Blue-green algae webinar: Q&A

Responses to stakeholder questions asked at the blue-green algae webinar for local water utilities on 9 May 2024.

Question: What is blue-green algae?

Algae has an important role in nutrient cycles and in food chains. Blue-green algae, which is also known as BGA or cyanobacteria, are tiny organisms that can have a significant effect on water quality and pose a risk to drinking water quality.

Blue-green algae use photosynthesis to produce food and make new cells. Blue-green algae cells receive sunlight from the water surface and can travel up and down the water column. Seasonal blue-green algae blooms can affect the taste and odour of drinking water and pose a risk to people’s safety.

Blue-green algae thrives in the warm upper layers of water and there are numerous species, many of which can cause problems in drinking water supplies in NSW.

Blooms can occur seasonally in specific water resource conditions and can cause harm to people and kill livestock. Decaying algae depletes oxygen in the water and can kill fish. Algae can cause unpleasant odours in water, force the closure of water storages for drinking or recreational use and increase the cost of water treatment.

To protect drinking water and the environment, prevention and response procedures need to be in place. Prevention is better than management, which is costly and labour intensive.

Question: What toxin detection methods to identify potential toxin produce species are recommended?

The first step is microscopic examination to determine the species of blue-green algae.

Once it is determined that potentially toxic cyanobacteria is in the water body, it is best to assume it is a toxin-producing species until it is proven otherwise. That is verified through toxin testing. There are different methods of determining the presence of potentially toxin-producing species and toxin testing. The Forensic and Analytical Science Services (FASS) government laboratory uses a range of different processes to determine if there are toxins present.

Labs use one or more of the following processes: Liquid Chromatography, Tandem Mass Spectrometry, Gas Chromatography, Tandem Mass Spectrometry and Gas Chromatography - Electron Capture Detector - Headspace to detect specific toxins and their variants.

Labs use different procedures to detect the presence of genes that are responsible for toxin production and that can be tested using qPCR (quantitative polymerase chain reaction) methods.

There are different independent and commercial labs that, with National Association of Testing Authorities (NATA) certification, also do cyanobacteria analysis and toxin testing (see list at end of this Q&A).

Question: Is there guidance on how to monitor algae and algae toxins in drinking water supplies for LWUs to follow?

The guidance that we use is the Australian Drinking Water Guidelines, which gives the framework for management of blue-green algae in drinking water.

Local Water Utilities have a Drinking Water Management System (DWMS), which is a legislative requirement, and utilities are encouraged to review that every 4 to 5 years.

That DWMS is your quality assurance program for your water utility and it ensures your utility is producing safe, quality drinking water and to identify the risks that you have with your water supply.

If you have a significant history of blue-green algae in your catchments in your water sources then it's recommended, through your DWMS, that you develop a blue-green algal response plan so that you are monitoring, taking action, escalating and communicating during an event.

There are also some other good supporting documents. There's the WQRA CRC Management Strategies for Cyanobacteria. That's a Guide for Water Utilities Research Report 74 and the Water Directorate has a blue-green algal management protocol that can assist utilities to develop the response plans.

Question: What type of algae toxins have been detected and/or reported to NSW Health and the department before?

NSW Health utilises the services of the Clinical and Environmental Toxicology Laboratory of Forensic and Analytical Science Services (FASS) in Lidcombe. FASS test for the following toxins: Cylindrospermopsin, Microcystin, Nodularin, Gonyautoxin, Neosaxitoxin and Saxitoxin.

In the Hunter New England area this season, there have been about half a dozen water utilities with blue green algal blooms. The department is aware of two water supplies that detected Microcystin in their raw water sources. Analysis of finished water validated that water treatment removed toxins.

Then, within toxins, there are different strains. For example, under “microcystin” there are five toxic strains: microcystin-RR, -YR, -LR, and –RR. Different strains may dominate at different times during a bloom cycle, but microcystin-LR is known to be the most potent strain. There are two other not-well-known strains of microcystin.

Question: What is the best method to treat blue-green algae that is not harmful to any aquatic organisms in a body of water?

Remember, prevention is better than cure.

Once you have a blue-green algae bloom you've got to get rid of it, ideally with the stratification and aeration or chemical dosing of some description. Most of the chemical algicides come at some sort of cost to aquatic organisms – that’s what they do by design.

Ideally, you promote destratification so you can get the dam moving because once you get those stratified parts of the dam, that's highly favourable to algae.

So the best way would be to make sure your destratification is working and to get it moving to break up that surface stagnation if you can.

Make sure that you minimise the actual amount of nutrients that are coming into or contained in a water body - nitrogen and phosphorus are the two big ones. If you get the right conditions, nitrogen and phosphorus will feed algae and promote a bloom.

So we talk about things upstream, such as catchment management activities, fencing and exclusion of stock. We don't want cattle grazing right on the water's edge not only because of the cryptosporidium risk but also because it can actually have an impact with when it comes to nutrients getting into the waterways. The reduction of riparian zones also helps algae to flourish.

If you have an opportunity to, avoid using that water. And if it's the same water body, things like variable offtake, if you've got enough depth there to get down below an algal bloom and take water from the bottom, noting there might be other water quality changes that you have to watch out for.

It needs to be a local decision at the time. In some cases, continuing to operate a destratification system when you've got a fairly serious algae bloom could mix it up throughout the whole water column and not give you that option to have cleaner water from a lower level.

It's worth understanding what does that bloom look like in the water body, looking at all of your options for water sources and then decide on the best way forward at the time.

Question: What are the most common treatment steps requires to effectively manage blue-green algae risk?

Better catchment management, informed decision-making (ideal time) to pump river water into off-creek dams and riparian zone management are among the proactive methods. Less common methods, such as sonication (vibration) to destroy the gas vesicles in some cyanobacteria species are sometimes used. Laboratory and some pilot trials were encouraging, but sonicating large water bodies is cumbersome and expensive.

Reservoirs which undergo stratification can be artificially "destratified" with mechanical (rotors) or hydraulic (air bubbling or water circulation) means to avoid any anoxic conditions in the deeper layers. In the absence of oxygen in water, metals and nutrients at the reservoir bed can become soluble and available in the water column. Hence, ongoing mixing during spring and summer seasons may be beneficial in some reservoirs.

Ideally, in natural system, like dams and weirs, a wholistic approach considered for any on-reservoir treatment once the cells are there. Algaecides, despite all their known short and long-term impacts, are used in some states in Australia, as the last resort.

Question: We use the 2010 Water Research Australia/Water Directorate "blue-green algae action flow chart alert level framework for management of cyanobacteria in drinking water" for management of blue-green algae in water storages. Is the framework still best practice?

This is a reasonable starting point for developing a local algae response plan. But it's worth noting that analysis based on cell counts and observations are inherently uncertain and those numbers can be rubbery. You'll see that for most of the species that are mentioned in there, that emergency level is put in at 10 times or five times the major level, which is an assumption to say if you're getting cell counts in that order of magnitude, you've got a potential risk there with a rapid die off for high levels of toxin that could have an acute public health risk.

Sticking hard and fast to the numbers that are in the published guidance is probably not going to be the most helpful way to respond. You need a bit of flexibility in your response and a plan that looks at what do you know about the history of your water bodies, the speed at which blooms can grow and die off, what treatment processes have you got in your plant and your ability to respond generally might allow you to be a bit more cautious. In some cases, for example, if you don't have a treatment plant and you're just chlorinating water then your level of risk is going to get serious much lower down in the cell counts.

Genetic testing of algae for the presence of potentially toxin producing genes has come in over the past couple of years. Most of the advice that's been previously published was before that became an available analytical tool and so with that, laboratories are now able to test algae for the likelihood of whether it might produce toxins or not. Even field kits are now becoming available where you can do that locally, reasonably cheaply and quickly. It's worth having a closer look at your monitoring program and aligning monitoring with that level of risk as it escalates.

NSW Health advises that advice on monitoring and management can be provided by the regional algal coordinating committee.

Question: What is the most cost-effective method of reducing an active bloom in a water body?

Prevention is better than cure. If you can prevent it from happening, it's going to be better than management.

Using an alternative water source such as another dam, bore or separate catchment is probably the most cost-effective approach. An active algae bloom on a dam will subside naturally as the prevailing conditions change.
If you are forced to reduce the active bloom due to supply constraints, you can flush the dam, but that relies heavily on weather conditions, type of dam, and availability of water. If you are lucky enough to have one dam above another, you can let it flow down and lift the level of your lower dam so that it can flush off the top. Catchment management will help, especially if you reduce the amount of nutrient that you allow into the water.

If you are managing an off-stream storage you can regulate how that storage is filled. If you are pumping from an algal-affected creek or river, you pump in a way that minimises the amount of algae cells being transported to your off-stream storage (variable level, time of day, flow etc.).

Copper-based algaecides are another control measure we can apply. Any sort of copper-based algaecide, whether it's a slow or fast release, or natural or not, there will be some uncertainty in how it will respond to the water body. This can have some potential health risks associated when used in a drinking water supply. The cost of copper-based algaecides can also vary greatly depending on the product.

We know that chlorine in the treatment process can remove toxins at a certain level. Chlorine and copper-based algaecides remove an algal bloom by killing it. If those algae do contain toxins, a mass die off has the potential to increase the concentration of toxins in the water – leading to an increased health risk.

It's worth having a clear understanding of rate of die off and the potential risks of using any kind of algaecide on a live bloom where that's your only water source.
Speak with everyone you can and get really good advice.

Question: If you have 4-plus weeks in a row of no-detection results for toxic blue-green algae in a water source, would it be reasonable to reduce the frequency of analysis (specifically external lab analysis) to fortnightly intervals?

That sounds reasonable. It's up to you to develop a local plan that makes sense, but a lack of detections over a longer period of time, along with other conditions that you can notice aren't favouring a bloom that it might you might want to keep an eye on whether an inflows and temperature and other things like that as potential triggers to scale up or down your monitoring program.

It is best to have monitoring programs that respond to the risks and with long periods of low risk there's no need for continued regular testing.

It's definitely reasonable to have monitoring that scales up and down depending on what you're finding from your previous monitoring and not stick to a hard and fast rule about when you should and shouldn't do something.

Your plan needs to be flexible so it can scale up and scale down as a plume does through a season. They can go up, drop back down and then weather conditions change a bit and we go in a dry period or warmer period to come back up again. The testing that we do, it's not super accurate. You might have low medium cell count one week and it's just around the threshold of going to an extreme but bounces around a bit. So a plan needs to be adaptable and flexible. You definitely can have reduced monitoring of samples when things are going in the right direction, but if it's starting to change back up again, then you need to escalate back up again and your plan should cover all those aspects.

Question: How effective is Powdered Activated carbon (PAC) dosing?

PAC dosing is very effective and it's generally your first line of defence once you've got an algal bloom. It is a very effective chemical, even at a low dosages, but you may need to increase it quite a bit as the bloom unfolds.

There are limitations with PAC however, as a 30-minute contact time is required to maximise effectiveness. Sludge production, manual handling, dust and dosing issues are commonly associated with this product.

Older treatment plants were generally not designed to accommodate 30 minutes of PAC contact time. It may become necessary to dose PAC at the dam or extraction point, which can often be located remotely leading to increased operational costs. It is possible to dose it straight into the clarifier if a suitable dosing point is not available. This can significantly limit the effectiveness of PAC and can cause issues with sedimentation and filter clogging.

PAC is a black powder that is manufactured from wood, coconut or coal, each having different adsorptive properties. Your supplier will be able to assess your water quality and recommend the best type of carbon for you.

As always, you should jar test to make sure that you get the result that you're looking for and that carbon addition is compatible with your treatment plant. PAC dosages should be carefully monitored to ensure the applied dose is compatible with the treatment plant because you can shorten up your filter run times quite considerably with PAC. It's definitely an effective chemical and it's very good to use when you're dealing with blue-green algae.

The technical advisory team at the department are very happy to work with councils, trying to select treatment processes to make sure they're best designed for what you're trying to achieve.

Question: Can you explain a bit more about the role of diatoms and industrial applications of using diatoms to control blue-green algae?

Biomanipulation is one of the options to manage cyanobacteria. This process includes:

- Removal of cyanobacteria species through introduction of predators such as zooplanktons or certain aquatic fauna to feed on cyanobacteria

- Modification of fish assemblages to enable an environment suitable for predators of cyanobacteria to dominate
- Facilitation of growth of less-problematic green algae and diatoms to starve cyanobacteria by preferentially consuming nutrients from water, etc.

It has been proposed to introduce certain diatoms or certain micronutrients that preferentially in waterways in Australia to manipulate nutrient dynamics, and to manage diatoms through fish. A study undertaken by WaterNSW (Rolhlfs et al., 2012) indicates that tests with an additive to encourage diatoms had no statistically significant effect on cyanobacterial growth or water quality parameters in the laboratory trial. This additive intended for use in water where there is excess of nitrogen and phosphorus relative to micronutrients.

Any biomanipulation of natural systems should be approached with utmost care in any natural systems. Water quality and ecosystems in rivers, ponds and dams are highly variable and any such processes should not be attempted without extensive consultation.

Further helpful information: Rohlfs, Davie and Pera (2012) Alternative cyanobacteria management approaches. Water eJournal,

Question: Are the regulators considering supporting, exploring or trialling emerging technologies to combat algae growth such as enzyme technology?

Biomanipulation has been presented as a potential option for cyanobacteria management.

The intention is to preferentially facilitate diatoms to proliferate in the freshwater over cyanobacteria, and let the aquatic fauna consume diatoms. Trialling (in a pilot or microcosm) and exploring, with experts in the field, is encouraged.

The introduction of zooplanktons and certain enzymes has also been discussed as a biomanipulation option.

Biomanipulation options are very subjective and their success is not consistent in a dynamic natural system. These options need to be considered carefully and a robust collaboration with the department and NSW Health is strongly advised.

Question: Is species cell count or species biovolume a better indicator of algae levels? What should be done in cases where we suspect we may have identified a potentially toxic strain of a previously non-toxic species?

Cell count data on their own are not always reliable as indicators of blue-green algal biomass and potential risk to water users, because the cell sizes of different species of blue-green algae vary widely from each other and there is also considerable intra-species cell size variability in many species. Converting cell counts to a biovolume for each taxa present in a sample and then summing these to obtain a total blue-green algae biovolume estimate provides an alternative measure for management use that is independent of the size differences between taxa. Reference: *Water NSW Guidelines to management response to freshwater, marine and estuarine harmful algal blooms.*

But total biovolume is an indicator for an unpleasant situation in the waterbody. The Australian Drinking Water Guidelines provide guidance on toxins associated with blue-green algae and the species of blue-green algae they are associated within an Australian context.

In an event, a potentially toxic species of blue-green algae may be present. All blooms of potentially toxic algal species must be assumed to be toxic until proven otherwise. Toxicity testing will determine if that particular bloom is producing toxin. Over time, a bloom can become toxic so it is important to regularly resample.

There are reliable methods now to detect potential presence of toxin producing genes in an algae – cyanobacteria population. Once there is a bloom, monitoring and analyses of data in terms of cells counts, biovolumes and toxin-producing genes should continue until the utility (and the department and NSW Health) is satisfied that the bloom is no longer toxic.

A Blue-Green Algae Response Plan should consider alert levels (either associated with biovolumes or cell counts) and should consider frequency of toxin testing based on alert level. A good Blue-Green Algae Response Plan will also highlight the appropriate barriers/CCPs for managing water treatment (cell removal and/or toxin destruction) and additional treatment specific to an algal event (such as PAC dosing). A plan may require additional emphasis (monitoring of performance) on those treatment steps which manage cell removal and/or toxin destruction.

Question: We are in about to have a process chosen for the WTP augmentation. The suggested technologies for removing blue-green algae by consultant is suggested is: BCA (biological activated carbon) and UV, GAC, or AOP like ozone /BAC. Given that we're in a cold climate area, which one is best for us?

This question appears to be about toxin removal, not cell removal. Most of those proposed technologies can be optimised to work in cold conditions as well. However, a proper response could be provided with more details on cell populations, variations, potential to produce toxins, other treatment unit process in the train, etc. The department can review the concept design.

Question: In the algae bloom, should we stop using the supernatant (backwash water) coming back to head of the works and reuse the water again?

Ideally, yes. Cell population may be low in the raw water. Modern plants endeavour to remove the cells without rupturing them. Hence all cells will be accumulated in the sludge from clarifiers, DAF, membrane filters and granular media filers. These cells may rupture in the presence of chemicals and with silt and clay. Hence, the supernatant may have elevated level of toxins. Ideally, keep this "toxin cocktail" away from the treatment train.

Question: If a LWU storage has had a number of blooms, is it worthwhile to install a cheaper aeration system in the storage - to turn it on and change the conditions during an algal bloom to strengthen other factors that could limit the algae organisms?

Aeration, or air bubbling, means dissolving air to the water column. Air bubbling is done to hydraulically mix the water column and high oxygenated water from the top surface is mixed with the anoxic bottom layer. This is relevant for reservoirs that are deeper than 18m (or so), which undergo stratification. "Cheaper aeration system" is an option only if it is effective.

Mixing the water column in the presence of an active bloom is not known to change the conditions to reduce the strength of an algal bloom. Each option needs to be reviewed case-by-case.

Question: If there becomes a need to treat the algae in the storage when there are no other options, does anyone have experience using copper-based algaecides? This is an alternative to using copper sulphate using 100% bioactive copper?

Source water treatment with a copper-based algaecide was proposed for a cyanobacterial bloom in an event earlier this year, but potential ecological issues with using it in a natural water body indicated it was unlikely to be approved for use by the Environment Protection Authority so it was not pursued further.

Use of algaecides is not encouraged as cell destruction may lead to other problem such as the release of toxins into the water body. Prevention through good catchment management, water extraction (to avoid high nutrient periods) and optimisation of water treatment such as PAC dosing, filtration, and chlorine disinfection for chlorine sensitive toxins or ozonisation as examples are recommended.

Question: Is there a list of laboratories that test for cyanobacteria (blue-green algae)?

Scientific laboratories offer services for cyanobacteria identification, cell counts and biovolumes, and for analysis of water for the presence of cyanobacteria toxins.

NATA is an Australian organisation that provides accreditation to laboratories to provide quality laboratory services. Accredited laboratories can be found by searching the NATA website - Search accredited organisations - NATA

The laboratories below offer services to NSW water utilities and were listed as NATA accredited on 30 May 2024.

NATA accredited laboratories for cyanobacteria identification, cell counts and biovolumes

Water utility laboratories:

- Port Macquarie Hastings Council - Port Macquarie Hastings Environmental Laboratory
- Tweed Shire Council - Tweed Laboratory Centre
- Sydney Water Laboratory Services
- Queensland Urban Utilities – Scientific Analytical Services Laboratory

Private laboratories:

- ALS Environmental – Newcastle Biology Laboratory, Sydney Biology Laboratory, Fyshwick Biology Laboratory, Brisbane Biology Laboratory
- Australian Water Quality Centre (AWQC) – Adelaide Laboratory – Microbiology and Biology
- Symbio Laboratories – Brisbane Microbiology Laboratory

NATA accredited laboratories for cyanobacteria toxin testing

Water utility laboratories:

- NSW Health Forensic & Analytical Science Service (FASS)
- Sydney Water Laboratory Services

Private laboratories:

- ALS Environmental – Newcastle Biology Laboratory, Sydney Chemistry Laboratory
- Symbio Laboratories – Brisbane Chemistry Laboratory

Australian Water Quality Centre (AWQC) – Adelaide Laboratory - Chemistry