

Tacoma's Water Quality Monitoring Program at Eagle Gorge Reservoir

Celine Mina, PE

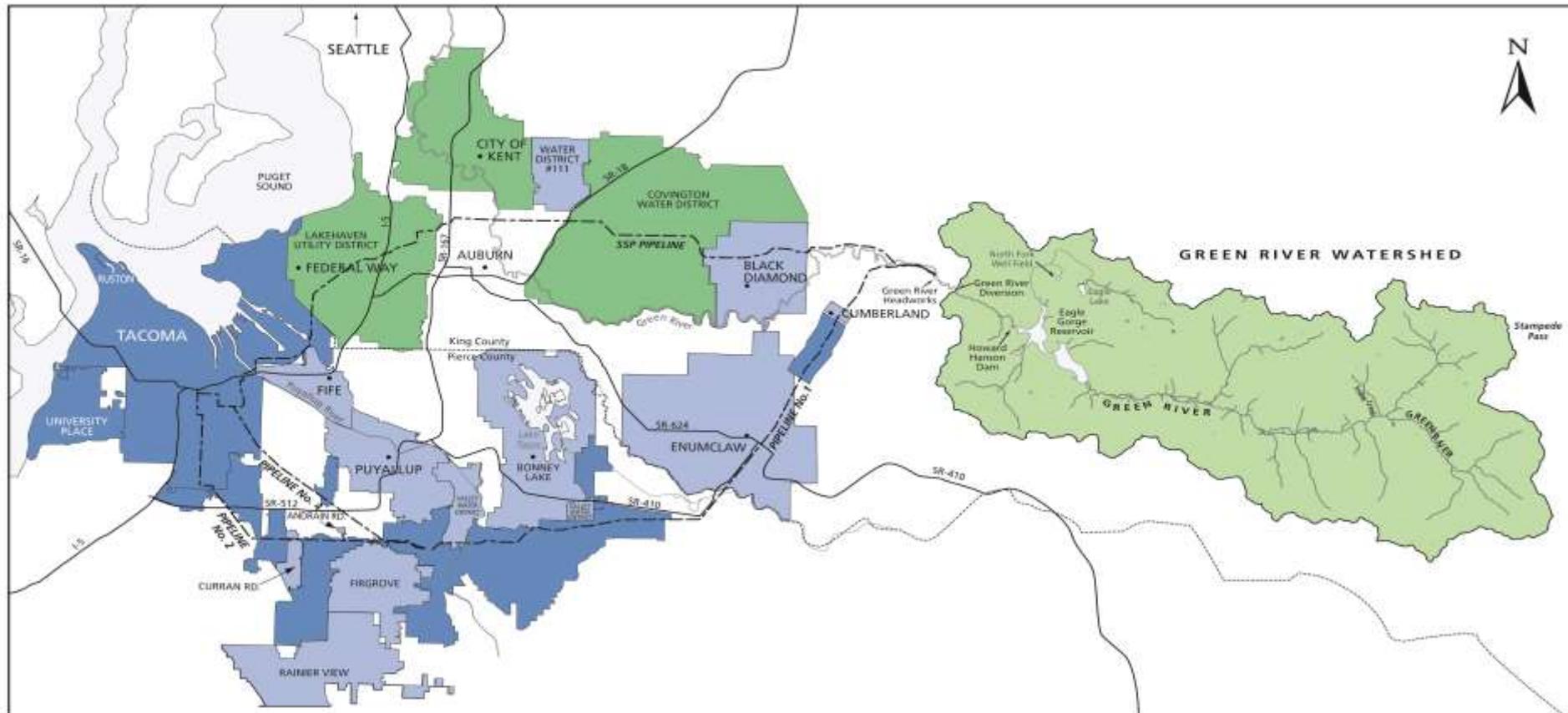
April 27, 2018

PNWS-AWWA Conference

TACOMA  **WATER**
TACOMA PUBLIC UTILITIES

System Overview

- System serves approximately 318,000 people directly in the Puget Sound Region, plus Partner and wholesale connections.
- 231 square miles of protected watershed in Cascade foothills.
- Green River supply was unfiltered until the Green River Filtration Facility was completed in December 2014.



Green River Filtration Facility



Green River Filtration Facility
April 5, 2015

Howard Hanson Dam

- **US Army Corps of Engineers dam 3 river miles upstream of intake.**
- **Constructed in 1961.**
- **Operated for flood control operations through the winter and additional water storage through the summer.**
- **Base of dam = 1035'**
- **Pool raised to 1167' for summer storage.**



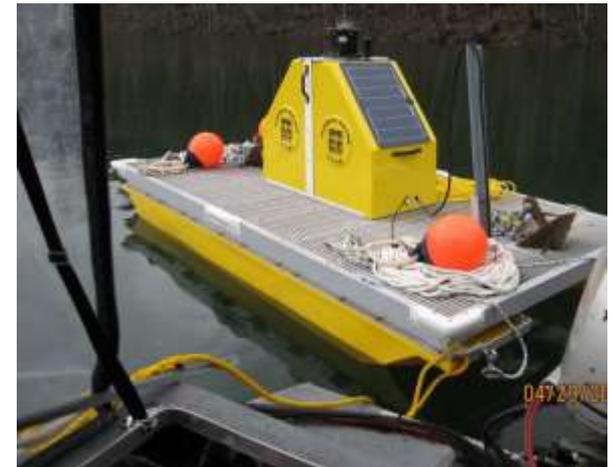
Reservoir Water Quality Monitoring Program

- **Focus on raw water quality behind the dam**
- **Monitoring program developed**
 - Understand water quality conditions upstream of the treatment plant
 - Monitor for potential water quality issues
- **Past water quality issues experienced**
 - Algae, taste and odor
 - Iron and manganese, yellow water



Monitoring Program Overview

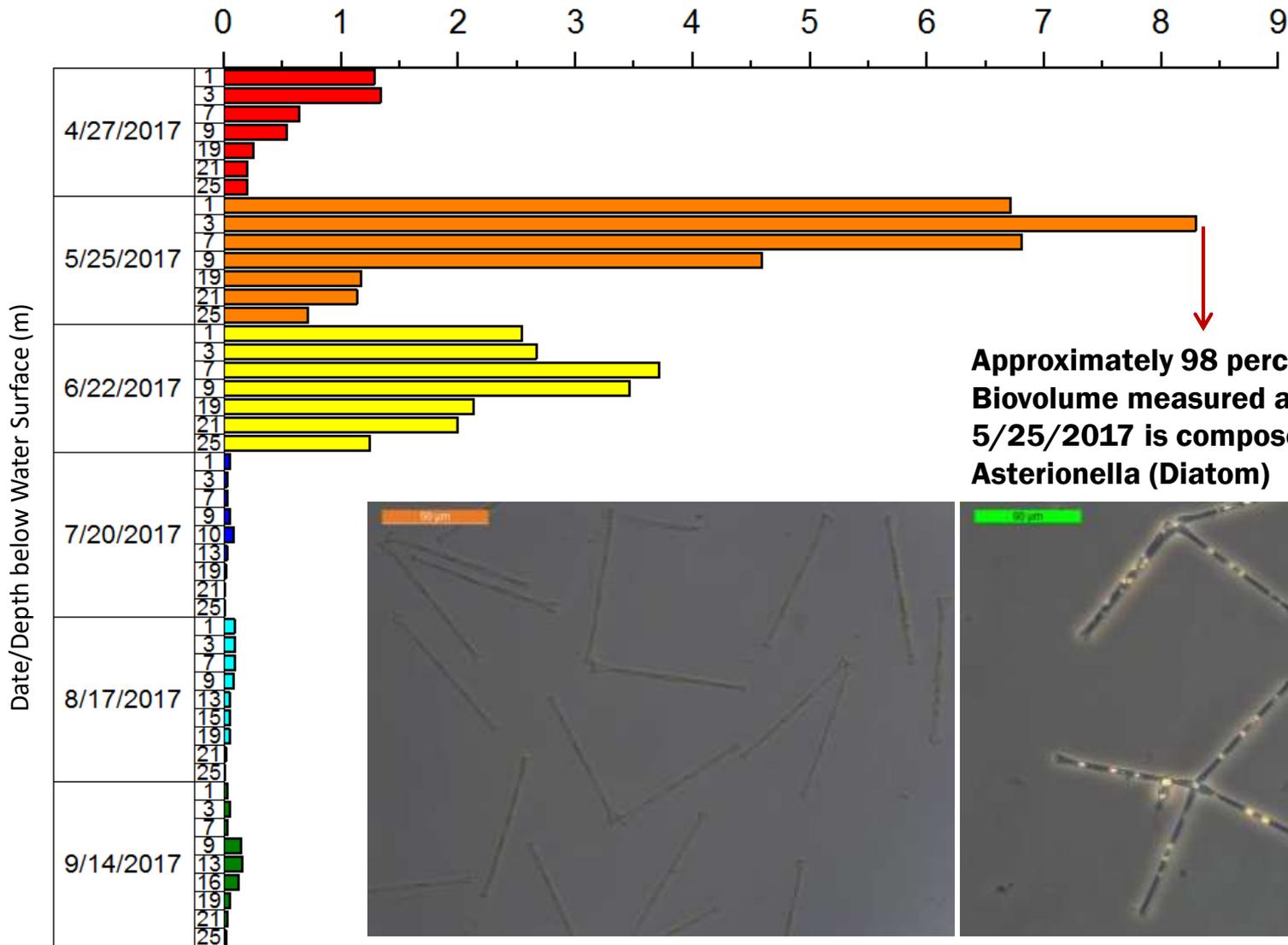
- **Grab samples**
- **Unattended profiler**



Monitoring Program Overview

- **Sampling from May to September**
- **Samples taken once a month**
- **Grab samples tested for:**
 - **Algae counts/biovolumes**
 - **Taste and odor (FRA)**
 - **TOC**
 - **Iron and manganese**
 - **UV254**
 - **Chlorophyll-a, phaeophytin-a**
 - **Nutrients (total phosphorus, soluble reactive phosphorus, nitrogen, nitrate, nitrite)**
- **Secchi depth**
- **Visual observations**

2017 Total Biovolume (mm³/L)



Approximately 98 percent of Total Biovolume measured at 3 m on 5/25/2017 is composed of *Asterionella* (Diatom)



Courtesy of SPU

Profiler System/Pontoon

- **Major components of the YSI Profiler include:**
 - Pontoon/winch
 - Data logger
 - Radios/antennas
 - Rechargeable battery/solar panels
 - Sondes: temperature, dissolved oxygen, pH, turbidity, specific conductivity, chlorophyll, blue-green algae
 - Pressure sensor (depth)
 - Software

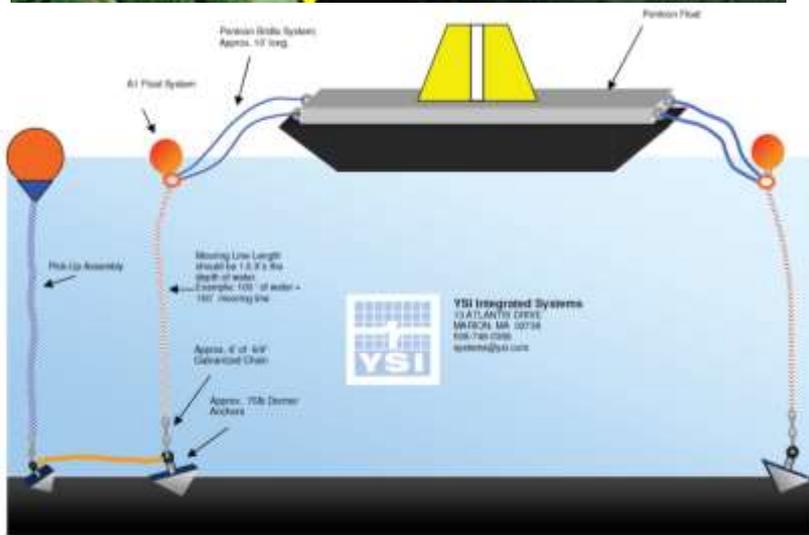


Courtesy of YSI Inc.

Profiler Deployment



- **Pontoon deployed from late-April to September**
- **Assistance from three plant mechanics and Corps**
- **Three anchors prevent the pontoon from moving**
- **Aim to set the pontoon in the same central location every year**
- **The specified location prevents potential damage to the pontoon from log booms**



Courtesy of YSI Inc.

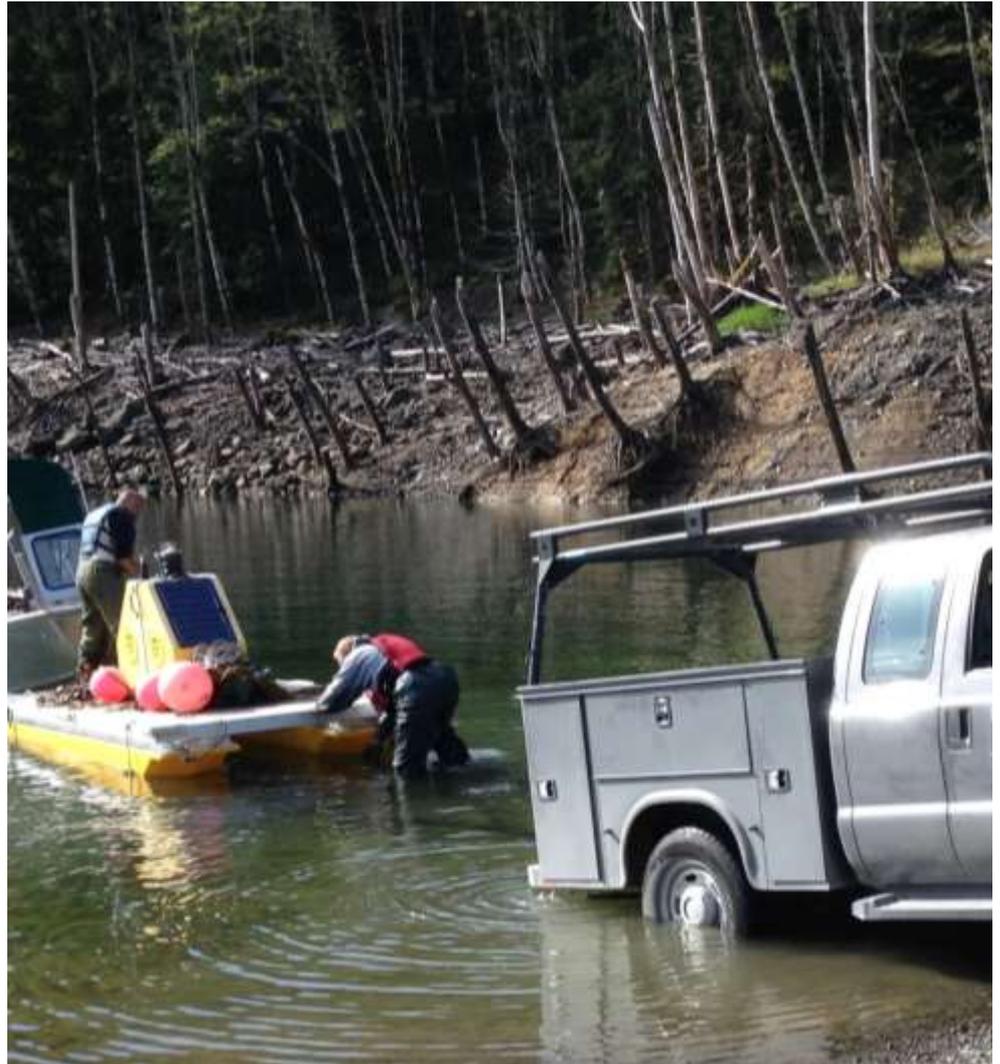
Maintenance/Calibration

- **Own two sondes with the same sensors (one duty, one spare)**
- **Sondes are switched out with newly calibrated sonde each month**
- **Each of the sensors are tested and calibrated using standards**
- **Site visit allows for visual inspection**
- **Sondes do accumulate biological growth and are cleaned when on-site**



Pulling the Pontoon

- **Pontoon is pulled in late September**
- **Assistance from three plant mechanics and the Corps**
- **Debris can accumulate on the three anchors making them very heavy**
- **Anchors are pulled by hand in sequence**
- **Winch is used when available**



How is the data collected?

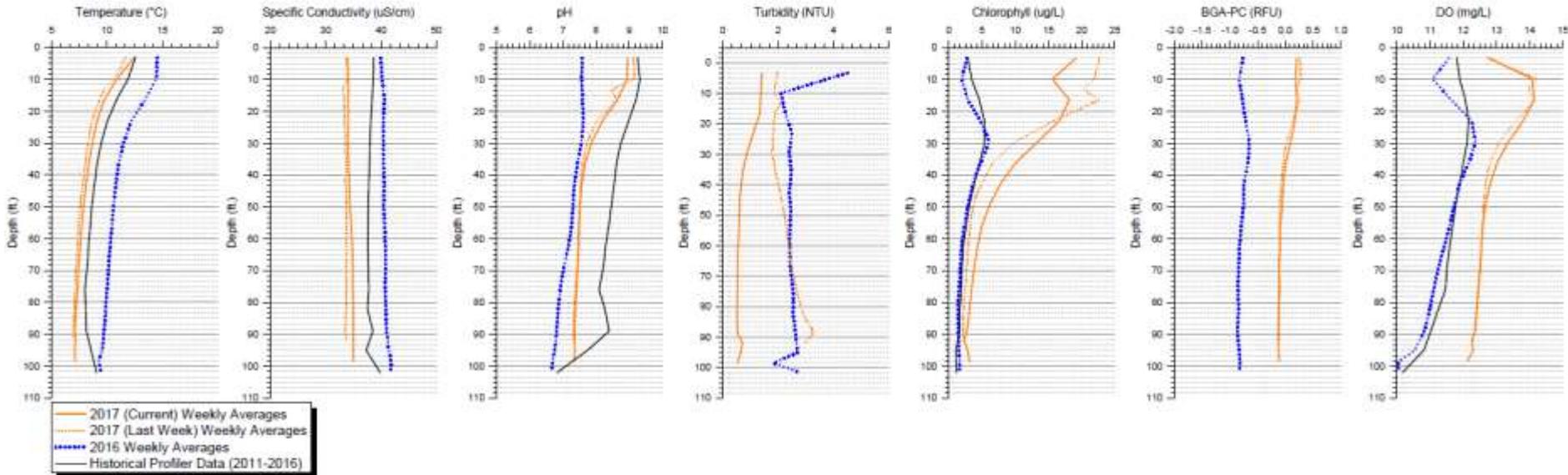
- **There are two separate programs running simultaneously**
 - **Every three hours, every 2 meters**
 - **Hourly at a parked depth of 5 meters**
- **Data can be downloaded remotely through an internet connection from the office**

How is the data used?

- **Development of a regular sampling plan and an algae/cyanotoxin monitoring plan**
- **Understanding baseline water quality conditions**
- **Serves as a communication tool for plant operators wherein weekly reports are generated**
- **Data is plotted over the entirety of the sampling season**
- **Certain profiler sensors perform better than other sensors**

Example of Weekly Report

Eagle Gorge Profiler Data - Weekly Averages - Week of 05-18 to 05-25-2017



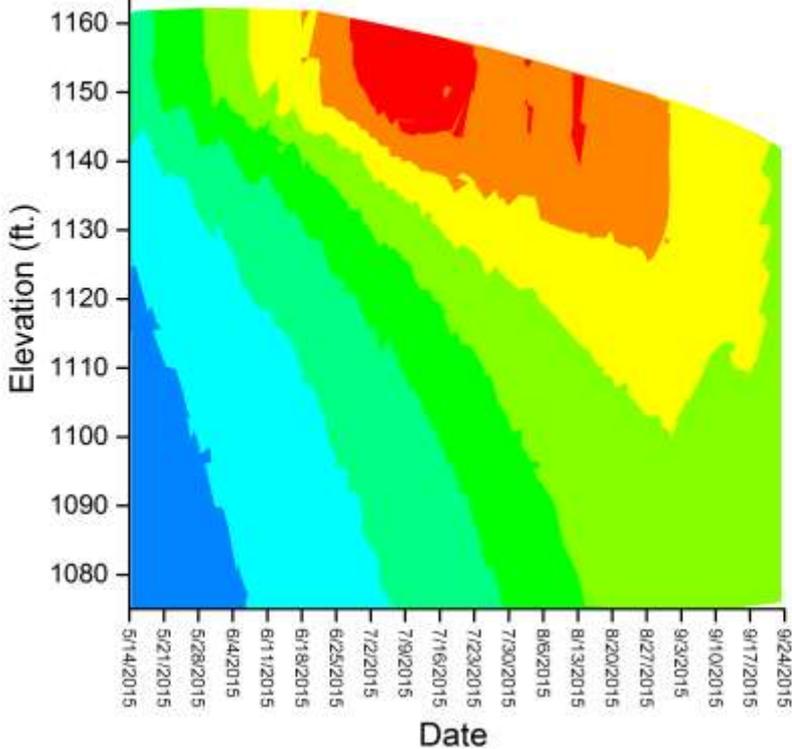
COMMENTS:

- * Added weekly averages from the previous week for comparison (2017 (Last Week) Weekly Averages).
- * Sonde continues to observe higher pH and higher DO values collected near the water surface. This is assumed to be due to probe inaccuracies/calibration.
- * The sonde continues to measure higher chlorophyll values near the water surface.
- * "2016 Weekly Averages" were taken from the week of 5/19/2016 to 5/26/2016.

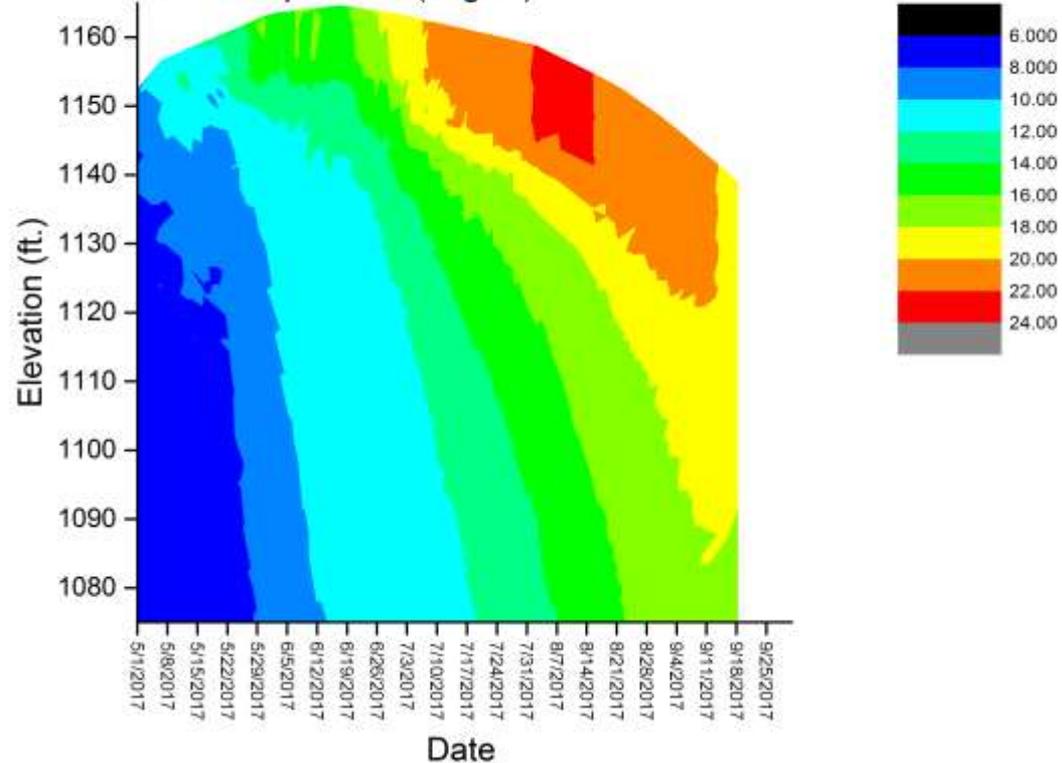
Sonde: "Rosie"

Temperature

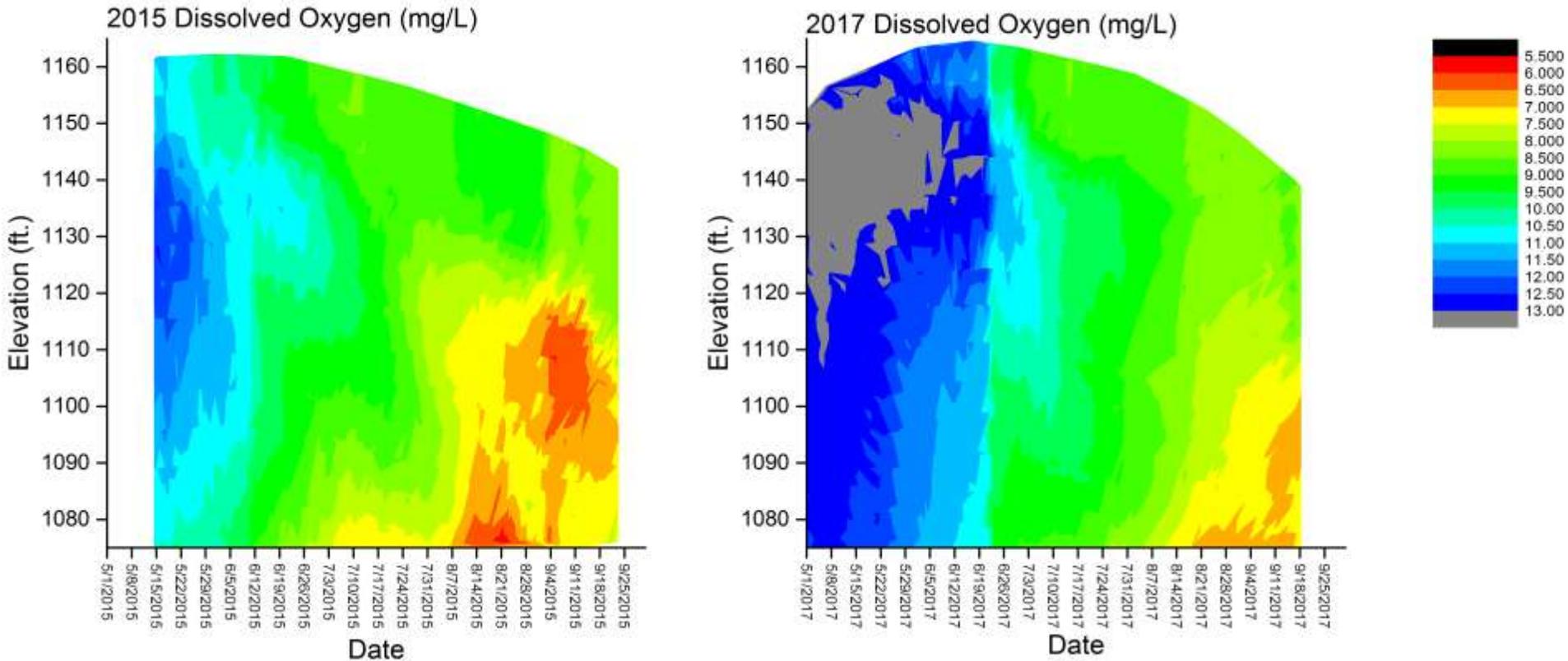
2015 Temperature (deg. C)



2017 Temperature (deg. C)



Dissolved Oxygen



Advantages/Disadvantages

- **Advantages**

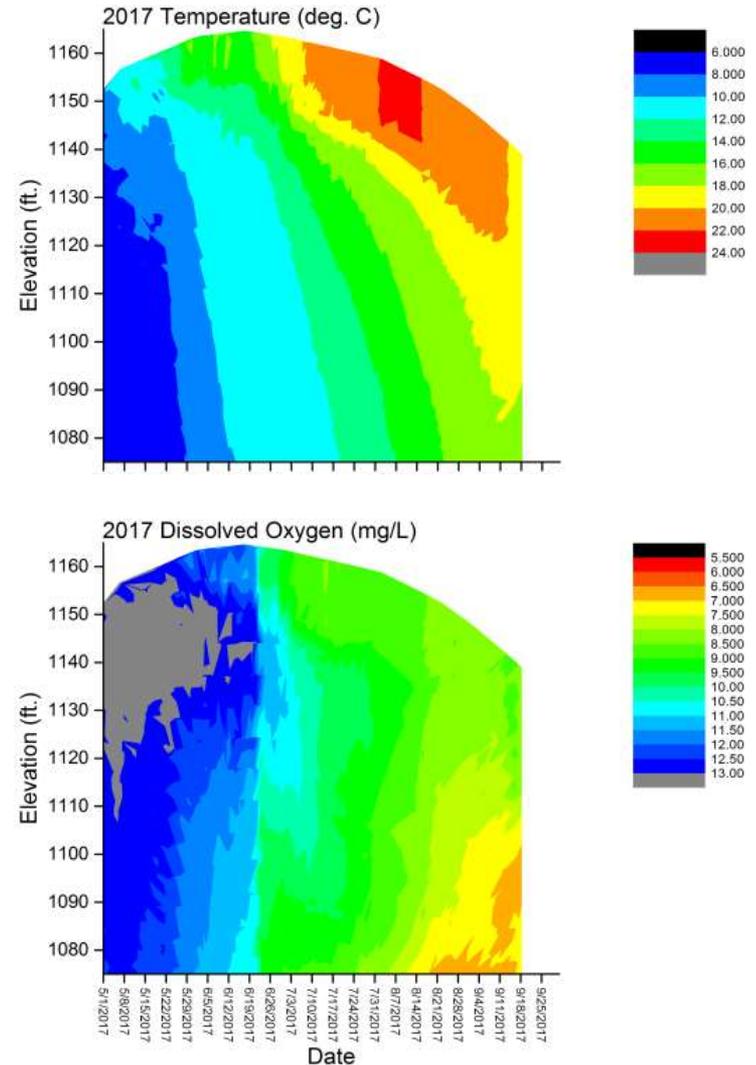
- Remote access to data
- Capture real-time data
- Understand water quality conditions prior to treatment plant
- Development of baseline, can observe differences

- **Disadvantages**

- Limited access to site, difficult to calibrate remotely and observe actual conditions on-site
- Limitations with sensors and calibration techniques
- Sensors/sondes are prone to damage and on-going repairs
- Equipment malfunction can lead to loss of data

Conclusions

- **Acquired data behaves as expected in terms of relationships among the water quality parameters collected**
- **Data is used qualitatively by understanding the relative trends**
- **Data allows us to understand how conditions are changing annually**
- **General observations**
 - **As temperatures increase during the sampling season, we see an increase in thermal stratification**
 - **There is a decrease in dissolved oxygen measurements towards the end of the sampling season**
 - **Increase in algae biovolume during the middle of the sampling season**



Future Work

- **Build on correlations between water quality conditions in the reservoir versus the treatment plant**
- **Make improvements to current operations and maintenance to close the gap on missing data**
- **Work on improving calibration techniques for certain profiler parameters**
- **Regularly update sampling plan as baselines change**

Depth in meters	Depth in feet	Temp (Degrees C)	pH	DO (mg/L)	Chlorophyll-a (profiler) (ug/L)	Turbidity (ntu)	Total Algae (Count per mL and Biovolume mm3/L)	Taste & Odor (Flavor Rating Assessment)	Fe (mg/L)	Mn (mg/L)	UVT % & UV254	TOC (mg/L)	Chlorophyll-a (lab)(ug/L)	Phaeophytin (ug/L)	Total Phosphorus (mg/L)	Nitrate (mg/L)	Total Nitrogen (mg/L)	Soluble reactive phosphorus (mg/L)
1	3.3	x	x	x	x	x	x				x	x						
3	9.8	x	x	x	x	x	x	x	x	x	x	x						
5	16.4	x	x	x	x	x												
7	23.0	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
9	29.5	x	x	x	x	x	x		x	x	x	x						
11	36.1	x	x	x	x	x												
13	42.6	x	x	x	x	x												
15	49.2	x	x	x	x	x												
17	55.8	x	x	x	x	x												
19	62.3	x	x	x	x	x	x				x	x						
21	68.9	x	x	x	x	x	x	x	x	x	x	x						
23	75.4	x	x	x	x	x												
25	82.0	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
27	88.6	x	x	x	x	x												
29	95.1	x	x	x	x	x												

HHD Outlet	x	x				x	x		x	x			x	x	x	x	x	x
------------	---	---	--	--	--	---	---	--	---	---	--	--	---	---	---	---	---	---

Intake		x	x			x	x	x	x	x		x	x	x	x	x	x	x
--------	--	---	---	--	--	---	---	---	---	---	--	---	---	---	---	---	---	---

HW Finished		x	x			x			x	x	x							
-------------	--	---	---	--	--	---	--	--	---	---	---	--	--	--	--	--	--	--

Profiler data

Thank You!

Celine Mina, PE
Tacoma Water
cmina@cityoftacoma.org

