 Common Weirs and Flumes

Rectangular (Contracted) Weirs (Cont'd)

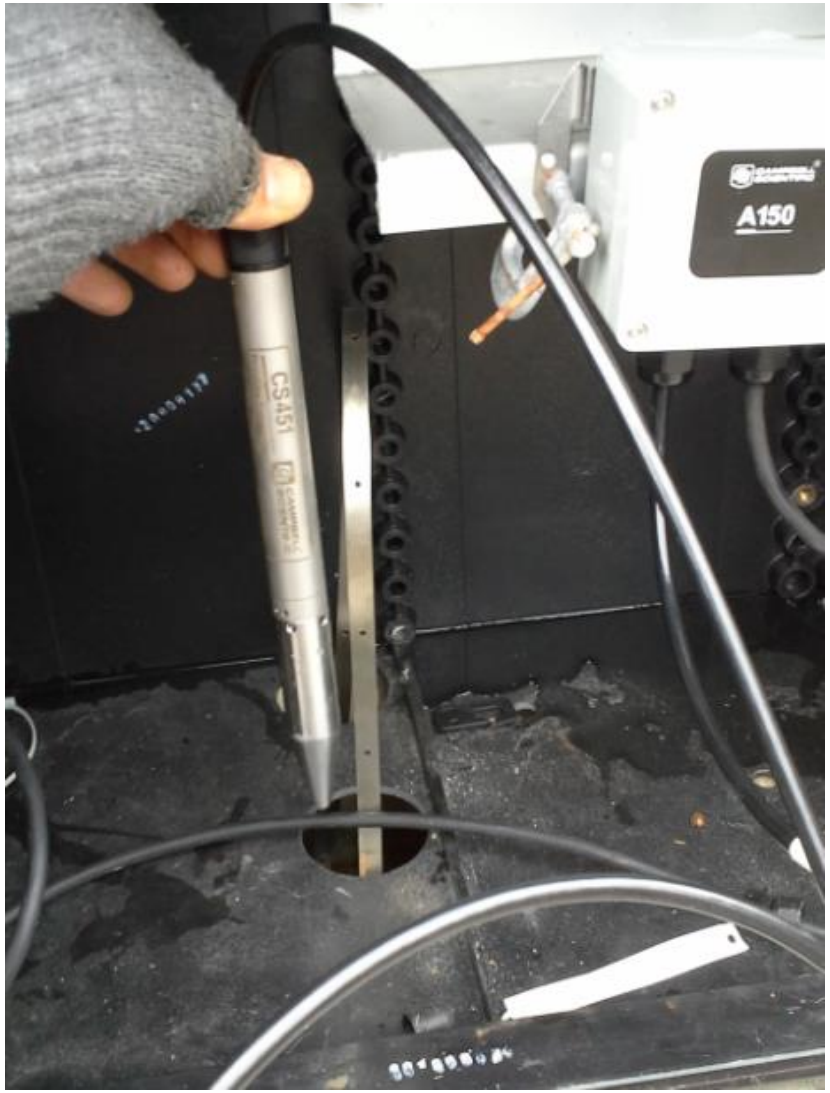
Length of Weir Crest

Head in Ft	1		1 1/2		2		3		4		5	
	CFS	MGD	CFS	MGD	CFS	MGD	CFS	MGD	CFS	MGD	CFS	MGD
0.31	0.539	0.348	0.827	0.535	1.114	0.720	1.689	1.092	2.263	1.463	2.836	1.834
0.32	0.564	0.365	0.866	0.560	1.167	0.754	1.770	1.144	2.373	1.534	2.975	1.922
0.33	0.590	0.381	0.905	0.585	1.221	0.789	1.852	1.197	2.483	1.605	3.115	2.013
0.34	0.615	0.397	0.945	0.611	1.275	0.824	1.936	1.251	2.596	1.678	3.256	2.104
0.35	0.641	0.414	0.986	0.637	1.331	0.860	2.020	1.306	2.710	1.752	3.399	2.197

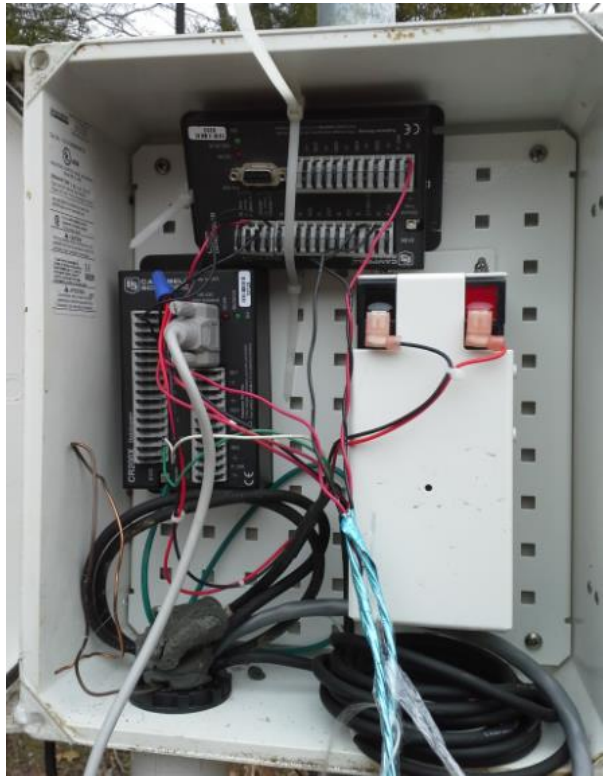
Stilling wells, shaft encoder and solar datalogger - 2007



New instrumentation - 2009

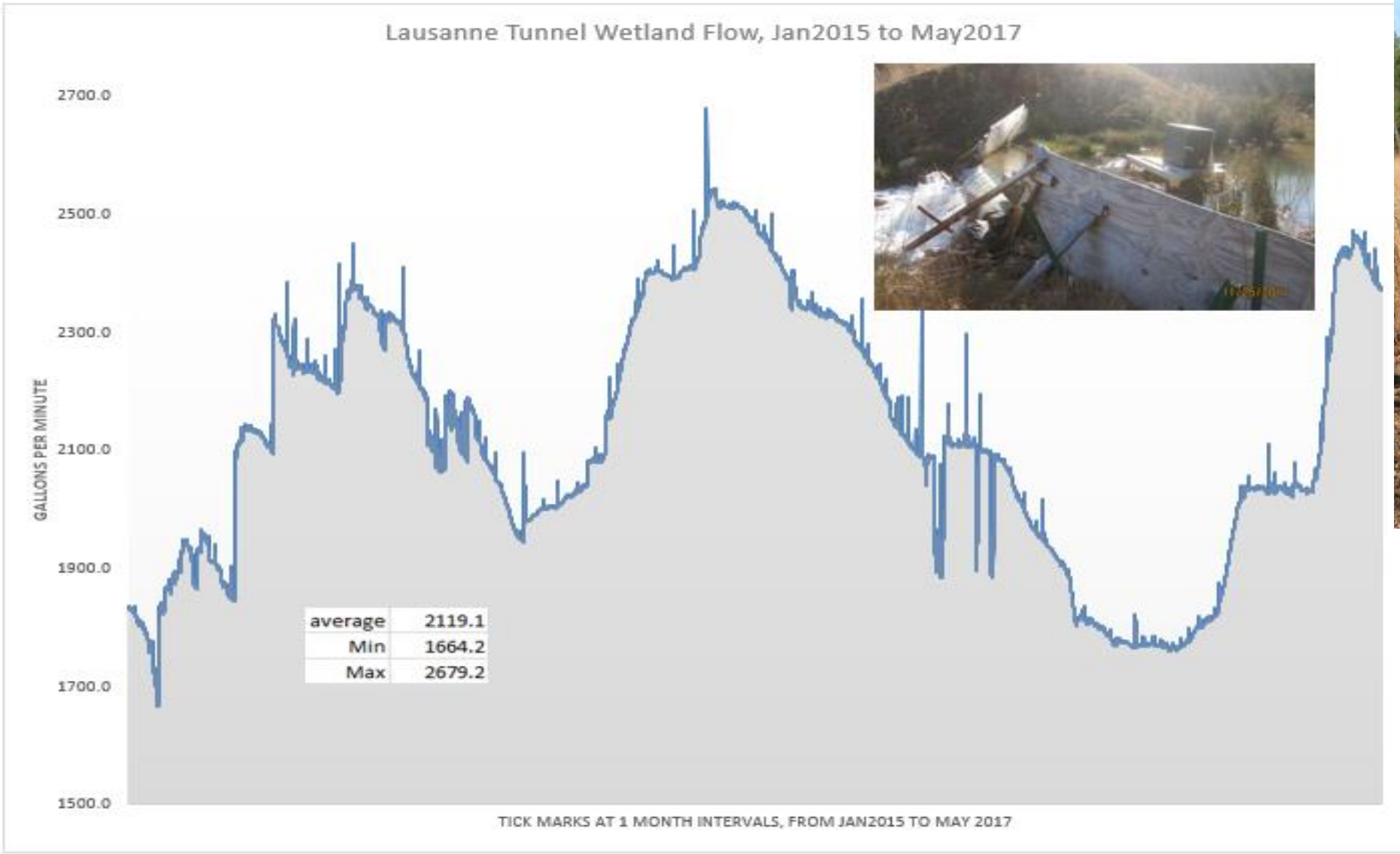


- Added second solar powered datalogger
- Replace shaft encoders with DP transmitters



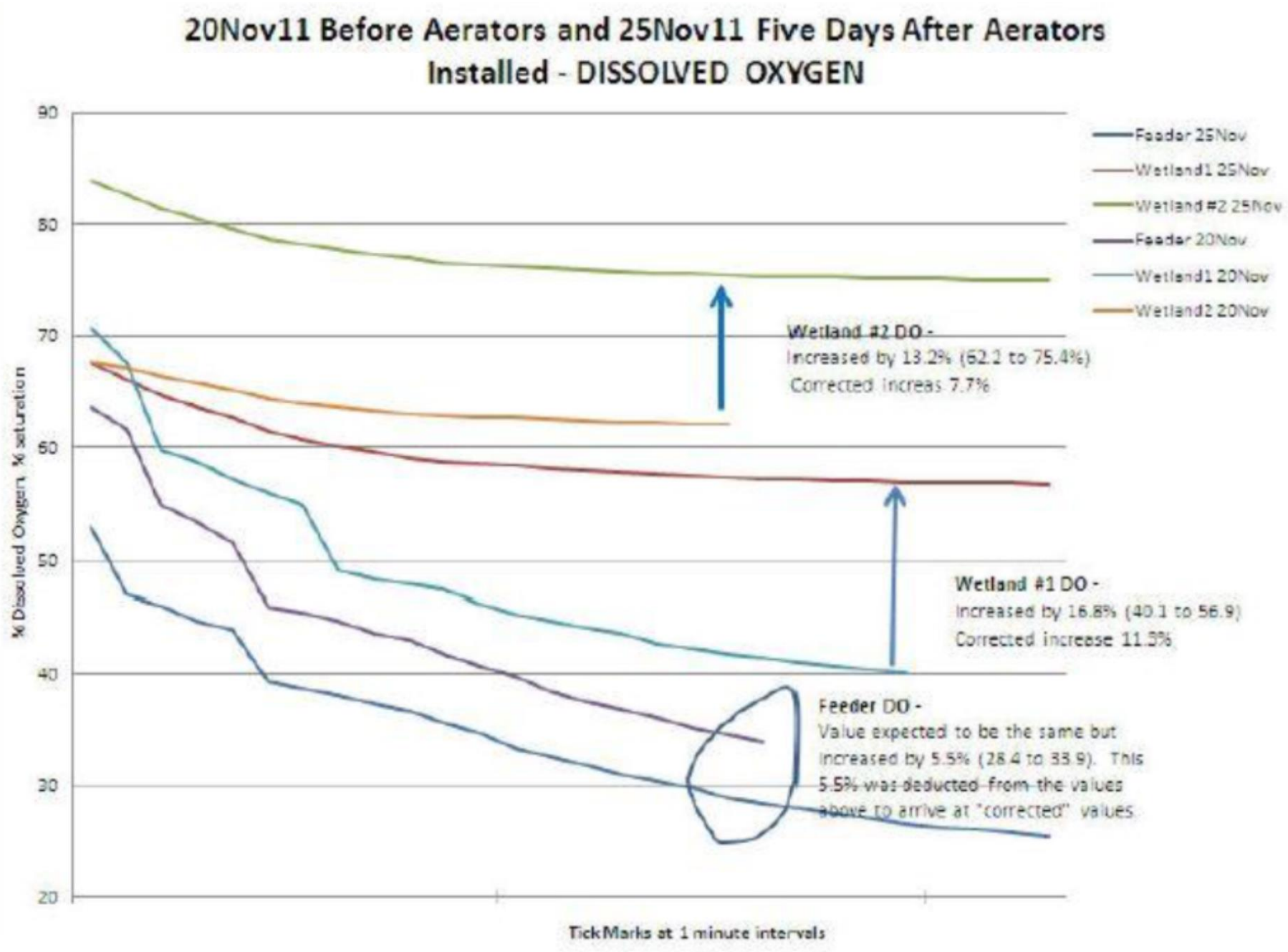
Bypass Flows, 2015-2017
(avg 2820gpm)

Wetland flows 2015-2017 (avg flow 2120 gpm)



- Downloading flow data to PC

Inlet Pipe Aerators in 2011


20Nov11 Before Aerators and 25Nov11 Five Days After Aerators Installed - DISSOLVED OXYGEN
% Dissolved Oxygen, % saturation
90
80
70
60
50
40
30
20
Feeder 25Nov
Wetland1 25Nov
Wetland #2 25Nov
Feeder 20Nov
Wetland1 20Nov
Wetland2 20Nov
Wetland #2 DO -
Increased by 13.2% (62.2 to 75.4%)
Corrected increas 7.7%
Wetland #1 DO -
Increased by 16.8% (40.1 to 56.9)
Corrected increase 11.3%
Feeder DO -
Value expected to be the same but
increased by 5.5% (28.4 to 33.9). This
5.5% was deducted from the values
above to arrive at "corrected" values
TickMarks at 1 minute intervals

Beaver Activity– Blocked inlets and dammed bypass!

- Cleared pipes with much difficulty
- Attempted to install siphon to supplement flow
- Beavers moved on, now just managing normal build up

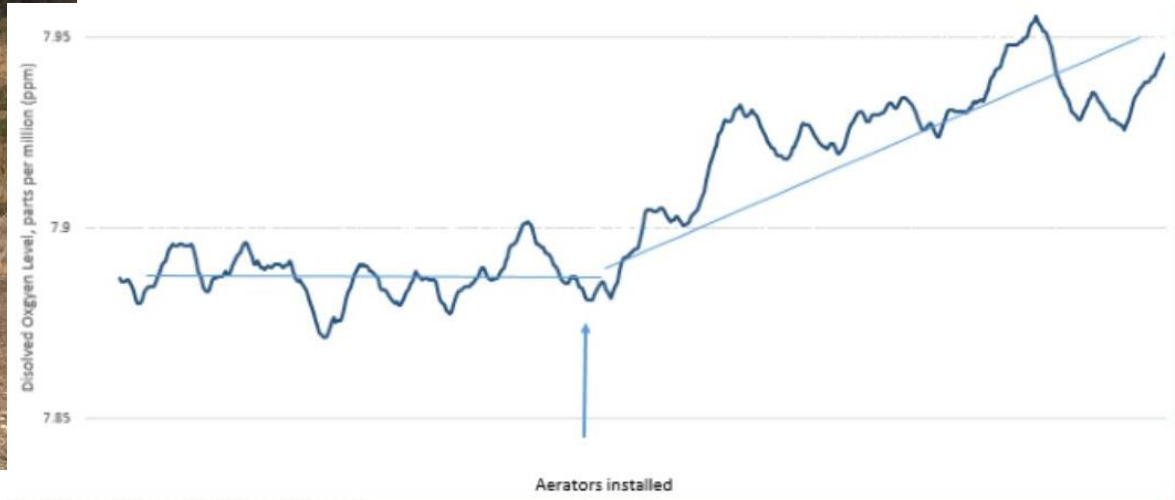
$2,500 Project to add 30 ft of 14” PVC to increase flow to design rates

Solar powered aerators - 2016

provides free 200 watts of power for two aerators that will operate each day during daylight hours

Dissolved Oxygen in the wetland increased after installation – more Fe2+ to Fe3+ Iron removal

- Project cost about $5,000
- Pond Hawk system



Wetland Analysis

AVG	Site 1	Site 2	Site 3	Site 4	Site 5
LDO (%)	35	59.8	65.4	73	77.8
NO_3- (mg/L)	0.07	0.08	0.08	0.08	0.09
pH (Units)	6.10	6.18	6.30	6.33	6.40
Temperature (°F)	54.1	53.9	55.4	55.0	55.1
S Cond (µS/cm)	700.4	706.1	701.7	704	704.5
ORP (mV)	-22.5	-20.5	-18.5	-24	-25.5
LDO (mg/L)	3.70	6.32	6.78	7.66	8.03

Site 1 - "Feeder Pool" from tunnel outlet.
Site 2 - After first aerator.
Site 3 - Before weir.
Site 4 - After weir.

LDO - Luminescent Dissolved Oxygen
NO_3- - Nitrate Levels
S Cond - Specific Conductivity
ORP - Oxidation Reduction Potential

Factor	Load (lbs/day)	Concentration (mg/L)
TDS	27766	501.00
Acidity	0	0.00
Aluminum	79	1.42
Manganese	141	2.54
Sulfate	18,267	329.61
Alkalinity	4484	80.91
Total Iron	246	4.44
pH	6.3	
Flow (gpm)	4618	
Total Load	18,733	

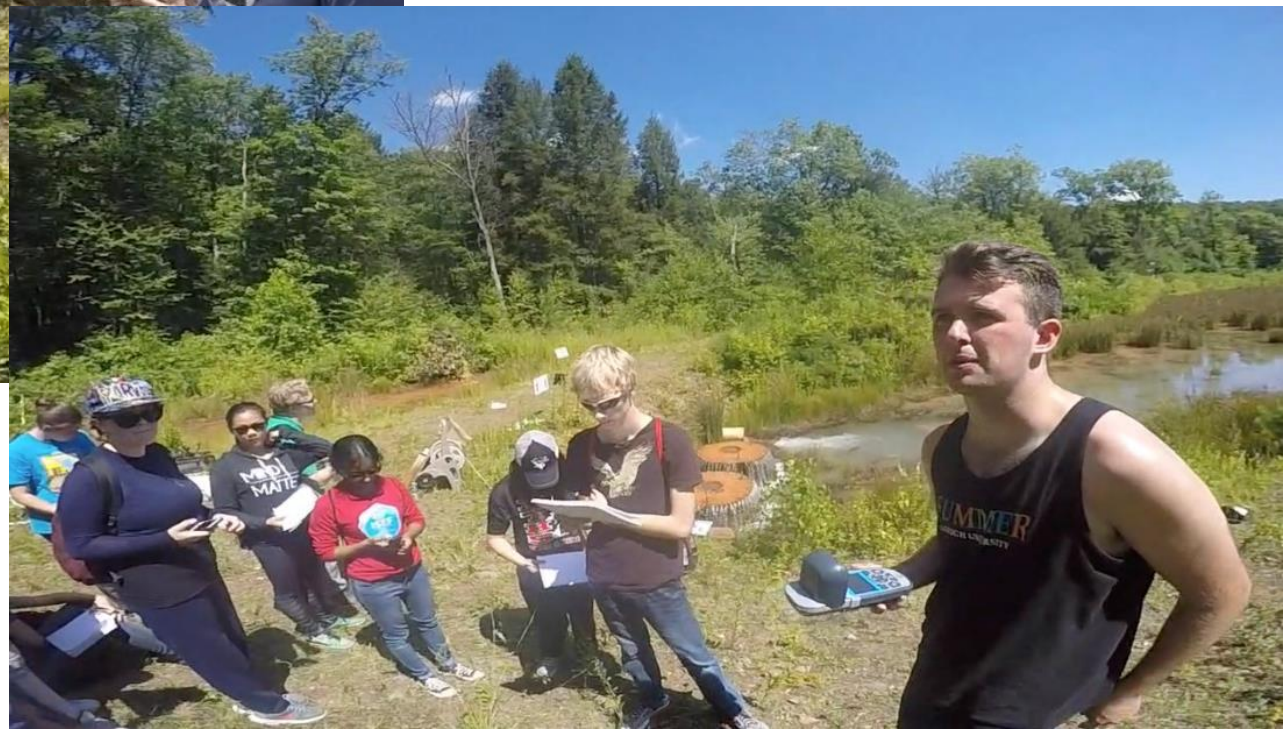
Data below from Neil at Hedin Envi.

SAMPLE ID	SAMPLE DATE	TAKEN BY	FIELD ALK mg/l	TEMP. deg C.	FIELD PH	LAB PH	COND. umhos	ALK. mg/L	ACIDITY mg/L	IRON mg/L	MANG. mg/L	ALUM. mg/L	SO4 mg/L	TSS mg/L
TUNNEL MOUTH	05/10/17	NEIL	93.0	12.6	6.3	6.53	820	106.78	-95.48	3.16	1.73	1.19	295.4	8
WETLAND MIDPOINT	05/10/17	NEIL	92.0	13.4	6.4	6.72	817	105.10	-96.28	3.08	1.76	1.12	268.8	10
FINAL	05/10/17	NEIL	89.0	14.4	6.7	6.90	819	106.33	-99.50	2.71	1.74	0.94	271.3	7

Group Outings – Young and Old enjoy learning!

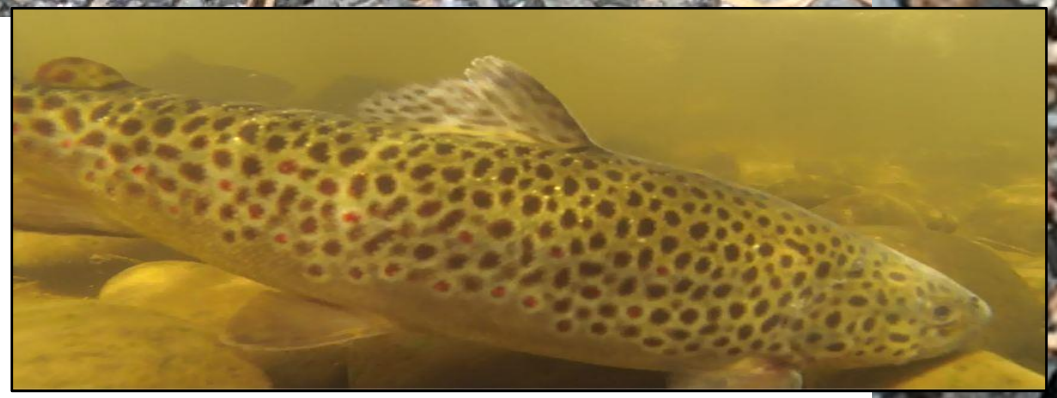
High School Student Summer Programs

- Program conducted in 2105 and 2016
- Coordinated with Lehigh University



- 100+ HS students exposed to environmental engineering

Resident Wildlife Observed Here



There is Light at the End of the Tunnel

A rare view from my kayak inside the Lausanne Tunnel

Volunteers Welcome to Help!

Thank you

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