NEW INNOVATIONS FOR CHANGING REGULATIONS

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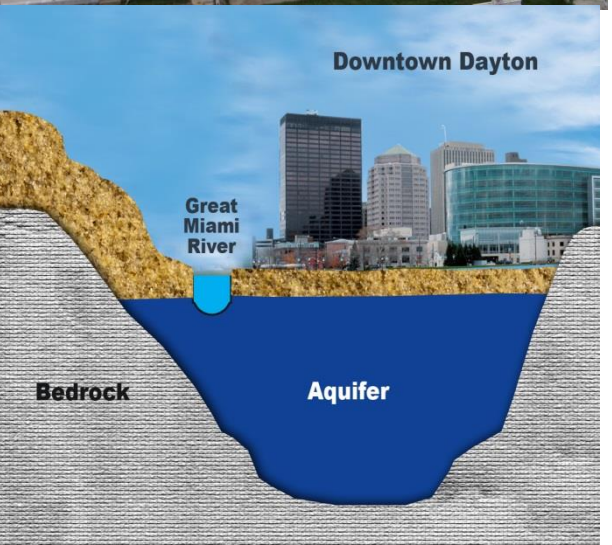

BACKGROUND

- The City of Dayton Water Department serves 400,000 people in the City of Dayton and surrounding Montgomery County.
- Pump 60-80 MGD.
- Two water treatment plants- both lime softening.
- Ground water under the influence of surface water.
- Lime Reclamation Facility

OVERVIEW

Regulation, Laboratory Procedures and Innovation surrounding:

- National Pollutant Discharge Elimination System (NPDES)
- Heterotrophic Plate Count (HPC)
- Revised Total Coliform Rule (RTCR) and Long Term 2 Enhanced Surface Water Treatment Rule (LT2)
- Harmful Algal Blooms (HAB)

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water
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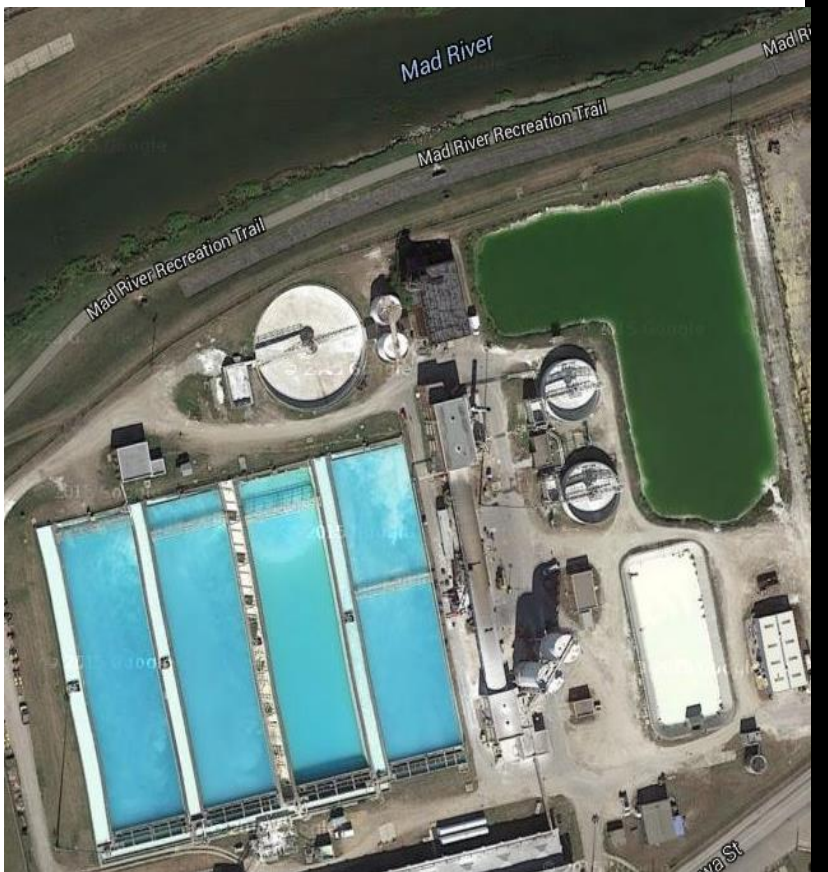
NPDES

NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM

NPDES REGULATION

- National Pollutant Discharge Elimination System is a set of effluent limitations for discharging pollutants to natural waterways.[2]
- Permit in place to ensure safety of the wildlife where the water is being discharged.
- The City of Dayton has an NPDES permit to discharge from the L-shaped Lagoon to the Mad River.



NPDES REGULATION (CONT.)

- **Per City of Dayton's permit, the amount of Total Chlorine and Total Solids discharged to the river is strictly limited.**
- **The amount of Chlorine discharged to the river cannot exceed 0.038 mg/L.**
- **The amount of total solids discharged to the river cannot exceed 45 mg/L at any point and cannot average more than 30 mg/L solids.**

NPDES LAB PROCEDURE

- **USEPA Standard Method 4500-Cl G for drinking water analysis uses DPD powder pillows and a colorimeter to quantify chlorine.**
- **This method can measure Cl from 0.02-2.00 mg/L.**
- **This process takes approximately three minutes.**

NPDES LAB PROCEDURE (CONT.)

- A 10mL portion of sample is added to a the vial.
- The vial is placed in the colorimeter and blanked.
- Add the total chlorine DPD packet to the sample.
- Wait three minutes, the sample will turn from clear to pink.
- Read the sample in the colorimeter.
- The stronger the pink color, the greater the chlorine
- The colorimeter will give a Cl value, in mg/L to two decimal places.

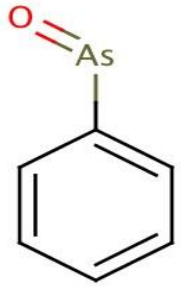
NPDES INNOVATION

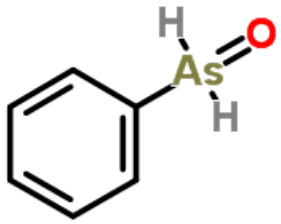
- **For the purposes of testing the Cl from the L-shaped lagoon, for the NPDES permit, the City of Dayton has moved away from the DPD method to an amperometric titration method.**
- **The Hach TitraLab AT1000 uses a forward titration to detect a Cl range of 0.003-5.00 mg/L.**

NPDES INNOVATION (CONT.)

- **Based on Standard Method 4500-Cl D, the Titralab AT1000 uses potassium iodide, and a pH buffer to titrate a chlorine sample with phenylarsine oxide (PAO).**
- **The end point is determined by a Pt-Pt Electrode**
- **The chemical reaction at work is:**

$PhAsO + Cl_2 + 2H_2O \rightarrow PhAsO(OH)_2 + 2Cl^- + 2H^+$





NPDES INNOVATION PROCEDURE

- **Titralab AT1000 for Total Chlorine Analysis:**
  - Measure out 200 mL of samples
  - Insert probes and tubing into sample
  - Add potassium iodide powder
  - Wait for results

NPDES OLD PROCEDURE VS INNOVATION

- **Hach Colometric DPD method has a magnesium interference.**
- **The L-shaped lagoon contains magnesium from lime residuals.**
- **Amperometric titration method can account for magnesium interference.**

HPC

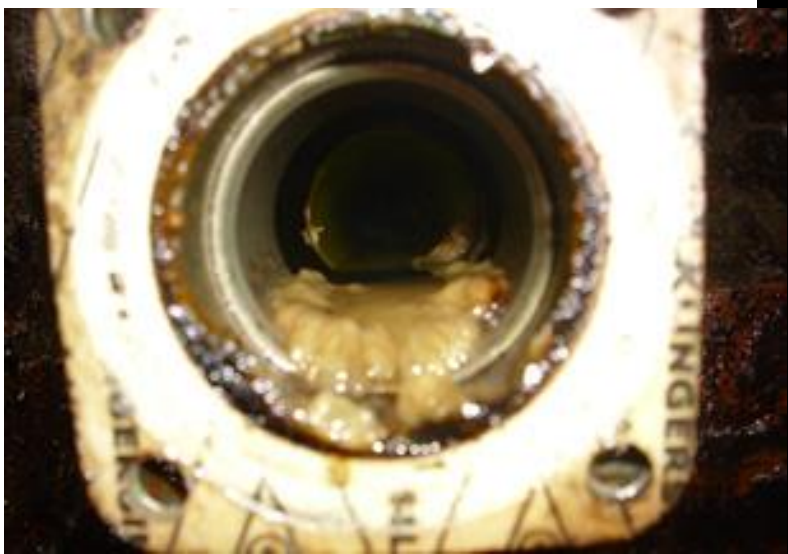
HETEROTROPHIC PLATE COUNT

HPC REGULATION

- HPC is standard analytical procedure to measure a of variety of bacteria commonly found in water.
- These bacteria are naturally present in the environment.
- HPC has no MCL. They are merely an indicator of the maintenance of the water system.[1]

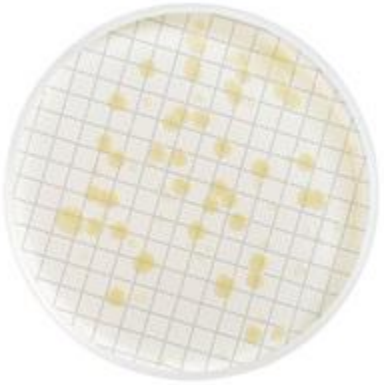
HPC REGULATION (CONT.)

- A high heterotrophic plate counts indicates biofilm build up in the distribution system.
- Although no MCL exists, treatment techniques should aim to maintain HPC below 500 CFU/mL.[5]
- For water utilities, the finished water should contain less than 10 CFU/mL.[5]
- There are various methods that can be used to measure HPCs.



HPC LAB PROCEDURE MEMBRANE FILTRATION METHOD

- **According to standard method 9215B, HPCs are determined via membrane filtration method.**
- **A 100mL sample is filtered, plated on R2A agar and incubated for 48 hours.**
- **After 48 hours, the colonies are counted.**
- **The results are reported as colonies per 100mL.**
  - Some samples must be diluted as to not have a result of “too numerous to count” (aka ≥200 colonies per plate).



HPC LAB PROCEDURE IDEXX METHOD

- **IDEXX provides a SimPlate method for Heterotrophic plate counts, this is based on the same principles as standard method 9215B.**
- **SimPlate uses a multiple enzyme technology medium.[3]**

HPC LAB PROCEDURE IDEXX METHOD (CONT.)

- This method works on the premise that waterborne bacteria will metabolize an enzyme substrate and produce a specific (fluorescent) signal.
- The plate is filled with sample and incubated for 48 hours.
- The number of wells that fluoresce convert to a most probable number.[3]

HPC INNOVATION LUMINULTRA

- The Luminultra method utilizes a photometer to measure the light produced from ATP contained in bacteria.[6]
- For drinking water, the intra-celluar ATP of living biological cells are measured to obtain a microbial count equivalent. [6]

HPC INNOVATION LUMINULTRA (CONT.)

- Results given in minutes.
- Portable set up.
- Reports results for all bacteria present.
- Long shelf life for consumables.
- Complex procedure.

HPC LUMINULTRA SOP

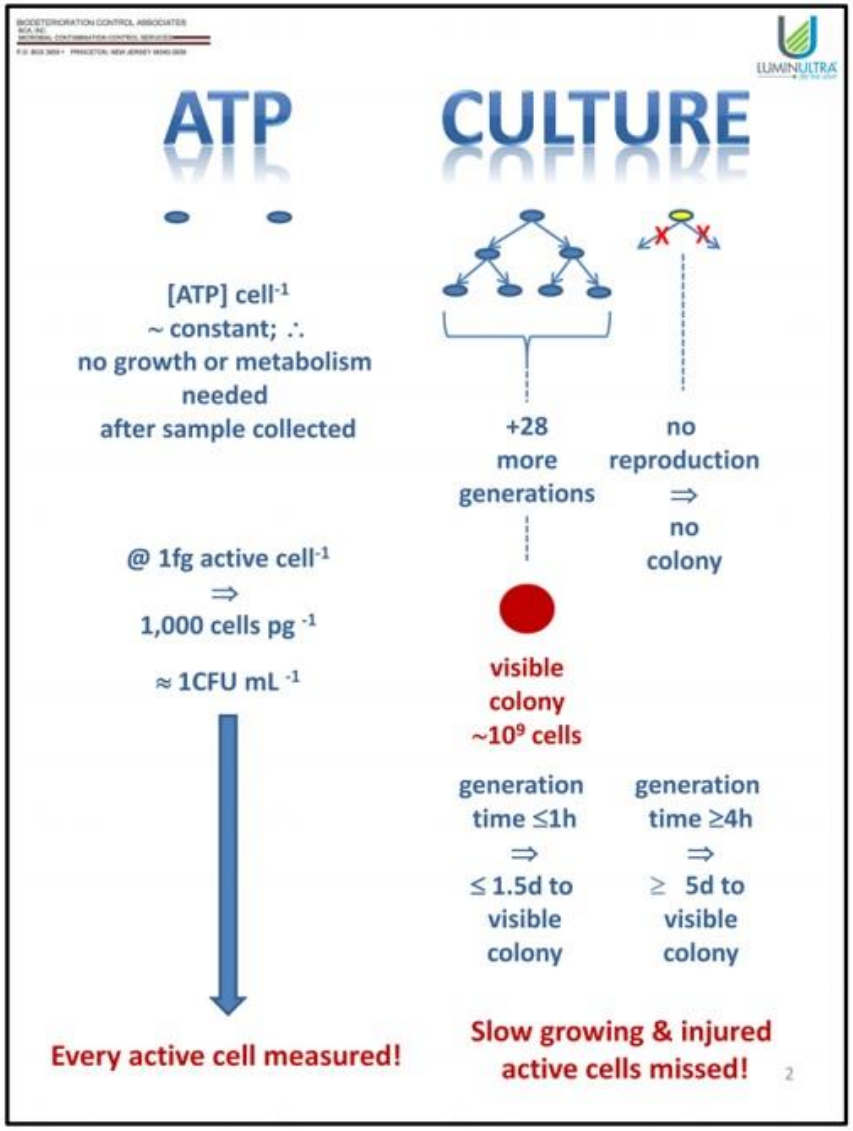
- Calibrate Luminometer.
- Mix sample for homogeneity.
- Remove plunger from 60 mL syringe, and attach filter.
- Pour into plunger sample
- Push sample volume through filter and into waste a rate of 3-5mL per second.
- Stop before air is pushed through filter, ensure filter remains wet.

HPC LUMINULTRA SOP (CONT.)

- Detach filter, and remove plunger.
- Re-attach filter and add 1mL of UltraLyse 7.
- Push Ultralyse entirely through filter, to dry, into an UltraLute dilution tube.
- Cap and invert 3x.
- Pipette 100µL of that into an assay tube and add 100µL Luminase.
- Insert assay tube and results are given instantly.

HPC PROCEDURE VS INNOVATION

- **Membrane filter method: sensitive, time consuming, inexpensive**
- **IDEXX method: unreliable, time consuming, moderate expense**
- **Luminultra method: portable, less time, expensive, extensive procedure**

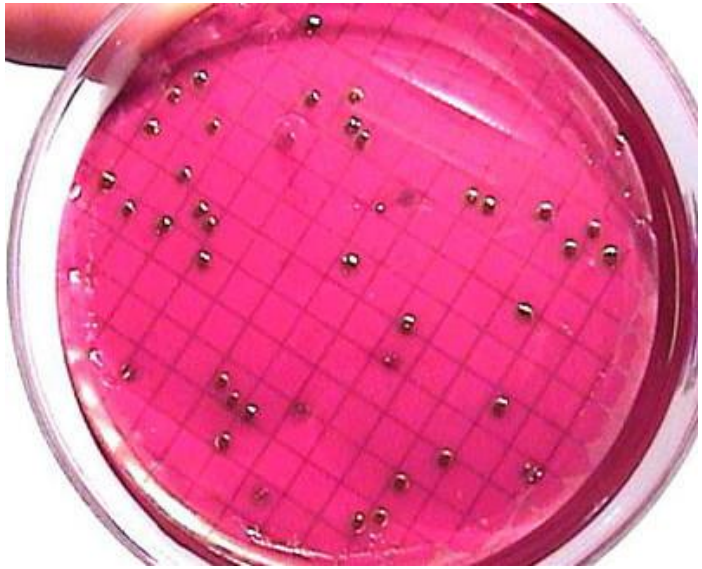


LT2

LONG TERM 2 ENHANCED WATER TREATMENT RULE

REGULATION LT2 RULE

- **The LT2 rule builds upon the Safe Drinking Water Act.**
- **Rule was added to monitor Cryptosporidium.[9]**
- **Crypto is resistant to disinfection.**



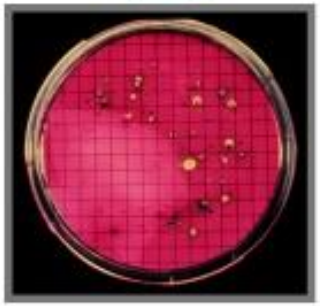
PROCEDURE LT2 RULE: MONTHLY COLLECTION

- Samples are collected at raw water inlet.
- Line is flushed for 2-3 min.
- Envirochek filter is connected to apparatus.
- At least 10 L of water is filtered through.
- Both ends of filter are stoppered, enclosing the remaining amount of water inside.

INNOVATION LT2 RULE: TESTING

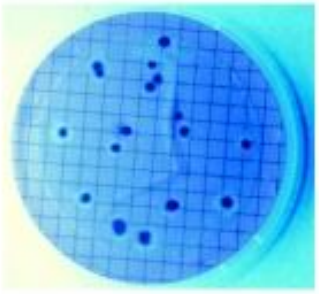
- A raw water bacteria sample is collected
- Sample is analyzed via membrane filter method on mENDO agar and incubated for 22-24 hours.
- Colonies are counted.
- Filter is then re-plated on to nutrient agar with MUG for four hours.
- Colonies that fluoresce are counted as E. Coli.

mENDO

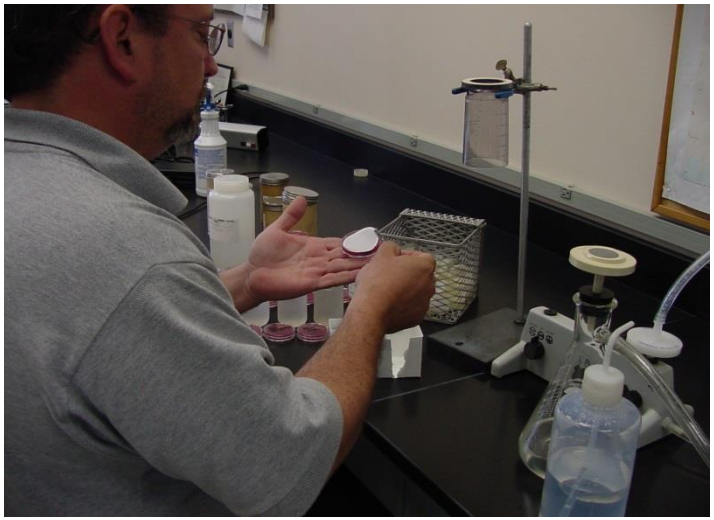


Colonies with a green metallic sheen are counted as total coliforms

NA-MUG



Colonies with a fluorescent halo are counted as *E. coli*



PROCEDURE LT2 ANNUAL COLLECTION & TESTING

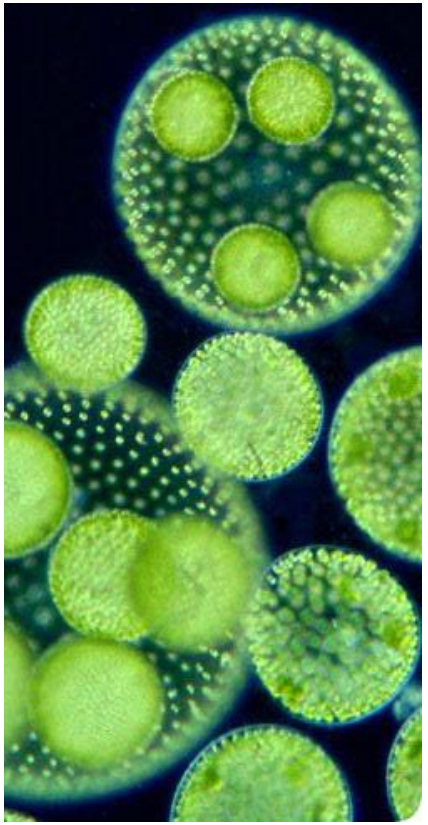
Matrix Spike:

A 10 L bulk sample of raw water is collected in a cubitainer and sent to a Crypto lab for a matrix spike analysis. This is collected once, every twenty samples.[10]

PROCEDURE LT2 ANNUAL TESTING (CONT.)

Microscopic Particulate Analysis:

100 L of water sent through an MPA filter over 12-24 hours. This is sent out for analysis, for: particulate debris, protozoans, algae and other organisms.[11]

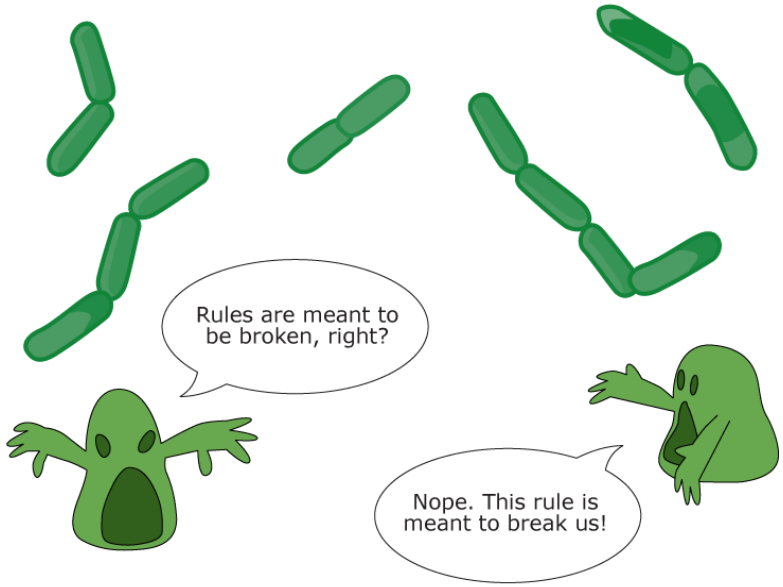


RTCR

REVISED TOTAL COLIFORM RULE

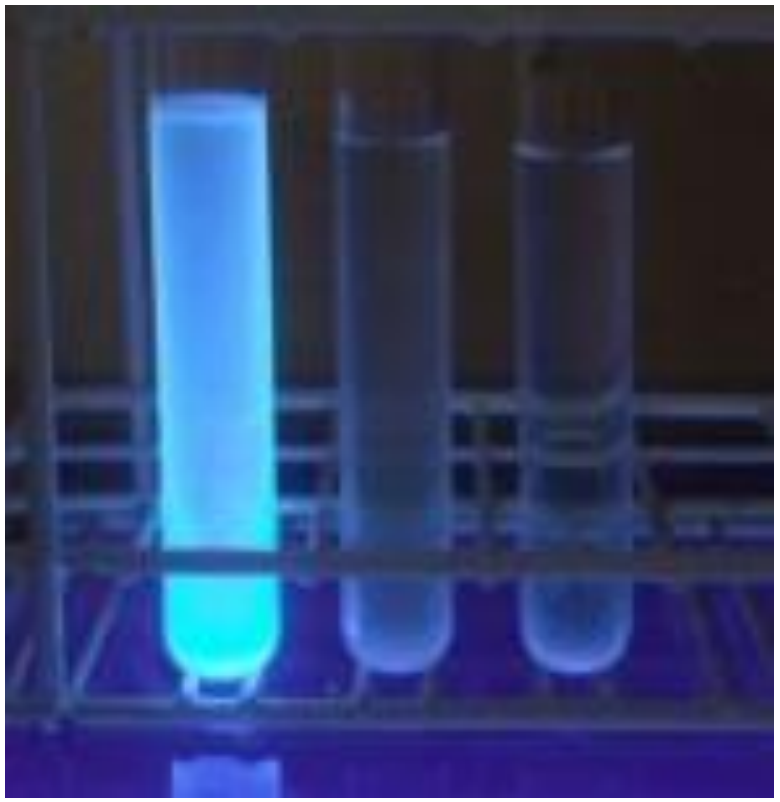
REVISED TOTAL COLIFORM RULE REGULATION

- Final revisions made 2/2014.
- In effect 4/2016.
- Set MCL for E. Coli.
- Eliminated Fecal Coliforms.
- Changed monitoring and public notification requirements.



RTCR INNOVATION

- **Eliminated Fecal Coliform Pos verification in favor of E.Coli verification.**
- **Made switch from EC media to EC with MUG.**



HAB

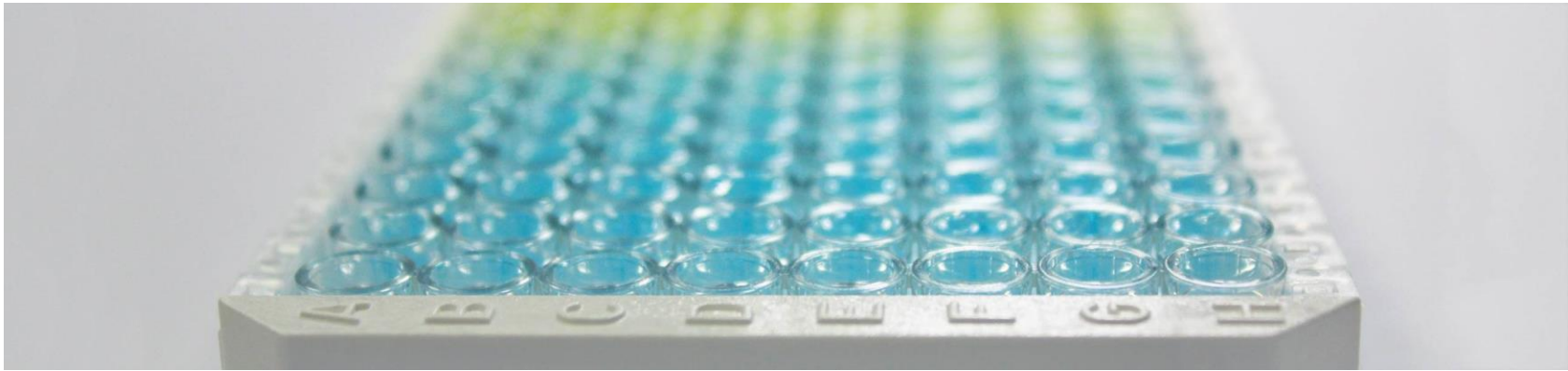
HARMFUL ALGAL BLOOM

HAB REGULATION

- Harmful algal blooms are large growths of cyanobacteria.
- Cyanotoxins can cause illness and even death.[4]
- The USEPA has implemented health advisory levels for the cyanotoxins- microcystins and cylindrospermopsin. [4]
- Monitoring is required only for public water systems sourcing surface water or groundwater under the influence of surface water.

HAB INNOVATION

- Harmful Algal Blooms are tested via the ELISA method, innovated by ABRAXIS.
- ELISA is enzyme-linked immunosorbent assay.
- ELISA is an immunoassay detection method for microcystins in water. [12]
- Specific antibodies compete with proteins on the plate for binding sites. [12]
- When combined with a color substrate, a blue color is given off and the intensity is read at 450 nm. [12]



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Questions

THANK YOU