Coliban Water

Epsom Spring Gully Recycled Water Project

Spring Gully Reservoir Risk Assessment

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1 Introduction

1.1 Project Overview

The Epsom Spring Gully Recycled Water Project makes use of both existing and new infrastructure to create a flexible and integrated water supply system within Bendigo.

Milestone 1 involves the following actions:

- Treatment at the Bendigo Water Reclamation Plant will be improved via installation of further UV capacity and new chlorination and de-chlorination equipment. A chlorine contact tank and final water tank will also be constructed;
- A 14 km pipeline to Spring Gully Reservoir will be constructed, with associated pumping facilities to transfer recycled water.

These improvements will enable recycled water to be supplied to a number of end users, including individual rural customers, public open spaces, standpipe users and industrial customers.

The recycled water to be supplied will be a mix of treated effluent from Coliban Water's Bendigo Water Reclamation Plant and treated groundwater from Bendigo Mining Limited. Both of these sources provide recycled water of very high quality.

1.2 Spring Gully Reservoir

Spring Gully Reservoir is located on the southern outskirts of Bendigo (refer to locality plan attached in Appendix 1). It is a service reservoir which supplies the Coliban rural channel system to the east and north-east of Bendigo. The capacity of the reservoir is 1680 ML.

Spring Gully Reservoir can be filled from the Lake Eppalock-Bendigo Pipeline, the Coliban Main Channel and now the Epsom Spring Gully Recycled Water Pipeline. It is also fed by a small catchment of 289 ha that is part of the headwaters of the Bendigo Creek. The catchment is entirely public land, used for water production purposes only.

This paper discusses the risks associated with storing recycled water in Spring Gully Reservoir and the management controls proposed for this element of the recycled water system.

2 Risk Assessment

2.1 Health Hazards

2.1.1 Regrowth of Pathogens

Of the four types of microorganisms identified for control (bacteria, viruses, protozoa and helminths) only bacteria are capable of regrowing in a recycled water system.

There is limited evidence to suggest that bacteria regrowth will occur, although there is some risk as a chlorine disinfection residual is not being maintained in the reservoir. However, the National Guidelines for Water Recycling state that “in general, enteric pathogens do not regrow in treated effluent or stormwater”. (Enteric pathogens are bacteria and parasites that do not normally reside in our gut and that can cause disease when they infest the gut.)

Monitoring of water quality will be undertaken to ensure that the water leaving the reservoir remains fit for purpose. The water will not be used for drinking. The reservoir is closed to the public and therefore is not used for swimming, fishing or other recreation purposes.

Risk Level = Low

2.1.2 Growth of Opportunistic Pathogens

Opportunistic pathogens are microorganisms that cause infections and disease under optimal conditions, commonly in the very young, elderly and immuno-compromised. These include Pseudomonas, Streptococcus, Flavobacterium, Legionellae and Aeromonas species. Little is known of the virulence of opportunistic pathogens and their human health significance within any water distribution system. They can be commonly isolated from a wide range of environmental water samples, including wastewaters. However, this very rarely translates into the incidence or reported outbreak of illness.

There is a wide range of factors that influence the extent of pathogen incidence, and the exact nature of this influence is largely unknown. Temperature, disinfectant residual, level of treatment and hydraulic conditions are considered important factors, and there is anecdotal evidence that elevated nutrient levels encourage pathogen growth.

Treatment of the recycled water has removed opportunistic pathogens from this source. Treatment has also significantly reduced the nutrient levels in the recycled water, so that opportunistic pathogens in the receiving environment have less potential to grow. However, residual chlorine levels will be essentially zero, as modeling by Beca indicates that chlorine will degrade during transport along the pipeline. This means that some risk of growth remains, particularly as there will be some nutrients in the recycled water.

There is potential for mixing of recycled water with raw water from Lake Eppalock, the Coliban Main Channel or the small catchment upstream of the reservoir. This water will be of very high quality and is not expected to have sufficient nutrients to cause the growth of opportunistic pathogens. For example water from Lake Eppalock has mean total nitrogen of 1.3 mg/l and mean total phosphorus of 0.04 mg/l. This is less than the recycled water.

Monitoring of water quality will be undertaken to ensure that the water leaving the reservoir remains fit for purpose. The water will not be used for drinking. The reservoir is closed to the public and therefore is not used for swimming, fishing or other recreation purposes.

In addition, Coliban Water will keep abreast of research relating to opportunistic pathogens. This is a very new issue and knowledge is rapidly improving. CSIRO and the CRC for Water Quality and Treatment currently have research projects underway.

Risk Level = Low

2.1.3 Contamination by Birds/Animals

Uncovered storages are subject to input of microorganisms from avian sources. Animals accessing the reservoir may also add faecal material and potentially die leaving a carcass. These aspects are managed through fencing and visual inspection of the reservoir.

Human waste does not enter the reservoir. The upstream catchment is public land used for water production purposes only.

The likelihood of contamination of water from birds/animals is almost unchanged from the present raw water supply. However, there may be some increase in the level of bird activity if the nutrients in the recycled water lead to increased fish production and algae growth.

Risk to human health is controlled by ensuring recycled water is not used for drinking or swimming. Water will remain suitable for livestock drinking.

Risk Level = Low.

2.1.4 Toxic Algal Blooms

The formation of toxic algal blooms occurs in conditions where there is high light exposure, high levels of nutrients (especially nitrogen and phosphorus) and warm, slow-moving water.

Spring Gully Reservoir has had blue green algae blooms in the past, although it is assigned a low risk rating by Coliban Water. The reservoir is in constant use and is designed to help ensure mixing of the water occurs (refer to 2.3.1 for further discussion). This may help to prevent algal blooms. The nutrients in the recycled water are slightly higher than the present raw water supply, resulting in an increased risk of algal blooms. However, the increase is not such that the risk rating should be raised from low.

The *Blue Green Algae Management and Response Plan* (Coliban Water, 2004) will continue to apply to monitoring and management of algal blooms in Spring Gully Reservoir. This plan includes threshold blue-green algal cell numbers that trigger actions, such as bypass of the reservoir or cessation of supply for stock drinking. Therefore if a toxic algal bloom does occur, downstream users will be protected from exposure.

Risk Level = Low

2.2 Environmental Hazards

2.2.1 Seepage to Surrounding Environment

Evidence of Seepage

Seepage through Spring Gully dam wall and its foundations (if any) is observed twice weekly and measured weekly at four sites. Following embankment/spillway works undertaken in 2003/04, there has been only one occasion at one of the monitoring sites on which any seepage was recorded. This occurred at a rate of 0.21 l/min.

The general permeability of the reservoir floor is unknown. Some seepage is expected to occur, but this is likely to be minimal. Use of the reservoir has occurred over a number of years and there is no evidence of significant leakage from the dam. Seepage from the reservoir will remain unchanged following use of recycled water and the recycled water is of high quality, with only minor increases in salinity and nutrients compared to the raw water supply.

Groundwater Depth and Quality

The following summary of groundwater depth and quality has been developed based on a search of the Victorian Groundwater Database, review of available literature/mapping and discussions with hydrogeologist Peter Hekmeijer (PIRVic, DPI).

The Spring Gully Reservoir site is underlain by Lower Ordovician shale, slate and sandstone. Groundwater moves through open fractures occurring within the upper 50 to 100m of these rocks. Groundwater depth varies, with bores in the area measuring 20 to 60m. In some instances, groundwater flow also occurs via the numerous underground tunnels created by historical gold mining activities. Old mine workings exist in the vicinity of the reservoir. However they are thought not to extend beneath the reservoir footprint.

Groundwater quality in the Bendigo district varies between 3,000 and 8,000 mg/L TDS. This is within the upper end of Beneficial Use Segment B (1000 – 3500 mg/L TDS) and the lower end of Beneficial Use Segment C (3500 – 13000 mg/L TDS). Groundwaters within these categories are suitable for stock water and industrial purposes. Segment B waters can also be used in irrigation.

In general shallow groundwater does not occur in the Bendigo area. The exception is that there are localised shallow groundwater systems that interact with the creeks running through Bendigo. A map showing depth to the watertable is attached in Appendix 2. This indicates that in the vicinity of Spring Gully Reservoir the depth to the watertable is >10m, whereas along the creeks it is <2m. These shallow systems are mapped as being within Beneficial Use Segment C (3500 – 13000 mg/L TDS).

In the north-east of Bendigo, there is another aquifer - the Huntly Deep Lead. Mapping shows that this does not extend as far south as Spring Gully Reservoir.

The salinity levels within the groundwater are high by comparison to the recycled water. Any seepage that does occur from Spring Gully Reservoir is unlikely to impact on beneficial use. Monitoring bores will be implemented to provide an ongoing assessment of impact.

Existing Bores

There are a number of bores in the vicinity of Spring Gully Reservoir (~45 within 5km). However, the vast majority of these are registered as non-groundwater (non-potable) bores not used for water extraction. It is thought that these may be old mineral exploration bores or similar. There are also salinity observation bores located along the Bendigo Creek and close to Kennington Reservoir, and some dewatering bores around Diamond Hill.

There are only five private bores and these are registered as being used for stock and domestic purposes. They are located to the south-east at Mandurang, and west at Kangaroo Flat. It is understood that groundwater in the Bendigo area generally flows towards the north, or north-west. Therefore it is unlikely that there will be any impact on the end use from these bores.

Management/Monitoring

Monitoring of seepage will be implemented using two methods – groundwater monitoring bores and measurement of a water balance in the reservoir (using water levels, inflows, outflows and climate data). These are discussed further in Section 3.2.

Risk Level = Low. Unchanged from present raw water supply.

2.2.2 Spills from the Reservoir

The Spring Gully embankment was upgraded in 2003/04 to ensure the reservoir meets current dam safety standards. Twelve standpipe piezometers are installed in the Spring Gully embankment for ongoing monitoring of embankment pore pressure.

Filling and drawdown of the reservoir will continue to occur subject to the conditions outlined in the *Spring Gully Reservoir O & M Manual* (Coliban Water, 2005). This sets limits on the rates to ensure prevention of piping failures in earthen embankments or slumping of the dam or reservoir basin. (Note: The capacity of the Epsom Spring Gully Pipeline is well below the filling limit).

The reservoir upgrade in 2003/04 also enhanced the spillway capacity to allow the Probable Maximum Flood to pass through the reservoir without overtopping the embankment.

The spillway for the reservoir is designed to discharge 3 m^3/s for a 1 in 100 year storm event and 84 m^3/s for the Probable Maximum Flood. In the event of severe wet conditions that could lead to flooding, supply of recycled water to Spring Gully Reservoir will cease. This will help to minimise any flow over the spillway. (Note: No spill has occurred since the spillway upgrade in 2003.)

The quality of the recycled water complies with requirements for direct discharge into local waterways. Any spill that does occur is unlikely to impact on the downstream environment.

Risk Level = Low

2.2.3 Increased Salinity due to Evaporative Concentration

Evaporation from open storages is approximately 7 ML/ha in the Bendigo climate. If the reservoir was maintained at 1700 ML across the entire summer, the salinity level could increase by approximately 14%, from 460 mg/L to 525 mg/L TDS (assuming a surface area of 30ha). In reality the water in the storage will be circulating during summer as it is used and the storage is topped up. Therefore the average salinity level supplied to the channel customers is unlikely to increase beyond 500 mg/L TDS. This is acceptable for the proposed end uses.

Salt levels in the recycled water will be reduced following a treatment upgrade in late 2007 through the addition of reverse osmosis. This will further reduce the risk due to evaporative concentration.

Salinity levels in Spring Gully Reservoir will be monitored on a monthly basis.

Risk Level = Low

2.3 Aesthetic Issues

2.3.1 Odour caused by Stagnation/Stratification

The reservoir will be in relatively constant use throughout the year, either filling or being drawn down or both. This will help to ensure prevention of stagnation. There is however a risk of odour in the event of an algal bloom. Refer to Section 2.1.4 for further details relating to algae.

The inlet and outlet structures are designed to prevent stratification. They help to ensure mixing within the reservoir to prevent portions of the water remaining in the storage for long periods of time. The inlet to the reservoir is via existing open concrete channel structure at the south-eastern end of the storage. The outlet from the reservoir is via the existing high and low level outlets at the northern end of the dam embankment.

The high level of treatment provided for the recycled water also helps to ensure that odour is unlikely to be produced.

Risk Level = Low

2.3.2 Airborne dust and algae increasing Turbidity

Discussion relating to algae can be found in Section 2.1.4.

Impact of airborne dust is unchanged from the current raw water supply.

Turbidity within the reservoir has not been a particular concern to date. This will not change through use as a recycled water storage.

Risk Level = Low

3 Management Controls

3.1 Existing Controls

The *Spring Gully Reservoir O & M Manual* (Coliban Water, 2005) outlines management controls in place relevant to filling, drawdown, seepage, embankment stability and access to the public. These will remain unchanged following implementation of the recycled water project.

A summary of these practices is as follows:

- The minimum operating level is EL 265.0, the normal operating level is EL 269.0 and the full supply level is EL 271.3.
- Filling should occur at <0.5 m/day (and preferably <0.3 m/day following prolonged periods of low water level);
- Drawdown should occur at <0.3 m/day (and where practicable <0.15 m/day, particularly after a prolonged period of high water level);
- Twelve standpipe piezometers are installed in the Spring Gully embankment for ongoing monitoring of embankment pore pressure. The standing water level is measured monthly;
- Seepage through Spring Gully dam and its foundations (if any) is observed twice weekly and measured weekly at four sites;
- The reservoir is closed to the public. Security fencing and signs are in place. Camping, boating, fishing, shooting and swimming are not permitted. The Reservoir Officer is authorised to enforce the regulations for control of public with Authority properties.

The *Blue Green Algae Management and Response Plan* (Coliban Water, 2004) will continue to apply to monitoring and management of algal blooms in Spring Gully Reservoir. This includes threshold blue-green algal cell numbers that trigger actions, such as bypass of the reservoir or cessation of supply for stock drinking.

3.2 Additional Controls

In addition to the existing management practices, the following will be undertaken:

- Monitoring of the water quality in Spring Gully Reservoir will be undertaken as outlined in Appendix 3;
- Use of the water exiting Spring Gully Reservoir will be in accordance with the relevant Health and Environmental Management Plan (HEMP). The water is not suitable for human drinking and will not be used for this purpose;
- In the event of severe wet conditions that could lead to flooding, supply of recycled water to Spring Gully Reservoir will cease to minimise the likelihood of spills;
- Monitoring of seepage from the reservoir will be undertaken via:
  - Installation of groundwater monitoring bores. The location and monitoring program will be designed in conjunction with PIRVic (DPI) hydrogeologists. It is planned to have the monitoring bores installed by the 1st of December 2007 provided that a drilling contractor can be procured. It is expected that monitoring will occur for

groundwater depth, salinity, nutrients, E.Coli and potentially some key contaminants;

- Calculation of a water balance based on monitoring of storage levels, inflows, outflows and climatic data. This will provide an indication of the amount of water being "lost" to seepage. There is generally a time-lag between seepage occurring and impact on groundwater. Use of a water balance is a more immediate method to identify the level of seepage.

- Coliban Water will keep abreast of research outcomes relating to opportunistic pathogens (or other relevant issues) and will update this risk assessment and monitoring/management practices as required.
- The *Spring Gully Reservoir O & M Manual* will be updated to account for the recycled water within the system and the additional management/monitoring practices outlined.
- Monitoring results will be reported in the recycled water scheme annual report to EPA. If monitoring detects adverse impacts on groundwater resources, appropriate investigations will be undertaken, and a plan will be developed for improvement actions to ensure that continual improvement is achieved.

3.3 Trigger Limits

Critical limits for water quality leaving Spring Gully Reservoir are as follows:

- Algal toxins - as per Blue Green Algae Management and Response Plan
- Turbidity - 10 NTU critical
- E.Coli - 5 org/100mL alarm, 10 org/100mL critical

These limits are detailed in the *Recycled Water Quality Management Plan* and the HACCP plan for the recycled water scheme.

If limits are exceeded, supply of recycled water from Spring Gully Reservoir to customers will cease (until water quality improves to within limits). This will be achieved by ensuring that both high level and low level hydraulically operated outlet valves upstream of the dam wall have been isolated / closed; and also that the offtake valves downstream of the dam wall to the Ascot Channel and the recycled water pipeline have also been isolated / closed. This will provide two levels of protection to any recycled water outside the critical limits being accidentally supplied to customers.

4 References

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Appendix 1: Site Locality Plan

Appendix 2: Depth to Watertable Map

Appendix 3: Water Quality Monitoring