

MANAGING COMMUNITY WATER SUPPLIES DURING RECHARGE OF THE YARRA VALLEY CONDUIT



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ABSTRACT

The Yarra Valley Conduit (YVC), along with the Yarra Silvan Conduits (YSC) move water from Melbourne's Thomson and Upper Yarra catchments into the metropolitan transfer system, via Silvan and Cardinia reservoirs. The Upper Yarra townships drinking water supplies are also taken directly off the YVC. A storm event in June 2007, where around 230mm of rain fell in the Upper Yarra and Thompson catchments in one night, resulted in high turbidity in the Upper Yarra reservoir with increased sediment deposited in the YVC. The transfer strategy for the 2007/2008 summer was to increase flows in the YVC significantly to meet the summer demands of the Silvan and Cardinia reservoirs. It was identified that this would create turbidities in the YVC much higher than experienced previously.

In order to prevent impact on the Upper Yarra townships, as well as the downstream reservoirs, the following plan was implemented:

- Conduct a sharp controlled increase in the YVC to flush out as much silt in as short a period as possible, and
- Change the Upper Yarra townships over to an alternative disinfected water supply during the flush.

This paper describes the challenges occurring as a result of the Upper Yarra turbidity incident, and the planning and implementation of the alternative disinfected water supplies to the Upper Yarra townships during the subsequent YVC recharge.

KEYWORDS

Storage reservoir management, turbidity, disinfection, incident management

1.0 INTRODUCTION

The Yarra Valley Conduit (YVC) is a vitally important asset in the Melbourne Water supply system. It enables the transfer of water from the Upper Yarra reservoir into the Melbourne metropolitan supply system via Silvan reservoir. The typical operating strategy for the YVC is for flows to fluctuate throughout the year in response to required storage levels in downstream storage reservoirs (Silvan, Cardinia).

The YVC and Yarra Silvan Conduits (YSC) all supply water from the Upper Yarra reservoir to Silvan reservoir (See Figure 1). Along the way, unfiltered water is supplied to Warburton, Warburton East, Yarra Junction and Woori Yallock townships in the Upper Yarra Valley. Water to the YSC first travels along the Yarra Silvan aqueduct for 11.4 km, whilst the YVC is an enclosed pipeline for its entire length. The YVC and YSC travel parallel to each other between Brahams and Lyrebird treatment plants and then separate. The YVC then travels north of Warburton and Yarra Junction, supplying water to the Martyr Rd and Yarra Junction treatment plants, whilst the YSC passes to the south of these towns. The two mains cross over downstream of Yarra Junction, with the YSC running alongside the Lusatia Park Treatment plant and terminating the northern end of

the Silvan reservoir. The YVC inlet to Silvan is at the southern end of the reservoir. In late 2007 the plan was for the flows in the YVC to be increased to supplement Silvan supply and also to enable transfer to Cardinia. The usual practice of recharging the main has always resulted in turbidity spikes. The flows had been much lower over the previous four months and the higher turbidity from the UY incident had deposited significant amounts of sediment in the YVC, hence high turbidities were expected.

It was decided that the recharge of the YVC would be managed along the lines of an incident, in that there was potential to impact community water supplies. The following sections describe the management of the original turbidity incident and the planning and implementation of the YVC recharge in December 2007, including provision of safe drinking water supplies to the Upper Yarra townships.

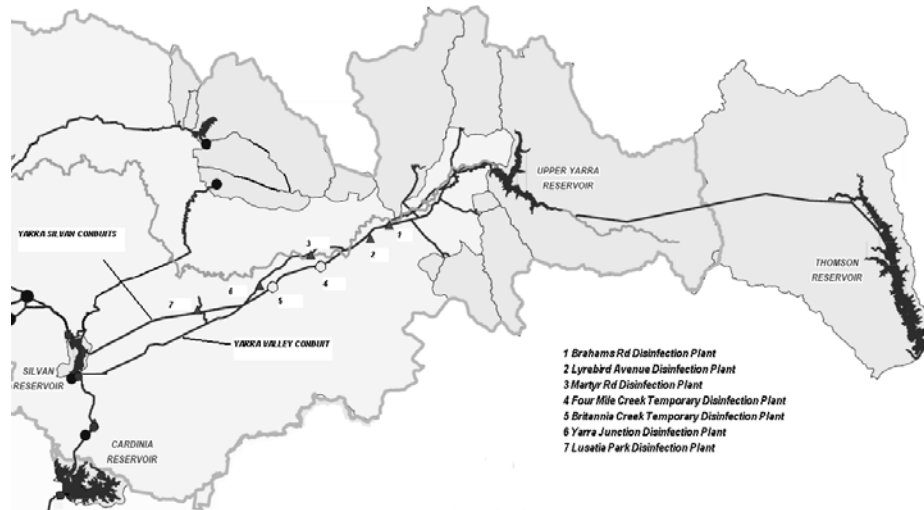


Figure 1: *Map of Thompson and Upper Yarra areas, including Upper Yarra and Silvan reservoirs, Yarra Valley and Yarra Silvan conduits*

2.0 THE UPPER YARRA RESERVOIR HIGH TURBIDITY INCIDENT

On the 27th of June 2007 a storm event, where around 230mm rain fell in the catchments overnight, resulted in record volumes of highly turbid water entering the Upper Yarra reservoir. Due to the previous year's drought and the resulting low levels in the Thompson and Upper Yarra reservoirs, exposed banks contributed high silt loads into the reservoirs.

Other contributing factors to the high turbidity in the Upper Yarra reservoir were;

- The previous year's fuel reduction burn which reduced the natural ground filtration in the catchment.
- Around 4 GL of high turbidity water which entered the Upper Yarra reservoir via Swingler weir prior to this supply being turned out.

In addition to these contributing factors, subsequent hydraulic modelling showed that short circuiting of highly turbid water was occurring in the Upper Yarra reservoir directly to the outlet, along the bottom of the reservoir.

In the following weeks, water at the outlet of the Upper Yarra consistently increased in turbidity, reaching a maximum of almost 30 NTU around the middle of July 2007. The turbidity at the outlet of the Upper Yarra reservoir stayed above 20 NTU for several weeks. Melbourne Water's operational response to this incident was to;

- adjust the offtake level in the reservoir to supply the lowest turbidity water,
- reduce flows in the YVC and YSC to slow the progress of the high turbidity water and aid in silt settling, and
- increase water quality monitoring to determine any risks to public health and manage customer impacts.

In addition to the above, boiled water notices were issued to the Yarra Valley townships in the middle of July 2007 and were in effect through to the middle of August. The boiled water notice was issued as a precautionary measure, as the major problem with such high turbidity water is that primary disinfection of town water supplies in the Upper Yarra is performed by UV. There was no certainty that the UV disinfection plants would be able to adequately disinfect water with turbidity above 20 NTU. A comprehensive program of pathogen monitoring along the YVC between Upper Yarra and Silvan reservoirs was carried out for the presence of Cryptosporidium and Giardia during the boiled water notice, and continued for a period of time after the notice was lifted. Flows remained low in the YVC until late 2007 until the turbidity in the Upper Yarra reservoir had returned to close to normal operational levels (around 1 NTU). Summer flows in the YVC were established after a carefully planned flush of the conduit, as described in the following sections.

3.0 THE UPPER YARRA TO SILVAN TRANSFER STRATEGY

The normal summer transfer strategy for the YVC is for flows to be increased to between 630 and 720 ML/d, with a variable flow in the YSC. This strategy is used to manage the water levels in Silvan and Cardinia reservoirs. In order to achieve the required summer flows without significant turbidity increases in the wider Melbourne Water supply system, the following strategy was implemented:

- Oct to mid November: supply Silvan and Cardinia using low flow in the YVC whilst maximising harvest from O'Shannassy reservoir and the Tributaries via the YSC .
- Demand on Silvan was kept to a minimum by maximising supply from other reservoirs to the Melbourne metropolitan distribution system. Hence, Silvan and Cardinia would maintain a good level during this period.
- Flush the YVC into Silvan reservoir in late November/ early December
- Begin high transfers to Cardinia by early December following acceptable water quality measured in Silvan Reservoir.

For the recharge, flow in the YVC was to be increased at a higher than normal rate to gain maximum suspension of silt that had settled in the conduit during the high turbidity incident. This created two major operational issues for Melbourne Water. The first and most immediate problem was the potential increase in turbidity and associated health implications to the Upper Yarra community water supplies. The second (and potentially more significant) was the downstream impact on the water quality in the Silvan reservoir. Silvan is the transfer hub for much of Melbourne's unfiltered water supply and hence a major turbidity incident in this reservoir could not be risked.

It was decided to install a silt curtain in Silvan Reservoir as a barrier against high turbidity water entering Silvan. The townships would be isolated for the YVC and provided with an alternative disinfected water supply from the YSC. It was also decided to rapidly increase the flow during the recharge over a two hour period. Systematic monitoring of the turbidity and water chemistry along the YVC was performed to better understand the impact of flow changes. Water supply to the Upper Yarra towns from the YVC was planned to be returned to the off takes once the turbidity had decreased to the same level as in Upper Yarra reservoir.

4.0 ALTERNATIVE DISINFECTED WATER SUPPLY ARRANGEMENTS

During the recharge of the YVC it was decided that the Upper Yarra townships would be provided with a disinfected water supply from the YSC. Some townships (East Warburton, Woori Yallock) were able to be connected to the existing plants at Brahams Rd, Lyrebird Avenue and Lusatia Park, via simple cross connections between the YSC and the plants. However the YVC and YSC run north and south of the townships of Warburton and Yarra Junction, making use of the existing treatment plants at Martyr Rd and Yarra Junction impossible. In order to secure a disinfected water supply for these townships during the flushing of the YVC, temporary disinfection plants were set up at Four Mile Creek and Britannia Creek, at off takes to the YVW retail distribution system. The plant at Four Mile Creek serviced Warburton and Britannia Creek serviced Yarra Junction.

4.1 Flow control in the YSC

The YSC is predominately a duel pipeline system. The YSC connects Upper Yarra Aqueduct to Silvan Reservoir. From the aqueduct two penstocks control the flow into each of the YSC mains. At Mt Little Joe, the two mains spill into a holding basin and flow into a single buried tunnel called Mt Little Joe Tunnel. Flow into this holding basin is controlled by two penstocks, one for each main. At the end of the tunnel the flow spills into a second holding basin. From the holding basin, flow is returned to a duel pipe system through to Silvan Reservoir. The YSC also takes water from two tributaries, as well as the O'Shannassy reservoir. When the YSC is used to provide water supplies to the Upper Yarra townships, these water sources must be turned out, due to variability in water quality.

It was proposed that only the north YSC be used for water supply to the towns and be reduced to low flow (roughly 30ML/day) during the flush of the YVC. Hence flow through the second conduit needed to be stopped during the flush. This was achieved by closing its associated penstock at Upper Yarra Aqueduct, and the penstocks, allowing entry and exit from Mt Little Joe Tunnel. In this way, the two conduits were completely isolated from each other. This was a necessary measure as it ensured 100% of the supply drawn from the YSC was disinfected by the treatment plant at Four Mile Creek.

4.2 Location of Four Mile Creek temporary disinfection plant

Figure 2 shows the details of the temporary disinfection dosing point and YVW offtake. Based on flow and chlorine CT calculations it was proposed at Four Mile Creek to dose 12.5% sodium hypochlorite directly into the north YSC.

A target chlorine residual of 0.5mg/L was calculated to achieve a CT of 6mg.min/L, prior to the water entering the YVW network. In other words, CT 6 would be achieved for all customers downstream of the YVW off take at Four Mile Creek. Discussions with the DHS reached agreement that a CT of 6 was an acceptable level of disinfection for customers at Four Mile Creek during the temporary supply period. In order to achieve a CT of 6 mg.min/L the dose point was located roughly 74m upstream of the YVW off takes.

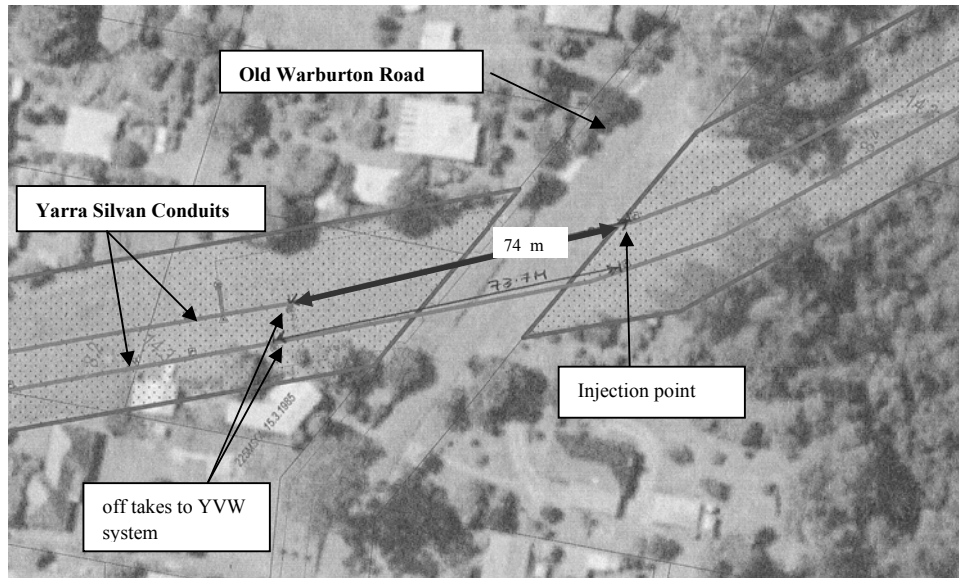


Figure 2: *Location of temporary disinfection system at Four Mile Creek.*

4.3 Location of Britannia Creek temporary disinfection plant

As all of the water in the north YSC had been dosed at Four Mile Creek, the water drawn off at Britannia Creek would have already received primary disinfection. At 30ML/day it was calculated that it would take approximately 16 hours for the dosed water to travel from Four Mile Creek to Britannia Creek. For this reason, dosing at Four Mile Creek began the day prior to the water supply being switched from the YVC to the YSC. From initial start up of the plant at Four Mile Creek, the chlorine residual was monitored along the YSC main, both at and downstream of Four Mile Creek. This gave a clear indication of initial chlorine demand and decay. At Britannia, 12.5% sodium hypochlorite was dosed prior to the water entering the YVW network. The aim at Britannia was to restore the chlorine residual to 0.3 mg/L, achieving secondary disinfection only. CT was not a requirement for this facility prior to entry to the reticulation network (the primary disinfection was provided by the plant upstream at Four Mile Creek). The DHS approved this arrangement for the temporary supply period at Britannia Creek, deeming the upstream disinfection sufficient.

4.4 Changing over water supplies to townships

As mentioned previously, the YVC recharge was managed along the lines of an incident with cooperation between MWC and Yarra Valley Water representatives. Prior to the YVC recharge a number of preliminary activities were carried out:

- The hydraulic capability for supply to Warbuton and Yarra Junction of the alternative offtakes at Four Mile Creek and Britannia Creek were verified by

MWC and YVW representatives.

- The alternative offtakes were field tested to verify the working state of valves etc,
- A detailed Operational Change Control Plan was prepared.
- YVW representatives carried out mains flushing in order to prepare for the new flows to Warbuton and Yarra Junction via the alternative offtakes.
- Incident management teams were mobilised by MWC at Silvan reservoir and by YVW at Mitcham office for the duration of the recharge.

In order to ensure a safe and successful recharge of the YVC, a number of hold points were agreed by MWC and YVW representatives. These included; verification that the Four Mile Creek disinfection plant was operating correctly, determining that the YVW offtakes were ready to be opened and that all flushing had been completed in the YVW distribution system, and ensuring that both Warburton and Yarra Junction had sufficient supplies of disinfected water from the alternative offtakes. Once these hold points were verified the YVC recharge could proceed.

5.0 CONCLUSIONS

Management of the impact of reduced water quality on community water supplies, as a result of extreme weather events, poses significant challenges to Australian water operators. This paper presents a case study of the management of such an incident in the Upper Yarra and the subsequent actions taken to maintain security and safety of water supply. Management of the YVC recharge from minimum to maximum flows, using an incident style method of management, proved to be a successful exercise. It enabled a flow change from minimum to full flow without impact on community water supplies or water quality in the downstream reservoirs. The recharge also provided some valuable insights and learning opportunities regarding the effective implementation of temporary disinfection systems.

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- MWC Operations Technical Support team
- Yarra Valley Water
- MWC Infrastructure (Civil Assets) team
- Transfield (alliance partner)