

Re: Human Health Risk Assessment of Microbiological Quality of Water used for Fighting the Hazelwood Coal Mine Fire.

Having reviewed the test reports I have outlined a risk assessment and management plan for the exposure to, and use of, water from the Hazelwood cooling pond. In providing this report I have used the *Australian Guidelines for Managing Risks in Recreational Water (AGMRRW)* and the *World Health Organisation: Toxic Cyanobacteria in Water: A guide to their public health consequences, monitoring and management (WHO)*. I have included references and links to these sources at the end of this document. This body of water is used recreationally and is best described as an open natural water body. The water is an open recirculating cooling pond. As a result of the cooling process the water will have elevated temperatures that may be conducive to the growth of a range of organisms including enteric organisms, cyanobacteria and algae.

1) Hazard Identification.

The test reports provided have identified the presence of a range of organisms. Those that have received the most attention are *E.coli* / coliforms / enterococci, *Pseudomonas* spp. and *Cyanobacteria* spp. (aka Blue-green algae), in particular *Microcystis* and *Merismopedia* spp. All of these organisms are normally found in natural water bodies. Environmental conditions may influence the concentrations and distribution of these organisms.

E.coli and coliforms: These organisms are used as indicators of faecal contamination of water and acceptable levels of these organisms are detailed in the Australian Drinking Water Quality Guidelines and in State guidelines. For the most part these organisms do not directly constitute a health risk in recreational water, but are used as indicators of the potential contamination by faecal material.

E.coli, coliforms and enterococci are part of the normal flora of the human body and intestinal tract and for the most part are benign. Their presence in natural water bodies is extremely common but this does not necessarily mean the water is contaminated by faecal material or enteric pathogens.

There exists a small group of *E.coli* strains that cause enteric disease through toxin production. Cases of this disease are associated with the ingestion of contaminated food or water, in particularly after processing. As ingestion of contaminated food or water is the cause of disease outbreaks pathogenic *E.coli* are not associated with natural water bodies.

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Pseudomonas spp.: These organisms are extremely common and abundant bacteria in the natural environment. They may be associated with food spoilage. For the most part they are benign and rarely cause infection. *Pseudomonas aeruginosa* is associated with wound infections. These infections are almost exclusively confined to individuals who have been hospitalized and who have a poor immune status. In particular *Pseudomonas* infections may occur in burn victims where significant areas of skin have been affected. They are considered 'opportunistic pathogens' causing disease in situations where the host immune system is already compromised. Transmission of the infection to healthy individuals is highly unlikely.

Cyanobacteria: Also known as blue-green algae, these organisms are a broad group of photosynthetic bacteria common in the environment. The term 'cyanobacteria' refers to a large and diverse group of bacteria that are common in the environment and for the most part harmless. Individual species or families within this group (eg *Microcystis*) may also be either harmless or toxin producing. They have been associated with nuisance growth in recreational waters, where odour, slime and discoloration may occur without any adverse health effect. In some circumstances some of these organisms produce toxins that can cause a range of symptoms. Symptoms may range from skin irritation, and rashes to nausea, vomiting or kidney and liver damage. 'Blooms' of these bacteria typically occur in natural water bodies where there is a high nutrient load (ie eutrophic). These bacteria are able to move themselves through the water column using flotation vesicles. As a result bacteria concentrate near the water surface and can then be further concentrated by prevailing wind action into 'blooms'. This leads to localised areas with high concentrations of the blue-green bacteria. These 'blooms' are associated with toxin release into the water.

In the Hazelwood scenario testing has identified a number of species belonging to the cyanobacteria group. Amongst these testing identified two species that have been associated with toxin production. The principle organism identified was a *Microcystis* species which was present in large numbers in February. Whether this isolated strain is associated with toxin production remains uncertain.

The test reports indicate that there has been a bloom in *Microcystis* cyanobacteria since testing in January 2013. This may be in response to high nutrient loads entering the water bodies, it may also be influenced by the warmer water temperatures due to the cooling water process. Some *Microcystis* spp. produce a toxin called microcystin. This toxin has been associated with severe gastrointestinal disease and liver damage after

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ingestion by humans and animals. Toxin is usually released as the bacterial cells die and breakdown. Toxin usually degrades naturally within 2 to 10 days of release.

Merismopedia spp. are commonly found in natural water bodies. They may produce toxins that can cause rashes and irritation on exposed skin, or gastrointestinal illness if ingested.

2) Exposure Assessment

The detection of these organisms in the water bodies is not surprising. The likelihood of exposures that may be a health risk is a function of both the concentrations of the organisms and the way they may be transmitted to cause illness.

The principle modes of exposure in the Hazelwood scenario are direct exposure (dermal contact), inhalation or ingestion. As the ingestion of the water is unlikely I have discounted this as a negligible health risk with the provision that animals ingesting the water may experience adverse health effects.

Dermal contact / direct exposure:

The potential for direct exposure to the water during the operations is very high. Of the organisms detailed in the test reports there are only two that might be considered any health risk from direct exposure to the water. Firstly *Pseudomonas* spp. have been detected in significant concentrations. Direct exposure to these organisms from natural water bodies to healthy individuals represents a minimal health risk. The exposure could be considered normal for any persons using recreational water. The Australian Recreational Water Quality Guidelines do not advocate testing for these organisms as a measure of health risk.

Of the two Cyanobacteria spp found in significant quantities only *Merismopedia* have an association with adverse health effects. Toxins from these organisms may cause skin rashes and irritations via dermal contact. There is no evidence of further more dramatic health consequences. The test reports do not identify the species of *Merismopedia* isolated and it is quite possible that the species present do not cause any adverse health effects.

Inhalation:

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The potential for inhalation of contaminated water during the operations is very high. Inhalation of any microorganisms in high concentrations presents a health risk and should be minimized. The organisms of most concern in relation to the Hazelwood operations are the *Microcystis* spp. As stated, the organisms in themselves do not cause disease but produce toxins that may cause a range of adverse health effects. There is an obvious potential for the inhalation of contaminated water that may contain toxins (microcystins). This may result in the symptoms described above (nausea, vomiting, kidney / liver disease).

These exposures may occur during any operations where splashing, spraying, misting or aerosolisation of the water occurs. The visible absence of algae (Cyanobacterial blooms) in water does not guarantee the absence of toxin, though the presence of toxin tends to be associated with visible blooms (and scum) of the organisms.

3) Dose Response

E.coli and coliforms: As ingestion is the only plausible cause of infection from these organisms the transmission of a dose likely to cause disease is unlikely. This is provided that the water is not ingested. Using the AGMRRW the test results for Coliforms would be regarded as representative values from samples taken from open recreational water bodies for a water body being used for swimming, diving etc. (Schedule 1 of the Guideline). The guideline also notes that neither *E.coli* nor coliforms are reliable indicators of faecal pollution in fresh water. It should be noted that Schedule 1 addresses 'direct exposure'. (The Guideline does not list directly *E.coli*, or *Pseudomonas* spp. as indicators of water quality). The guideline also states that there is insufficient data available to use intestinal enterococci as indicators of health risk. In my opinion similar test results for the sample sites could be obtained from rain water being used by any person using it as a drinking water source.

Pseudomonas spp.: As mentioned the guidelines do not recommend the testing for these organisms as indicators. Given the ubiquity of *Pseudomonas* spp. in the human and natural environment it is unlikely that the water would provide a dose above and beyond everyday interaction with the environment. Doses causing infection in burns victims are variable and very much a function of the health status of the individual. In many cases infection occurs in health care settings where the organism is transmitted to the individual during their treatment.

Cyanobacteria: Ingestion or skin contact with *Microcystis* spp. does not in itself constitute a health risk. However, exposure to the toxin, microcystin,

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either by ingestion or inhalation may present a serious risk to health. Test results from February indicate a significant 'bloom' of these organisms in the Hazelwood Lake samples taken at the boat launching ramp, Yacht club pier, wind-surfing area and North-east of the pond. Test reports showed numbers of $<10^8$ organisms per mL in the samples this is well in excess of the 10^4 organisms per mL suggested by WHO for protection against health outcomes. Concentrations in test reports indicate that a visible blue-green colour or a thick slimy scum was probably visible in the water at these locations when samples were taken.

The test reports do not confirm whether the organisms detected were of the species that produce toxins, and so the presence or concentration of toxin is unknown. Samples taken from other water bodies did not indicate significant concentrations of these toxins. If toxin is being produced in the blooms then I would expect a noticeable environmental impact. The toxin also affects fish, birds and animals. I would expect that there would be noticeable mortalities of these animals – particularly fish as they have the highest exposure and cannot leave the water body. As a result I suspect that the algal bloom, though a nuisance, is not of a toxin-producing species of *Microcystis*.

The potential exists for inhalation of toxin from the water where these cyanobacteria were detected. This is especially true during activities like firefighting where significant aerosol is produced. Although data suggests that there may be significant exposure to toxin through inhalation there is no established relationship between toxin concentrations in aerosol and concentrations in source water. As such, the actual health risk is unknown. WHO recommend exposure to toxin contaminated aerosols should be avoided.

Merismopedia spp. were also detected in the same samples in which *Microcystis* was found. These were the only other cyanobacteria reported that are associated with health effects. Concentrations were much lower and would not have produced any visible colouration in their right. The dose from skin exposure to these organisms is probably minimal and in the light of the WHO limits (quoted above) unlikely to cause any detectable health effects.

4) Risk Assessment

E.coli, coliforms, enterococci and *Pseudomonas* spp.: Risks to human health from these organisms are minimal, provided ingestion of the water is avoided. In this situation health risks are not elevated above those presented by exposure to natural water bodies.

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Cyanobacteria : Of the organisms detected only Microcystis presents a significant health risk at the concentrations detected. Whether the organisms detected were of a toxin-forming species is not known, but the absence of fish, bird and animal mortalities tends to suggest they are not. However possible exposure via inhalation or ingestion should be avoided. Skin contact is not a health risk for the toxins produced by these organisms.

The information outlined above demonstrates that only one water body being used presents a significant health risk beyond those associated with normal exposures to natural water bodies. That is the Hazelwood Lake that is used as a power station cooling pond and for a range of recreational activities. It is apparent that there was a bloom of a Cyanobacterial species (Microcystis) in early / mid-February in this lake. Concentrations of these organisms would be consistent within an in-flux of nutrients and in particular nitrogen and phosphorus, and thermal effects from the cooling system. Increasing concentrations of other bacteria in this water body would be consistent with such events.

5) Risk Management

The major health risk posed by the exposure to the water bodies is inhalation. Ingestion and dermal contact are minimal but possible risks. Although only one water body appears to have any elevated risk to human health I believe it would be wise for the same precautions to be taken in dealing with exposures to all of the natural water sources being used in the firefighting operations. My opinion is that whether the organisms present produce toxin or not the same steps to minimize risk to persons using the water should be taken. In essence it would be safer in the interests of public health to assume the organism does produce toxin and act accordingly. If that precautionary approach is taken then my opinion is that testing for cyanobacterial toxin (also known as Blue-Green Alga toxin or BGA) would be a largely academic exercise as the results would not change the risk management process.

a. Dermal exposure.

All personal directly using or indirectly exposed should wear personal protective equipment that will minimize exposures. This should include water proof gloves and protective clothing that will prevent skin contact.

b. Inhalation.

Persons using the water in applications where splashing, spraying or aerosolisation is likely to occur should use all of the PPE suggested in

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a. above. Persons not directly involved in these activities but in the vicinity of them should also wear the same equipment. People should be aware that transmission of aerosol may be over distances of greater than 10 metres from the source. This means that those working within this sort of proximity to the water should continue to use PPE.

c. Recreational Use.

The test results suggest that the water may be unfit for recreational use. The cyanobacterial bloom in the lake should subside naturally. The length of time for this process is variable and dependent on a range of environmental conditions. This process will release toxin (if it is present) into the water which may persist after the bloom is no longer visible. I advise against attempts to disinfect the water as this may result in a very rapid release of toxin making the water body more harmful over a short period. The toxin will degrade in the water column and sediments shortly after the bloom ceases. I advise that the water bodies should not be open for recreational use until laboratory testing indicates that cyanobacteria are no longer detected.

d. Disease Symptoms.

Persons exposed to the water that show symptoms of gastrointestinal illness or skin irritations or rashes should seek medical advice and advise their physician of possible exposure to cyanobacterial toxins.

References:

Australian Guidelines for Managing Risks in Recreational Water

<http://www.nhmrc.gov.au/guidelines/publications/eh38>

World Health Organisation: Toxic Cyanobacteria in Water: A guide to their public health consequences, monitoring and management.

http://www.who.int/water_sanitation_health/resources/toxicyanbact/en/

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