

Blue-Green Algae in Recreational Water Management Strategy

This management strategy replaces the *ACT Guidelines for the Management of Blue-Green Algae in Recreational Water*. This management strategy has been developed based on the recommendations of the National Health and Medical Research Council's *Guidelines for Managing Risks in Recreational Water (2008)*.

1.0 Introduction

Cyanobacteria, commonly referred to as blue-green algae, are found in all waters and form part of the phytoplankton and the benthos. Naturally-occurring low levels of blue-green algae are of benefit due to their nitrogen fixing capabilities. However, in excessive numbers (blooms) blue-green algae cause problems by giving rise to odours and taints, or by producing toxins.

The predominant species of blue-green algae found in the ACT's lakes and rivers are *Microcystis spp.* and *Anabaena spp.*

During certain times of the year the occurrence of *Tychonema bornetti* is predominant. This species is benthic and will only grow attached to objects such as sand, rocks and possibly ribbon weed. During the process of photosynthesis, oxygen bubbles can become trapped in the benthic mats, causing them to float to the surface where they die, releasing toxins into the water.

2.0 Scope

This paper outlines a management strategy for recreational waters in the ACT in the event of algal blooms. The management strategy provides a uniform approach for all managers of ACT waterways to ensure consistency and increase public understanding of the blue-green algal risk.

The approach outlined in this paper is based on a preventive, risk-management approach and will provide guidance on free floating blue-green algae, as well as the benthic *Tychonema sp.*

3.0 Health Effects

3.1 Exposure

There are three potential routes of exposure to blue-green algal toxins:

- direct contact with exposed parts of the body, including sensitive areas such as the ears, eyes, mouth, nose and throat;
- accidental swallowing; and
- inhalation of water.

Reactions are unpredictable as certain individuals are more sensitive to algal exposure or may have underlying medical conditions that increase their reaction. The risks associated with blue-green algae also vary depending on length and type of contact.

Important toxin exposure routes during water contact sports include accidental swallowing, contact with nasal mucosa and inhalation. There have been reported cases of people becoming sick after exposure via inhalation and absorption through nasal and pharyngeal mucous membranes in water sports involving submersion of the head (jumping from diving boards, sail boarding, canoe capsizing, and swimming) and inhalation of aerosols (water skiing).

The greatest risk to recreational users is posed by algal surface scums. These are concentrated accumulations of blue-green algae which tend to settle along shorelines, where recreational users are likely to come in contact with them as they enter the water.

Primary contact recreation

This involves whole-body contact in which the entire body or the face and trunk are frequently immersed or the face is frequently wet by spray, and where it is likely that some water will be swallowed, inhaled, or come into contact with ears, nasal passages, mucous membranes or cuts in the skin (e.g. swimming, diving, waterskiing, windsurfing, white-water canoeing).

Secondary-contact recreation

This may involve incidental contact in which only the limbs are regularly wet and in which greater contact is unusual (e.g. boating, fishing, canoeing, rowing). There may be occasional and inadvertent immersion through accidents (e.g. slipping into water).

3.2 Toxins

Blue-green algae can produce three types of toxins, each with different modes of action.

Hepatotoxins

These are the most common of the blue-green algal toxins. They attack the liver and other internal organs. They may also cause visual disturbances, gastroenteritis, nausea, vomiting and muscle weakness. They are slower acting than neurotoxins. They can be produced by such species as *Anabaena*, *Cylindrospermopsis*, *Microcystis*, *Nodularia*, and *Oscillatoria*.

Neurotoxins

These act as neuromuscular blocking agents. They produce death by paralysis of peripheral skeletal muscles, then respiratory muscles, leading to respiratory arrest. Neurotoxins are produced by species of *Anabaena*, *Aphanizomenon*, *Nostoc* and *Oscillatoria*.

Endotoxins

The outer walls of all blue-green algae contain lipopolysaccharides. These are mainly contact irritants and can cause severe dermatitis and conjunctivitis in people coming into contact with the algae through swimming or water spray. They may also cause stomach cramps, nausea, fever and headaches. If swallowed, they may also cause irritation to airways and breathing difficulties.

There have been many reported cases of adverse health events for recreationists exposed to blue-green algae blooms. The symptoms include itchy contact dermatitis, hay fever like symptoms, conjunctivitis and asthma. Gastroenteritis may result from accidentally ingesting the water.

3.3 Potential Toxicity of Blue-Green Algae Species

This list below is to provide an *indication* of potential toxicity of certain genera. This list is not complete and provides an *indication only* of the potential toxicity, and hence potential risk, to recreational users of contaminated water.

High Risk	Potential Risk	Lower Risk
<i>Microcystis sp</i>	<i>Aphanizomenon sp.</i>	<i>Cyanodictyon sp.</i>
<i>Anabaena sp.</i>	<i>Planktothrix sp.</i>	<i>Aphanocapsa sp.</i>
	<i>Pseudoanabaena sp.</i>	<i>Chroococcus sp.</i>
	<i>Phormidium sp.</i>	

4.0 Management

4.1 Biovolume

Biovolume is the measure of space occupied by the algae. It is used as a quantitative measure of the volume of algae cell material in the sample.

The size of cells can vary within and between algae species. Toxin concentration relates more closely to the amount of dry matter in a sample than the number of algal cells. Therefore, biovolume has been included in the assessment process to account for mixed species or small algal cells in water samples.

Cell counts should be used as the primary source for determining risks from recreational activities. The biovolume should be used for determining the risks associated with mixed species where a known toxin producer is dominant or small algae such as *Aphanocapsa spp.*, *Aphanothece spp.*, *Cyanodictyon spp.*, *Chroococcus spp.*, or *Radiocystis spp.* are dominant.

4.2 Inspections and Observations

If visual inspections detect changes (e.g. colour of water, appearance of surface scums), cell counts and species identification should be undertaken to determine the suitability of the water for recreational activities. Water samples are to be taken from the swimming areas of the relevant lakes.

If identification reveals that the blue-green algae are dominated by small species, biovolume should be determined to provide additional data in assessing the suitability of the water body for recreational use.

4.3 Toxicity Testing

Research has shown that toxin production varies during a bloom and that a bloom may be toxic one week and not toxic the next. There are a large number of toxins produced and current toxicity testing only identifies a few. In addition, there is no way to accurately forecast what level of toxins will be produced in coming days or weeks. Based on the uncertainty from the testing and delay in receiving results, there is very little benefit to toxicity testing of recreational water from a public health perspective.

5.0 Blue-Green Algae Action Plan

Alert level	Blue-green algae cells/ml*	Biovolume equivalent*	Monitoring requirements	Typical actions (NCA [^] , EPA ^{^^} or ACT Health)
Low	>500 to <5,000	>0.04 to <0.4 mm ³ /L.	Weekly visual inspections.	<u>NCA/EPA</u> : Maintain routine monitoring.
Medium	≥5, 000 to <50,000 >20,000	≥0.4 to < 4 mm ³ /L >1.6 mm ³ /L	Increase to twice weekly visual inspections & take water samples as required.	<u>NCA/EPA</u> : Increase visual inspections and sampling for algal counts. <u>NCA/EPA</u> : If > 20,000 cells/mL, advise ACT Health &, following advice from ACT Health, post on-site warning signs to indicate increased risks for skin irritations, gastrointestinal illness. <u>NCA/EPA</u> : Issue Media release to public and lake users.
High	≥50,000 to ≤125, 000	≥4 mm ³ /L to <10 mm ³ /L	Maintain twice weekly visual inspections and take water samples as required.	<u>NCA/EPA</u> : Maintain increased visual inspections. Regular algal counts. <u>NCA/EPA</u> : Advise ACT Health. <u>NCA/EPA</u> : Advise public that water, or part thereof, is closed for primary contact users following advice from ACT Health. <u>NCA/EPA</u> : Issue Media release to public and lake users to indicate lake closed from primary contact use. <u>NCA/EPA</u> : Change lake warning signs to indicate lake closed for primary contact use.
Extreme	≥125,000 or scums are consistently present** (40,000 cells/mL <i>Anabaena</i> sp.)	≥10 mm ³ /L	Maintain twice weekly visual inspections and take water samples as required.	<u>NCA/EPA</u> : Advise ACT Health. <u>NCA/EPA</u> : Advise public that contact with water, or part thereof, poses an increased level of risk for secondary contact users following advice from ACT Health. The risks associated with secondary contact use at this alert level may be reduced provided that: <ul style="list-style-type: none"> • users are experienced; • users understand the algae risk and what to do if contact occurs; • users do not engage in primary-contact; and • showers, with suitable water, are available after recreation. <u>NCA/EPA</u> : Issue Media release to public and lake users.

* Figures refer to *Microcystis aeruginosa* only.

** Persistent scums are scums that are seen at some time each day at the recreational site.

[^] National Capital Authority (NCA) – Commonwealth department responsible for Lake Burley Griffin.

^{^^} Environment Protection Authority (EPA) – ACT Government unit responsible for ACT waters.

5.1 Decreasing Alert Levels over Time

Reductions in alert levels from a higher to a lower level should not occur until the results from two consecutive samples have recorded lower counts and anticipated environmental conditions (e.g. temperature etc) are not conducive to facilitating a rapid increase in blue-green algae populations.

5.2 *Tychonema* sp. Action Plan

The advice to the public on the blue-green algae *Tychonema* sp. is based on visual site inspections and the detection of benthic growth or in worst-case situations floating clumps of *Tychonema*.

Alert level	Inspection	Monitoring requirements	Typical actions
Low	No obvious benthic growth	Weekly visual inspections.	Maintain routine monitoring.
Medium	Benthic growth observed	Twice weekly visual inspections.	Maintain visual inspections and indicate risk on permanent warning signs.
High	Obvious benthic growth and floating mats	Maintain twice weekly visual inspections and take a water sample to confirm the identity of the algae.	After advice from ACT Health, close affected area of the lake to primary contact recreation. Change warning signs to reflect this closure.

5.3 Lake Burley Griffin Captain Cook Memorial Jet Action Plan

The jet fountain shoots water approximately 100 metres above the lake. Winds can create fine mists and cause it to travel to areas around the lake. This may expose the public to algae during an algal bloom through direct contact with, or inhalation of, the mist.

Blue-green algae cells/mL	Biovolume equivalent	Typical actions
≥50,000	≥4 mm ³ /L	Turn off water jet

6.0 Agency Responsibilities

ACT lakes are inspected weekly to detect visual changes in water quality. The inspection results are updated and made available on the National Capital Authority (NCA) and Department of the Environment Climate Change, Energy and Water (DECCEW) web sites. If algae are assessed to be at significant levels in any of the lakes, water samples are taken to determine the blue-green algal count.

The Health Protection Service (HPS) of ACT Health assesses information provided by the NCA for Lake Burley Griffin and/or the Environment Protection Authority (EPA) (part of DECCEW) for Lake Tuggeranong, Ginninderra, Yerribi, Gungahlin, Point Hut Pond and Molonglo River. The HPS then provides advice on the course of action e.g. changing of warning signs or lake closures.

The HPS also provides advice on the health effects of algae, including routes of exposure, toxicity of the various species and exposure symptoms.

7.0 Advice from ACT Health

The collection of samples and availability of results is critical when providing advice to recreational users on the health risks and possible closures of a water body.

To provide timely advice to event organisers for weekend events, ACT Health requires the results from samples by 10.00 am on Thursdays.

Reductions in alert levels from a higher to a lower level require two consecutive samples to have recorded lower counts. For example, samples should be taken on Monday and Wednesday to provide information by 10.00 am Thursday.

8.0 Warning Signs

Permanent warning signs are to be present at high-traffic water entry areas. These warning signs are to be changeable to indicate the current risk posed by blue-green algae. The EPA is responsible for changing the warning signs at the waters they manage in response to changes in blue-green algae risk levels.

The NCA will be responsible for changing warning signs at LBG in response to changes in blue-green algae risk levels.

9.0 Media

The NCA and DECCEW, in consultation with ACT Health, will issue media releases for Medium, High and Extreme blue-green algae alert levels. They will also advise key stakeholders of changes in these alert levels.

Key points for media messages when blue-green algae counts reach $\geq 20,000$ cells/ml or biovolume is ≥ 1.6 mm³/L) include:

- that some susceptible individuals may experience skin irritations, hay fever-like symptoms or flu-like symptoms after contact with affected water;
- that water users should shower after water contact and avoid submersion; and
- that water users should look for algae warnings signs indicating the current alert level at major water entry points.

Key points for media messages when blue-green algae counts reach the High alert level (algae counts are $\geq 50,000$ cells/ml or biovolume is ≥ 4 mm³/L) include:

- that there is an increased risk of adverse health events from water exposure;
- that symptoms of exposure may include skin/mucosa irritation, flu-like symptoms, and gastrointestinal illness;
- that the affected water is closed to primary contact recreation (including swimming, diving, water skiing and windsurfing);
- that persons engaged in secondary contact recreation should be careful to limit any water exposure;
- that water users should shower after water contact;
- that event organisers should ensure that participants are aware of the blue-green algae alert level, associated exposure risks and provide adequate showering facilities for after events; and
- that water users should look for algae warnings signs indicating the current alert level at major water entry points.

Key points for media messages when blue-green algae counts reach the Extreme alert level (algae counts are $\geq 125,000$ cells/ml, scums are persistent, or biovolume is ≥ 10 mm³/L) include:

- a reiteration that waters, or part thereof, are closed to primary contact recreation (including swimming, diving, water skiing and windsurfing);
- that there is an increased risk of adverse health events from water exposure for secondary contact recreation;
- that symptoms of exposure may include skin/mucosa irritation, flu-like symptoms, and gastrointestinal illness;
- that people should not engage in secondary contact recreation unless:
 - they are experienced;
 - they are informed of the algal risks and what to do if contact occurs;
 - they do not engage in primary-contact during the recreation; and
 - showering facilities, with suitable water, are available for washing after the recreation;
- that event organisers should ensure that participants are aware of the blue-green algae alert level, associated exposure risks and provide adequate showering facilities for after events; and
- that water users should look for algae warnings signs indicating the current alert level at major water entry points.

10.0 Contacts

Health Protection Service

ACT Health
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 Weston Creek ACT 2611

Phone: 6205 1700

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Environment Protection Authority

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 GPO Box 158
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