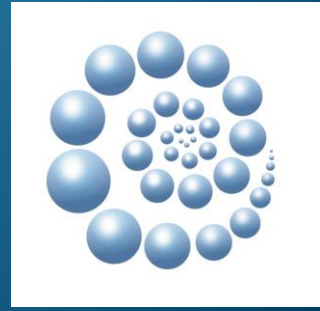
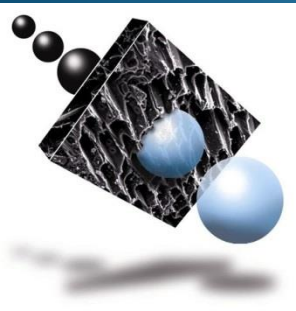


Peta's BGA Tour of the Murray River

March 2016

Presented by Activated Carbon Technologies and
Research Laboratory Services



The Inspiration...

VIC EMERGENCY PREPARE & GET READY INCIDENTS & WARNINGS RELIEF & RECOVERY In an emergency, call Triple Zero (000)

Blue-green algae

List Both Map Filter Search address... Q Locate Me

Warnings 2 Incidents 1

Type Updated

Community Update

Blue Green Algal Bloom Murray River

ISSUED: 11/03/16 5:00 PM

This update is being issued by Department of Environment, Land, Water and Planning for the Murray River.

Incident Information:
High levels of blue-green algae have been detected in the River Murray between Lake Hume and Barham/Koondrook, the channels servicing the Murray Valley Irrigation area, the Torrumbarry Irrigation area east of the Loddon River and the Loddon River between Caim Curran and Laencoorie.

Lake Hume, Lake Mulwala, Lake Moodemere, Reedy Lake and Lake Boqa are also part of the affected area. [More...](#)

Map showing the affected area in Victoria, Australia, with a blue shaded region along the Murray River. Locations marked include Wagga Wagga, Canberra, Echuca, Shepparton, Bendigo, Ballarat, and Melbourne. National Parks shown include Wyperfeld, Kosciuszko, and Alpine National Parks. The map is updated 12/03/2016 09:51:31.

Navigation: About Impact Contacts

About blue-green algae

Blue-green algae (BGA) is naturally occurring bacteria in our waterways.

News and Media About this site Text Only Key/Legend

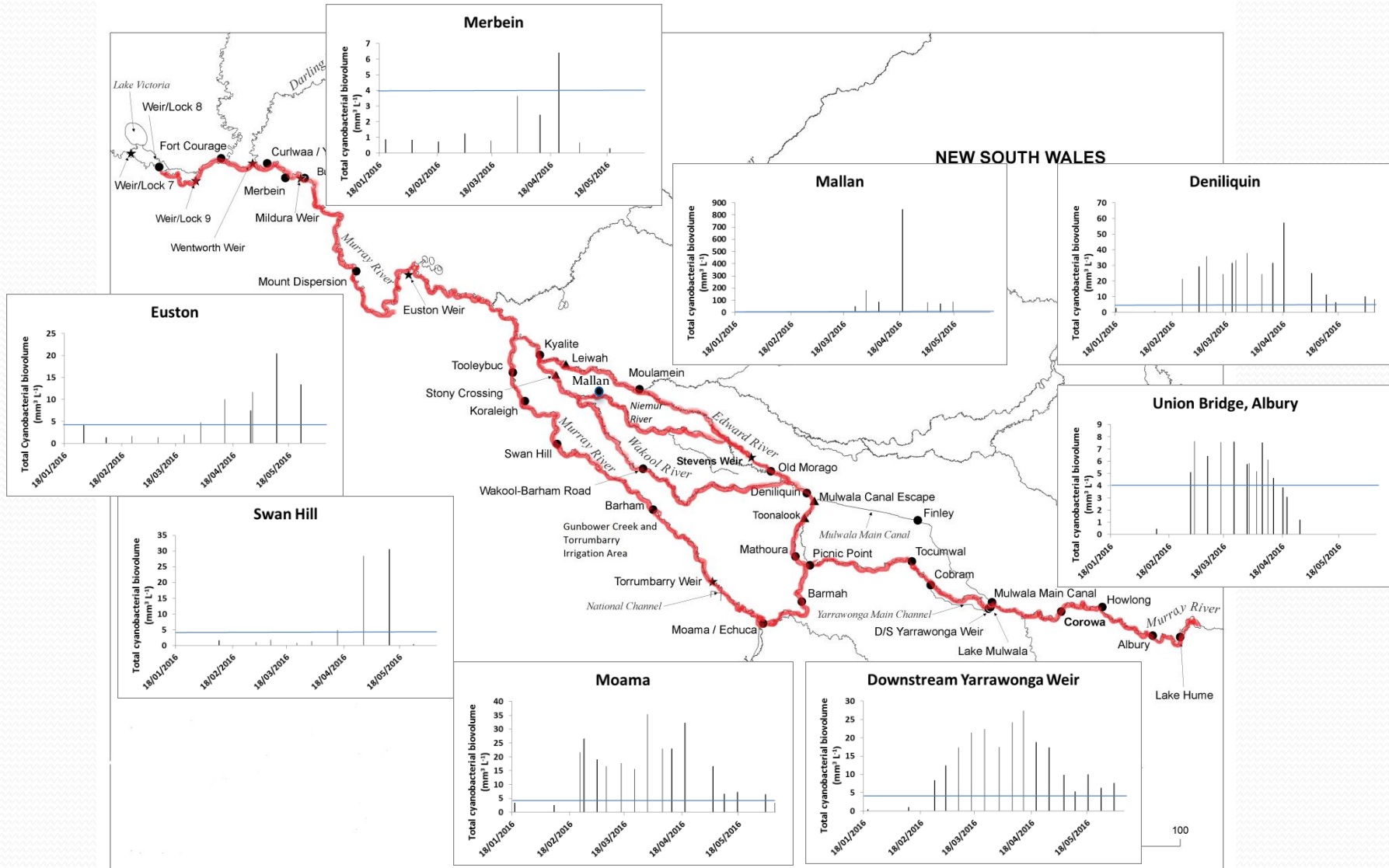
Blue-green algae
A Twitter list by @vicemergency

BGA Levels 19 Jan – 3 Mar

| Distance | 19/01/2016 | 20/01/2016 | 21/01/2016 | 28/01/2016 | 1/02/2016 | 2/02/2016 | 4/02/2016 | 9/02/2016 | 10/02/2016 | 11/02/2016 | 16/02/2016 | 19/02/2016 | 22/02/2016 | 23/02/2016 | 24/02/2016 | 25/02/2016 | 27/02/2016 | 29/02/2016 | 1/03/2016 | 2/03/2016 | 3/03/2016 |
|----------|-------------|-------------|------------|------------|-----------|-----------|-----------|-------------|-------------|-------------|------------|------------|-------------|------------|------------|-------------|---------------|-------------|------------|-----------|---------------|
| 0 | | 0.16 (0.06) | | | | | | | | | | | | | | 3.52 (3.38) | | 5.08 (4.85) | | | |
| 25 | | 0.04 (0.01) | | | | | | | | 0.49 (0.26) | | | | | | | 9.1 (8.09) | | | | |
| 135 | | 0 | | | | | | | | 0.82 (0.28) | | | | | | | | | | | |
| 216 | | | | | 0.7 | | | | | | 4.2 (4.1) | | | | | | | | 7.9 (7.67) | | |
| 216 | | 1.15 (0.31) | | | | | | | 2.09 (1.32) | | | | | | | | | | | | |
| 216 | | 0.47 (0.17) | | | | | | | | 1.14 (0.79) | | | | | | | | | | | |
| 299 | | 0.51 (0.00) | | | | | | | 2.03 (1.25) | | | | | | | | | | | | |
| | | | | | | | | | | | | | 7.49 (5.07) | | | 6.66 (5.30) | | | | | |
| | | | | | | | | | | | | | | | | 6.50 | | | | | |
| 329 | | 0.53 (0.24) | | | | | | | | 1.68 (0.71) | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | 15.04 (13.89) | | | | |
| 412 | 2.50 (0.73) | | | | | | | 1.47 (0.20) | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | |
| 450 | | | | | | | | | | | | | | | | | | | | | |
| 450 | | | | | | | | | | | | | | | | | | | | | 15.42 (14.94) |
| | | | | | | | | | | | | | | | | | | | | | |
| 497 | | | | | | | | | | | | | | | | | | | | | |
| 497 | 3.45 (0.39) | | | | | | | 2.53 (0.30) | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | |
| 579 | | | | | | 1.9 | | | | | | | | | | | | | | | |
| 579 | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | |
| 680 | | | | | | | | | | | | | | | | | | | | | |
| 680 | 3.86 (0.48) | | | | | | | 0.54 (0.09) | | | | | | | | | | | | | |
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| 785 | | | | | | | | | | | | | | | | | | | | | |
| 785 | | | | | | | | | 1.67 (0.32) | | | | | | | | | | | | |
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| 871 | | | | | | | | | | | | | | | | | | | | | |
| 871 | | | | | | | | | | 1.16 (0.22) | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | |
| 1070 | | | | | | | | | | | | | | | | | | | | | |
| 1070 | | | | | | | | | | | | | | | | | | | | | |
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| 1177 | | | | | | | | | | | | | | | | | | | | | |
| 1177 | | | | | | | | | | | | | | | | | | | | | |
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| 1288 | | | | | | | | | | | | | | | | | | | | | |
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| 1319 | | | | | | | | | | | | | | | | | | | | | |
| 1319 | | | | | | | | | | | | | | | | | | | | | |
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| 1343 | | | | | | | | | | | | | | | | | | | | | |
| 1343 | | | | | | | | | | | | | | | | | | | | | |
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| 1384 | | | | | | | | | | | | | | | | | | | | | |
| 1384 | | | | | | | | | | | | | | | | | | | | | |
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| 1457 | | | | | | | | | | | | | | | | | | | | | |
| 1457 | | | | | | | | | | | | | | | | | | | | | |

- First high alert in February 2016 and started to decrease in late April
- Over the Easter long weekend massive disruptions to tourism with large signs on the highway warning people about BGA on entry to all towns

Maximum extent of the bloom



The First Road Trip...

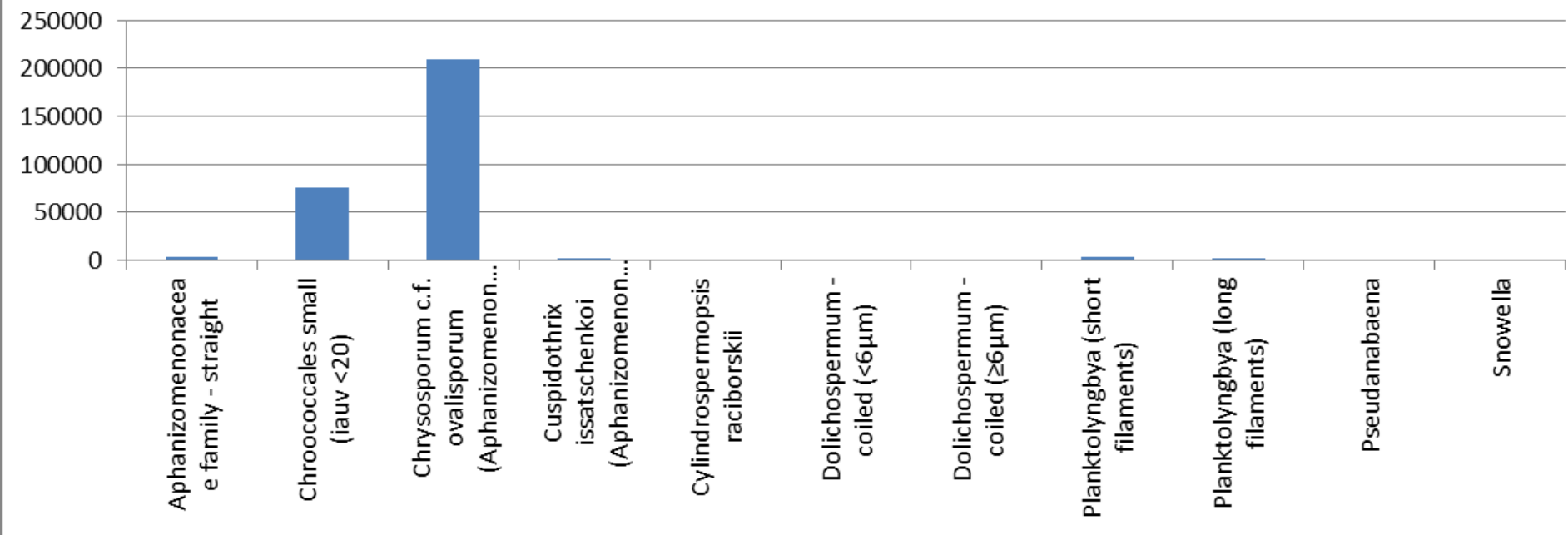
Barmah

10 March 2016



Blue Green Algae Soup

Total BGA Counts (cells/mL) at
Barmah 01 March 2016



Chrysochlorium c.f. *ovalisporum* (*Aphanizomenon* c.f. *ovalisporum*)

Figure 1. Trichomes of *Dolichospermum mendotae* (a,b) and *Chrysochlorium ovalisporum* (c,d) showing vegetative cells, heterocysts and akinets. Scale bars indicate 10 μm .



(a)



(b)



(c)



(d)

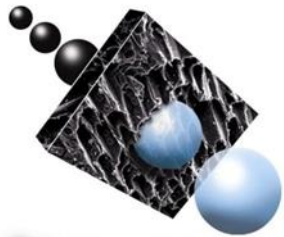
From: Akcaalan R, et al (2014) First Report of Cylindrospermopsin Production by Two Cyanobacteria (*Dolichospermum mendotae* and *Chrysochlorium ovalisporum*) in Lake Iznik, Turkey

Cylindrospermopsin

- This toxin has been associated with *Chrysosporium ovalisporum* and *Cylindrospermopsis raciborskii*
- ADWG states: “Cylindrospermopsin is a general cytotoxin that blocks protein synthesis. The major pathological effects are damage to the liver, kidneys, lungs, heart, stomach, adrenal glands, the vascular system, and the lymphatic system. Acute clinical symptoms are kidney and liver failure.”
- The 2016 Murray River event did not return any positive toxin results
- However a high proportion of cylindrospermopsin in *C. raciborskii* blooms may be extracellular and present within the water body

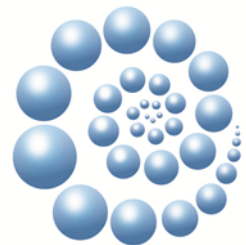
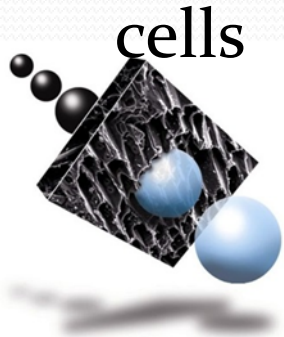
Drinking Water Treatment Options: Multibarrier Approach is Best

- Coagulation/ Filtration – to remove whole cells
- Powdered Activated Carbon – to remove dissolved compounds within the water body such as cylindrospermopsin present outside of the cell
- Granular Activated Carbon or Ozone/ BAC
- Disinfection - Chlorine



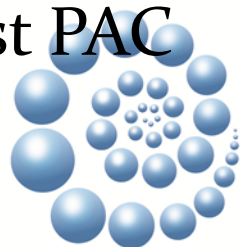
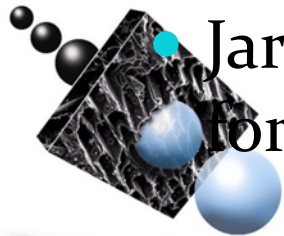
Coagulation and Filtration + PAC

- Coagulation removes whole cells and any toxin present within the cell
- PAC removes the dissolved toxins (and T&O)
- Filtration removes the PAC and any remaining cells



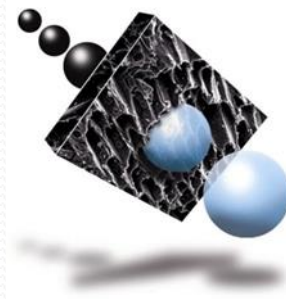
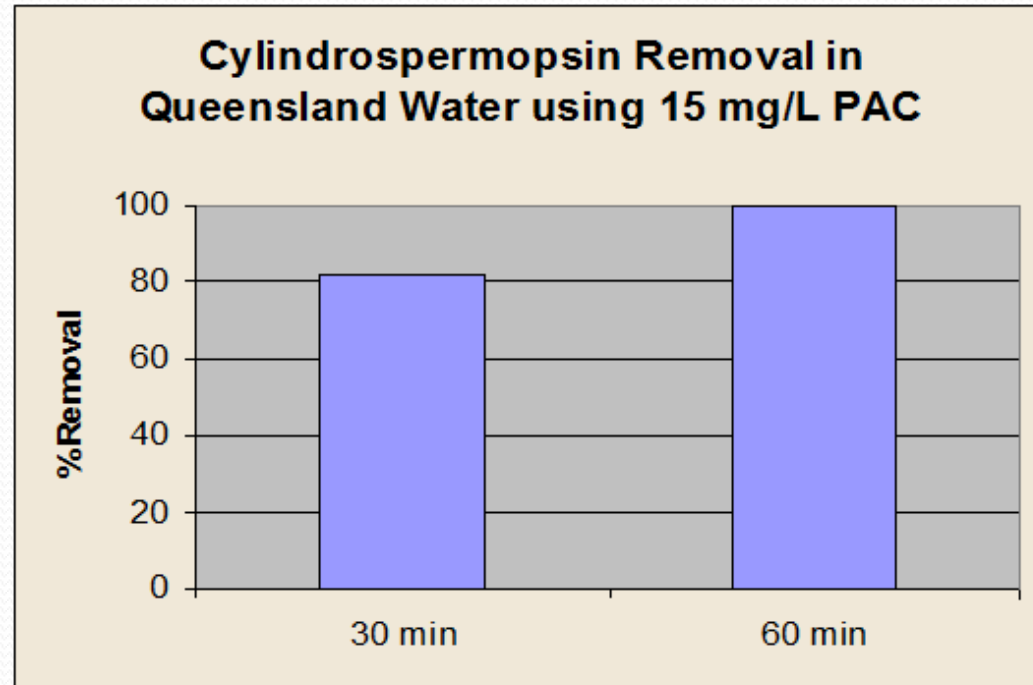
Powdered Activated Carbon (PAC)

- The best PAC has a wide range of pore sizes, small particle size, high adsorptive capacity and correct surface chemistry for:
 - High kinetics
 - Low interference from DOC
 - Best value for money PAC for algal metabolite reduction
 - Proven to remove target contaminants such as Cylindrospermopsin
- PAC available in different levels of adsorptive capacity, in different particle sizes and from different raw materials
- Jar testing is recommended to determine the best PAC for your conditions



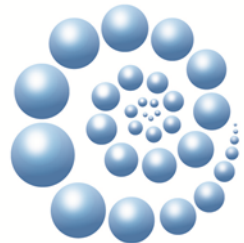
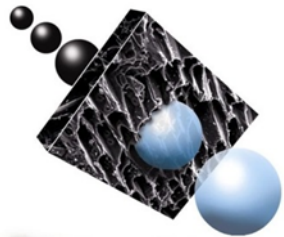
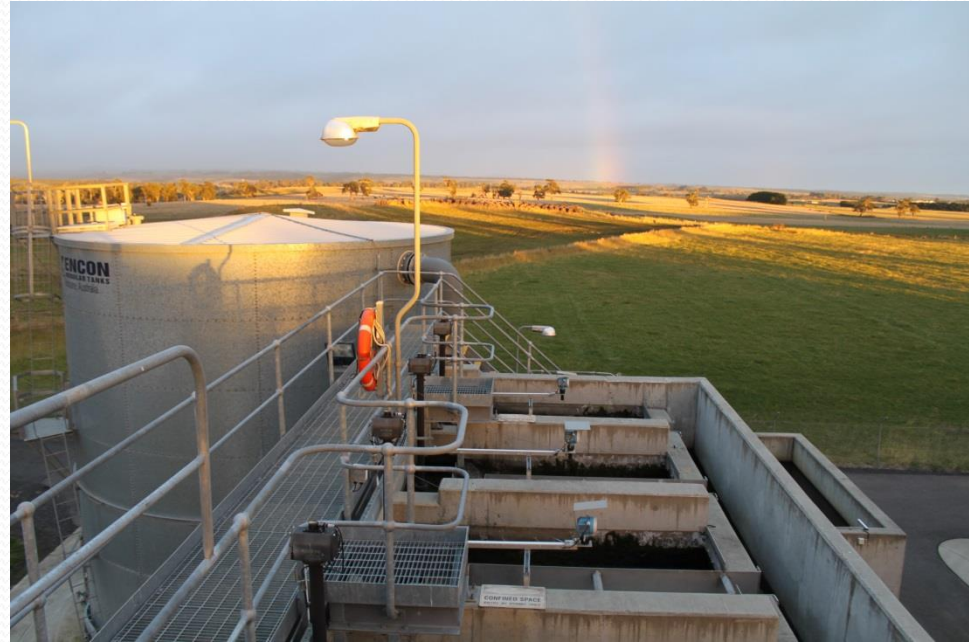
Acticarb PS1000

- Jar Test:
 - Raw Water – 4mg/L DOC + 100µg/L cylindro spike
 - 15mg/L PS1000 Dose Rate
- In full scale plant:
 - level of cylindro was much lower (1-5 µg/L)
 - dose rate of PAC also much lower (<5mg/L)
 - Dosed at the filters (after coagulation)
 - 100% removal



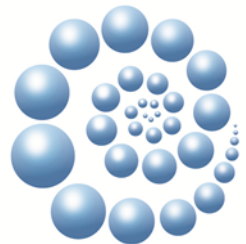
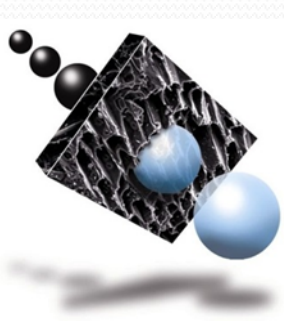
Granular Activated Carbon

- Can be used with or without ozone
- Ozone/BAC 100% effective in removing cylindro
- AWQC has found cylindro to be biodegradable and therefore able to be removed by activated carbon with long bed life (10-15 years)



Oxidation

- Pre-oxidation is not recommended as this may lyse the cells and release more toxin into the feed water
- Ozone reacts more quickly with microcystins, anatoxin-a and cylindrospermopsin than other common oxidants
- Ozone needs to be followed by activated carbon to remove BDOC and increase treated water's biostability
- Chlorine (as a disinfectant) can be effective in removing cylindro (at pH below 8) however it is important that whole cells are removed prior to chlorination



Powdered Activated Carbon

- Powdered Activated Carbon
 - 300-500kg bulk bags
 - 15-20kg paper bags
 - Moderate capital cost
- PAC Slurry
 - Pails Acticarb WTS 5-20
 - Drums Acticarb WTS60-160
 - Low capital cost however high cost of product and transport
- GAC/ BAC
 - High capital cost, low operational cost

Powdered Activated Carbon (PAC) Slurry



The Second Road Trip...

Hume Weir

15 March 2016



Tocumwal



Echuca

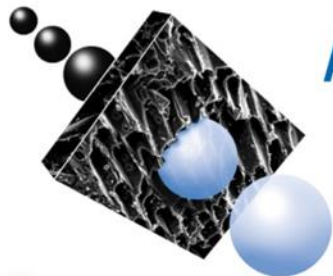


Echuca



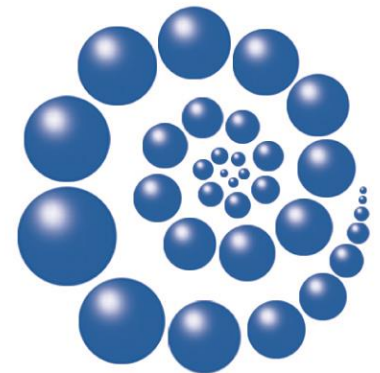
Thank you

Research Laboratory Services and Activated Carbon Technologies



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