Algae Monitoring in the Clackamas River Watershed

From monitoring to response.

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Clackamas River Water

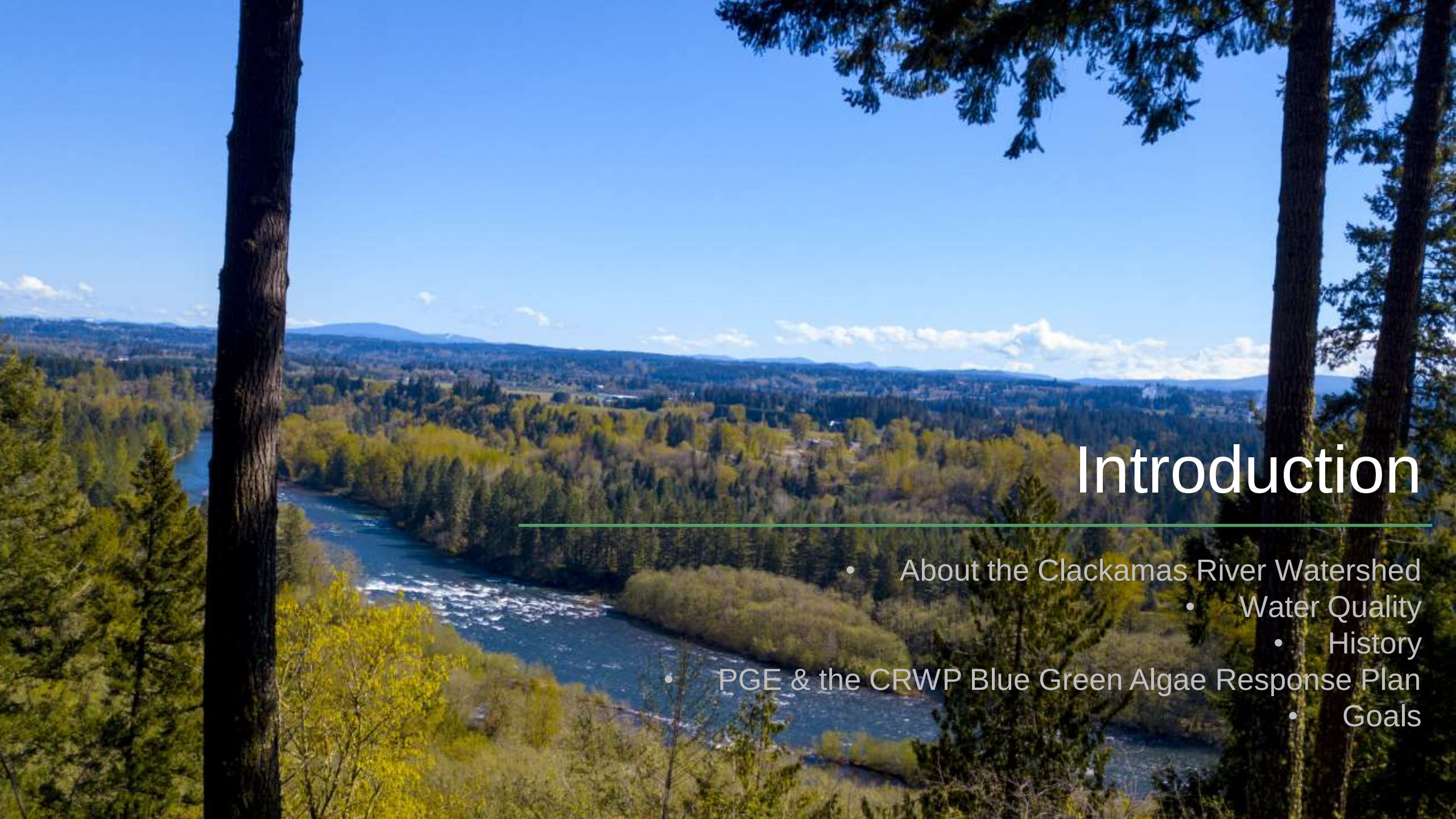
Clackamas River Water Providers

USGS science for a changing world

Clackamas Community College

PGE

April 27, 2018

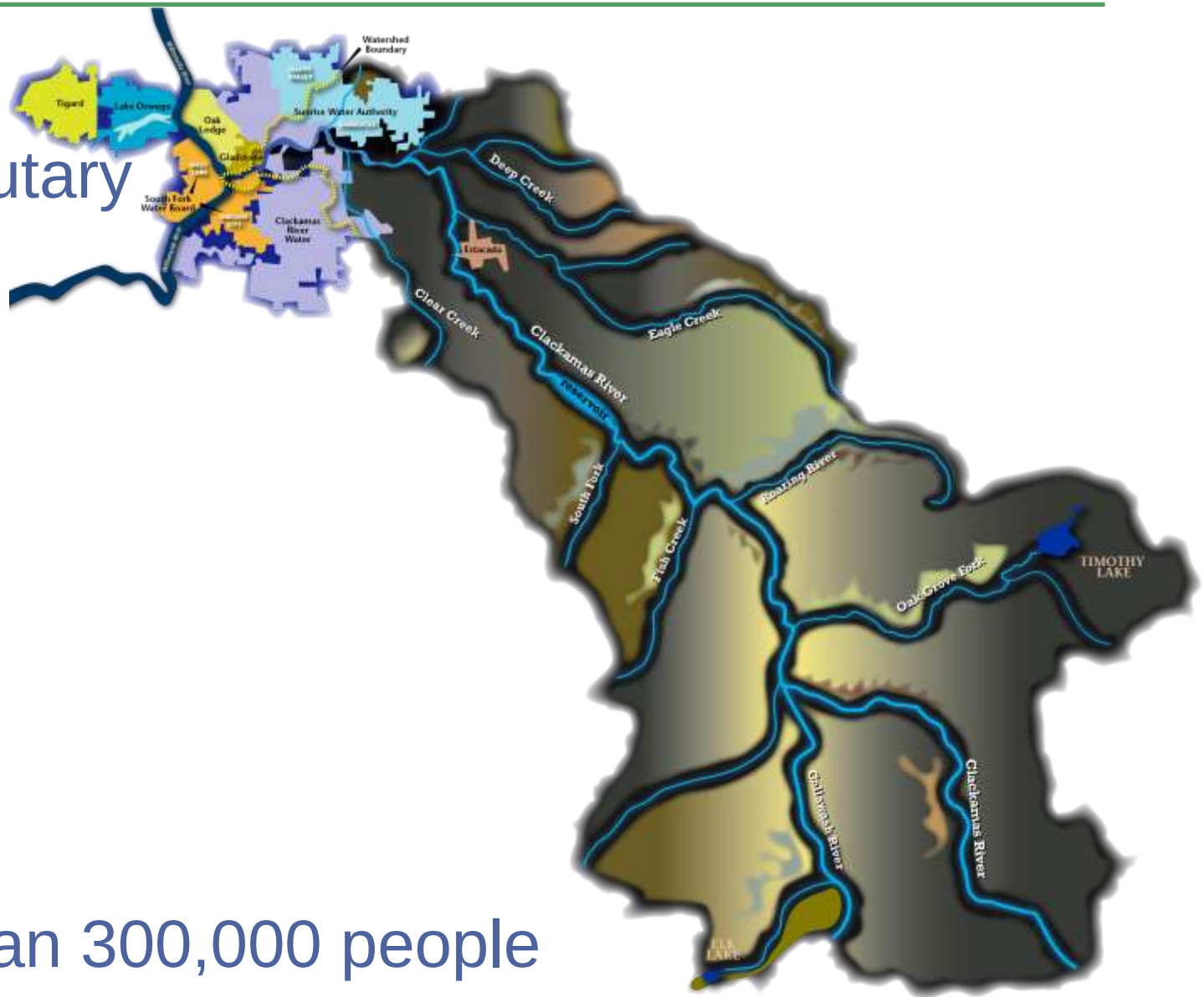


Introduction

- About the Clackamas River Watershed
- Water Quality
- History
- PGE & the CRWP Blue Green Algae Response Plan
- Goals

The Clackamas River Watershed

- Clackamas River is an approximately 83-mile tributary of the Willamette River
- Drains approx. 940 mi^2
  - Forests
  - Agricultural land
  - Residential
  - Light industrial
- Hydroelectric power
- Drinking water for more than 300,000 people



Water Quality

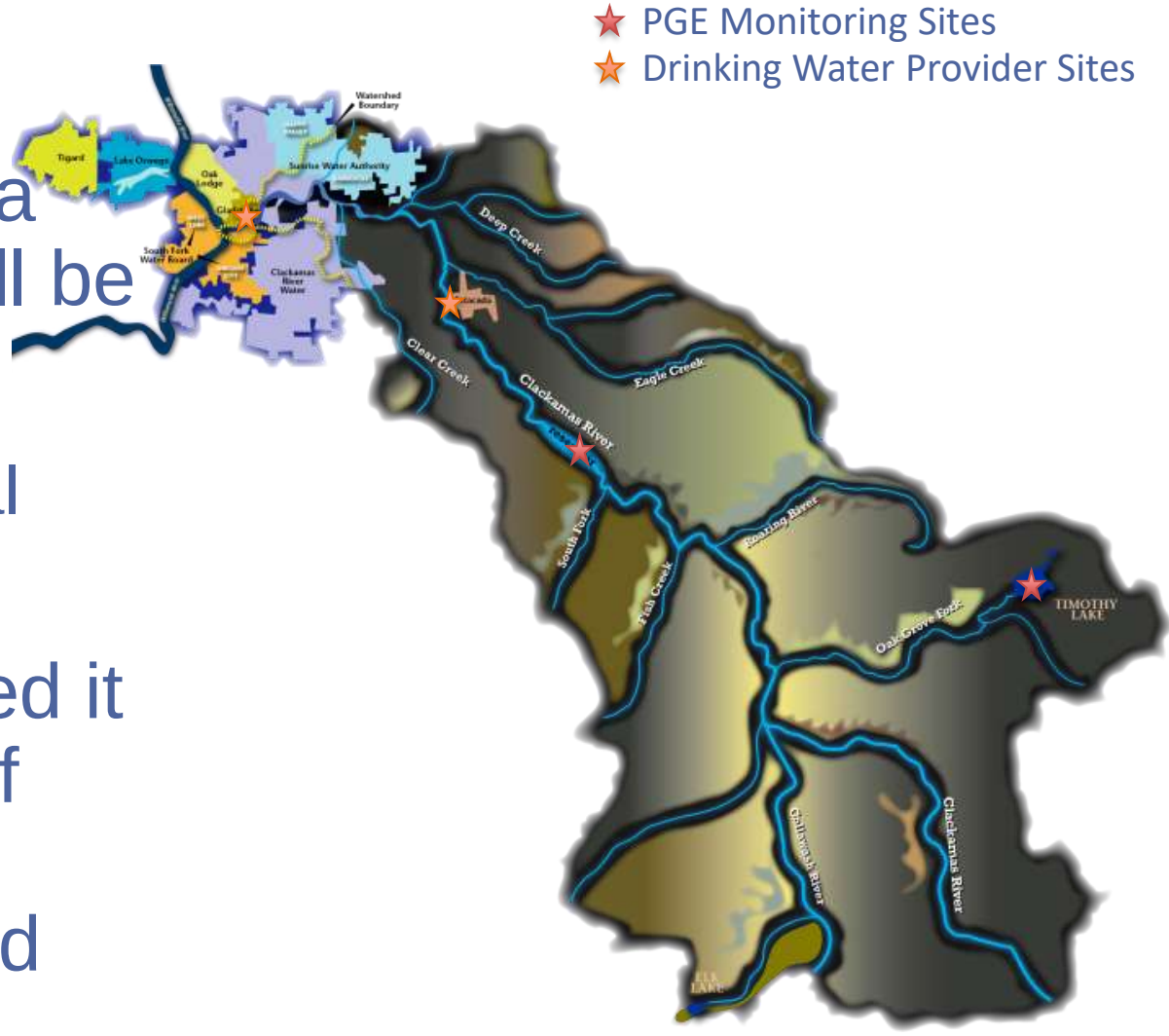
- Water quality is rated good to excellent.
- Problems such as high levels of turbidity occasionally occur from soil erosion.
- Low-nutrient system.

History of Algae Blooms in the Clackamas River

- Cyanobacteria in blooms have been known to occur in two Portland General Electric (PGE) Project reservoirs (Timothy Lake and North Fork Reservoir) in the Clackamas basin up river from water provider intakes.
- In September 1994 a taste and odor event was reported by drinking water providers on the Clackamas.
  - A survey of the watershed suggested an algae bloom in the North Fork Reservoir was likely the cause.
  - Water samples collected from the reservoir contained Anabaena and were positive for geosmin.
- Seasonal blooms still occur intermittently in Timothy Lake and the North Fork Reservoir.
- Taste and Odor events almost every summer.

PGE & CRWP Monitoring

- One visit per week May - Sept.
- If visual signs of a cyanobacteria bloom are present, a sample will be collected for toxin testing.
  - Positive samples trigger additional sampling.
- If any level of toxins are identified it requires the following the City of Estacada and the City of Lake Oswego to take raw and finished water samples.



Goals of the CRW-CRWP Monitoring Program

Algae blooms, cyanotoxin events, and taste and odor events can negatively impact a customer's confidence in the safety and quality of their tap water.

1. Be more proactive with water sampling.
2. Track conditions that lead to a bloom.
3. Employ preventative measures.
4. Be able to make operational decisions as needed.

Field Assessment & Ambient Monitoring

- Practical Application
- Collaboration

Monitoring Raw Water for Cyanobacteria

- The instruments CRW uses for algae monitoring allow for the rapid identification and quantification of algae and nutrients in the system.
- Samples are analyzed for dominant species with a Fluid Imaging Technologies FlowCAM (2014).
- Nutrient concentrations (ammonia, nitrate + nitrite, orthophosphate) with an Astoria-Pacific ChemWell-T AutoAnalyzer (2015).

FlowCAM operation at CRW

AutoAnalyzer

Water for Cyanobacteria

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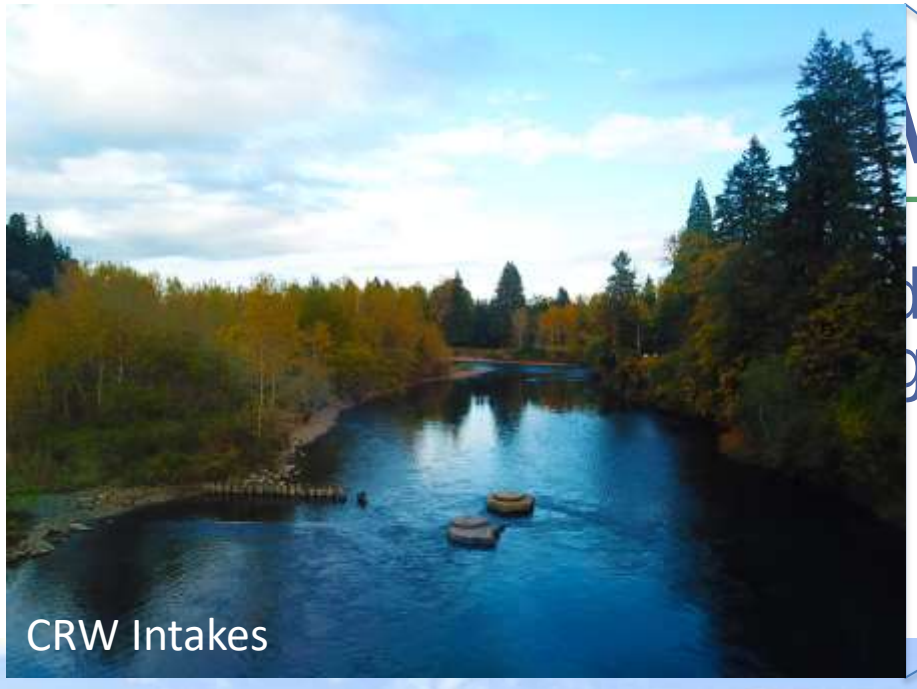
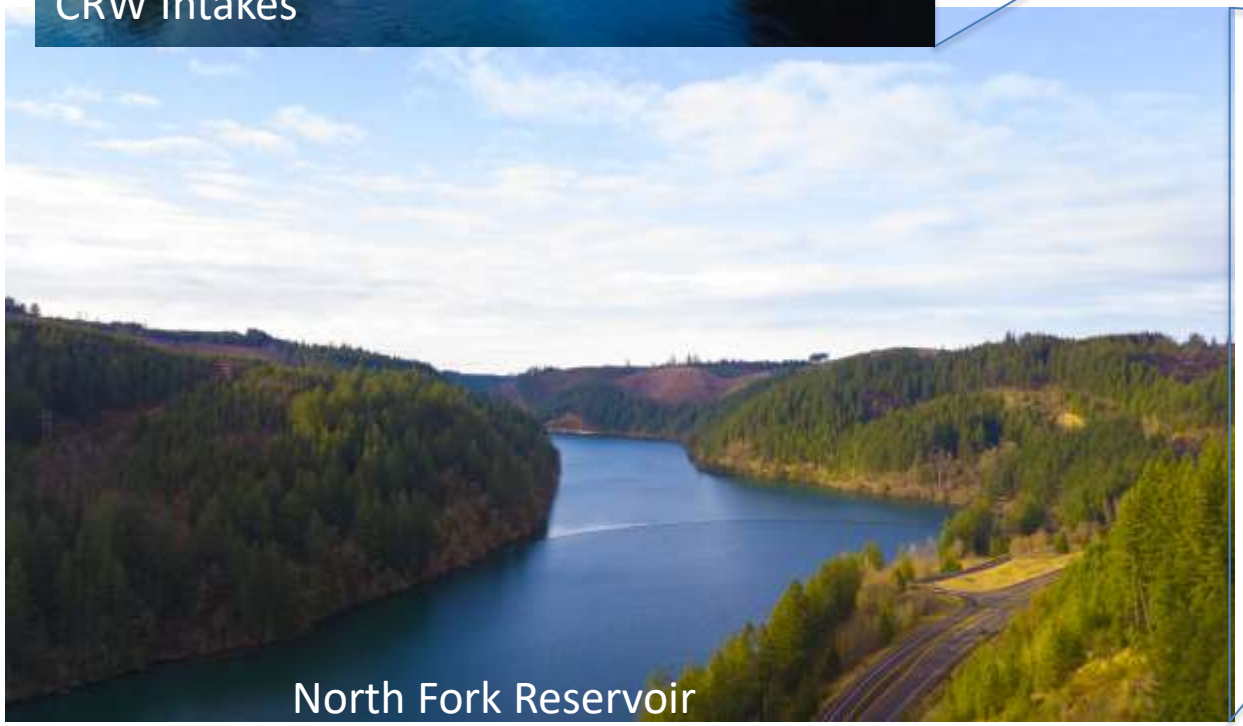
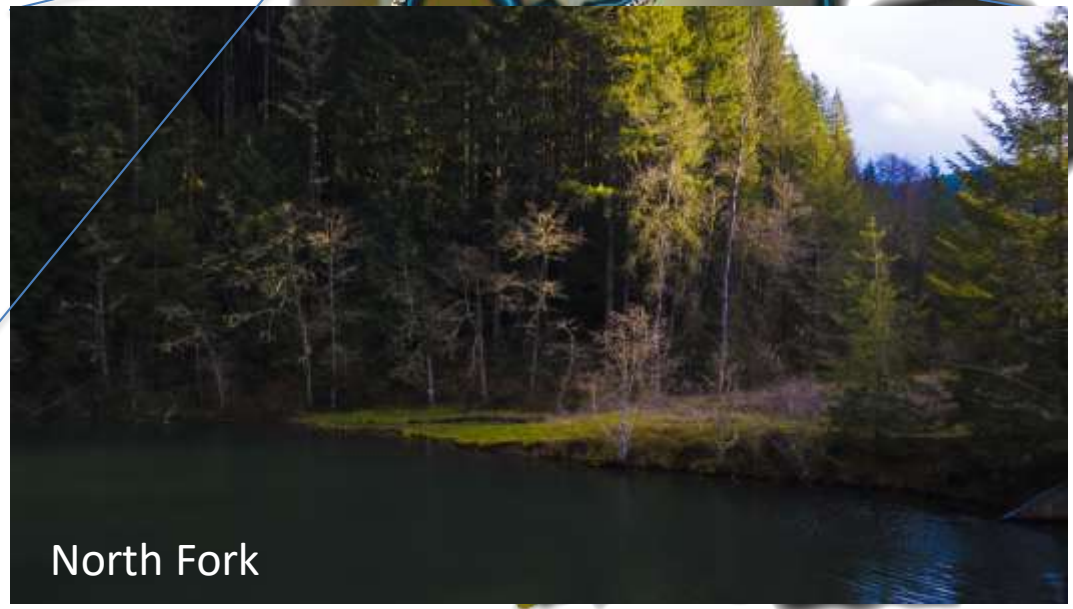
gh

Fork

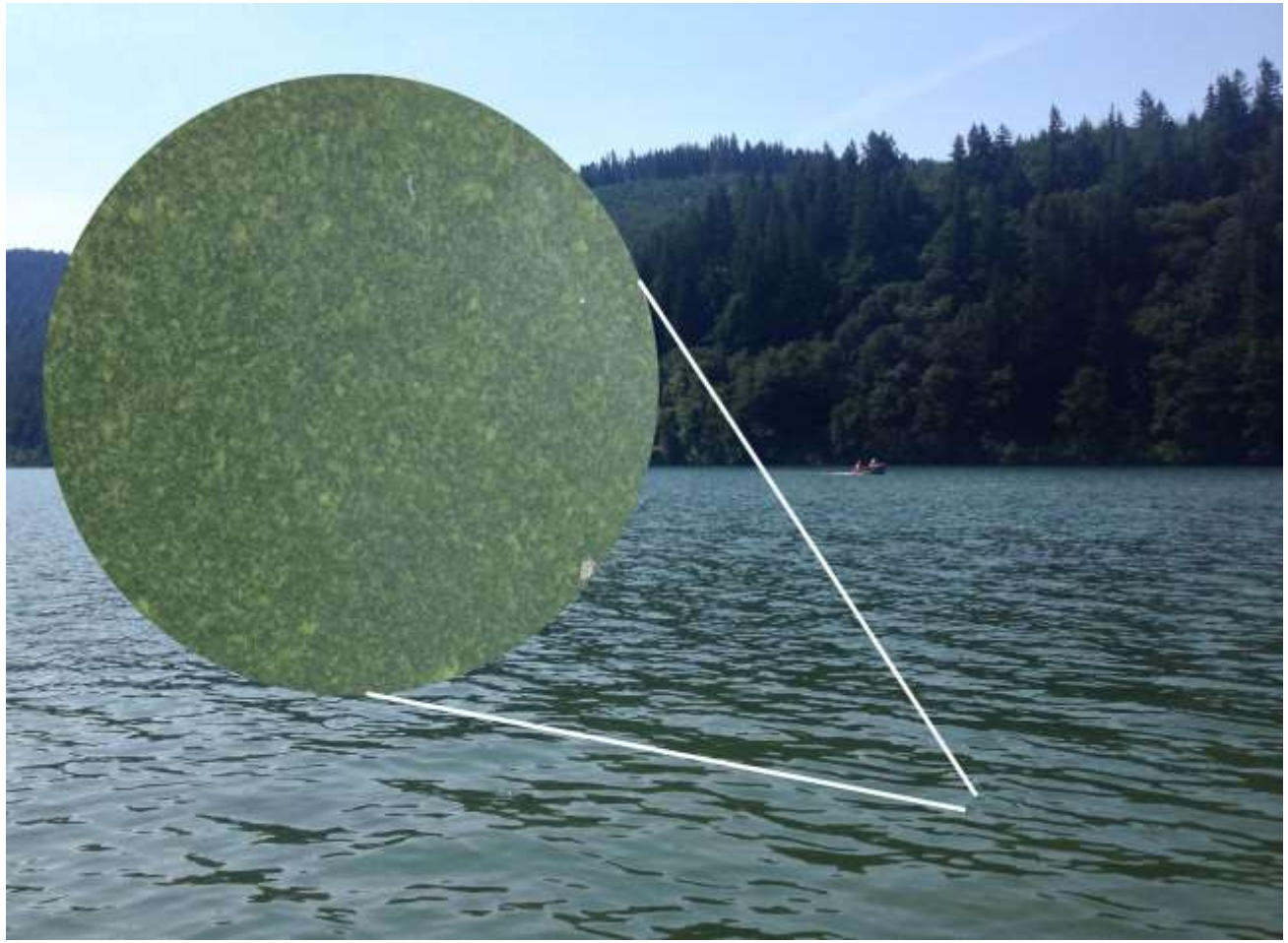




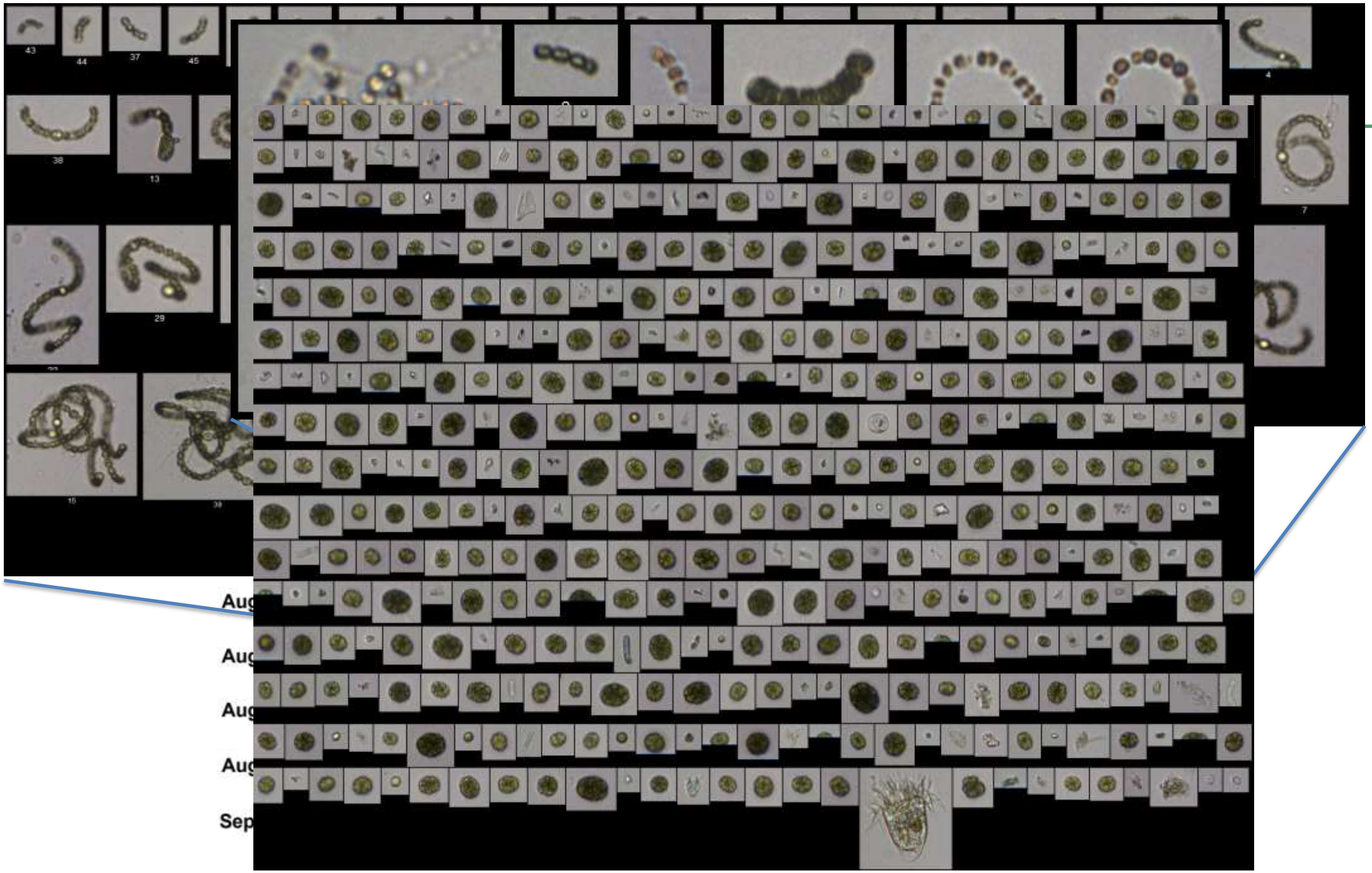


2014 Bloom Perfection

- Late July into early August 2014 the North Fork Reservoir experienced a large cyanobacteria bloom.



Cyanobacteria Bloom in the North Fork Reservoir


Aug
Aug
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Aug
Sep

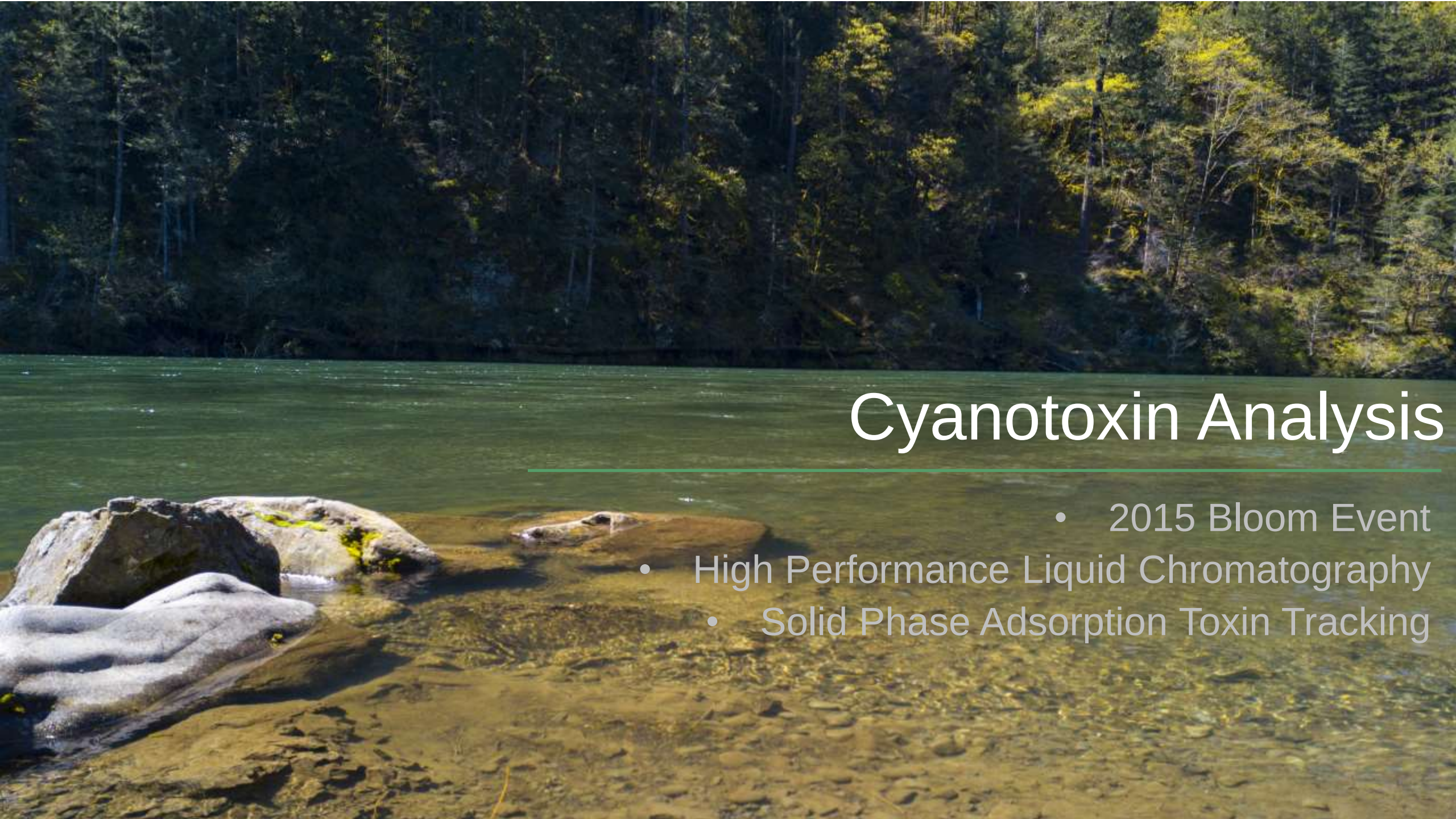
Drinking Water Impacts

- Taste and Odor issues were reported in finished drinking water.
- Were Dolichospermum detected at the drinking water intakes during the bloom period?
  - **No.**

What we've learned from monitoring so far…

Collecting baseline data since 2014

- Shifts in algal communities in the North Fork Reservoir can be observed within days.
  - Primary potential toxin producer is Dolichospermum.
  - Weekly monitoring shows that, in most cases, dominant cyanobacterial species will be observed at low levels prior to the blooms.
- At the CRW intakes changes are observed over longer time frames.
  - Primarily diatoms in the main stem of the river.
  - Rarely see cyanobacteria.
  - Benthic species are occasionally observed.



Cyanotoxin Analysis

- 2015 Bloom Event
- High Performance Liquid Chromatography
- Solid Phase Adsorption Toxin Tracking

August 2015 Bloom

- August 2015 a small Dolichospermum bloom occurred in the North Fork Reservoir.
  - Triggered toxin sampling at North Fork Reservoir, Estacada, and Lake Oswego.
  - Low levels of Anatoxin-A were detected at North Fork Reservoir and Lake Oswego.
- Dolichospermum never detected at CRW intakes.

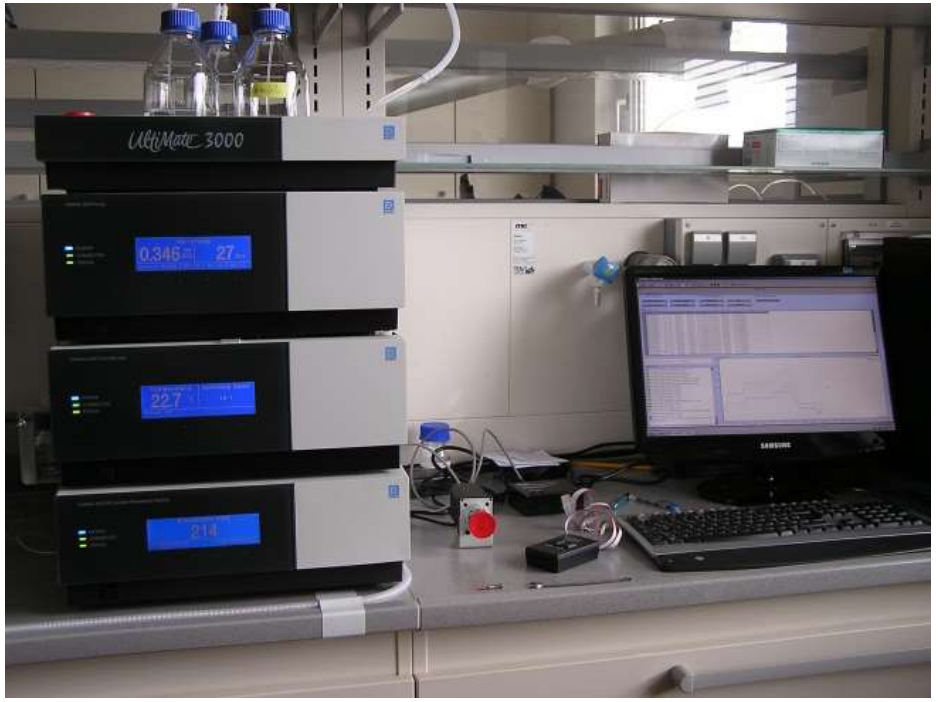
Is the toxin free floating?

Is the toxin coming from something other than the reservoir bloom?

Toxin Analysis by High-Performance Liquid Chromatography (HPLC)

In collaboration with Clackamas Community College.

- HPLC is a technique in analytical chemistry used to separate, identify, and quantify each component in a mixture.
- Pumps pass a pressurized liquid solvent containing the sample mixture through a column filled with a solid adsorbent material.

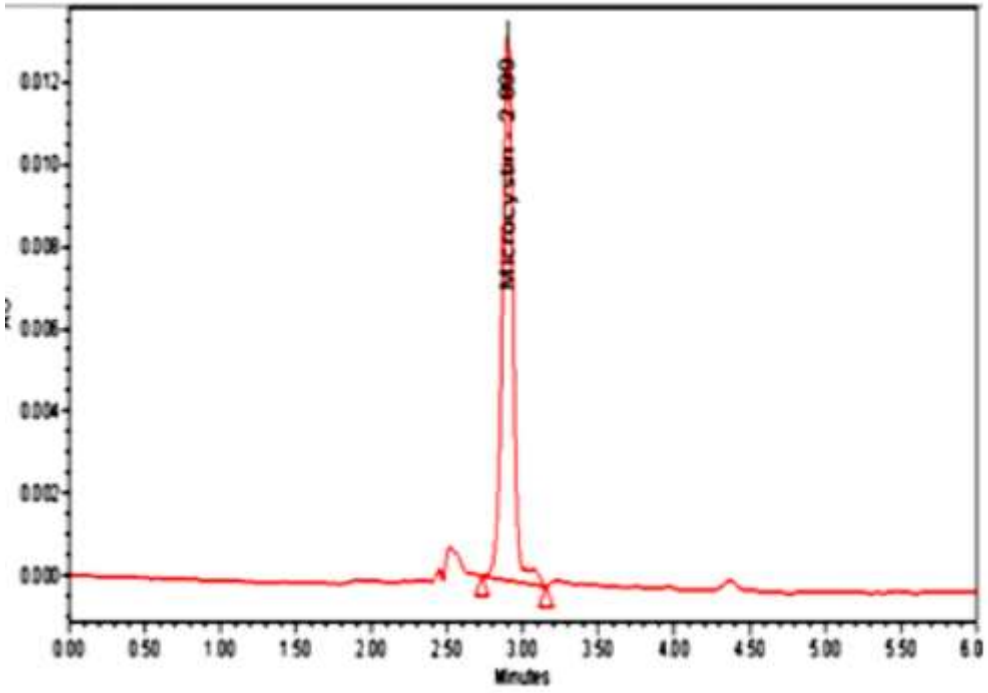


High Performance Liquid Chromatography (HPLC) at Clackamas Community College

- Each component in the sample interacts differently with the adsorbent material, causing different flow rates for the different components and leading to the separation of the components as they flow out the column.

Cyanotoxin Analysis by HPLC

- Development of cyanotoxin analysis
  - Microcystin- LR
  - Anatoxin A
  - Cylindrospermopsin
  - Saxitoxin
- Rapid detection of toxins in raw water if a bloom is identified.
  - Currently samples are shipped to Lake Superior State University in Michigan.
- Provide the ability to test for toxins in finished drinking water.



HPLC Chromatogram of Microcystin LR Standard

Solid Phase Adsorption Toxin Tracking (SPATT)

- A simple and sensitive in situ method for monitoring the occurrence of toxic algal blooms.
- Passive adsorption of cyanotoxins onto porous synthetic resin filled sachets (SPATT bags).
  - Qualitative sampling- presence/absence
  - Aggregate of all the toxins passing by over time.
- Followed by extraction with methanol and analysis.

SPATT Construction

SPATT Deployment

A detection without a bloom?

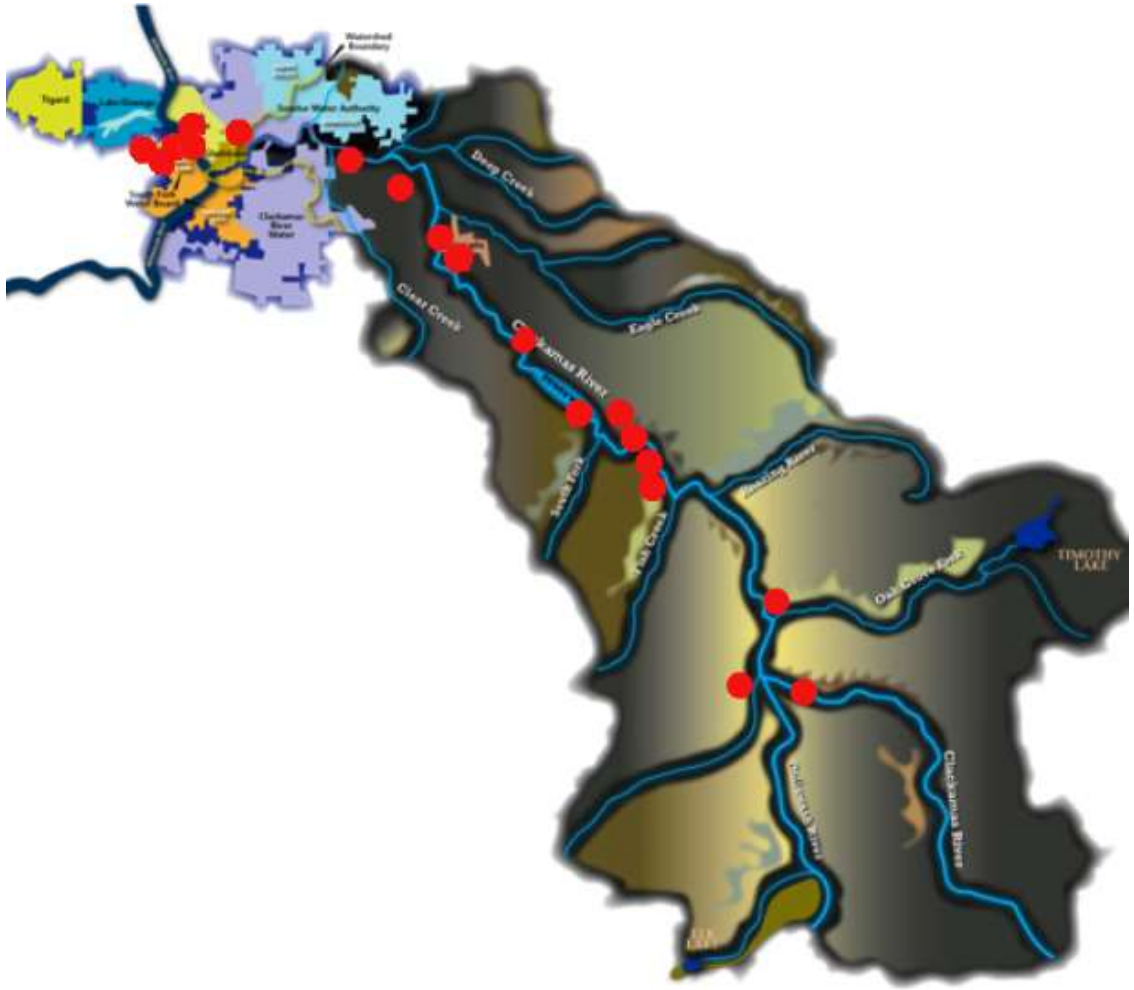
- Low levels of microcystin were detected in SPATT extracts in July 2017 at CRW's intakes.
- No toxins were detected in ANY SPATT extracts in the North Fork Reservoir.
  - No reported blooms at the time.

USGS Pilot Study- Benthic “Periphyton” Blooms

- Recent research suggests that periphyton (benthic algae) can produce toxins.
- A preliminary study conducted in 2016 in the Willamette Valley (including the Clackamas Basin) found that many benthic algae samples collected yielded detectable cyanotoxins.

2017 USGS- Cyanotoxin Study

- Multi-year study to determine the extent that benthic cyanobacteria may contribute to cyanotoxin detection in the Clackamas River Watershed.
- Net tows and benthic sampling.
- Monitoring at 5 Drinking Water Treatment Plant Intakes and 15 Mainstem/Tributary sites through SPATT deployments.



2017 USGS- Cyanotoxin Study Conclusions

- High percentage of cyanotoxins in benthic colonies.
- Frequent detection of cyanobacteria and cyanotoxins in plankton net tows (in transport).
- Microcystin and Anatoxin-a were detected in 53% of SPATT extracts by ELISA.
  - Microcystin detected in extracts from July 2017.

Next Steps

1. Continue the development of toxin analysis by HPLC.
   - Toxin analysis via HPLC remains the biggest challenge moving forward.
   - Spiked sample analyses are required before finalizing microcystin protocol.
2. Continue the collection of baseline data at established sites.
3. Part 2 of USGS Benthic Study
   - Continue testing benthic cyanobacteria, plankton net tows, and SPATTs
   - Sample fewer locations but sample more frequently (increase SPATTs from 2x per season to 4-6 x per season) at selected DWTPs
4. Integrate with UCMR4 sampling.

Tying it together

- CRW’s Algae Monitoring and Response Plan

Tier 1

Sampling, Testing, and Treatment Response

Tier 1- Initiating Condition: Reports of taste and odor issues in finished drinking water; or
Visual bloom reported in watershed boundaries

CRW Response- increased algae monitoring at established sampling sites and intake

Potential toxin producer detected?

yes: Collect samples for toxin analysis at all locations

Toxin detected?

yes

no

no: Continue monitoring species until bloom subsides

Public Outreach Response

Tier 1- Initiating Condition: Reports of taste and odor issues in finished drinking water; or
Visual bloom reported in watershed boundaries

1. Notify Customer Service Department
   Provide Fact Sheet and/or talking points
   Provide CRWP taste and odor tracking
2. Update social media to direct users to fact sheet

Tier 2

Sampling, Testing, and Treatment Response

Tier 2- Initiating Condition: Toxic bloom event

CRW Response- continued monitoring at established sampling sites dictated in Tier 1
HPLC analysis of cyanotoxins throughout duration of bloom as needed

Toxin detected at intake?

yes: Test finished water for toxins

Toxins detected?

yes

no

no: Continue sampling and toxin analysis at intakes daily until bloom subsides

Public Outreach Response

Tier 2- Initiating Condition: Toxic bloom event

1. Provide talking points to Customer Service Department
2. Post information on line about recreating in waterbodies experiencing toxic blooms online
   Post links and updates on social media
   Provide information on any adjustments made to treatment
   Provide updates weekly (at minimum)

Tier 3

Sampling, Testing, and Treatment Response

Tier 3- Finished water cyanotoxin event

CRW Response- continued monitoring at established sampling sites dictated in Tier 2

Is the toxin potentially intracellular?
Based on FlowCAM data.

yes: Adjust Treatment Processes
Pre-Treatment
Discontinue pre-chlorination
Use PAC
Coagulation/Sedimentation
Focus on the removal of intact cells
Keep pH above 6.5
Filtration
CRW's direct filtration should be effective at removing cells but NOT cyanotoxins
Do not recycle filter backwash

Focus on pre-treament

no: Is the toxin Anatoxin-A?

yes: Chlorine treatment ineffective

no: Chlorine disinfection effective. Optimized dosage based on pH and temperature. Compliment with PAC.

Public Outreach Response

Tier 3- Finished water cyanotoxin event

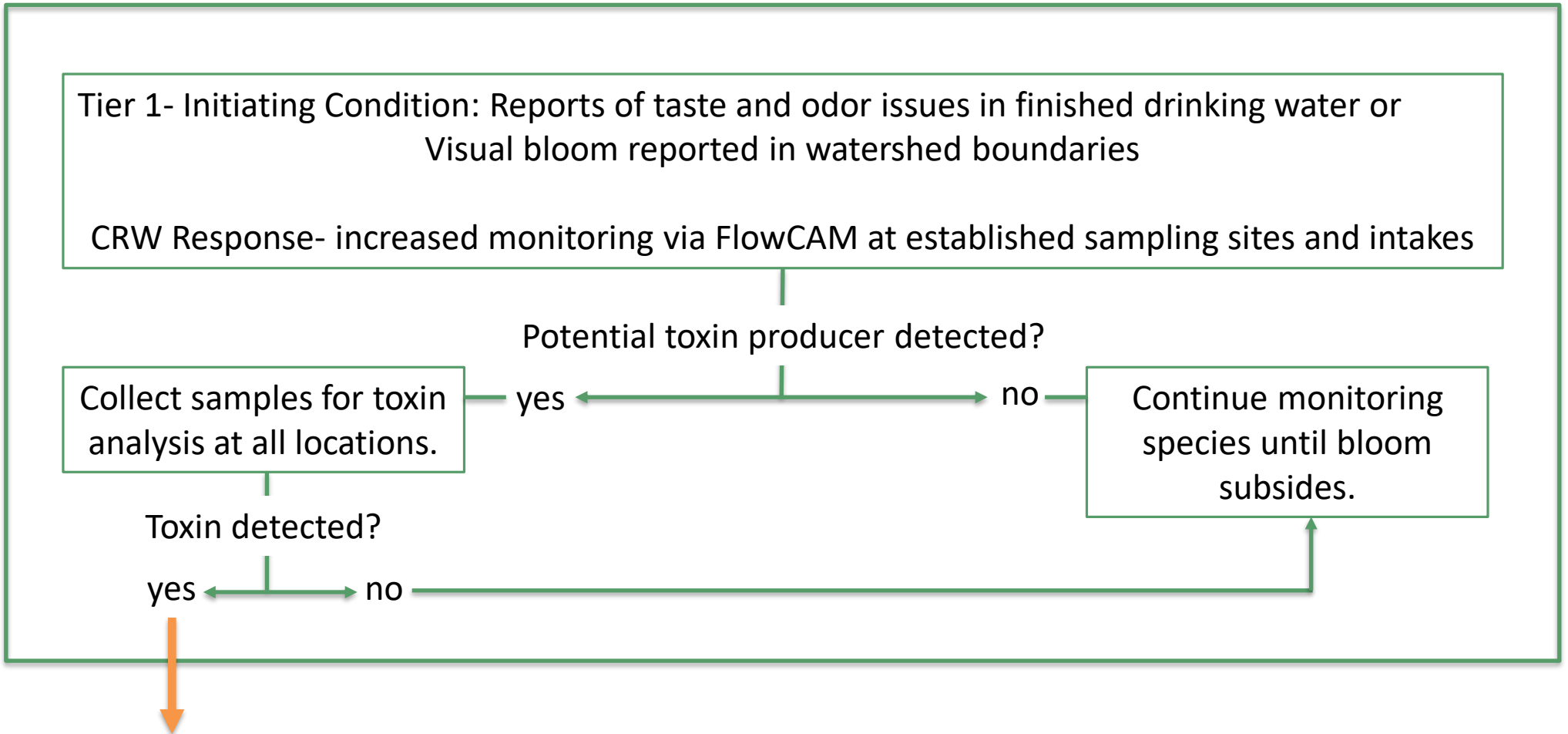
CRW will respond at levels for EPA guidelines values for children under 6

1. Consult with OHA
2. Notify CRW Management and Staff of intent to issue DO NOT DRINK
3. Provide Customer Service Department with talking points
4. Issue DO NOT DRINK order (template)
5. Notify media (template)
6. Notify dialysis centers/at risk populations
7. Activate autodialer or reverse 911
   Deploy reader boards as needed
8. Provide notification via social media (templates)
   Provide updates 1-2x's/day during event

Tier 1- San

Public Outreach

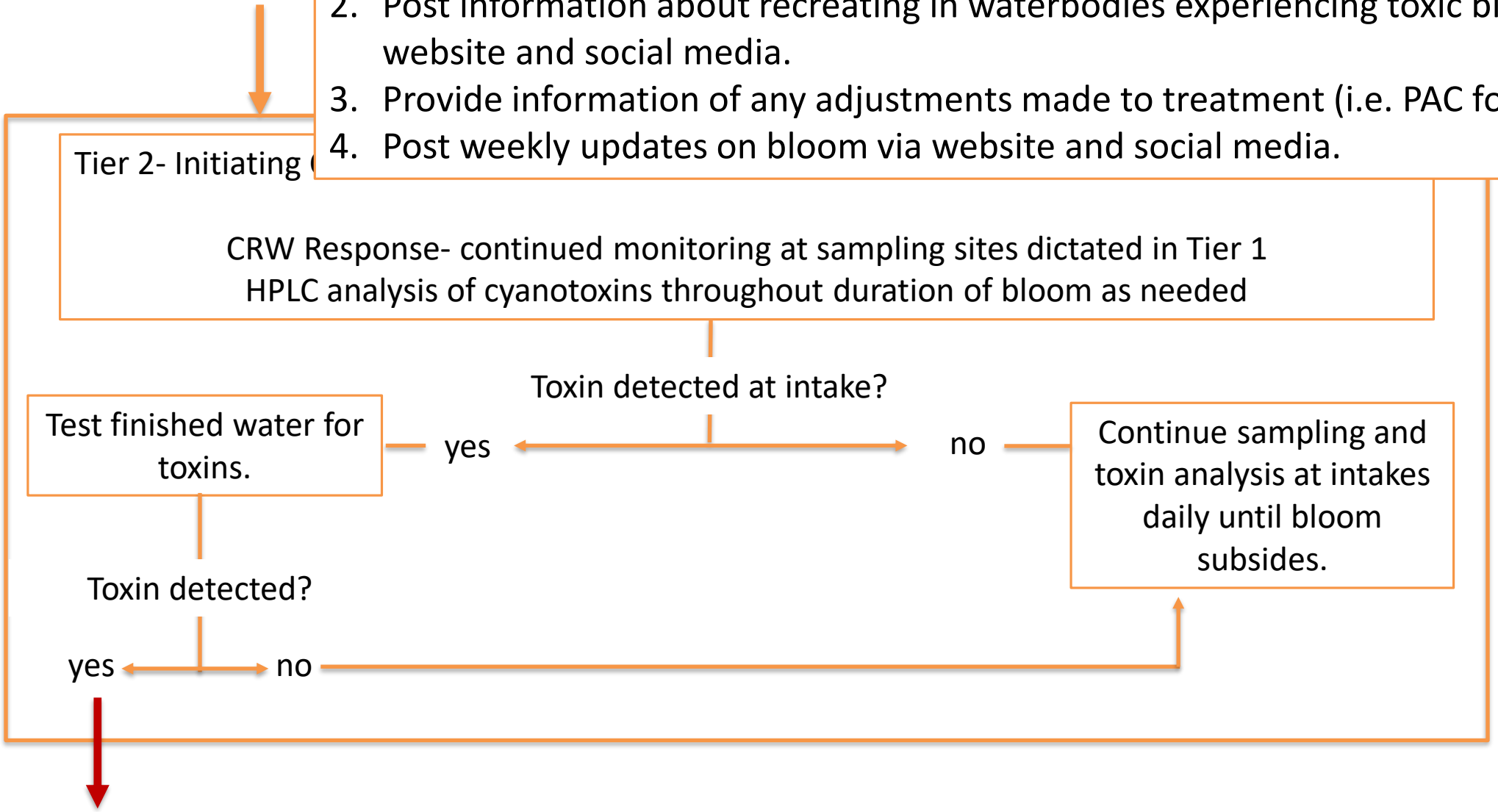
1. Notify Customer Service Department
2. Provide Customer Service Department with talking points.
3. Provide CRWP taste and odor (T&O) tracking data.
4. Update website and social media to direct users to fact sheet.



Tier 2- San

Public Outreach

1. Provide Customer Service Department with talking points.
2. Post information about recreating in waterbodies experiencing toxic blooms via website and social media.
3. Provide information of any adjustments made to treatment (i.e. PAC for T&O).
4. Post weekly updates on bloom via website and social media.



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4. Issue DO NOT DRINK order (template).
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6. Activate reverse 911 (CCENS)
7. Deploy reader boards as needed.
8. Provide notification via social media (templates).
9. Updates on situation 1-2x's day during event via website and social media.

ed in Tier 2

Use PAC

Coagulation/Sedimentation

Focuse on removal of intact cells

Keep pH above 6.5

Filtration

CRW's direct filtration should be effected at removing cells but NOT cyanotoxins

Do not recycle filter backwash

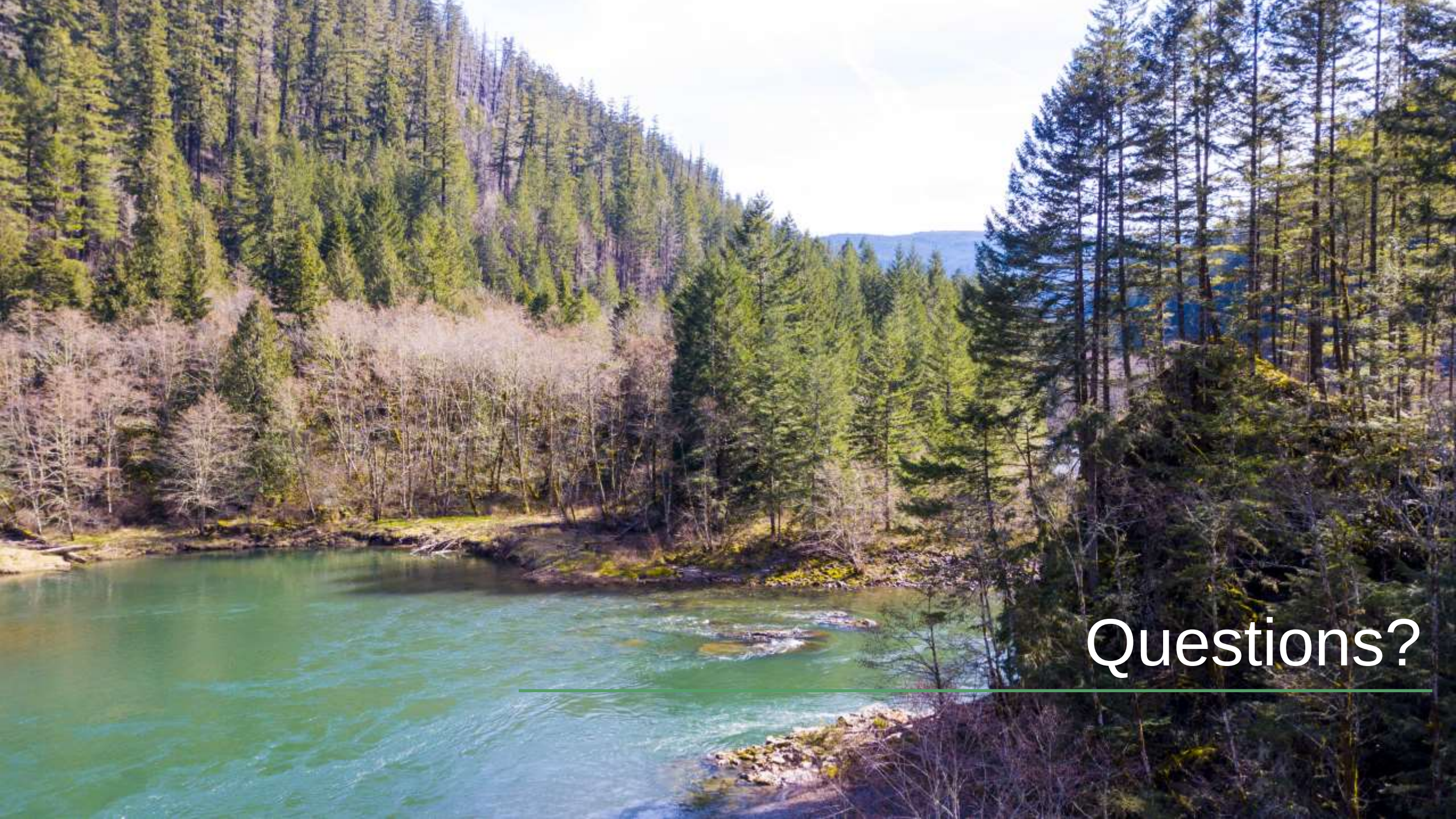
Chlorine Treatment Ineffective

Focus on Pre-Treatment

Compliment with PAC.

Next Steps

1. Coordinate basin-wide cyanotoxin sampling, testing, and response plan.
2. Evaluate alternative water supplies within the Clackamas Basin.
   - Look at the ability for CRWP member treatment plants to handle a cyanotoxin event.
   - Can water be moved around the basin to avoid a DO NOT DRINK for some providers?


Questions?

The Rise of Dolichospermum

The Rise of Dolichospermum