Massachusetts Water Resources Authority

Monitoring and Management of Taste and Odor-Causing Organisms in a Water Supply Environment

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Boston, MA

Northeast Regional Cyanobacteria Workshop
January 13, 2010

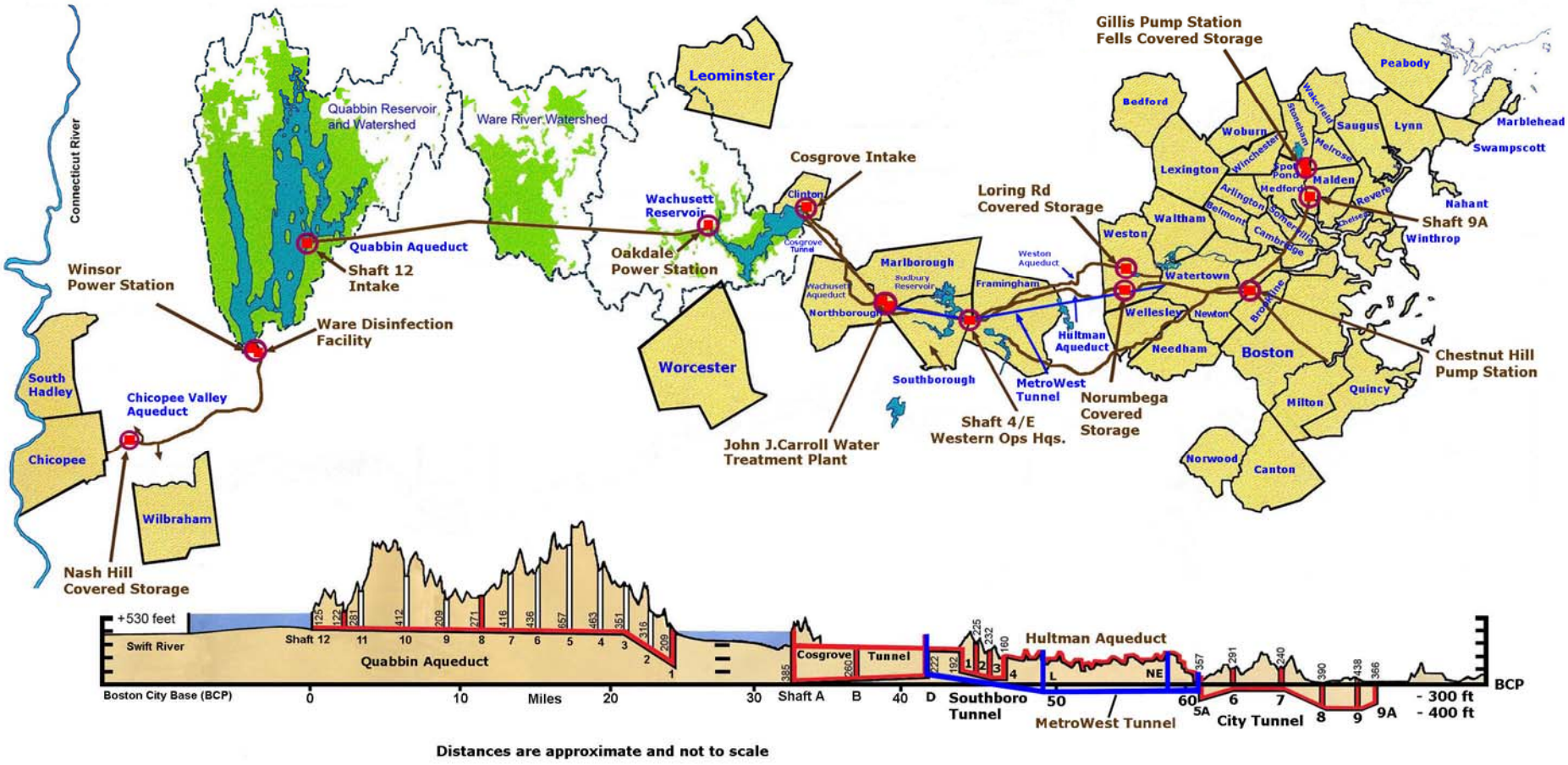
MWRA Water System

- Quabbin Reservoir – 412 Billion gallons
- Wachusett Reservoir – 65 Billion gallons
- Wachusett Reservoir is an oligotrophic, low nutrient water body
- Wholesaler to over 40 communities, 2 + million residents. Boston is our largest customer.
- 225 MGD annual daily average, 405 MGD design max

System Characteristics

- Over 6,000 miles of distribution piping
- Water storage tanks: MWRA has 12 tanks, communities have over 60 tanks
- Residence time well over 2 weeks

MWRA WATER SUPPLY SYSTEM



Treatment System

- Treatment:
  - Ozone (started July 2005)
  - Chlorine
  - Ammonia
  - Soda ash and CO_2 for corrosion control
  - Fluoride

- UNFILTERED surface water

Monitoring and Control of Nuisance Algae

- It is about:
  - Developing a response plan to control nuisance algae
  - Application methods
  - Monitoring technologies

- This is NOT about:
  - Algae control treatment chemicals
  - Controlling all algae
  - Treatment technologies for removal of T&O compounds

Concepts may be applicable to your unique situation

Algae - Taste and Odor

- Nuisance algae release taste and odor substances including geosmin and MIB *(2-methylisoborneal)*
- Other compounds, besides MIB and geosmin, generate taste and odor complaints
- T&O compounds may be released from the cells during log growth phase, or may be released when the cells are lysed

Which algae need to be controlled?

- Algae counts may not always indicate T&O problem: are you assuming dominant algae are responsible for T&O? Usually not true.

- Have you properly associated the algae species to the T&O problem, or is another algae type actually responsible? Many algae grow together.

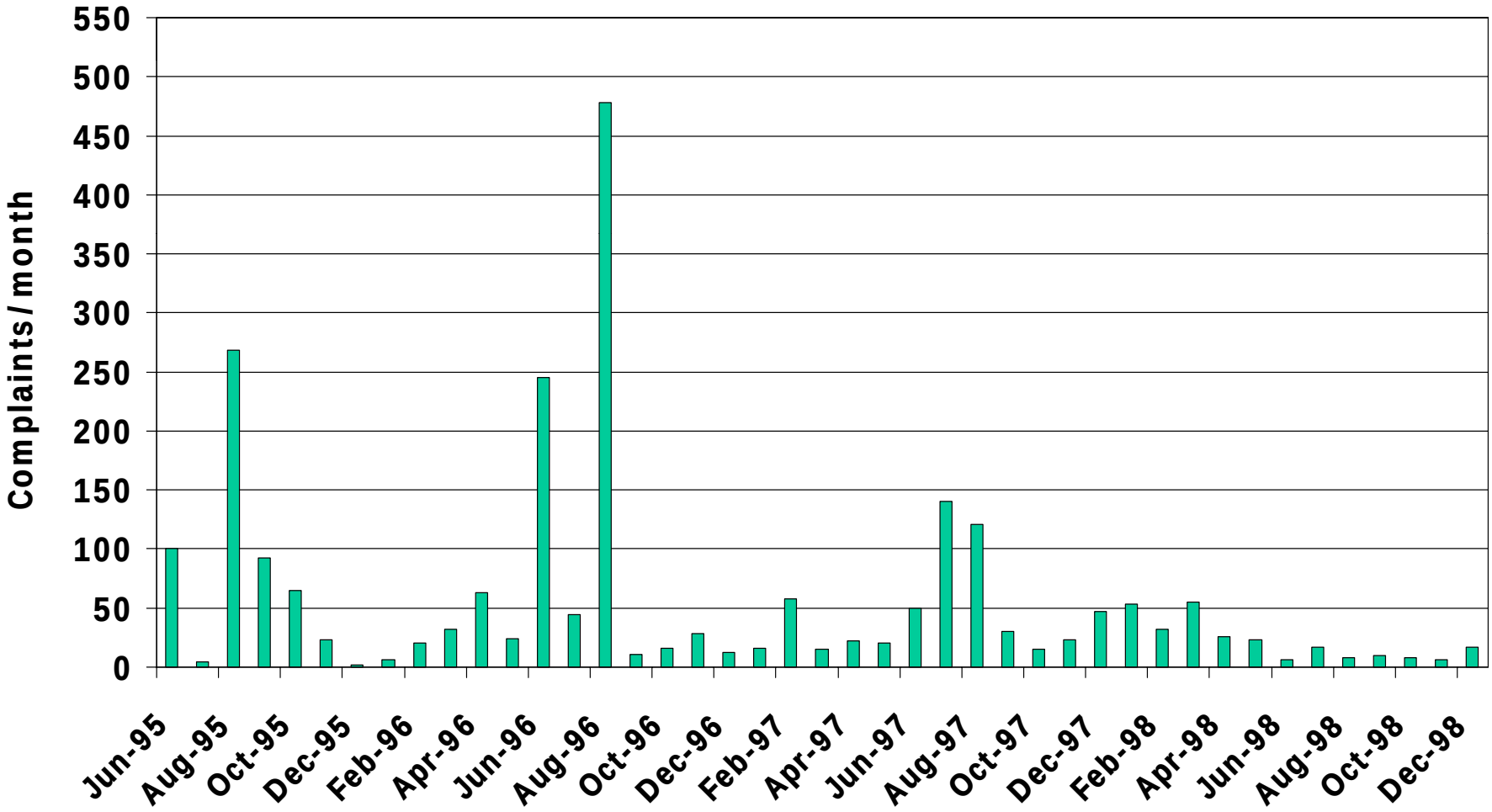
- Monitoring for total algae, chlorophyll a, or other general indicators (geosmin/MIB) may not be enough to tell you when you have a problem

When do algae need to be controlled?

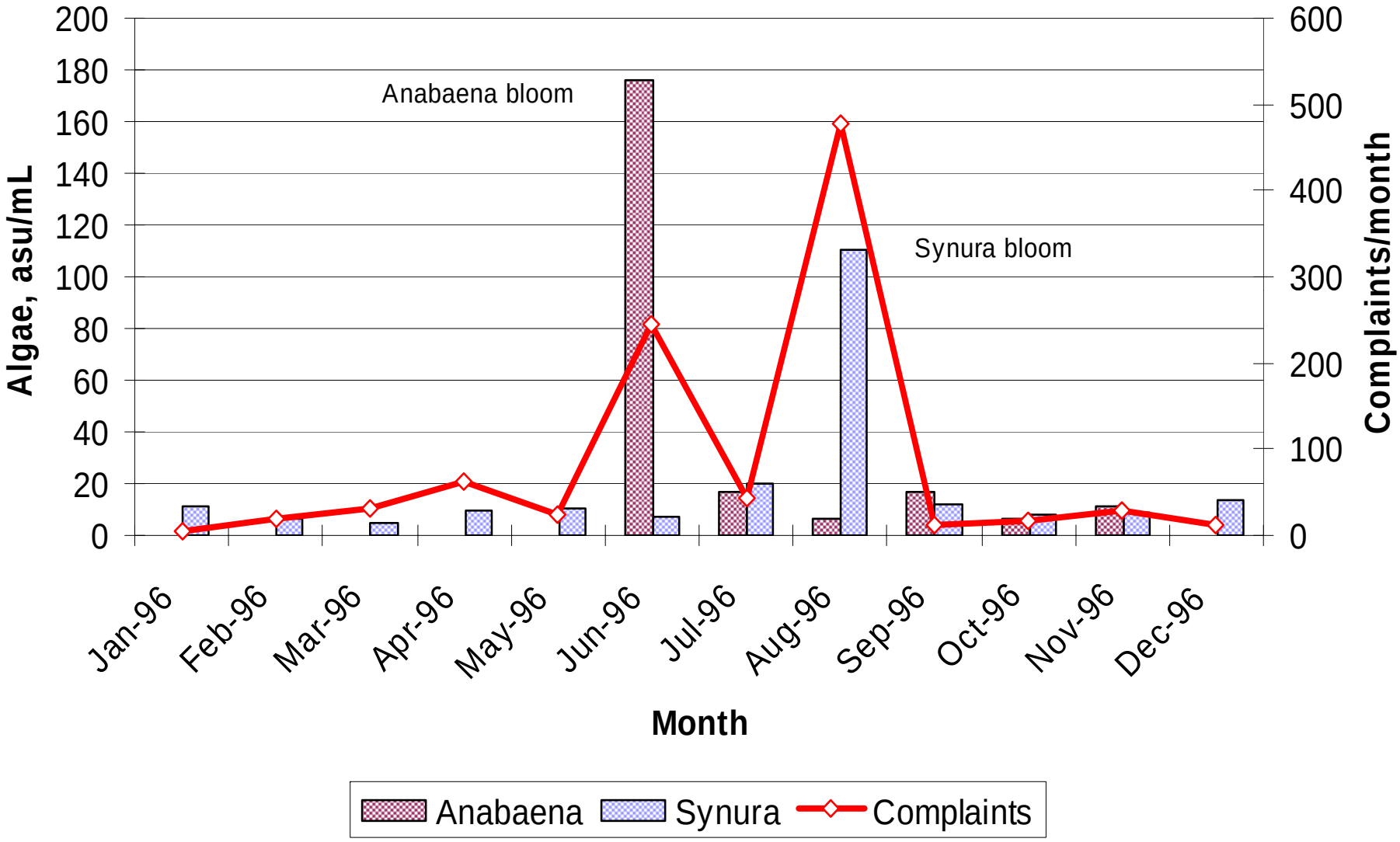
- Treatment to control a bloom must happen during a narrow window of opportunity*
- If taste and odor complaints have started, it is already too late!
- Taste and odor compounds may be released in the process of controlling the bloom
- Treatment once a bloom is established is less effective

**AwwaRF Report "Early Warning and Management of Surface Water Taste-and-Odor Events"*

Taste and Odor Complaints, 1995-1998



Anabaena, Synura, and T&O Complaints, 1996



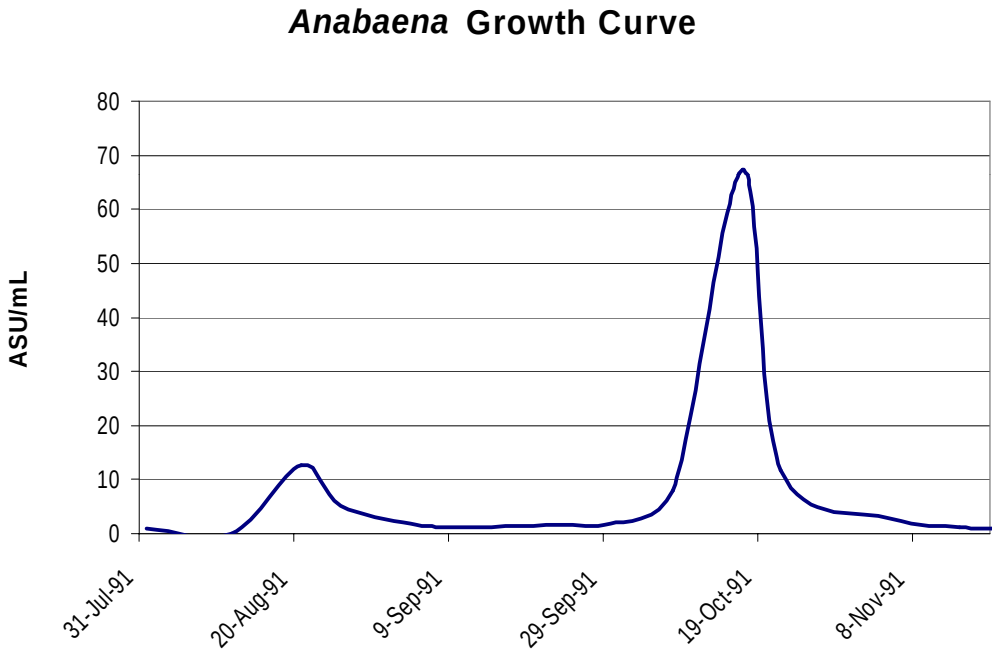
Typical Summer

- Algae data available, but treatment based more upon consumer complaints, rather than algae results
- Treatment method not highly effective for algae growing at depth

Algae Growth

- Goal is to control algae just as they are entering log growth

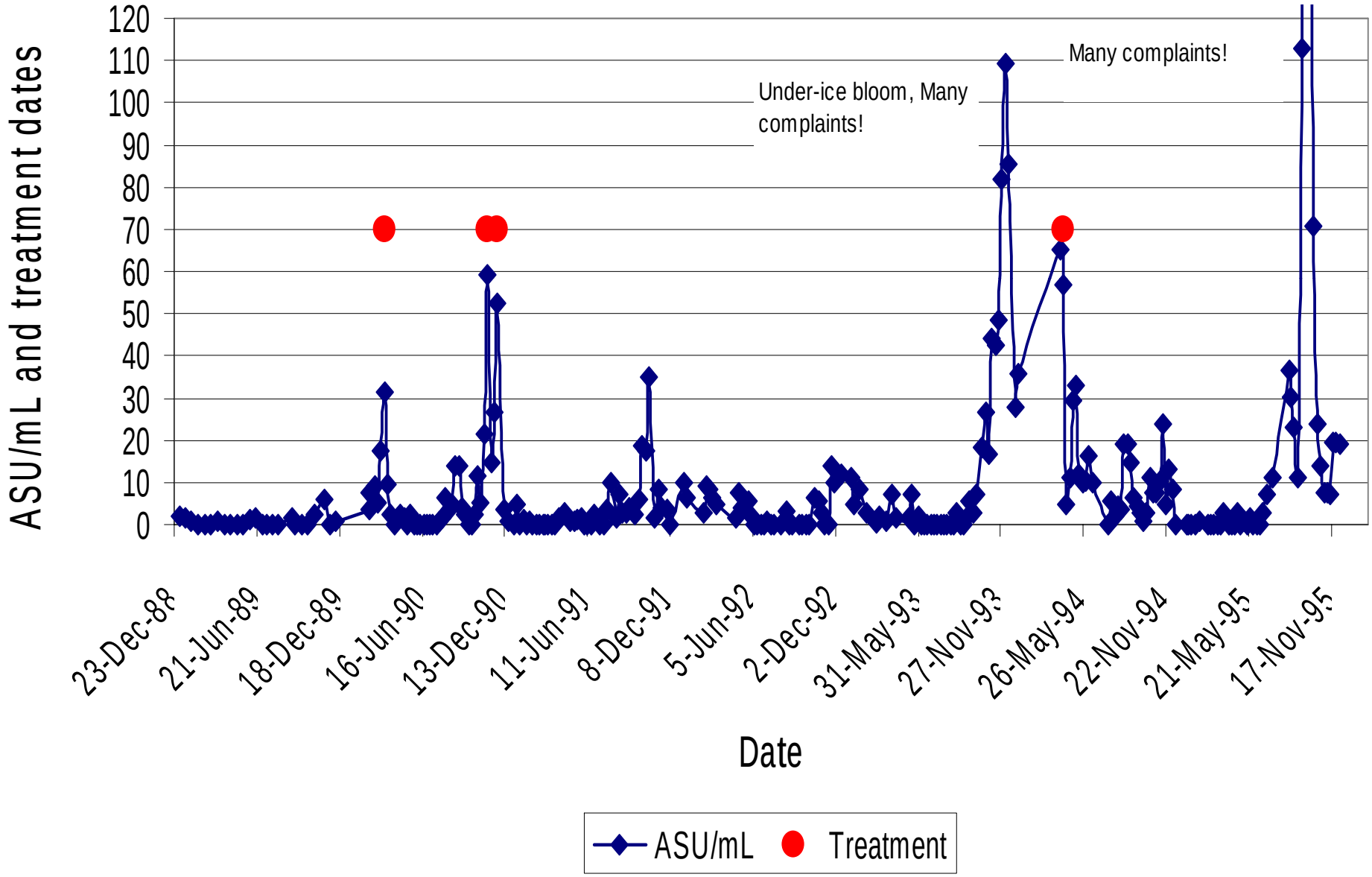
- Some algae may immediately “crash” after a bloom – but you are still stuck with the T&O problem!



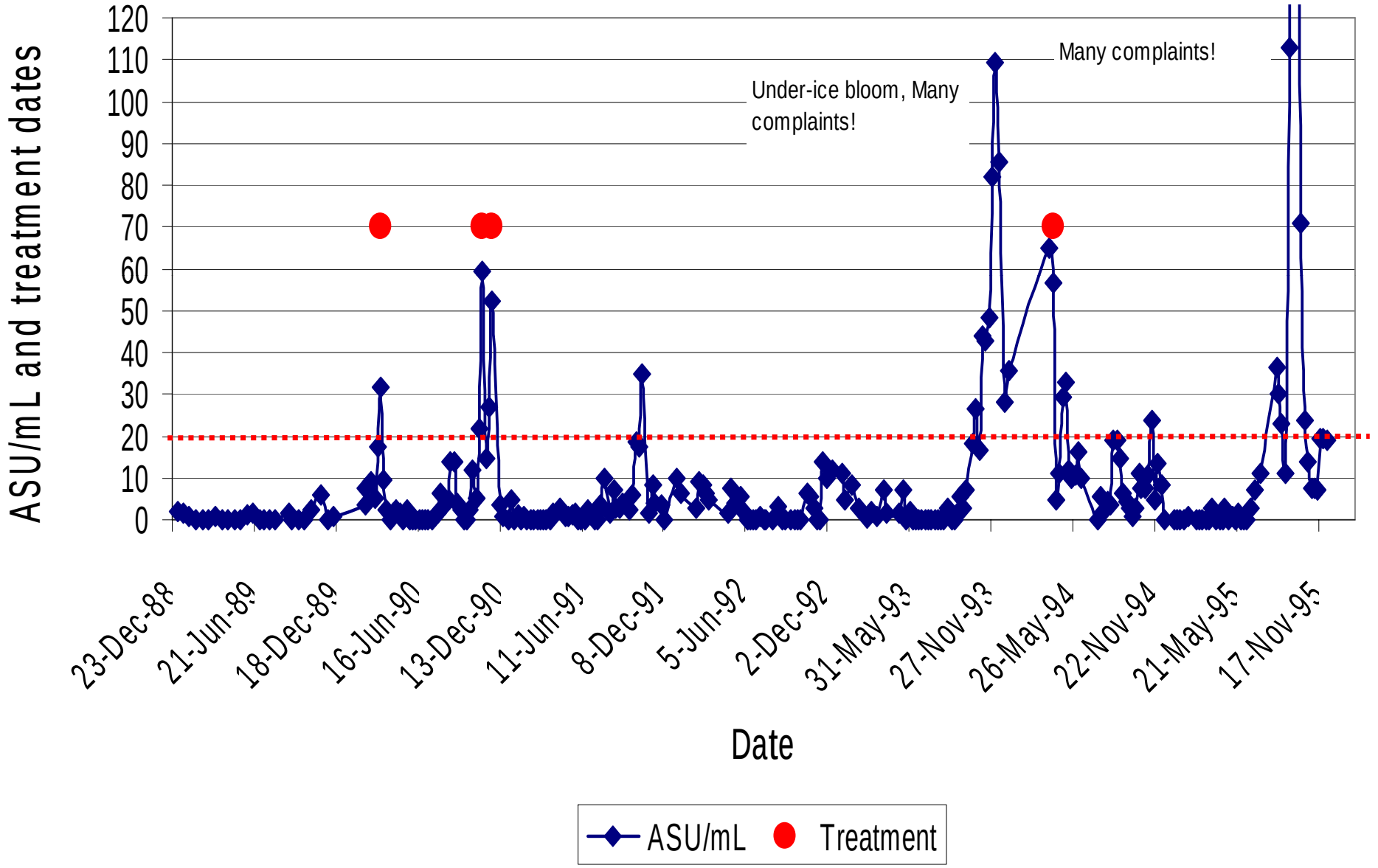
Trigger Levels

- Trigger levels were developed to focus staff on the need to treat nuisance algae before they became a T&O problem
  - *Anabaena*: Early trigger 25, Late trigger 50 ASU/mL
  - *Synura*: Early trigger 12 ASU/mL, Late trigger 20 ASU/mL
- How are “trigger levels” determined?
  - Early in “log growth”
  - Before they are a taste and odor problem

Synura Trends, 1989-1995



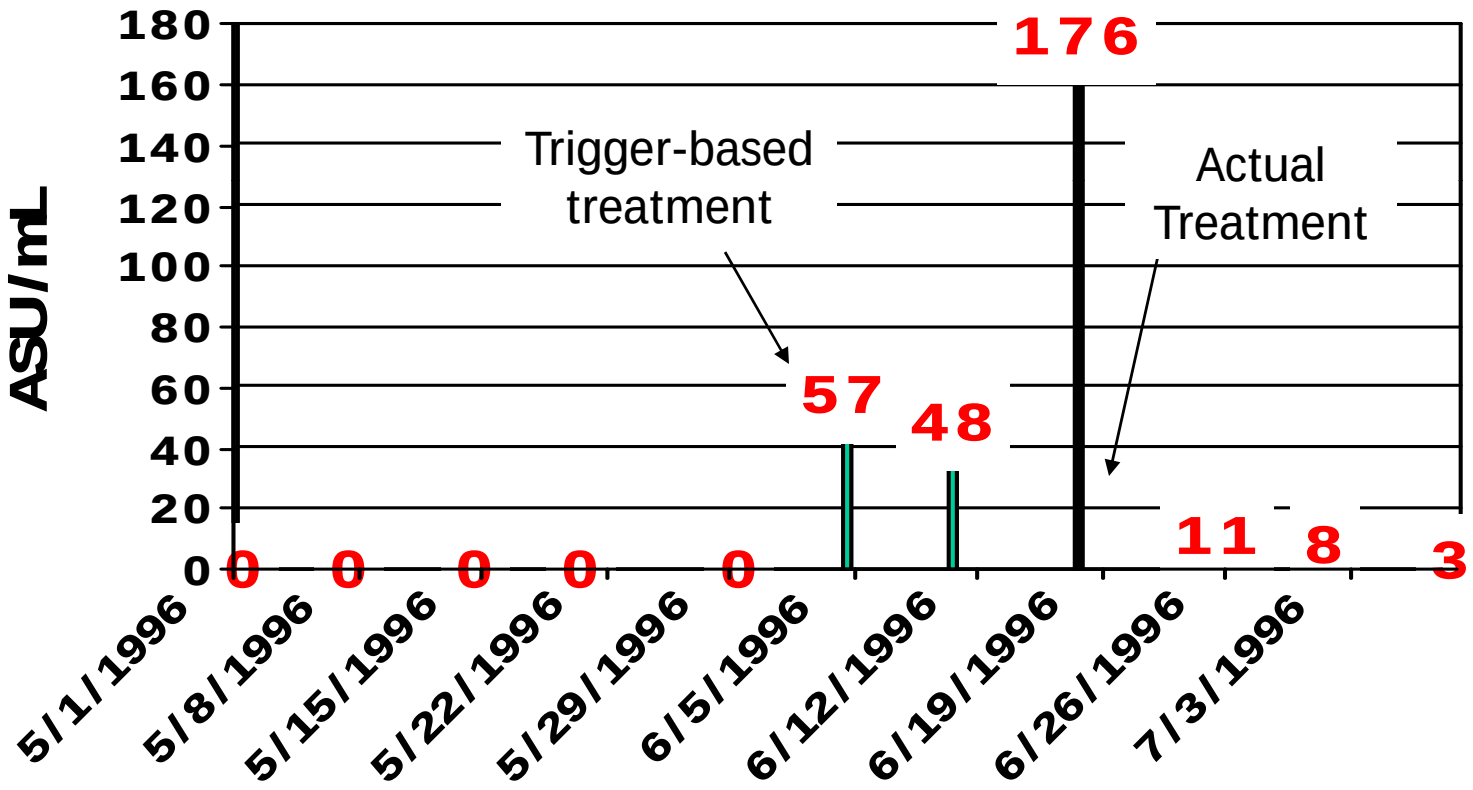
Synura Trends, 1989-1995



Development of Trigger Levels

- Early trigger levels used to recommend increased monitoring and focus on the algae data
- Late trigger levels used to prepare staff for a possible treatment
- Treatment never based on algae results alone. Use judgment to consider weather, growth conditions, etc. to recommend treatment. The more you know about the specific algae, the better!

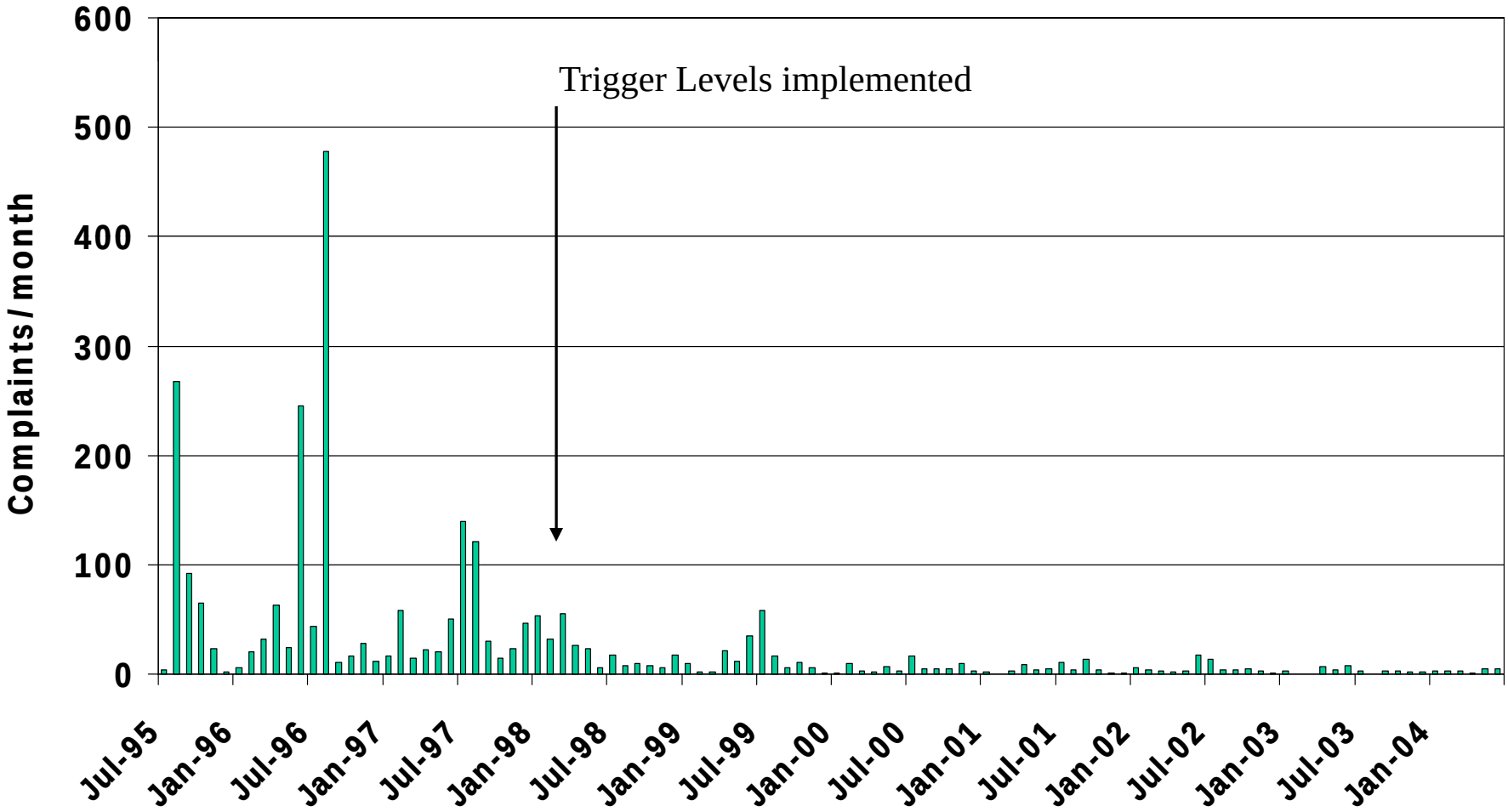
Anabaena Bloom, June 1996



Nearly 250 complaints due to bloom!

Complaints in June could have been avoided if treatment occurred earlier.

Has It Worked? Taste and Odor Complaints, 1995-2004



Recent Improvements to Response Program

- MONITORING
  - Purchased FlowCAM to aid with monitoring and enumeration of algae

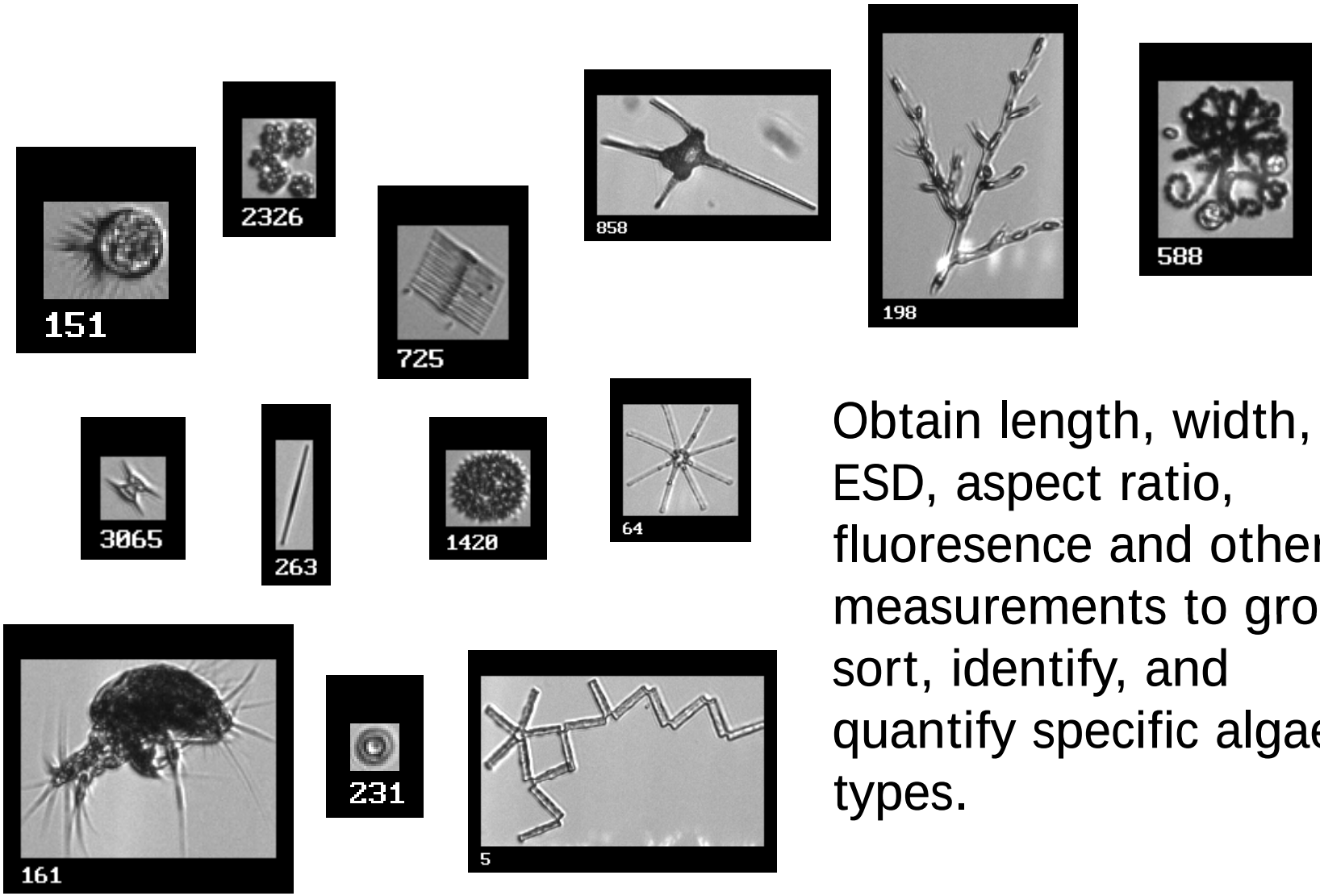
- TREATMENT
  - Purchased new boat and fabricated improved depth injection system to apply copper sulfate. Boat equipped with GPS

Improvements to Monitoring

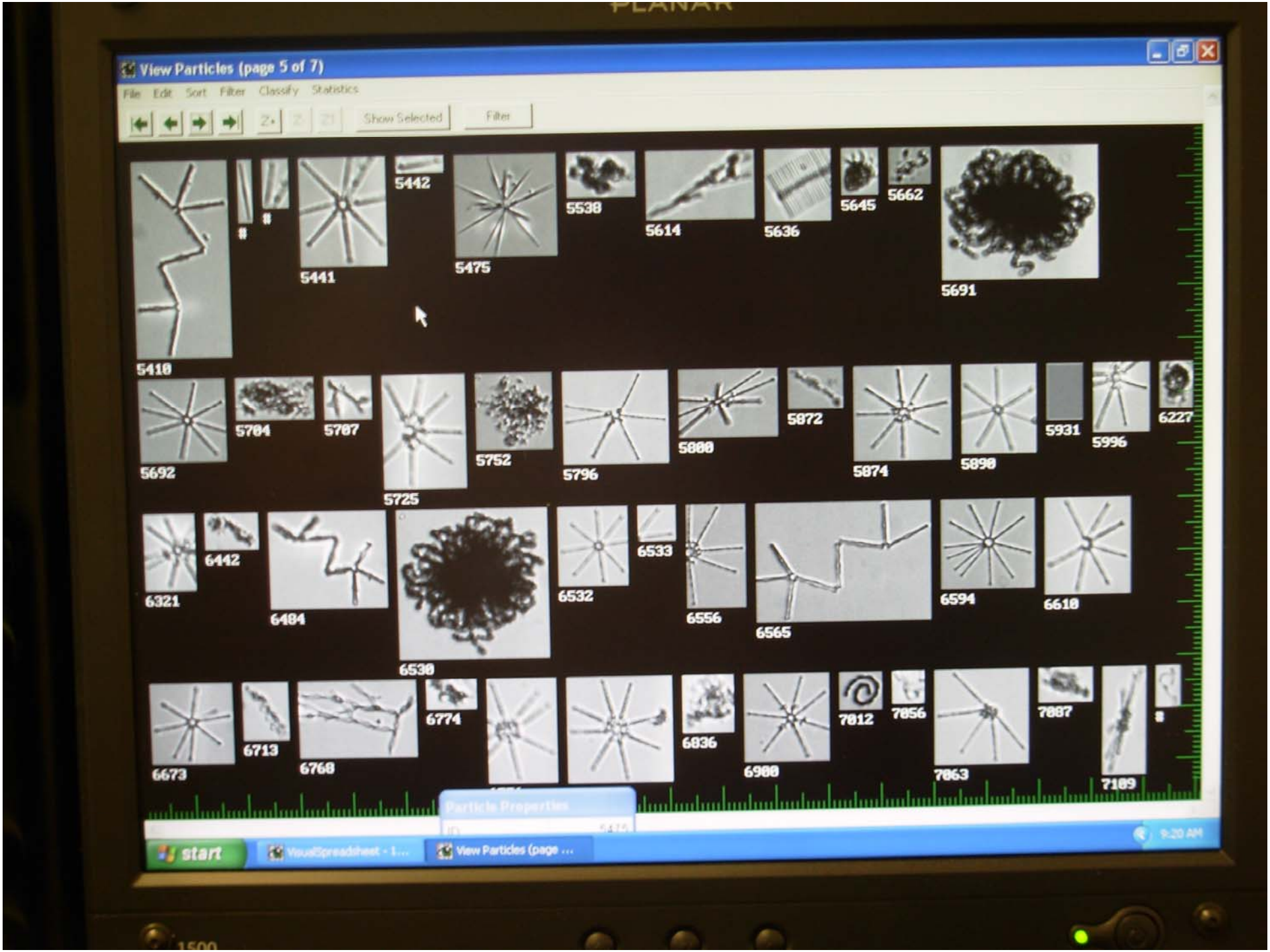
- Sample Analysis – *manual* - Concentration of sample, followed by microscopic exam

- Sample Analysis – *semi automated* - FlowCAM

FlowCAM - Algae Images



Obtain length, width, ESD, aspect ratio, fluoresence and other measurements to group, sort, identify, and quantify specific algae types.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View Particles (page 1 of 1)

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Particle Properties

ID	5691
Length	243.86
Width	194.24
Diameter (ABD)	195.57
Diameter (ESD)	218.87
Aspect Ratio	0.80
Compactness	8.48
Elongation	24.59
Opacity	110.91
Perimeter	1788.76
Roughness	2.59
Max Angle	11.25
Particles/Chain	1
Ch1 Peak	1327
Ch2 Peak	65
Filter Score	0.00

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2	1	30040.83	195.57	218.87	243.86	194.24	0.8	8.48	24.59
3	2	31875.27	201.46	224.54	231.76	208.64	0.9	8.57	24.89
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5		SUM(**number1**, [number2], ...)							

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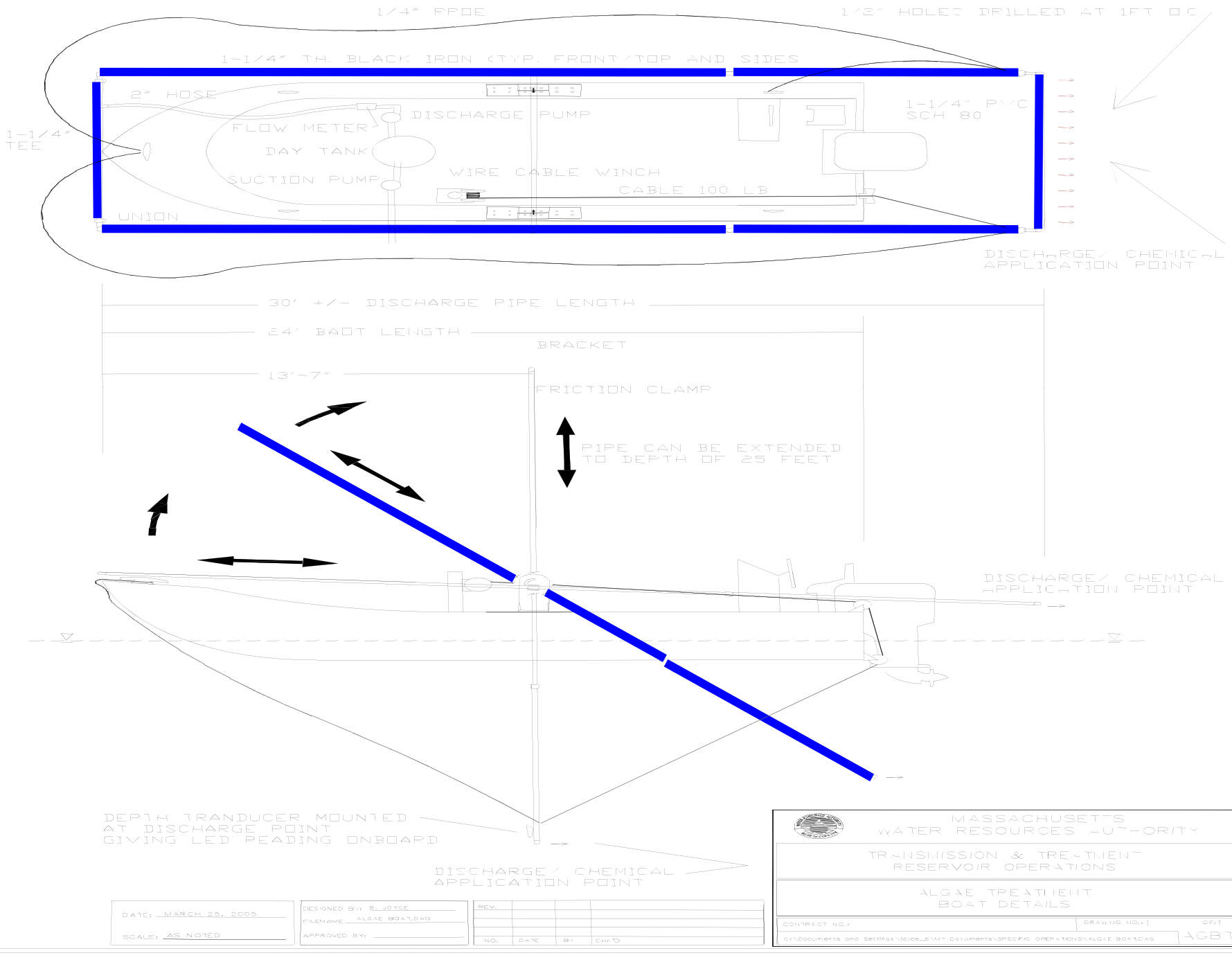
Treatment - Depth Application

- Manifold system
- Pump $CuSO_4$, exit through diffuser holes in bottom cross pipe
- Improved dispersion and depth control



DATE: MARCH 25, 2005
SCALE: AS NOTED

DESIGNED BY: B. JOYCE
FILENAME ALGAE BOAT.DWG
APPROVED BY:

REV. NO.	DATE	BY	CHK'D

MASSACHUSETTS
WATER RESOURCES AUTHORITY

TRANSMISSION & TREATMENT
RESERVOIR OPERATIONS

ALGAE TREATMENT
BOAT DETAILS

CONTRACT NO.: DRAWING NO.: 1 OF: 1

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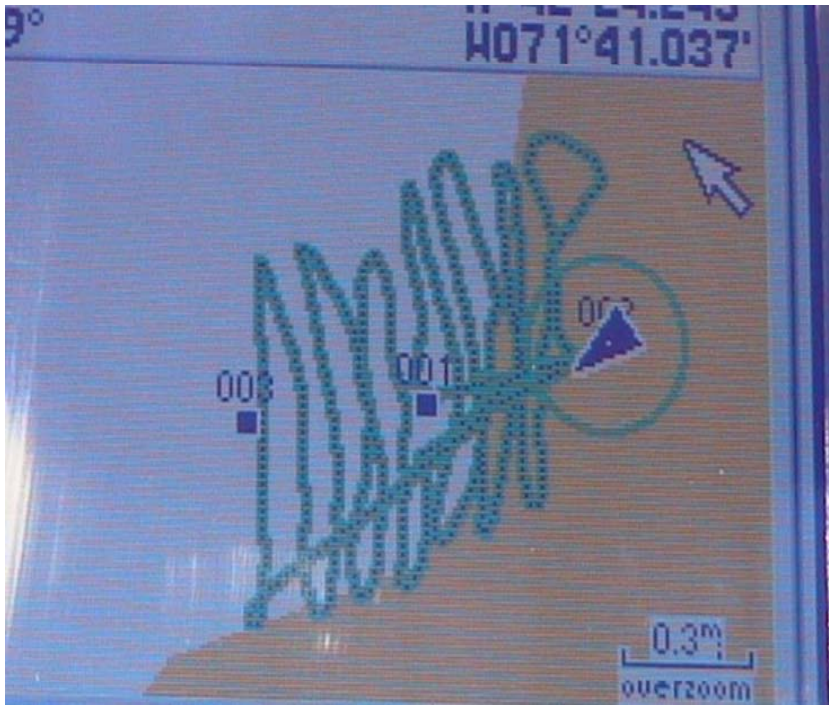
AGBT

Treatment -Surface Application

GPS

- Use Navigation System to identify treatment area - Repeatable



Actual Comments

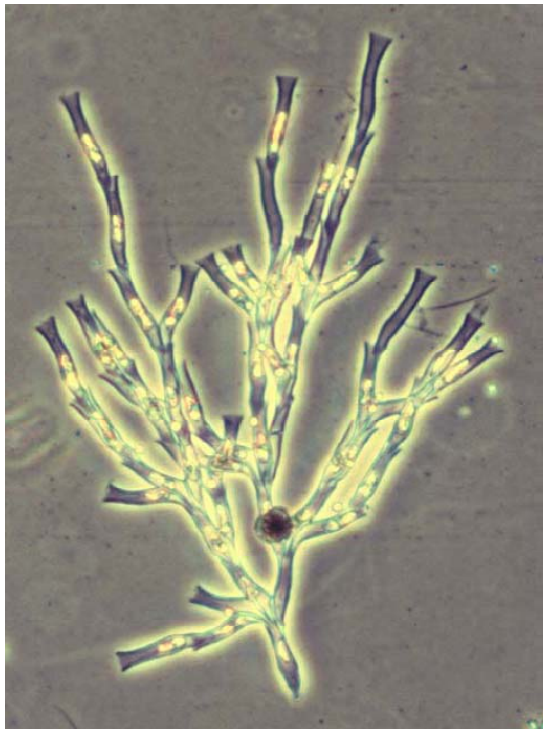
"**The water tastes great!** I have noticed a marked taste improvement a a complete lack of odor in the water. You are doing splendid work.

MWRA WATER HOLDS ITS OWN AGAINST BOTTLED

Taste test shows price is all that separates them

Conclusions

- Monitoring
- Data analysis
- Trigger levels
- Treatment



Acknowledgements

- Guy Foss, Manager, Treatment Operations
- Ken Perry, Sr. Program Manager
- Mary Bezek, Laboratory Supervisor
- Larry Pistrang, Department of Conservation and Recreation
- Dave Worden, Department of Conservation and Recreation

Questions?

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