



Government of **Western Australia**
Department of **Health**

Constructed feature lakes – health issues, guidance and management

health.wa.gov.au

Constructed Feature Lakes - Background

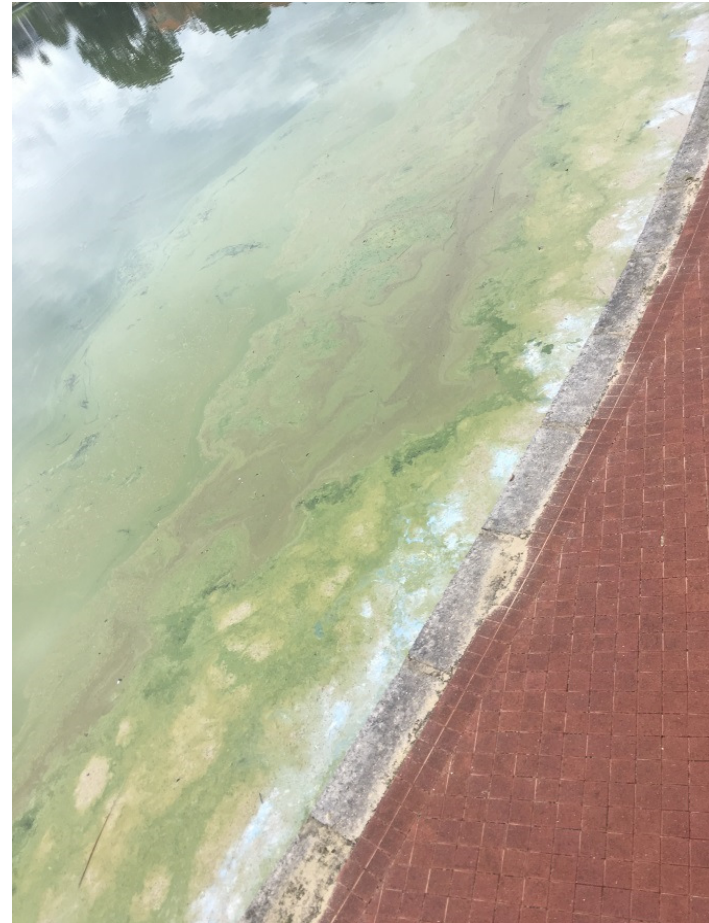
- Highly modified “natural” wetlands
- Expn. sgnf. drying last 30 years
- Created in residential estates
- Sgnf. visitation/passive rec. e.g.
 - walking, cycling & adjacent parkland recreation.
- Generally no direct water contact
- Primarily **incidental** contact/risks
- Oft. utilised for parkland irrigation



Image: Ridgewood Lake – Courtesy of City of Wanneroo

Health Issues/Concerns

- Stagnant water – inadequate/ lack of aerator/ fountain operation
- Dis-coloured water - brown/green
- **Algal scum**
- Odour impacts
- **Aerosols - respiratory effects**
- Acts as local stormwater sump
- Subject to **wastewater** overflows
- Sediment condition
- Impact upon residential amenity (restricts opening windows, recreation etc.)
- Use for **irrigation** purposes – **skin contact** etc.



Cyanobacteria/ Blue-green Algae (BGA) Risk

- Most const. lakes likely to have sgnf. BGA issues.
- Few local government authorities have:
 - Investigated their lakes/wetlands for BGA
 - Regular/routine BGA monitoring programs/plans.
- Nature & sgnf. of risk of exposure sources, cyanobacteria & cyanotoxins - poorly understood.
- Little known about BGA toxins in Perth lakes.
- Climate change forecast – situation will get worse

Note: Water Research Australia - Health Stream – July 2018 –
'Cyanobacteria and Climate Change'

Why is BGA a problem?

- BGA impacts water quality
- Some species - toxins - harmful to people & animals.
- Algae & assoc. toxins may be present in lakes w/out being visible.
- Can be mixed in the water column, or produce a smelly, thick scum on water surface.
- Not all blooms are toxic, but in the interest of public health & safety should be treated as toxic until tested.
- Algal blooms may occur every year with varying severity & can persist for weeks, months or even an entire season if the right conditions exist.

Types of BGA Toxins/Health Effects

- **microcystins, nodularins, cylindrospermopsin, anatoxins & saxitoxins**
- Pot. neurotoxic effects of non-encoded amino acid **BMAA** (β - *N*-methylamino- l-alanine) - some BGA:
 - postulated in human neurodegenerative diseases (e.g. Parkinsons disease).
- **Lipopolysaccharides (LPS)** - cyanobacterial cell wall:
 - skin irritation on contact & GI symptoms if ingested.

Note: Dermal irritation is side of things according to literature & public health experts - generally self limiting in nature.

 - Secondary recreation focus is more on inhalation risks.

General features of cyanotoxins

Toxin group ^a	Primary target organ in mammals	Cyanobacterial genera ^b
Cyclic peptides		
Microcystins	Liver	Microcystis, Anabaena, Planktothrix (Oscillatoria), Nostoc, Hapalosiphon, Anabaenopsis
Nodularin	Liver	Nodularia, Anabaena, Planktothrix (Oscillatoria), Aphanizomenon
Alkaloids		
Saxitoxins	Nerve axons	Anabaena, Aphanizomenon, Lyngbya, Cylindrospermopsis
Anatoxin-a	Nerve synapse	Anabaena, Planktothrix (Oscillatoria), Aphanizomenon
Anatoxin-a(s)	Nerve synapse	Anabaena
Aplysiatoxins	Skin	Lyngbya, Schizothrix, Planktothrix (Oscillatoria)
Cylindrospermopsin	Liver	Cylindrospermopsis, Aphanizomenon, Umezakia, Raphidiopsis, Anabaena
Lyngbyatoxin-a	Skin, gastrointestinal tract	Lyngbya, Schizothrix, Planktothrix (Oscillatoria)
Lipopolysaccharides (LPSs)	Potential irritant; affects any exposed tissue	All

a Many structural variants are known for each structural group

b This is a compilation of worldwide information, and the toxins are not produced by all species of the particular genus.

Source: Sivanen and Jones (1999)

Source: NHMRC (2008) Table 6.1 General features of the cyanotoxins (pg 93)

BGA Potential Health Issue: LPS - Skin Irritation

- Cyanobacteria: gram -ve bacteria, produce **LPS**
- LPS known to elicit irritant & allergenic responses in humans & animal tissues.
- Skin irritation (inc. eyes, nose & throat) via aerosols/spray-type irrigation.
- Cyanobacterial LPS - thought to be less potent (weakly toxic) than pathogenic gram -ve bacteria.
- Cyanobacterial LPS unlikely to initiate skin reactions in healthy people who may become exposed.

Source – National Health and Medical Research Council, 2008,
'Guidelines for Managing Risks in Recreational Water'

Questions to understand BGA risk?

- What is happening in the lakes/wetlands?
- What are the pot. toxin producers & toxin conc risk?
- When are the high & low risk periods?
- When should or should not lake water be used for irrigation? or under what conditions?

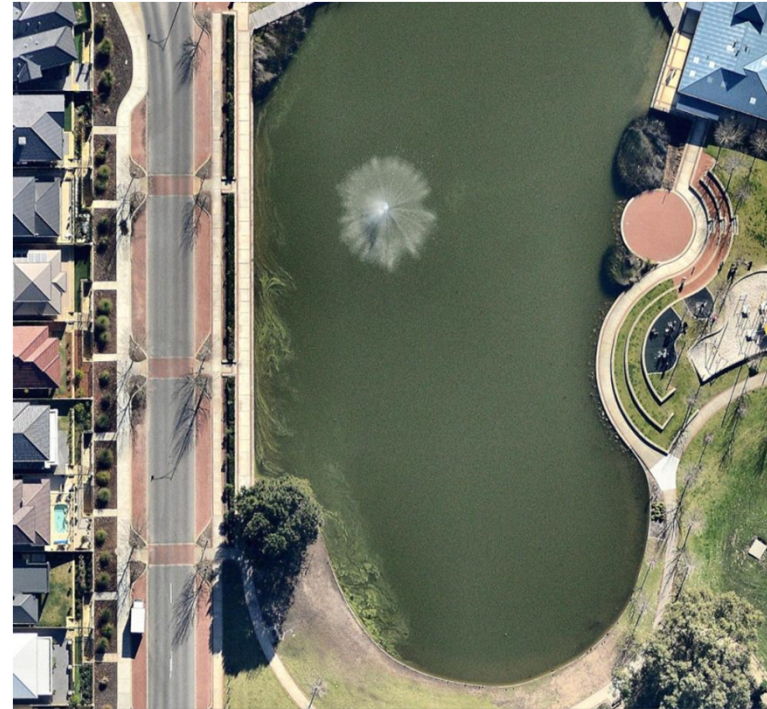


Image: Beeliar Constructed Lake –
Courtesy of City of Cockburn



Reported Blue-Green Algal Blooms in Constructed Lakes 2014 to 2018

Notification Date	Water Body Name	Suburb	LGA District(s)	Sample Date	Class/Genus/Species/Toxins	Cell counts (cells/mL)	Biovolume (mm ³ /L)	Bvlme Exceed Factor	Warn Signs	Media Y/N
24/05/2016	Lake Eyre	Middleton Beach	Albany	20/05/2016	<i>Microcystis flos-aquae</i>	114,130	2.51	0.6	Yes	No
24/05/2016	Lake Eyre	Middleton Beach	Albany	20/05/2016	<i>Microcystis</i> spp.	43,430	3.78	0.9	Yes	No
12/09/2014	Brickworks Lake	Maylands	Bayswater	26/02/2015	<i>Oscillatoria</i> spp.	7,272	31.09	3.1	Yes	Yes
22/09/2014	Lake Brearly	Maylands	Bayswater	22/09/2014	<i>Microcystis</i> spp.	958,187	83.36	20.8	Yes	Yes
18/06/2018	Lake Brearly	Maylands	Bayswater		cyanobacteria			0.0	Yes	Yes
12/09/2014	Lake Bungana	Maylands	Bayswater	3/09/2014	<i>Limnothrix</i> spp.	1,045,532	12.55	3.1	Yes	Yes
12/09/2014	Lake Bungana	Maylands	Bayswater	22/09/2014	<i>Microcystis</i> spp.	185,537	16.14	4.0	Yes	Yes
12/09/2014	Lake Bungana	Maylands	Bayswater	26/02/2015	<i>Cylindrospermopsis raciborskii</i>	2,750,028	115.50	28.9	Yes	Yes
15/08/2017	Beeliar Lake	Beeliar	Cockburn	10/08/2017	<i>Cylindrospermopsis raciborskii</i>	2,040,200	85.69	21.4	Yes	Yes
15/08/2017	Beeliar Lake	Beeliar	Cockburn	24/01/2018	cyanobacteria, cylindrospermopsin, saxitoxin				Yes	Yes
24/01/2018	Beaumont Lake	Success	Cockburn	24/01/2018	cyanobacteria, microcystin/nodularin, cylindrospermopsin, saxitoxin				?	
24/01/2018	Harmony Lake	Atwell	Cockburn	24/01/2018	cyanobacteria, cylindrospermopsin, saxitoxin				?	
9/11/2016	Alexandria Blvd Reserve Lake	Canning Vale	Gosnells	12/12/2016	<i>Microcystis</i> spp.	74,000	6.44	1.6	Yes	No
31/10/2016	Cadoux Reserve Lake	Canning Vale	Gosnells	12/12/2016	<i>Microcystis</i> spp.	1,100,000	72.00	18.0	Yes	No
7/05/2018	Blue Gum Lake	Booragoon	Melville	4/05/2018	<i>Microcystis aeruginosa</i>			0.0	Yes	No
7/08/2018	Blue Gum Lake	Booragoon	Melville	2/08/2018	<i>Microcystis aeruginosa</i>	107,396	9.34	2.3	Yes	No
2/03/2018	Lake McDougal	Como	South Perth	31/01/2018	<i>Dolichospermum circinale</i>	579,740	144.94	36.2	Yes	Yes
2/03/2018	Lake Hurlingham	South Perth	South Perth	31/01/2018	<i>Dolichospermum spiroides</i>	1,593,780	398.45	39.8	Yes	Yes
28/02/2018	Egerton Park Lake	Aveley	Swan	23/01/2018	<i>Dolichospermum sigmaideum</i>	39,030		0.0	?	No
26/02/2015	Sherlock Lake	Jane Brook	Swan	25/02/2015	cyanobacteria			0.0	Yes	No

BGA Blooms in Constructed Lakes

**Egerton Lake West - 20/04/2012 – possibly
Microcystis sp. &/or *Dichlostermium sp.*
Image - Courtesy of City of Swan**



**Egerton Lake West – 10/06/2014 – possibly
Microcystis sp. - Image courtesy of City of
Swan**



BGA toxin factors

- Not all strains of pot. toxic BGA carry **genes** reqd for toxin prod
- Factors which trigger toxin prod. - not well understood
- BGA blooms often contain a mixture of toxin producing & non-producing strains - proportions can vary over bloom duration.
- Toxin prod. is strain dominant:
 - millions of cells may produce no toxin
 - A few thousand cells may produce large quantity of toxin
- Toxin conc's. in small shallow systs. persist weeks - months depending upon bloom severity
- Not possible to reliably predict if bloom includes toxin-capable strains will produce toxin or how much may be produced.

Water Analysis for BGA Toxins

- **Disadvantages**

- Local lab's don't undertake toxin analysis (add **time, cost**)

- **Advantages:**

- Pot. reduce water sampling - triggered by high biovolume.
- Reduced analysis & human resource time.
- Eastern States lab's – undertake quantitative toxin tests:
 - Liquid chromatography–mass spectrometry

Note: Symbio Laboratories - Perth receival facility, BGA toxin analysis undertaken in Brisbane:

- Analyse 5 main toxins & sev. sub species (LR, RR, YR etc.).

- **Alternative** potential toxin analysis:

- Rapid test kits (qualitative & quantitative) - interim management tool (accuracy?)

Rationale for BGA Toxins Analysis

- Green water is not aesthetically pleasing
 - May not be as much of a public health risk
 - e.g. absence of toxins when toxins have been tested.

Note: Seqwater - pioneered Australia's first program focused on managing waterways for **cyanotoxins**, rather than proxy indicators.

<http://www.seqwater.com.au/recreation/blue-green-algae-and-recreation>

Seqwater BGA Toxin Monitoring

- Analyse amount of toxins dissolved in water.
- Toxin conc. primary indicator for health risks.
- Presence of scum - priority over cyanotoxins.
 - i.e. when scum risk id. is medium or low.
- Toxin prod. vary week to week during bloom
 - dominant sp., cell death & toxin release.

Seqwater Recreational Toxin Trigger Values

Recreational toxin triggers					
Cyanotoxin	Unit	Low level	Medium level	High level	Extreme level
Microcystin	ug L ⁻¹	< 3	≥ 3	≥ 10	≥ 25
Saxitoxin	ug L ⁻¹	< 9	≥ 9	≥ 30	≥ 75
Cylindrospermopsin	ug L ⁻¹	< 3	≥ 3	≥ 10	≥ 25
Nodularin	ug L ⁻¹	< 4	≥ 4	≥ 13	≥ 30
Anatoxin-a	ug L ⁻¹	< 3	≥ 3	≥ 10	≥ 25

Note: ug L⁻¹ = micrograms per litre. Toxin concentration in the lake is measured in units, by the amount of toxins (microgram) per volume of water (litre).

- **High Level** = Lake closed for primary contact (in-water) recreation.
- **Extreme Level (EL)** = Advisory notice issued for secondary contact (on-water) recreation.

Note: EL: Weekly toxin tests. Advisory lifted when two consec. water quality test results w/in acceptable limits.



NHMRC, 2008, Freshwater Guideline Levels for Cyanobacteria in Recreational Waters

Organism/ Toxin	Level 1 - Surveillance	Level 2 - Alert Mode - Caution	Level 3 - Action Mode
cyanobacteria		Biovolume ≥ 0.4 to <4 mm ³ /L combined total (known toxin producer dominant)	Biovolume ≥ 4 mm ³ /L combined total (known toxin producer dominant)
cyanobacteria	Biovolume ≥ 0.04 to <0.4 mm ³ /L combined total	Biovolume ≥ 0.4 to <10 mm ³ /L combined total	≥ 10 mm ³ /L total biovolume
cyanobacteria			scums consistently present
microcystins			≥ 10 µg/L total
<i>Microcystis aeruginosa</i>	≥ 500 to <5000 cells/mL	$\geq 5,000$ to $<50,000$ cells/mL	$\geq 50,000$ cells/mL toxic

Recreational Water Primary Contact Trigger Levels - Cyanobacteria

- Over conservative for typical lake/ irrigation exposure:
 - incidental contact (cont. land surface),
 - inhalation of droplets/aerosolised toxins etc.
- Current Gap – known toxin producers present but not dominant (>75% of tot cyanobacteria biovolume).
- Recommend risk approach to interpreting NHMRC Guidelines based on likely means of exposure etc.
- Any new trigger levels – ideally evidenced based/ scientific validation (this data is not likely available).
- Cell counts in interim – may still be informative



Potentially harmful microorganisms - in sewage affected constructed feature/ irrigation lakes

Organism Category	Organism	Species	Disease/Illness	Infected Body Area	Transmission/ Method Aquired
Bacteria	Aeromonas	hydrophilia	gastroenteritis, skin infections	GI, skin	break in skin - can lead to infected wounds
	Leptospira	spp.	Leptosporosis	skin, eyes	skin contact with contam. water (animal urine) - in warmer regions
	Mycobacterium	ulcerans	haemorrhage	skin	cont. water, soil, veget., aerosols , in disease areas (not in WA)
	Pseudomonas	aeruginosa		skin	freshwater - warm conditions
	Salmonella	spp.	skin ulcers	GI, skin	swimming freshwater exposed wounds, cuts
	Shigella	spp.		GI	touching cont. surfaces - faecal-oral route
	Staphylococcus	aureus		skin	touching cont. surfaces - faecal-oral route
Helminths	(C) Cestodes		GI + anaemia	skin	skin penetration
	(N) Ancylostoma	duodenale		skin	walking barefoot , ingestion of larvae
	(N) Enterobius	vermicularis	GI + anaemia	skin	skin penetration
	(N) Necator	americanus	GI - diarrhoea, abdom. pain, cognitive develop. & stunt growth	skin	walking barefoot
Viruses	Adenoviruses		respiratory disease, gastroenteritis	respiratory	touching cont. surfaces - faecal oral route , mouth, nose, eyes
	Coxsackie				touching cont. surfaces - faecal oral route mouth, nose
	Hepatitis	E			touching cont. surfaces - faecal oral route
	Hepatitis	A	Hepatitis A		touching cont. surfaces - faecal oral route (survive in environ. /on hands for several hrs)
	Noroviruses		diarrhoea, vomiting		touching cont. surfaces - faecal oral route , airborne?
	Polioviruses		Poliomyelitis, Indicator (vaccine strains)		touching cont. surfaces - faecal oral route , respiratory droplet
	Rotaviruses				touching cont. surfaces - faecal oral route , respiratory droplet



Reported Wastewater Overflow Events into Constructed/Ornamental Type Lakes 2010 to 2018

Event Date	OvFI Suburb	LGA District	Affected Water Body	Const. Lake	WW Q (kL)	Warning Signs	Water Samples	Cause Overflow	Cause Overflow Specifics
19/06/2016	PIARA WATERS	City of Armadale	Park Piara Waters - living stream	No	5	Yes	No	Blockage	Rags
12/02/2012	Belmont	City of Belmont	Centenary Park Lake	Yes		Yes	Yes	Infrastructure	Sewer main - burst
19/02/2016	BEEILIAR	City of Cockburn	Beeliar Lake	Yes	2	No	No	Blockage	
11/10/2010	Canning Vale	City of Gosnells	Alexandria Blvd Reserve Lake	Yes	0.1	Yes	No	Blockage	fat & tree roots
23/09/2014	HILLARYS	City of Joondalup	Mawson Park Lake	?	1	No	No	?	
27/04/2014	KARDINYA	City of Melville	Frederick Baldwin Park Lake/ Comp Basin	?	109	Yes	No	Blockage	Tree roots
28/07/2016	KARDINYA	City of Melville	Frederick Baldwin Park Lake/ Comp Basin	?	180	Yes	No	Blockage	Tree roots
31/08/2017	NEDLANDS	City of Nedlands	Aberdare Rd Comp Basin, Kilgour Park, adjac to Sir Charles Gairdner Hospital	?	430	Yes	Yes	Equipment	Pump failure
27/03/2010	Glendalough	City of Stirling	Wetland/Swamp	No	3	Yes	No	Blockage	fat
20/10/2011	Stirling	City of Stirling	Candella Square Lake	Yes	25	Yes	No	Equipment	sewer PM - failure
30/03/2013	Stirling	City of Stirling	Candella Square Lake	Yes	10	Yes	No	Blockage	
27/02/2014	Stirling	City of Stirling	Candella Square Lake	Yes	5	Yes	No	Blockage	Rags & debis
4/11/2015	Stirling	City of Stirling	Candella Square Lake	Yes	20	Yes	No	Infrastructure	Sewer main - burst
18/05/2011	Shenton Park	City of Subiaco	Jualbup Lake	?		Yes	Yes	Blockage	sewer main
28/08/2013	Shenton Park	City of Subiaco	Jualbup Lake	?	0.72	Yes	No	Blockage	Tree roots
14/05/2013	BEECHBORO	City of Swan	Altone Park ornamental lake	No	2	Yes	No	Blockage	
5/05/2018	ELLENBROOK	City of Swan	Brook Park/Wood Lake (small)	Yes	10	Yes	No	Blockage	comb. of concrete, brick fragments & fat
7/05/2018	ELLENBROOK	City of Swan	Brook Park, Wood lake	Yes	1	Yes	No	Blockage	comb. of concrete, brick fragments & fat
27/06/2012	Henley Brook	City of Swan	Lake Yakine	No		No	No	Equipment	SPS Alarm
6/08/2012	The Vines	City of Swan	Golf course pond/lake	?	5	Yes	No	Equipment	
29/03/2016	AUSTRALIND	Shire of Harvey	Treendale Park Lake	Yes	10	No	Yes	Infrastructure	Sewer main - burst

Sewage Overflows into Constructed Lakes



Image: Health Warning Signs Erected – Jualbup Lake – City of Subiaco



Image: Wastewater entering Jualbup Lake via stormwater drain - City of Subiaco

Guidelines - Recreational Water - Bacterial (**Enterococci**) **Generic** Trigger Levels

- Primary Contact

1 off result: > 700 MPN/100mL

2 results in-a-row: > 100 MPN/100mL

- Secondary Contact

1 off result: > 7000 MPN/100mL

2 results in-row: > 1000 MPN/100mL

Note: These DOH alert levels were first established and adopted in 2015, in application to a ministerial statement for Champion Lakes.



Monitoring Requirements - Guidelines for the Non-potable Uses of Recycled Water in WA

Exposure Risk Level (level of human contact)	Potential end-uses	Parameter	Compliance value ¹¹	Monitoring frequency
High	• Urban irrigation with unrestricted access & application ^{a,17}	<i>E. coli</i> ¹	<1 MPN or cfu /100mL	Weekly ^d
		pH	6.5 - 8.5	Continuous online
		Turbidity	< 2 NTU (95%ile) ¹⁰ < 5 NTU (maximum)	Continuous online
		Disinfection	UV ¹³ UVT ¹⁴ >75% UV intensity: drop <25% at 254nm UV dose: 40 - 70ml/cm ²	Continuous online
Medium	• Urban irrigation with some restricted access & application ^{b,17} • Fountains & water features	<i>E. coli</i>	<10 MPN or cfu /100mL	Monthly ^d
		pH	6.5 - 8.5	Continuous online
		Turbidity	< 5 NTU (95%ile) ¹⁰	Continuous online
		Disinfection	UV ¹³ UVT ¹⁴ >75% UV intensity: drop <25% at 254nm UV dose: 40 - 70ml/cm ²	Continuous online
Low	• Communal sub-surface irrigation ¹⁷ • Urban irrigation with enhanced restricted access & application irrigation ^{c,17}	<i>E. coli</i>	<1000 MPN or cfu /100mL	Monthly ^d
		pH	6.5 - 8.5	Continuous online
		SS ¹⁸	30 mg/L	Monthly

Source: Modified from 'Table 8: Minimum ongoing monitoring requirements' from the 'Guidelines for the Non-potable Uses of Recycled Water in WA'.

Recycled Water: Irrigation Area - Access Control Requirements

- **Medium** or **Low** exposure RL:
- **Night time irrigation:**
 - Commence after 9pm,
 - Cease min 1hr before sunrise.
- **Withholding periods:**
 - (Table 13) &/or
- Simple non-continuous barriers – direct public towards signage, or
- Fencing w/ lockable gates.

Table 13: Irrigation area minimum withholding times

Exposure Risk Levels	Minimum Withholding Times
High	Not required
Medium	1 hour
Low	4 hours
Extra Low	Not applicable

Recommended Monitoring for Irrigation Purposes

- **Seasonal monitoring program** - regular (fortnightly – monthly):
 - Bacteria (E.Coli & Enterococci)
 - Phytoplankton cell counts/biovolume
 - BGA toxins (less frequent)
- **Event based monitoring:**
 - wastewater overflow events,
 - heavy rainfall events,
 - bloom/scum evident

Constructed Lake – Notional Bacterial Irrigation Trigger Values

Potential End Use Management	Interpretation - End Use Management	Human Contact Exposure Level	Recommended Level
Unrestricted access & application	Full public contact, no control to restrict access or minimise spray drift	High	<i>E. coli</i> < 10 MPN or cfu/100mL
Some restricted access & application, fountains & water features	Display signs - irrigation water quality is variable & public should avoid contact	Medium	<i>E. coli</i> < 100 MPN or cfu/100mL
Enhanced restricted access & application	Display signs (see above) + No access after irrigation for 1-4 hrs or until dry , or buffer zones, or drip irrigation, spray drift controls etc.	Low	<i>E. coli</i> < 1000 MPN or cfu/100mL

Irrigation Management Measures

Minimising Spray Drift

- **Purpose** – prevent/reduce risk assoc. - human contact/expos.
- **Avoid**: drinking fountains, buildings, playgrounds & BBQ's picnic table areas
- **Control measures** examples include:
 - Buffer zones: to nearest dwellings or public areas
 - Tree/shrub screens
 - Irrigation times: operate only during low risk expos. 9pm – 5am
 - Weather wind monitoring (anemometer switching systems)
 - Sprinkler design:
 - selection of large droplet design (to reduce aerosols)
 - lower spray height to reduce wind carriage effect.
 - Avoid surface runoff or ponding (mosquito issue)

Irrigation Management Measures – Warning Signs

- Erect temp. or permanent warning signs e.g.
“Irrigation water health risk – Do not drink this water. Avoid direct skin contact or inhalation”
- Display advisory signs on irrigated areas



Environmental Drivers of Blooms

- Nutrient availability
 - (N & P)
- Atmospheric CO₂ conc.
- Air Temperature
- ↑ Water temperature /
↑ water stratification
- Climate change...



***Microcystis* Bloom 2010 – Freeway Lakes — Image courtesy of DoW**

Nutrient Reduction Measures

- Multi-faceted approach – to achieve effective nutrient reduction entering water bodies
 - May still require decades to deplete existing nutrient accumulation
 - Reduce phosphate availability:
 - remove or cover nutrient-rich sediment, or;
 - adding phosphorus-binding clays
- Note:** These may provide improvement, but is likely to be temporary unless inputs are also controlled.

Nutrient Reduction Measures

- Reduce nutrients washing into roadside drains - flow into local waterways, e.g. wash cars on lawns rather than on roads
- Use phosphorus-free detergents
- Reduce fertiliser use (where possible)
- Rehabilitate waterways
- Prevent land erosion (where possible).

BGA Control Methods

- **Artificial mixing** to disrupt buoyant cyanobacterial aggregates (aeration, mechanical mixers):
 - rate of vertical mixing rate must exceed floatation velocity of cyanobacteria strains
- **Chemical control** agents to kill
- **Biological controls** e.g. pathogens or predators.

Note: For toxic blooms, any measure which causes lysis of cyanobacterial cells – likely to release large amounts of intracellular toxin - spike in toxin levels.

General Algal Bloom Response

- BGA/algal bloom apparent:
 - **Sample & analyse water** - confirm potentially harmful species/toxins
 - **Erect health warning sign** (precautionary measure): alert passive recreation users
 - **Issue local media advisory**

Note: Under no circumstance should people or their animals have direct water contact as harmful effects may result.



Acknowledgements

- **Dr Stuart Hellen** - Aquatic Ecologist/
Phytoplankton Taxonomist - Dalcon
Environmental
- **Dr Cameron Veal** – Technical Coordinator
– Catchment Water Quality - Seqwater
- **Nick Jones** – Manager Environmental
Health – City of Cockburn
- **Seqwater**

Questions?

Further information:

Jared Koutsoukos

P: 9388 4933

E: Jared.koutsoukos@health.wa.gov.au