APPENDIX M

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Memorandum

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Subject	**Literature Review - Risks of Acrolein in Drinking Water**	**Project Name**	Townsville Haughton Pipeline Stage 2 Detailed Business Case
Attention	Matt Bradbury	**Project No.**	IH175200
From	Nicholas Stanton		
Date	29 March 2019		

1. Executive Summary

1.1 Purpose

The purpose of this literature review is to identify and document the following:

1. Any relevant regulatory or other published limits on Acrolein concentrations in drinking water (This will be addressed in **Section 3**);

2. Any published information about the toxicity of Acrolein to humans, particularly based on oral exposure from concentrations in drinking water (this will be addressed in **Section 4**);

3. Any published information about the persistence of Acrolein in surface water (This will be addressed in **Section 5**).

1.2 Investigation Summary

1.2.1 Limits on Acrolein in Drinking Water

Acrolein concentrations in drinking water are not regulated in Australia.

A review of major international drinking water standards found no health limits on acrolein.

1.2.2 Toxicity of Acrolein to Humans

The literature reviewed showed that Acrolein is known to have acute toxic impacts on humans, generally due to inhalation of vapour, however there is limited information on the toxic effects of acrolein due to ingestion of acrolein concentrations in drinking water.

There is currently inadequate data to comment on the carcinogenicity or any other negative health effects of Acrolein exposure in drinking water.

1.2.3 Persistence of Acrolein in water

The literature reviewed indicated that acrolein used in natural waters for herbicidal use is likely to persist for up to 6 days after dosing depending on the conditions. Verifying whether this timeframe is applicable to local conditions would require a sampling program or liaison with Sunwater (who may already have information about decomposition time) however this is a reasonable estimate to reference in a risk assessment.

1.3 Implications on Drinking Water Supply

Notwithstanding the fact that there is no guidance for acrolein in the ADWG, the direct use of acrolein in the source water would need to be captured as a potential hazard in the risk assessment which supports the Drinking Water Quality Management Plan (DWQMP). The hazard would be assessed based on the consequence of exposure to humans, and the likelihood of the contaminant being present in the drinking water supply.

The assessment of consequence should be conservatively applied given the lack of data on health impacts. This means that until proven otherwise, a risk of negative health impacts should be assumed.

The likelihood of there being acrolein still present in the drinking water supply would need to consider factors such as the natural decomposition of acrolein in the water, the water age between application point and the point of extraction, climatic conditions, and the level of dilution.

1.4 Recommendations

The following further steps are recommended:

1. Undertake hydraulic calculations to determine the expected water age in the system between the point of acrolein application and the point of raw water extraction. Note that the half-lives referred to above relate to water in a channel system and the degradation of acrolein levels in a pipeline may be different;

2. Liaise with the registered water service provider to determine if the risk of acrolein has already been considered in their approved DWQMP; and

3. Undertake a program of water sampling during an acrolein dosing period to determine the decay kinetics under local conditions.

2. Introduction

Acrolein is a chemical used by Sunwater as a biocide for treatment of submerged and floating weeds in their irrigation networks. This method of weed control is used periodically in the Burdekin-Haughton irrigation system with Acrolein being dosed into the Haughton Main Channel.

The concentration of acrolein used in the Haughton Main Channel is unknown but likely varies considerably based on conditions and weed levels.

3. Limits on Acrolein in Drinking Water

3.1 Australian Drinking Water Guidelines (ADWG)

The ADWG contains no guidance for Acrolein.

3.2 World Health Organisation (WHO) Guidelines for Drinking Water Quality

The WHO Guidelines for Drinking Water Quality contains no guidance for Acrolein.

3.3 United States Environmental Protection Agency (USEPA) Drinking Water Standards

The USEPA *National Primary Drinking Water Regulations*, and the *Secondary Drinking Water Standards* contain no guidance for Acrolein.

The USEPA does list Acrolein in the current contaminant candidate list (CCL5) and has done so since the release of a previous list (the CCL3) in 2016. "*The drinking water CCL is a list of contaminants that are currently not subject to any proposed or promulgated national primary drinking water regulations, but are known or anticipated to occur in public water systems*"[1]. This effectively means that Acrolein has been noted by the USEPA as a chemical that is known or anticipated to occur in public water systems, is not subject to any current or proposed US national regulation but may require future regulation.

3.4 European Union (EU) Drinking Water Directive

The EU drinking water directive provides no guidance on Acrolein.

3.5 Conclusion

There is no guidance on the presence of acrolein in drinking water in the ADWG, or in the equivalent USEPA, WHO, or EU guidelines.

4. Toxicity of Acrolein to Humans (from Drinking Water)

4.1 National Pollutant Inventory (NPI), Australian Government Department of the Environment and Energy)

The NPI lists Acrolein and describes it as follows: *"Acrolein is a clear, yellowish liquid with a burnt, sweet, pungent odour. It is highly flammable. It has a high vapour pressure and has significant water solubility. Acrolein is considered a volatile organic compound by the National Pollutant Inventory."*[2]

The NPI lists symptoms from both single or short term, as well as longer term exposure and references the *workplace exposure standards for airborne contaminants* produced by Safe Work Australia which provides a Maximum eight-hour time weighted average, and a Maximum short term exposure limit for exposure to Acrolein vapour.

The NPI provides no specific information about the toxicity of acrolein to humans ingesting drinking water.

4.2 USEPA Integrated Risk Information System

The USEPA maintains a system called the Integrated Risk Information System (IRIS) which is used to identify and characterise the health hazards of chemicals found in the environment. IRIS contains a chemical assessment summary for acrolein which outlines the following which are relevant:

- Oral Reference Dose for Chronic Oral Exposure (RfD);
- Carcinogenicity Assessment.

[1] https://www.epa.gov/ccl/basic-information-ccl-and-regulatory-determination
[2] http://www.npi.gov.au/resource/acrolein-2-propenal

4.2.1 Oral Reference Dose for Chronic Oral Exposure

The RfD is an estimate of a daily exposure to the human population (including sensitive sub groups) that is likely to be without an appreciable risk of deleterious effects during a lifetime.

The RfD for Acrolein is 5 x 10^{-4} mg/kg-day[3].

4.2.2 Carcinogenicity Assessment for lifetime exposure

The IRIS chemical assessment summary notes that the cancer assessment for acrolein added to the IRIS database in 1988 classed acrolein as a possible human carcinogen (Category C).

The current chemical assessment dated 6/3/2003, has replaced the previous cancer assessment of 1988 and states; *"Under the Draft Revised Guidelines for Carcinogen Risk Assessment (U.S. EPA, 1999), the potential carcinogenicity of acrolein cannot be determined because the existing "data are inadequate for an assessment of human carcinogenic potential for either oral or inhalation route of exposure."* (US EPA, 2003)

This research was supported by the *Concise International Chemical Assessment Document 43: Acrolein*[4].

4.3 Conclusion

The literature reviewed suggests that Acrolein is known to have acute toxic impacts on humans, generally due to inhalation of vapour, however there is limited information on the toxic effects of acrolein due to ingestion of acrolein concentrations in drinking water.

There is currently inadequate data to comment on the carcinogenicity of Acrolein.

5. Persistence of Acrolein in Surface Water

5.1 Review of Documentation

A number of studies were identified which have examined the persistence of acrolein in surface waters. In particular there were some studies which provided specific guidance as to the approximate half-life of acrolein used as a herbicide in irrigation channels.

Acrolein: Environmental Fate and Ecotoxicology[5] states that *"In natural waters, at rates suggested for herbicidal use, acrolein persisted for up to 6 days, depending on temperature"*. It further states that the half-life of Acrolein has been observed to be approximately 10 hours in weeded canals and 7.5 hrs in non-weeded canals. The report also states that Acrolein is dosed into irrigation systems at concentrations up to 15 mg/L.

Another report; *Concise International Chemical Assessment Document 43: Acrolein* (WHO, 2002) references previous studies and states that; "*Observed* dissipation half-lives of acrolein applied as a herbicide in irrigation canals range from 7.3 to 10.2h"

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[3] Integrated Risk Information System Chemical Assessment Summary (Acrolein), US EPA, 2003
[4] Concise International Chemical Assessment Document 43: Acrolein, WHO, 2002
[5] *Acrolein: Environmental Fate and Ecotoxicology,* K King, California Department of Pesticide Regulation, 2016

With an initial concentration of 15 mg/L and a half-life of 10 hours the concentration after 6 days would be approximately 0.0009 mg/L (0.9 µg/L) which would be considered largely dissipated.

5.2 Conclusion

The literature reviewed indicated that acrolein used in natural waters for herbicidal use is likely to persist for up to 6 days after dosing.

6. Summary and Implications on Drinking Water Supply

6.1 Drinking water regulation

The Water Supply (Safety & Reliability) Act 2008 (the Act) outlines obligations and requirements for all water service providers providing drinking water services throughout Queensland. The Act requires all water service providers to develop a drinking water quality management plan (DWQMP) aimed at protecting public health. The act is administered by the Queensland Department of Natural Resources, Mines and Energy.

The purpose of the DWQMP is to protect public health through the identification, and minimisation, of any public health risks associated with drinking water. Its development must follow a risk-based system for identifying, assessing, mitigating and managing all potential health risks associated with the supply of drinking water.

Risk Assessment

Given the above information, and notwithstanding the fact that there is no guidance for acrolein in the ADWG, it's direct use in the source water would need to be captured as a potential hazard in the risk assessment which supports the DWQMP. The hazard would then be assessed based on the consequence of exposure to humans, and the likelihood of the contaminant being present in the drinking water supply.

Consequence

The research referred to in **Section 4** indicates that there is inadequate data for an assessment to be made about the toxic and carcinogenic risk of acrolein in drinking water. Given this uncertainty a conservative approach would be required, this means that until proven otherwise, a risk of negative health impacts should be assumed. Therefore, detectible concentrations of acrolein in a drinking water supply should be assumed to represent a risk to public health. Engagement with Queensland Health would be required if detectible concentrations of acrolein were expected to be present in the drinking water supply.

Likelihood (Unmitigated)

An assessment of the unmitigated likelihood of there being detectible levels of acrolein in the drinking water supply would initially involve an assessment of the initial application of acrolein in the channel, and the decomposition of acrolein in the water prior to reaching the point of raw water extraction.

The research referred to in **Section 5** indicates that when dosed at a concentration typically associated with use as an aquatic herbicide for weed removal in irrigation channels, acrolein is expected to persist in the water for 6 days. In simple terms, if it could be demonstrated with confidence that the water age between the point of application and the point of extraction for drinking water treatment is greater than 6 days, the likelihood applied to the hazard would be expected to be low, and further mitigations may not be required.

This would likely also require empirical validation by way of water sampling to demonstrate the applicability of the research to the local context.

Potential Mitigations

If the water age between the point of application and the point of extraction is not demonstrated as sufficient to allow near complete natural degradation of the acrolein then other mitigation measures may be required. The following high-level mitigations may be appropriate:

- Limiting extraction to periods when acrolein is not being dosed. Given the research, it would be expected that this would result in shut down periods of up to 6 days from the time of application, but this would need to be confirmed based on local conditions; and

- Developing treatment processes (preferably multiple barriers) at the water treatment plant (WTP) to remove acrolein.

6.2 Recommendations

The following further steps are recommended:

1. Undertake hydraulic calculations to determine the expected water age in the system between the point of acrolein application and the point of raw water extraction. Note that the half-lives referred to above relate to water in a channel system and the degradation of acrolein levels in a pipeline may be different;

2. Liaise with the registered water service provider to determine if the risk of acrolein has already been considered in their approved DWQMP; and

3. Undertake a program of water sampling during an acrolein dosing period to determine the decay kinetics under local conditions.