Water Quality Issues

Friends of the Earth

Ballarat
Bendigo
Benalla
Water supplies

January 2005 - March 2010

BALLARAT
BENDIGO
BENALLA

Friends of the Earth

By Anthony Amis

Water Quality Report 2005/2010

Perpetual

Funded by the Estate of the Late Blanch Brooke Hutchings, managed by Perpetual.

Lake Eppalock - November 2009

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This report looks at the land use contained in the water supplies of three regional Victorian Communities. The communities are Bendigo, Ballarat and Benalla. The study focuses on the years 2005-2010 with the main attention placed on the risk of pesticide movement from agricultural land into water supplies.

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2005-2010, were for water authorities, the most difficult they may ever encounter. Victoria was in the grip of serious drought conditions. Ballarat and Bendigo almost ran out of drinking water and authorities were forced by necessity to construct a pipeline to connect these cities to the irrigation water supply of the Goulburn River system. Arguably, the Goldfields Superpipe marked the largest ever 'shake-up' of water infrastructure for Ballarat and Bendigo. Benalla's water supply was also impacted as a result of the Tolmie fires in January 2007 which effectively burnt out almost the entire water supply catchment for the town. The February 2009 bushfires in the headwaters of the Goulburn River system also most likely impacted on water quality.

To provide safe drinking water during these trying times, must have been a difficult exercise and credit must be given to the three water authorities (Coliban Water, Central Highlands Water and North East Water) that had the responsibility of supplying drinking water to Ballarat, Bendigo and Benalla.

This report in no way should be seen as being critical of the performance of the water authorities. The report is basically a collation of information, sourced from a range of publications, which may enlighten the reader to better understand where their drinking water is sourced from and the type of land use that occurs within the areas where the water is sourced.

The Ballarat supply includes ~22 different communities. It was decided to limit the study to impacts of water supplies ~15km from Ballarat. This then would include; Ballarat Central, Ballarat North/Nerrina, Bungaree, Buninyong/Mt Helen, Cardigan Village, Haddon, Napoleons, Sebastopol and Wendouree. Communities such as Ballan, Creswick, Enfield, Fiskville, Glenmore, Gordon, Lal Lal, Linton, Mt Egerton, Skipton, Smythesdale and Wallace were outside the scope of this study even though their drinking water comes from the same source as Ballarat. Dean was also not included in this study, as their drinking water is sourced from a separate supply.

For the sake of consistency the Bendigo supply system was treated the same way as Ballarat. Communities within 15km of Bendigo were included in the study including; Big Hill, Epsom, Junortoun, Maiden Gully, Marong, Spring Gully and Strathfieldsaye. Axedale however was not included.

In late 2009, Friends of the Earth produced an unpublished list compiling which town in Victoria has the best quality drinking water based on assessing maximum result readings from all Water Authority Water Quality Reports published by the Victorian Government over the 2007/8 year. The list compiled all the results for the 472 communities in Victoria who have treated drinking water.

It would appear that from assessing this list, Bendigo had the best quality water in 2007/8 in terms of health and aesthetic factors when comparing Bendigo, Ballarat and Benalla. Time constraints have not allowed a similar report to be conducted for 2008/9 or other years included in this report, yet it is Friends of the Earth's opinion that the list is useful in determining where Ballarat, Bendigo and Benalla sit in relation to water quality with to the rest of Victoria.

2007/8 ratings from Victoria Wide Survey

126. Bendigo Southern (Coliban Water)
129. Bendigo Northern (Coliban Water)
143. Strathfieldsaye (Coliban Water)
144. Maiden Gully/Marong (Coliban Water)
180. Ballarat North/Nerrina (Central Highlands Water)
186. Big Hill (Coliban Water)
199. Buninyong/Mt. Helen (Central Highlands Water)
227. Junortoun (Coliban Water)
244. Bendigo Spring Gully (Coliban Water)
256. Bungaree/Wallace (Central Highlands Water)
286. Benalla (North East Water)
290. Napoleons (Central Highlands Water)
350. Haddon (Central Highlands Water)
358. Sebastopol(Central Highlands Water)
362. Cardigan Village (Central Highlands Water)
386. Ballarat Central (Central Highlands Water)
397. Wendouree (Central Highlands Water)

Key Findings

*Of the three communities, Ballarat district had the most breaches to the Australian Drinking Water Guidelines (ADWG), several times the breaches recorded for Bendigo and Benalla combined.

*The Ballarat breaches were dominated by aesthetic issues (mainly pH, Total Dissolved Solids and Hardness), however lead detections were frequent in 2006/7, with Haddon recording a lead reading 63 times above the ADWG in 2006/7. Ballarat Central recorded high lead levels at least once during 2006/7, 2007/8 and 2008/9.

*Blue Green Algae was detected in most of the reservoirs that provide Ballarat and Bendigo with drinking water.

*Manganese has been a problem in Ballarat and Bendigo storages.

*The algal generated toxins MIB and Geosim were detected by Central Highlands Water in White Swan Reservoir.

*Lack of adequate pesticide testing by Coliban Water and Central Highlands, particularly for pesticides currently used in agriculture. This is strange because agriculture is the main land use within the water supplies of Bendigo and Ballarat. According to data supplied by Drinking Water Quality Reports. Central Highlands Water (Ballarat) and Coliban Water (Bendigo) test for only a fraction of currently used pesticides within their catchments. Friends of the Earth estimates that in the Ballarat catchments, 59 pesticides of high risk to water quality could be used and for Bendigo catchments 38 pesticides of high risk to water quality could be used within those catchments.

*Lack of adequate testing by water authorities for a range antibiotic and hormone products used in agricultural, particularly in the dairy industry. Some of these substances are known endocrine disruptors (for lists see Appendix 1).

*Pesticides are not regularly tested for at Lake Nagambie, Waranga Basin or Waranga Western Channel by Goulburn Murray Water. Small traces of Atrazine and Endosulfan were detected in Waranga Western Channel and Lake Nagambie in a 3 year study conducted by Goulburn Murray Water published in 2006 (39). Bendigo and Ballarat are now connected to the Waranga Western Channel via the Goldfields Superpipe.

*Endosulfan detected in Lake Nagambie/ Goulburn Weir in the Goulburn Murray Water study (39) is likely to have been sourced from cropping, not fruit and vegetable growing as suggested by the EPA. (32)

*Without the Goldfields Superpipe Bendigo and particularly Ballarat could have run out of water.

*Reservoir Levels dropped considerably particularly between April 2007-April 2008, with White Swan (Ballarat) 6.7% April 2008, Lake Eppalock (Bendigo) <1% April-July 2007, Newlyn (Ballarat) 3% May 2007, Lake Eildon (Ballarat/Bendigo) 5% May 2007 and Waranga Basin (Ballarat/Bendigo) 3% 2003.

*Weed control in Lake Nagambie could cause potential pesticide problems for downstream users (Ballarat and Bendigo).

*Waranga Western Channel is connected to potential agricultural runoff at Groves Weir, 7km south east of Colbinabbin.

*Very turbid water detected in Puckapunyal Military Base, (up to 20 times higher than the ANZECC Guidelines for Freshwater in lowland rivers) in water monitoring conducted for the Department of Defence. Water leaves the 40,000 ha Puckapunyal site less than 20 km upstream of Goulburn Weir and the off takes to the Waranga Basin. Total sediment and toxicant loads from Puckapunyal remain unknown.

*Plantations. Central Highlands Water owned plantations could be using between $17.7 million and $26.6 million worth of water per year. Foreign owned plantations in Benalla's catchments could be using $11 million of water per year.

*Logging of native forest, particularly in the ash forests of the Goulburn system likely to use vast quantities of water.

*According to Water Quality Reports Coliban Water test for the least number of Organic Compounds of the three water authorities studied.

*In October 2008, Coliban Water purchased 6900ML of water from the Murrumbidgee region of New South Wales. The quality and exact source of this water could not be determined in this study.

1b. Recommendations.

1. Increase pesticide monitoring by Central Highlands Water to take into account currently used pesticides in the catchments of Ballarat as well as pesticides used in the Goulburn Catchment above Lake Nagambie.

2. Increase pesticide monitoring by Coliban Water to take into account currently used pesticides in the catchments of Bendigo as well as pesticides used in the Goulburn Catchment above Lake Nagambie.

3.Implement recommendations made by Friends of the Earth and the National Toxics Network in relation to the 2008 Friends of the Earth Report 'Survey of Pesticides in Surface Waters of Domestic Water Supplies' (see below).

4.Goulburn Murray Water, in conjunction with Coliban Water and Central Highlands Water need to increase pesticide monitoring to include Lake Nagambie, Waranga Basin and Waranga Western Channel (including Groves Weir)

5.Coliban Water, Central Highlands Water and Goulburn Murray Water need to start programs which monitor for antibiotic and hormones in drinking water associated with runoff from agricultural practices such as Dairying.

6. Water authorities need to be in better contact with the Department of Defence regarding water testing leaving Puckapunyal Commonwealth Area via Major Creek into the Goulburn River. A monitoring program needs to start focussing on a range of toxicity testing that may be associated with military training exercises.

7.Water authorities should investigate impacts of tree plantations within their domestic water supplies in terms of loss of revenue associated through water consumption by the plantations.

Those recommendations were/are;

In 2008 Friends of the Earth published a Report looking at impacts of pesticides in domestic water supplies in Victoria (63). The recommendations from that report still hold as being what should be enacted for Bendigo, Benalla and Ballarat.

1. Water authorities must undertake detailed catchment surveys to determine which pesticides are being used in what volumes in different parts of their catchments to aid in the design of more effective monitoring programs. Catchment protection should be a priority including multiple barriers to prevent pests and toxic chemicals getting into waterways. Rapid implementation of water protection policies also needs to occur.

2. Water authorities must be transparent and accountable in relation to pesticide monitoring in water supplies. The number of pesticides tested and the frequency of testing needs to be reviewed to ensure the programs are relevant and are measuring currently used pesticides.

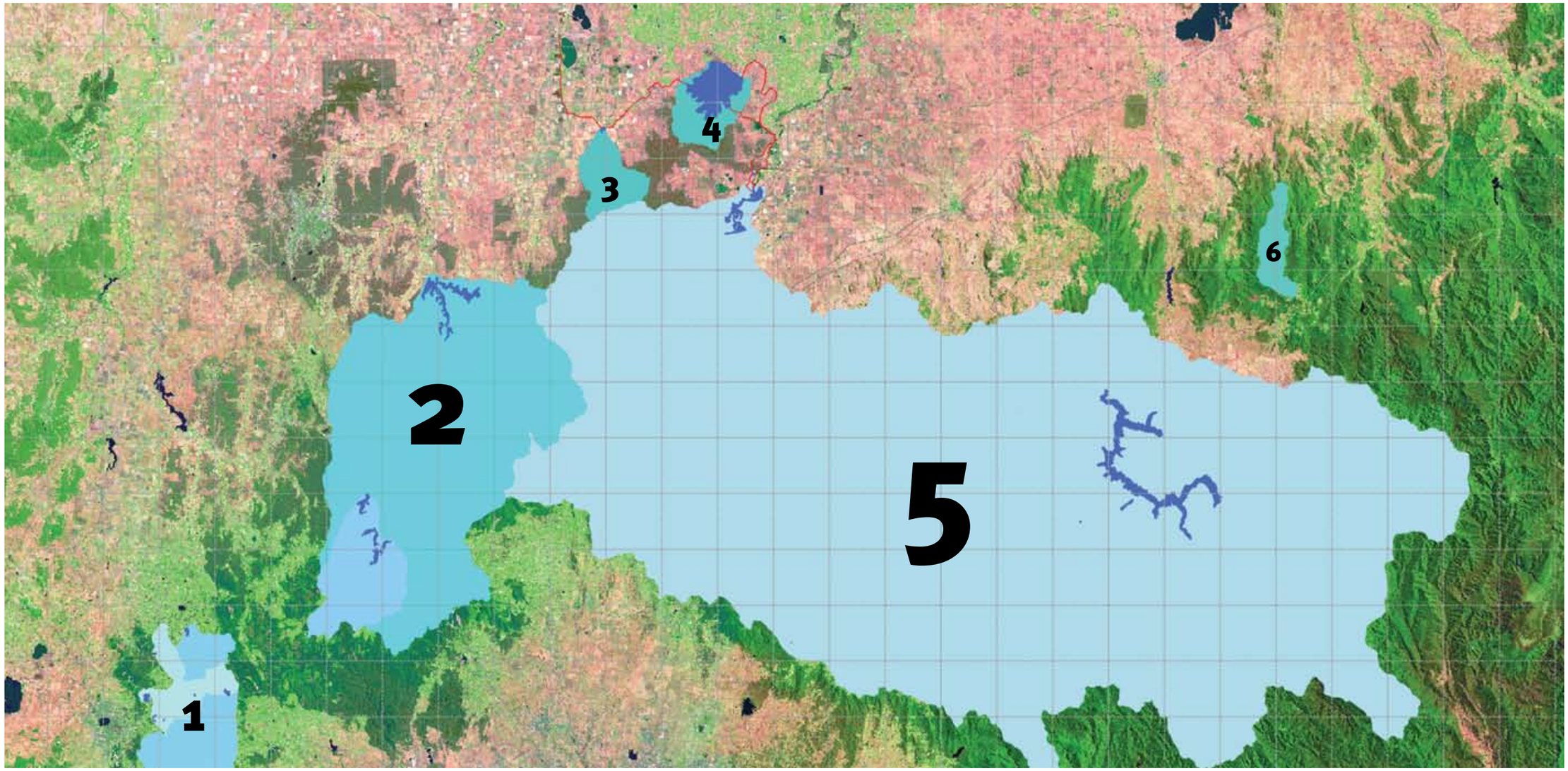
3. A list of Restricted Use "Water Supply" pesticides must be determined by the Department of Primary Industries, after public consultation, and circulated to all pesticide users within domestic water supply catchments. This could be regarded as an extension of the current 'restricted use' provisions already in operation. If restricted pesticides continue to be detected they should be banned from use in domestic water supply catchments.

4. The pesticide control of use legislation must be amended to require commercial users of pesticides operating in domestic water supplies, to maintain records for an indefinite period. Copies of pesticide records should be made available to water authorities and the DPI.

5. Positive pesticide detections must be followed up with an investigation by water authorities and/or the DPI to determine the source of the pesticide contamination. Remedial action must be taken to stop the source of pesticide contamination entering waterways. Positive pesticide results, at any level must be made public by water authorities.

6. Water authorities managing high risk catchments should invest in water treatment facilities which incorporate the use of treatments to remove pesticide residues such as carbon filters and/or reverse osmosis filtration.

Water Supply location map for Ballarat Bendigo Benalla



1 - Ballarat Water Supplies

2 - Colliban System (Bendigo)

3 - Groves Weir (Ballarat and Bendigo)

4 - Waranga Basin (Ballarat and Bendigo)

5 - Goulburn System (Ballarat and Bendigo)

6 - Ryans Creek (Benalla)

BENALLA

Ryans Creek lies on the northern section of the Tolmie Highlands and is part of the Broken River catchment. The water supply is almost completely forested with Wet Schlerophyll (Manna Gum, Messmate & Blackwood) dominating the headwaters, with Narrow-leaf peppermint and Candlebark on the drier sites. There are also ~800ha of pine plantations located in the upper reaches of the catchment managed by Hancock Victorian Plantations. Erosion hazard on the steep slopes is high. Parent rocks in the catchment are Upper Devonian porphyritic dacites. The headwater region near Acherton is on basalt, with the majority of the rest of the catchment located on acid igneous type rocks.

Source of Water Supply: Ryans Creek (McCallsay (1000ML) and Loombah Reservoirs (740 ML)). (Raw water from Loombah Reservoir is piped to Kelfeera Service Basin and then piped to Benalla Treatment Plant).

Water Authority: North East Water.

Loombah Weir is situated 30km south east of Benalla, with the catchment being 8000ha in size. As of early February 2010, Benalla Reservoirs held ~90% of capacity. Bulk Water Entitlement (North East Water) 2324ML.

Treatment: Flocculation, Floatation, pH Correction, Chloramination (Added substances: (Powder Activated Carbon, Potassium Permanganate available). Aluminium sulphate, Soda Ash, Ammonia, Chlorine).

Fluoridation started in Benalla December 2009.

MAIN WATER QUALITY ISSUES:

Main problems appear to be with aesthetic issues. According to Water Quality Reports published by North East Water, in 2004/5 aluminium readings were recorded above Australian Drinking Water Guidelines (ADWG) Aesthetic Guidelines and almost above ADWG guidelines in 2005/6. In 2006/7 and 2007/8 Manganese readings were above Aesthetic guidelines (in 2006/7 by three times). Relatively turbid water was also recorded in 2007/8 and 2008/9. In 2007/8 Benalla recorded one Iron level over the ADWG aesthetic limit. Overall the quality of Benalla's drinking water appears to be good.

In January February 2007, low reservoir levels at Benalla meant elevated levels of manganese which caused discolouration to the water. Additional water quality monitoring was needed and additional water treatment methods were implemented.(1)

Almost all of the catchment consists of native forest, most of which was burned in the January 2007 fires. These burnt forests will, in the future, consume large amounts of water.

Climate Change Affected Yield will drop from 1700ML (2004-5) to 1200ML (2054-55) (2). Total demand 1800ML (2004-5), 3200ML (2054-55). Additional entitlements are held on the Broken River, with a possible pipeline from the Broken River being suggested. Location of the future pipeline was not determined in this report.

History:

Ryans Creek Catchment (Benalla Water Supply) was prepared for consideration by the Land Utilization Advisory Council in February 1970. A Land Use Determination of the Ryan's Creek Catchment was prepared by the Land Conservation Council in June 1974. Ryans Creek was declared a Special Area (Water Supply Catchment) on October 30 1974 (covering 7,964ha). Hardwood logging was then the dominant land use, with pine plantations planted on both ex native forest sites and ex farmland. Fire burnt through almost all of the catchment in December 2006/January 2007. 33,000ha of forest in the region was burnt in the Tatong fires, including 1,100 ha of pine plantations. The fires burnt right up to the surrounds of Loombah Weir and McCallsay Reservoirs.

Potential Problems: In 1983 the Forest Commission conducted research into the aerial application of 3,6-DCPA (Lontrel) into 56ha's of pine plantations near Archerton in Benalla's water supply. The Lontrel was sprayed at 2.5kg/ha and stream water was sampled just below the sprayed area and at a point 13km downstream over a 19 day period. During this time there were seven substantial rainfall events totalling 143mm. The highest recorded level of Lontrel was 15ug/L detected just below the sprayed area, whilst at the downstream sampling point, Lontrel was detected at 1ug/L.
(3) According to Freedom of Information documents sourced by Friends of the Earth, in late 1993 175ha of silver Wattle was sprayed with 1496 litres of Lontrel. Little is known of how much of the pesticide was washed downstream. Lontrel is listed by the Pesticide Action Network as being a potential groundwater contaminant.

Theoretically any runoff would be concentrated in McCallsay Reservoir as this is the reservoir that would collect the residues first. It is however possible that Loombah Weir could also be affected. Loombah Weir lies about 13km downstream of the nearest plantation headwaters on Whiskey Creek and the 1983 Forest Commission study did detect Lontrel 13km downstream.

Approximately 800ha pine plantations located in the catchment are managed by Hancock Victorian Plantations, who own the plantations in perpetuity. (Theoretically these plantations could be using 7200ML of water per year. The current price of water paid by North East Water customers is $1564.50 meaning that these plantations could be using $11,264,400 worth of water per year. This means potentially that one hectare of plantation in the Ryans Creek catchment could be worth $14,080/yr in terms of the water that the plantation uses. This is far greater than the $4000-$5000ha that Hancock paid for the plantations when they purchased them from the State Government in 1998).

Very little native forest logging appears to be now occurring within the catchment, however an as yet undetermined amount of water will be reduced in the catchment due to the recent 2007 bushfires and past logging practices.

BENALLA CONTINUED

Herbicides used on Pine Plantations in North East Victoria by Hancock Victorian Plantations. (Unsure whether herbicide application by State Government in the Ryans Creek Catchment followed January 2007 fires).

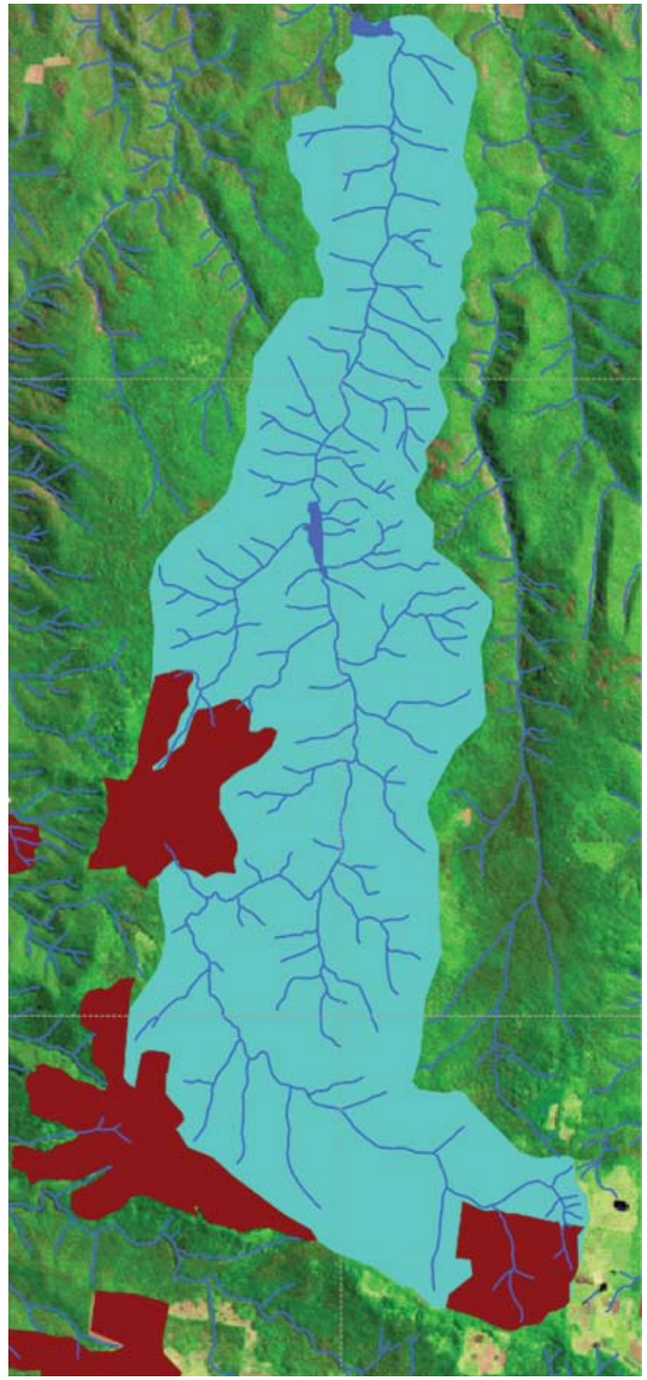
Carfentrazone-Ethyl, Clopyralid, Glyphosate, Hexazinone, Metsulfuron-Methyl, Triclopyr.

What Pesticides North East Water test for (annually): 2,4-D, Aldrin, Amitrole, Atrazine, cis-Chlordane, DDT, Dieldrin, Endosulfan 1, Endosulfan 2, Endosulfan Sulphate, Glyphosate, Heptachlor Epoxide, Hexazinone, Lindane, Methoxychlor, trans-chlordane. (Note: Aldrin banned 1994, Chlordane banned in 1997, DDT use banned in 1990, Dieldrin banned 1988, Heptachlor banned 1997, Lindane dergistered in 1985, Methoxychlor banned 1987).

14 pesticides tested, 7 deregistered = 7 currently used pesticides. Testing occurs for only 1/6th of the pesticides used on pine plantations in the Ryans Creek catchment.

Organic Compounds tested for by North East Water: 1,1-Dichloroethane, 1,1-Dichloroethene, 1,2-Dichlorethane, 1,2,3-Trichlorobenzene, 1,2,4-Trichlorobenzene, 1,2-Dichlorobenzene, 1,3-Dichlorobenzene, 1,4-Dichlorobenzene, 2,4,6-Trichlorophenol 2,4-Dichlorophenol, 2-Chlorophenol, Benzene, Benzo[a]pyrene, Carbontetrachloride, CIS-1,2-Dichloroethene, Ethylbenzene, Hexachloro-1,3-Butadiene, M-&_P-Xylene.

Map of Ryans Creek Water Supply



Native Forest within Ryans Creek

Hancock Victorian Plantation

BALLARAT

Ballarat drinking water is treated by two treatment plants, White Swan and Lal Lal (there is also a disinfection plant at Ballarat West). The treatment at each plant varies slightly. Chloramination is used in both plants. White Swan treats the water with lime, aluminium sulphate, Poly electrolyte, chlorine gas, aqueous ammonia. Powder Activated Carbon and Potassium Permanganate are used if required. Lal Lal's process is the same except soda ash is used instead of lime. (19).

Fluoridation started in Ballarat in November 2009.

According to a US EPA 2001 report published in the United States, "conventional treatment has little or no effect on the removal of mobile (hydrophilic or hydrophobic) pesticides...Powder Activated Carbon (PAC) filtration, Granulated Activated Carbon (GAC) filtration and reverse osmosis (RO) have been demonstrated to be highly effective processes at removing organic chemicals, including certain pesticides (primarily acetanilide herbicides), but specific data on removal of most pesticides are not available". (64)

Treatment: Conventional DAFF plants situated on White Swan and Lal Lal Reservoirs under 25 year contract with United Water (95% owned by Veolia Water). (DAFF is Dissolved Air Filtration Flotation plant). For definition see here: http://www.waterit.com.au/index.php?q=node/58

COMMUNITIES SUPPLIED: THE BALLARAT SUPPLY

Supply Includes ~22 different communities. For this study it was decided to limit the impacts of water supplies ~15km from Ballarat. This then would include; Ballarat Central, Ballarat North/Nerrina, Bungaree, Buninyong/Mt Helen, Cardigan Village, Haddon, Napoleons, Sebastopol and Wendouree. Communities such as Ballan, Creswick, Enfield, Fiskville, Glenmore, Gordon, Lal Lal, Linton, Mt Egerton, Skipton, Smythesdale and Wallace were outside the scope of this study even though their drinking water comes from the same source as Ballarat. Dean was also not included in this study, as their drinking water is sourced from a separate supply.

Source of Water Supply: Ballarat initially sourced its drinking water from Gnarr Creek (1852) and Lake Wendouree (construction began 1858). Water from both these sources was deemed unsatisfactory. Kirks Reservoir was purchased and then enlarged by the local municipality. By 1891 there were five reservoirs in use.

Moorabool Reservoir* (6738ML) was completed in 1915, White Swan (14,107ML) was completed in 1952 and Lal Lal (60,000ML) was constructed in 1972, although Lal Lal water was also shared with Geelong, under the West Moorobool Water Act. This act specified that Ballarat Water Board was entitled to 2/3rds of the supply and the Geelong and District Water Board entitled to the remaining residual yield.

(*The Moorabool supply system also has a number of smaller reservoirs. (see below)).

In regards to the catchment use of the Moorobool reservoirs the following descriptions were written in 1979 and are still useful to use now (please note that Ballarat Water Commissioners would now read as Central Highlands Water);

Moorabool (1915): 3026ha: 60% forested, remainder potato cropping and dairying.
Wilsons (1891): 841ha: Ballarat Water Commissioners 500ha. Remainder potato cropping/freehold.
Pincotts (1867): Leigh Creek, northern slopes of Mt Warrenheip.
Gong Gong (1877): 2553ha, mostly freehold, used for grazing and potatoes, also Ballarat Water Commissioners.
White Swan (1952): 1117ha mostly native forest and Ballarat Water Commissioners (4).

Due to the recent drought Central Highlands Water has also had to add capacity to their water supply network. This was done by the commissioning of the Goldfields Pipeline in 2008.

Cosgrove Reservoir (once water supply for Creswick) was also reconnected to the Ballarat system in 2006. Newlyn Reservoir was connected in 2008 (via the Newlyn Interconnector) and accessing groundwater via the Cardigan Aquifer (July 2007) and Bungaree Aquifer (mid 2007). Both the Cosgrove and Newlyn reservoirs lie downstream of farmland and could be very susceptible to agricultural runoff. Bungaree groundwater is drawn from a depth of ~54m and Ballarat West 100m. It is interesting to note that in earlier times, the quality of water sourced from Newlyn and Cosgrove reservoirs was questioned.

Newlyn Reservoir. Built 1880 (3,280 ML) located on Birch Creek, is a deep lake surrounded by grazing land. The lake has little aquatic vegetation and water is often turbid.(5) "...colour and turbidity levels together with numbers of coliforms and E.Coli generally exceed desirable levels set for drinking water standards". (6) "With respect to sediment and turbid runoff, the hazard it poses to the water supply will be greatest during periods of high runoff from the following areas: the intensively cropped land to the south and south-east of Creswick... Hazards created by the presence of the above pollutants in the water supply could arise from: the generally unrestricted access that stock and humans have to the streams, and that stock have to the storages, thus providing an opportunity for the entry of pathogens to the water by way of direct contact with faecal contamination, contamination of streams with urban drainage, or polluted runoff from the intensively cropped areas, the grazing land and unsewered areas, giving rise to the possibility of streams and storages containing toxic chemicals, high levels of nutrients and pathogenic organisms". (6).

Newlyn Reservoir is a Goulburn Murray Water storage. In 2003 potentially toxic Anabaena spp were reported at Alert Levels for the first time since 1999, reaching Alert Level 3 in March. Low water levels (15% of capacity in July) and elevated levels of nutrients were seen to be the cause of the problems. (7). BGA also recorded at high levels in March April 2004. Storage capacity reached a low of 5% in May (increasing to 100% by September). 2007 also saw BGA problems with alert level 3 being reached in January and February 2007. Levels of the reservoir dropped to 3% in May 2007 (an historic low). Nitrogen levels were also high during the year and phosphorus levels increased significantly in 2003, 2006 and 2007. 2006/7 was easily the peak year in terms of BGA algal counts at Newlyn Reservoir, with 17 counts above 500 cells/ml being recorded. (8).

Cosgrove Reservoir: “The following potential hazards to water supply exist: ... An existing problem associated with turbid runoff from cropping areas and roading. The possibility of toxic chemicals used in crop management entering the watercourses and storages. An increase in nutrient levels in the storages as a result of high levels of fertiliser use, this could lead to algal blooms and eutrophication of storages” (9) The 680ML Reservoir was built in 1977 but did not meet drinking water guidelines when it was removed from service... Central Highlands Water has followed expert advice in connecting water from Cosgrove Reservoir with the White Swan Reservoir and treating it to a high quality there” (10)

WATER QUALITY ISSUES: 2004/5

Blue Green Algae reached detectable trigger levels at White Swan Reservoir. Ballarat North/Nerrina recorded an aluminium reading of 0.2mg/L which is the ADWG guideline limit for this substance. Ballarat Central recorded a Turbidity reading of 12 NTU and Skipton 6.9NTU. Several locations also recorded pH levels above the 8.5 as specified by the ADWG. Ballan 8.8, Ballarat Central 8.8, Bungaree/Wallace 9.1, Cardigan Village 8.8, Haddon 9.0, Sebastopol 8.6 and Wendouree 8.8. Ballarat North/Nerrina recorded an iron reading above the ADWG of 0.65mg/L.

2005/6

In 2005/6 there were three detections of ecoli (one in the Buninyong Tank and two in the Warrenheip Basin). White Swan and Lal Lal also had taste and odour problems and Powder Activated Carbon was required. There were 4 breaches to the ADWG with Ballarat Central recording one turbidity reading almost 3 times the ADWG. Elevated pH levels were also detected at Buninyong/ Mt.Helen, Haddon and Wendouree. Bungaree/Wallace also recorded Trihalomethane (THM) levels of 0.161mg/L, which is below the Australian Guideline, but above the American Guideline.

2006/7

There were numerous breaches to the ADWG, with a serious lead and Trihalomethane (THM) problem occurring in nine communities covered in this study.

High lead readings were recorded at Ballarat Central 0.110mg/L (11 times over the ADWG), Ballarat North/Nerrina 0.064mg/L, Bungaree/Wallace 0.098mg/L, Buninyong/ Mt Helen 0.140mg/L, Cardigan Village 0.07mg/L, Haddon 0.630mg/L (63 times over the ADWG), Napoleons 0.03mg/L, Sebastopol 0.033mg/L and Wendouree 0.160mg/L. The nearby community of Enfield also recorded a lead level of 0.610 or 61 times over the ADWG for lead. The lead issue at Ballarat appears to be the most frequently reported lead problem in Victoria over the past few years.

One sample of E.coli was detected at Mount Rowan Tank (Wendouree Reticulation) on 28/3/07. Central Highlands Water was also forced to switch disinfection methods; “In order to maintain water quality due to low water levels there was a change on the Ballarat and district water supply disinfection method from chloramination to chlorination...Notification of the return to the chloramination disinfection method was provided with the change in supply notice issued on the 24th November 2006” (11) (Note: Chloramination blends ammonia with chlorine).

THM levels increased substantially at one point during 2007. Napoleons breached the ADWG with a level of 0.281mg/L.

Ballarat North/Nerrina, Ballarat Central, Bungaree Wallace, Buninyong/Mt Helen, Cardigan Village, Haddon, Sebastopol and Wendouree all recorded THM levels between 0.092mg/L and 0.233mg/L at least once during the year. Ballarat/Enfield levels peaked between November/December 2006 and Ballarat Napoleons peaked in November possibly as a result of the change of disinfection method. Ballarat North/Nerrina recorded an aluminium reading of 0.2mg/L which is the guideline level.

Aesthetic guidelines were breached for pH at Ballarat Central, Bungaree/Wallace, Cardigan Village, Haddon, Sebastopol and Wendouree. Total Dissolved Solids (TDS) levels were breached at Ballarat Central, Bungaree/Wallace, Buninyong/Mt Helen, Cardigan Village, Haddon, Napoleons, Sebastopol and Wendouree.

2007/8

Almost all of the breaches, the most of any year, concerned aesthetic breaches to water quality, although there was also two breaches to health guidelines. This included a lead reading of 0.015mg/L for Ballarat Central (this was the second highest lead level recorded in Victoria in 2007/8) and an aluminium reading of 0.25mg/L at Wendouree. Ballarat Central also breached the ADWG aesthetic guidelines at least once in 2007/8 for turbidity, pH, hardness, iron levels and Total Dissolved Solids. In March 2009, ecoli was detected at Cardigan Village Tank.

Ballarat North/Nerrina, Bungaree/Wallace, Buninyong/Mt Helen, all had at least one stance of breaches for pH, hardness and Total Dissolved Solids. Cardigan Village and Haddon had aesthetic breaches for pH, hardness, Iron and Total Dissolved Solids. Napoleons and Sebastopol had at least one breach for hardness, iron levels and TDS and Wendouree had breaches for turbidity, pH, hardness, Iron and Total Dissolved Solids.

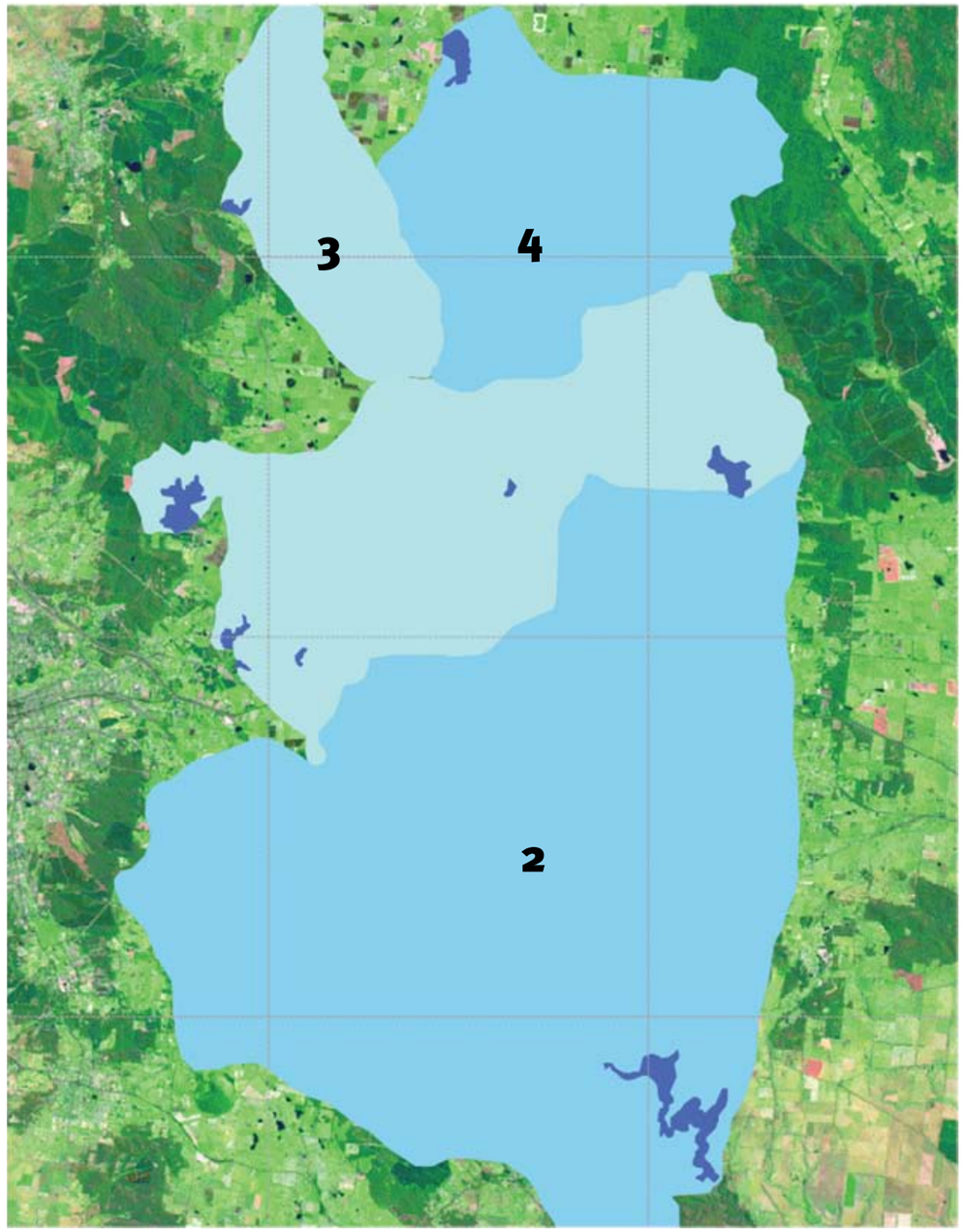
2008/9

Several breaches of the ADWG occurred, with Ballarat Central and Cardigan Village recording lead levels of 0.012mg/L and 0.011mg/L respectively.

Haddon, Napoleons, Ballarat Central, Cardigan Village, Bungaree/Wallace and Wendouree all breached the ADWG at least once in regards to both Hardness and TDS. Ballarat North/Nerrina breached guidelines for TDS. There were also several breaches of pH above 8.5.

In November 2009 ABC reported concerns over discoloured water in the Ballarat supply system. United Water also wrote that because of drought “Reservoir levels were critically low, resulting in poor raw water quality prior to treatment. This included increased alkalinity and organic content and a higher level of Manganese” (12) Manganese problems were also reported at Lal Lal and White Swan Reservoir.

On 19/12/07 the Courier reported that Ballarat’s drinking water was of a consistently high quality. “The few glitches for the Ballarat water supply included higher than recommended levels of trihalomethanes at Enfield and Napoleons, while Enfield also failed to comply with a colour requirement.”



Water Supply location map for Ballarat
(excluding groundwater sources).

1 - Moorabool Catchment

2 - Lal Lal Catchment

CATCHMENT BACKGROUND

In 1979 the Soil Conservation Authority wrote "The Ballarat catchments are fairly intensively used for agriculture and other uses. The water quality consequences is not at all time ideal. The Ballarat Water Commissioners have actively pursued a policy of buying critical areas of land close to reservoirs and streams to help protect water quality. The main water quality problems are algal growth, high iron concentrations, occasional undesirable turbidity and bacterial levels. Colour is above desirable objectives on most occasions.". (4)

In terms of pesticide monitoring, little appears to have changed in 30 years.

"Pesticides and herbicides are used widely in the catchment...It is not known whether any of these chemicals persist in the water supply at dangerous levels to health" (13)

"The basalt plains have two main types of soil; the red gradational (or krasnozemic type) or grey sodic duplex soils. The red gradational soils are well structured, fertile and well drained and are predominantly used for potato cropping. The grey sodic duplex soils tend to occur lower in the landscape. They are poorly drained, and difficult to cultivate, and are used mainly for grazing and occasionally for cereal crops...There are several dairy farms in the catchment". (4)

"The "runoff" yield from the total catchment area of 10.150ha is approximately 28.2% of annual rainfall". In 1979 the Soil Conservation Authority highlighted the following hazards to water supplies in the Ballarat catchment: "Pathogens (including stock and domestic effluents), Nutrients (particularly through fertiliser use in potato cropping), Toxicants "The potential exists for pesticides and weedicides to enter the water from cropping and other agricultural enterprises", Sediment, Metals (particularly iron with potential problems with lead and mercury)". (4)

The catchment of the Lal Lal Reservoir was proclaimed a Water Supply catchment on the 6th of June 1973, but the Ballarat water supplies were excluded from this proclamation at the request of the Ballarat Water Commissioners. Eventually it was declared a Water Supply Catchment on December 19 1979. The size of the catchments are: Ballarat Water supply: 9,413ha. Lal Lal: 21,042ha.= 30,455ha.

The most common forms of land use in the Lal Lal catchment in the 1970's were potatoes in the northern section of the catchment on the red soils (red clay loams) and sheep, cattle grazing and dairies. Other crops in the catchment include turnips and oats. <5% of the catchment was forested. Little has changed in the catchment since that time.

"Sheep and cattle grazing are the most prevalent uses of the land in the Lal Lal catchment, although in the northern half of the catchment potato cropping is a significant use". "Northern half of the Lal Lal catchment is dominated by potatoes, peas, dairy cattle, fat lambs, cereals. The Southern half: grazing (sheep and cattle), some cereal and cash cropping" (13) It was estimated in the 1970's that 2190ha of the catchment was cropped, with 18,180ha grazed. Cropping at that time was estimated to use 1095Kg Nitrogen and 3636kg nitrogen from grazing.

In 1977 the Soil Conservation Authority wrote: "Pesticides and herbicides are used widely in the catchment...It is not known whether any of these chemicals persist in the water supply at dangerous levels to health" (13)

Pests outlined by Soil Conservation Authority occurring in Lal Lal catchment in 1977; Pasture Cock Chafer, Red Legged Earth Mite, Underground Grass Caterpiller, Fried Cricket, Southern Army Worm, Wingless Grasshoppers, Plague locusts, Potato Moth and Aphids. Weed/fungal control was required in potatoes, haulms killing of potatoes, post maturity weed control in potatoes, weed control in cereals, weed control in pastures, furze, blackberries. Pesticides used included Lindane, Phosmet, Dimethoate, Chlorfevinphos, Maldison, Fenitrothion, Azinophosetyl, Demeton-S-Methyl, Metribuzin, Diquat, Amitrole, Paraquat, Bromonoxynil, MCPA, Trifluralin, 2,4-D and 2,4,5-T. (13)

IMPACTS OF DROUGHT & THE GOLDFIELDS SUPERPIPE.

In August 2005, the Victorian Government agreed to reconnect Cosgrove Reservoir to the Ballarat supply system (White Swan Reservoir). Cosgrove was taken out of service in December 2000, when the town of Creswick was connected to the Ballarat system. Cosgrove was constructed in 1977 and has a 680ML capacity. It did not meet Australian Drinking Water Guidelines when it was removed from service.

On October 18 2006. The Age reported a $300m State Government package to help ease the state's water crisis. Included in this package was a $180m Goldfields Superpipe that would link Ballarat and Bendigo to the Waranga Western Channel. The pipe would deliver 10,000ML/yr potentially increasing to 18,000ML/yr. Also announced was to Interconnect Cosgrove Reservoir (290-450ML), Interconnect Newlyn Reservoir by 2007 (320-350ML) and the pumping of 10,000ML from Cardigan Aquifer (1700ML until 2010).

Under the proposal Lal Lal reservoir would then be freed up to solely supply Geelong's needs. The Goldfields pipeline was eventually funded by $71m from the Victorian Government, $90m from Commonwealth Government and $19m from Central Highlands Water. There was also discussion about piping water from Lake Cairn Curran in the Loddon Catchment.

In 2007/8 water levels in White Swan Reservoir dropped below 10% which caused unprecedented algal growth. Reservoir level bottomed out in April 2008 at 7%... Water also had to be taken from the lowest off take, meaning potentially higher levels of manganese, iron, colour and turbidity. Methylisoborneol (MIB) and geosim are created by the algae. MIB was detected at White Swan Reservoir at levels in much higher numbers and a prolonged dosing of Powder Activated Carbon (PAC) occurred. A temporary aeration installation was installed in October 2007 (with a permanent installation commissioned on January 2 2008). Cyanobacteria was also detected. Alum dosing was increased to deal with these problems. PAC was successful at removing 80% of the taste and odour compound of MIB (14)

The contractual requirement for manganese (Mn) at the White Swan and Lal Lal WTPs is 0.02mg/L, much lower than the ADWG or WHO guideline values... Raw water quality risk lies with United Water who is required to meet the treated water specification regardless of the raw water quality.

United Water specifies the reservoir off take to be used but is not responsible for catchment management or reservoir water quality... Ballarat and surrounding areas have received below average rainfall for 8 consecutive years. The low reservoir levels currently encountered at White Swan and Lal Lal have caused a number of problems"

United Water specifies the reservoir off take to be used but is not responsible for catchment management or reservoir water quality... Ballarat and surrounding areas have received below average rainfall for 8 consecutive years. The low reservoir levels currently encountered at White Swan and Lal Lal have caused a number of problems". Stratification is occurring where a distinct separation of a layer of warmer water at the top and colder layer of anaerobic water at the bottom. When outside temperature drops eg at autumn the two layers mix, with manganese oxidised during this process." (15)

"In Ballarat the drought brought different challenges. Reservoir levels were critically low, resulting in poor raw water quality prior to treatment. This included increased alkalinity and organic content and a higher level of manganese, which can contribute to water quality issues ... including dirty water, taste and odour" (16)

In October 2007, Barwon Water agreed to transfer its existing 750ML share of water in Lal Lal Reservoir to Central Highlands Water, due to the drought situation. The water was required so that Central Highlands Water would have enough supply until the Goldfields Superpipe came on line. In November 2009, the Mooroobool received its first environmental flows in some time. The Mooroobool River was according to The Courier 22/12/09 "..the most flow-stressed in the state".

On the 25th of March 2008, it was reported that "extra water from Cosgrove Reservoir, Newlyn Reservoir, Ballarat West Groundwater Supply and Bungaree Groundwater were keeping Ballarat above the worst case scenario in regards to the drought". These additional water sources had been promised by the Labor Party in the 2006 State Election.

On the 22nd of April 2008, The Courier reported that Ballarat's water supplies had fallen to below 8% for the first time. (White Swan 6.7% (946ML) and Lal Lal 9.6% (3820ML). Central Highlands Water estimated that without rainfall the reservoirs could fall to 6.5% by June, or the same time as the Gold Fields Pipeline was due to come on line.

The Goldfields Superpipe came online on May 19 2008. Water was piped into White Swan Reservoir ,with works six weeks before schedule. Ballarat's water supply at the time had dropped to 7.4%. It was initially designed to come on line for 2010 but was fast tracked.

On October 7 2008, the ABC reported that Ballarat's water supplies were about 13% with Ballarat almost entirely reliant on the Goldfields Superpipe. To meet demand Central Highlands Water managed to pump 240ML from a disused Kaolin mine near Lal Lal and a bore sunk near western Ballarat.

UNITED WATER/BALLARAT WATER

A 25-year Build Own Operate Transfer (BOOT) contract was awarded to Thames Water in April 1999 and extends until 12 July 2025. “Under the Water Services Deed (WSD), Thames Water became responsible for the operation of the existing bulk water pumping and chemical treatment facilities. It was also contracted to build, commission and operate for 25 years, two 65ML/day Dissolved Air Flotation Filtration (DAFF) water treatment facilities and associated pipelines”. (17)

It also appears that Ballarat Water is 100% owned by The Infrastructure Fund managed by Hastings Funds Management (since 2007). “Ballarat Water recorded a revenue of $7.3million and EBITDA of $3.3million for the year, representing an increase of 2.9 percent and 5.8 percent respectively relative to the previous corresponding period... Ballarat Water volumes were under budget for the full year due to ongoing drought conditions and Stage 4 water restrictions” (18). Hastings Fund Management is owned by Westpac Banking Corporation. In 2000, Hastings was appointed by the Board of The Private Capital Group as trustee and Manager of The Infrastructure Fund.

The Goldfields Pipeline not only secured water supply for Ballarat, but also secured profits for the shareholders of Ballarat Water.

CENTRAL HIGHLANDS WATER AND PLANTATIONS.

Central Highlands Water manage about $5.7 million worth of timber plantations, most of which are located in the Ballarat Water Supply Catchment. Many were planted as a means of stabilising and protecting soils around water supplies and in terms of water quality the plantations are probably a better option than potato farms. Yet the plantations are not without their own environmental challenges. These plantations amount to ~1400ha and could use up to 12.6GL of water per year (based on the assumption that they use 9ML/ha). About 30-35ha are clear felled each year, with another 100ha being thinned. Central Highlands Water earnt about $1.2 million in 2008/9 (19) from the plantations. Current water prices for water users in Ballarat vary between $1405.30ML and $2108ML. At these prices Central Highlands Water plantations could be using between $17.7million and $26.6million worth of water each year. No native forest logging appears to occur within Ballarat’s water supplies, except perhaps for firewood in the Wombat Forest near Barkstead.

Central Highlands Water use 3 types of herbicides on their plantations. During establishment, Velpar DF (Hexazinone 750g/ha) or Velmac G (for spot application – Hexazinone 200g/ha) can be used in tree rows meaning that 33% of area would be sprayed. During the second year Velmac G is spot applied at 2g/tree or 2.6kg/ha. For under canopy weed control, Weedmaster Duo (glyphosate 360g/L), Brush Off (Metsulfuron Methyl 600g/kg) or Roundup Biactive (Glyphosate 360g/L). Of the plantation pesticides used by Central Highlands Water only Glyphosate is tested for.

What Pesticides Central Highlands Water test for (annually*) in Ballarat Catchments:

DDT (isomers), Aldrin and Dieldrin, Hexachlorobenzene, Heptachlor/epoxide, Gamma-HCH (lindane), Methoxychlor, 2,4-D.

(Note: DDT use banned in 1990, Dieldrin banned 1988, Aldrin banned 1994, Heptachlor banned 1997, Lindane dergistered in 1985, Hexachlorobenzene banned for general use in 1985-87, Methoxychlor banned 1987).

*An email from Central Highlands Water (dated 25/2/10) states that Central Highlands Water also scan for OC/OP Pesticides, Atrazine, Chlordane, Glyphosate and Simazine.

14 pesticides tested, 7 deregistered = 5 currently used pesticides (excluding Organophosphorus Scan).

Pesticides most likely to be of most risk to water quality in Ballarat Water Supply Catchments.

Land Use: 1. Pasture. 2. Potatoes. 3. Cereals. 4. Lucerne. 5. Pine Plantations

Herbicides: 2,4-D, Amitrole, Atrazine, Chloridazon, Chlorthal Dimethyl, Clomazone, Clopyralid, Dicamba, Dichlobenil, Diquat, Diuron, Ethofumesate, Glyphosate, Hexazinone, Imazapic, Imazethapyr, Imidacloprid, Isoxaben, MCPA, Metsulfuron Methyl, Molinate, Monosodium Methylarsonate, Norflurazon, Oryzalin, Paraquat, Picloram, Prometryn, Propyzamide, Sethoxydim, Simazine, Tebuconazole, Tebuthiuron, Terbacil, Terbutryn, Thiobencarb, Tralkoxydim.

Insecticides: Acephate, Carbaryl, Chloropicrin, Diazinon, Dimethoate, Disulfoton, Fipronil, Imidacloprid, Maldison, Methamidophos, Methidathion, Methomyl, Phosmet, Piperonyl Butoxide.

Fungicides: Azoxystrobin, Chlorothalonil, Dimethomorph, Fludioxonil, Iprodione, Mancozeb, Metalaxyl, Metiram.

Organic Compounds tested for by Central Highlands Water (annually): Benzene, Benzo[a]pyrene, Carbon Tetrachloride, 1,1-Dichloroethene, 1,2-Dichlorethane, Tetrachloroethene, Trichloroethene, 2,4,6 Trichlorophenol.

Total Goulburn Catchment ‘most at risk to water’ Pesticides above Colbinnabbin Offtake for Goldfields Superpipe.

Now that Ballarat source drinking water from the Goulburn Catchment, pesticide scans should be increased in order to take account of pesticides used in the Goulburn Catchment.

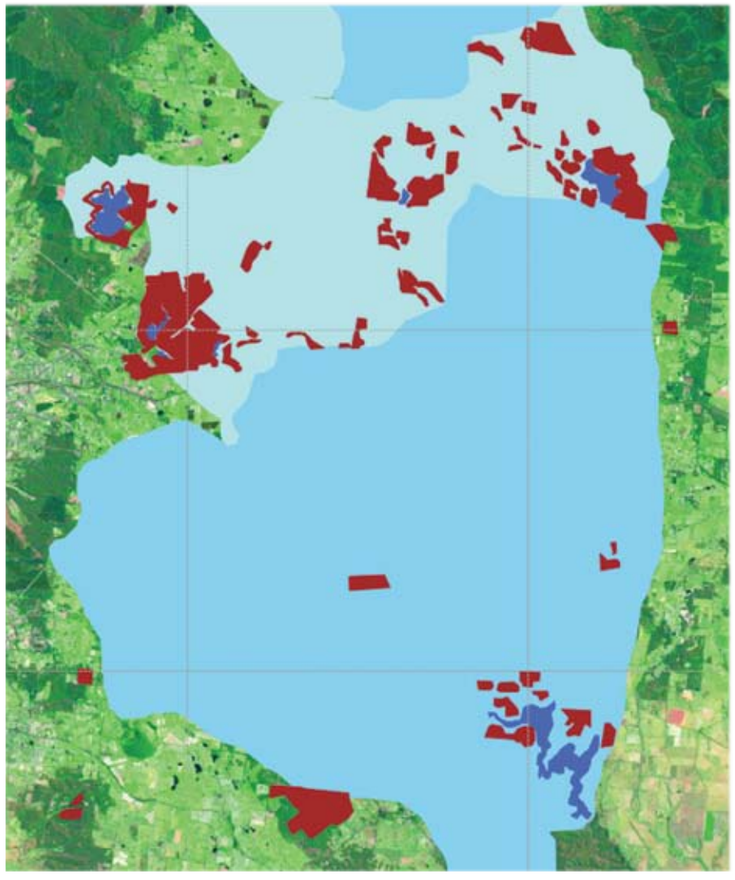
Land Use: 1. Pasture. 2. Grapes. 3. Cropping. 4. Turfgrass.
Herbicides: 2,4-D, Amitrole, Atrazine, Bromoxynil, Chlorthal Dimethyl, Clopyralid, Dicamba, Dichlobenil, Diquat, Dithiopyr, Diuron, DSMA, Ethofumesate, Fluometuron, Glyphosate, Halosulfuron-Methyl, Hexazinone, Imazapic, Imazethapyr, Isoxaben, MCPA, Mecoprop, Metsulfuron Methyl, Molinate, MSMA, Napropamide, Norflurazon, Oryzalin, Paraquat, Picloram, Prometryn, Propyzamide, Rimsulfuron, Quinclorac, Sethoxydim, Simazine, Tebuthiuron, Terbacil, Terbutryn, Thiobencarb, Trifloxysulfuron Sodium.
Insecticides: Azinphos Methyl, Carbaryl, Diazinon, Dimethoate, Disulfoton, Emamectin, Endosulfan, Fenamiphos, Fenthion, Fipronil, Imidacloprid, Maldison, Methidathion, Methomyl, Parathion Methyl, Phosmet, Piperonyl Butoxide, Thiamethoxam.

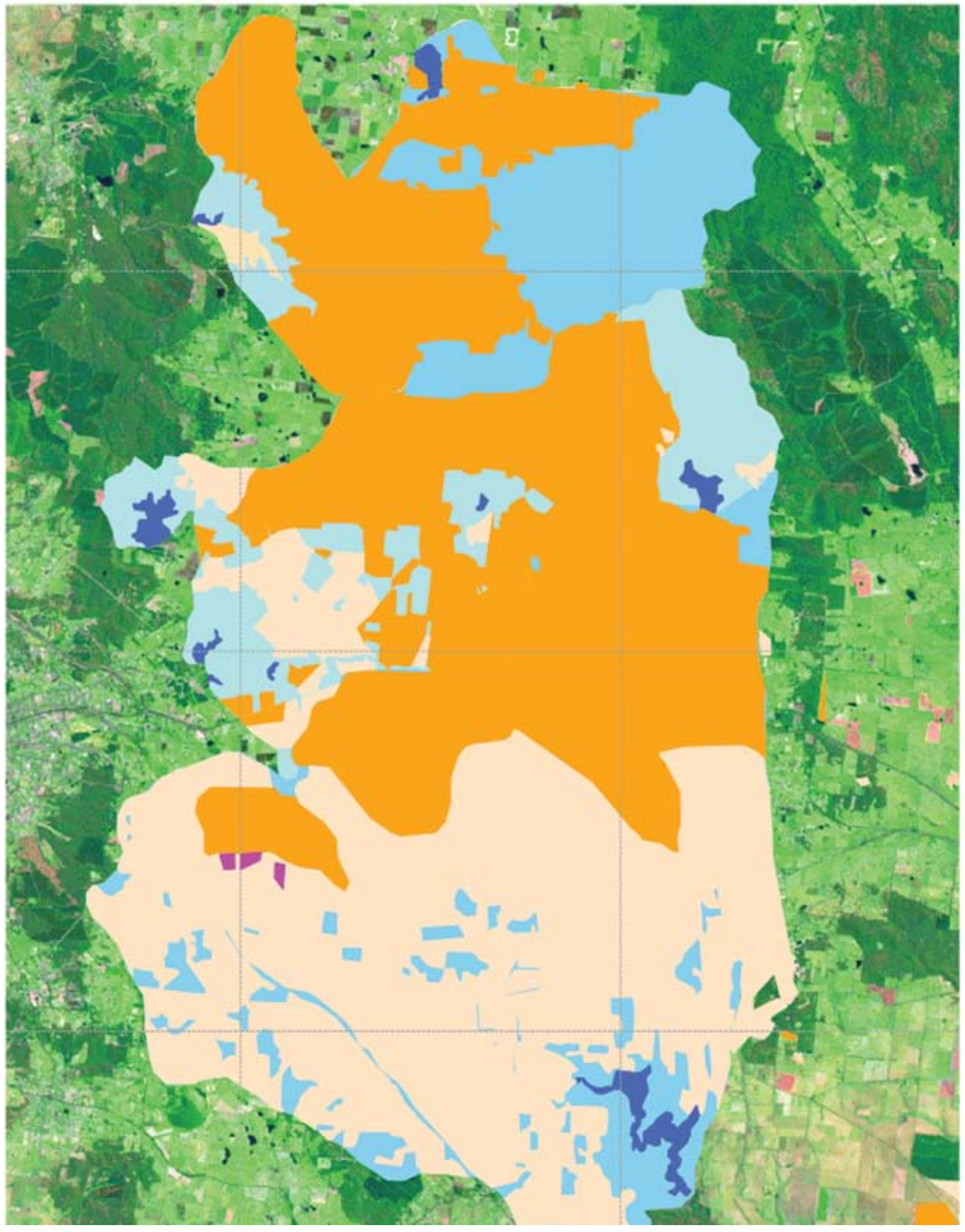
Fungicides: Azoxystrobin, Chlorothalonil, Cyprodinil, Dimethomorph, Fenarimol, Fenhexamid, Fludioxonil, Iprodione, Mancozeb, Metalaxyl, Metiram, Propiconazole, Pyraclostrobin, Tebuconazole, Tebufenozide, Triadimefon.

Fumigant: Chloropicrin.

Plant Regulator: Trinexapac-Ethyl

76 'high risk to water' pesticides used in Goulburn System upstream of Colbinnabbin.





Land use map for Ballarat Water Supply Catchments

- Cropping (potentially high pesticide use)
- Primarily pasture (lower pesticide use)
- Horticulture/ Vineyards (potentially high pesticide use/)

BENDIGO

Water Authority: Coliban Water

Source of Water Supply: Supply was from Malmsbury and Eppalock Reservoir. The water was transported via the Coliban Main Channel and stored in Sandhurst Reservoir. The Coliban Main Channel usually runs between November to May (irrigation season) and then only one month at a time to replenish the urban supply. There is also a supplementary supply from Lake Eppalock which feeds into Sandhurst Reservoir via the Eppalock – Sandhurst Pipeline.

Supply system was created in 1877, when 65km of the Coliban Main Channel were constructed from Malmsbury Reservoir to Bendigo. In 1902 the system was expanded when Upper Coliban Reservoir was constructed. Lauriston Reservoir was constructed in 1941. The Coliban supply system consists of over 500km of open channel (both concrete and earthen) and pipeline.

Capacity of Reservoirs: Upper Coliban 37,500ML, Lauriston 19,870ML, Malmsbury 17,760ML, Sandhurst (Bendigo) 2500ML, Spring Gully (Bendigo) 1700ML, Lake Eppalock 312,000ML.

In October 2008, Coliban Water announced that the northern and southern areas of the Coliban system were now operating as two distinct supplies. Southern towns such as Kyneton and Castlemaine would be supplied by the reservoirs located near Malmsbury, whilst towns in the north including Bendigo would be supplied by the connection to the Goulburn River, via the Goldfields Superpipe.(20)

Treatment: Microfiltered, taste/odour/algae/toxin removal, pH correction, disinfection. Added substances: (alum, alum chloryhydrate, activated carbon, ozone, lime/soda ash/caustic soda/carbon dioxide/sulphuric acid, chlorite, ammonia, fluoride.

Fluoridation started in Bendigo in 2002.

COMMUNITIES SUPPLIED:

~75,000 people. Between 2004-6, Coliban Water designated the supply zones as; Belvoir Park, Big Hill, Edwards Rd Tank, Huntly, Strathfieldsaye, Marong, Sandhurst and Specimen Hill. Almost 95% of water supplied to Edwards Rd Tank, Sandhurst and Specimen Hill.
From 2007-9 Coliban Water supply zones renamed to; Bendigo Southern, Bendigo Northern, Bendigo Spring Gully, Epsom-Huntly, Junortoun, Maiden Gully-Marong and Strathfieldsaye.

Main Water Quality Issues: In 2003/4 Strathfieldsaye, one sample did not meet the ADWG aluminium guidelines. In 2004/5 Big Hill, Marong and Strathfieldsaye reached the ADWG in terms of Bromate. Strathfieldsaye had a pH level outside of the guidelines of 6.4. In 2005/6 Edwards Road Tank and Sandhurst reached ADWG levels for Bromate. Most complaints were from Specimen Hill and Sandhurst mainly relating to colour.
During 2006/7 Bendigo drinking water was at the high end of hardness (although under ADWG). In 2007/8 Bendigo (Spring Gully) recorded a lead level of 0.011mg/L (ADWG health guideline 0.01mg/L). Overall in terms of health and aesthetics Bendigo's water quality appears to be good.

WATER QUALITY AND GOLDFIELDS PIPELINE

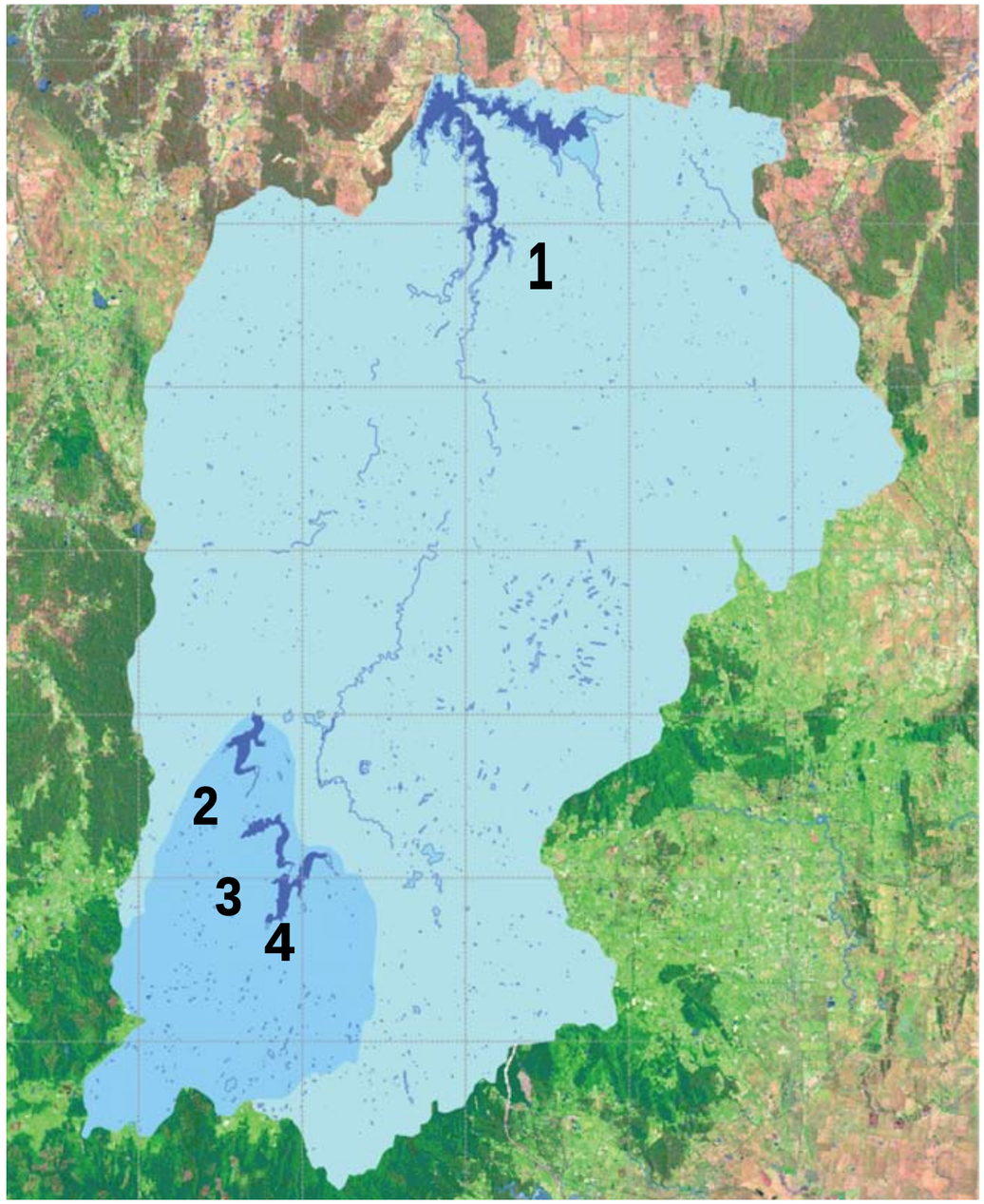
The Goldfields Superpipe which pipes Goulburn River water from Waranga Western Channel (near Colbinabbin), was officially opened at Bendigo on the 31st of August 2007. 20 billion litres of water would be allocated for the Pipeline, of which Coliban Water had already purchased 10 billion litres of permanent water rights (water for 100,000 people). (10GL=10,000 ML). Bendigo may well have run out of water without this pipeline. Goldfields Pipeline represents 3-4% total capacity of Waranga Western Channel.

The water was sourced from the Lake Eildon Water Quality Reserve, which in turn will also be directed to Melbourne via the North-South Pipeline due to open in early 2010. The pipeline to the Bendigo supply consisted of a 45km pipeline from Waranga Western Channel to the Eppalock to Bendigo pipeline and a 1.5km pipeline to Lake Eppalock. The pipeline then continues to Ballarat's White Swan Reservoir.

"The Super-Pipeline' may meet the immediate crisis faced by those living within the Coliban Water Supply District, however, such a solution draws water from other catchments in the Lower Murray Darling catchment for which the future "run-off" prognosis is alarming". (21)

January 26 2007, saw Minister John Thwaites, endorsing a joint proposal by the North Central Catchment Management Authority, Coliban Water and Goulburn Murray Water to loan the remaining 'environmental water' in Lake Eppalock to Coliban Water for urban supply.

Water Supply mapfor Bendigo (Coliban/Campaspe Catchments)

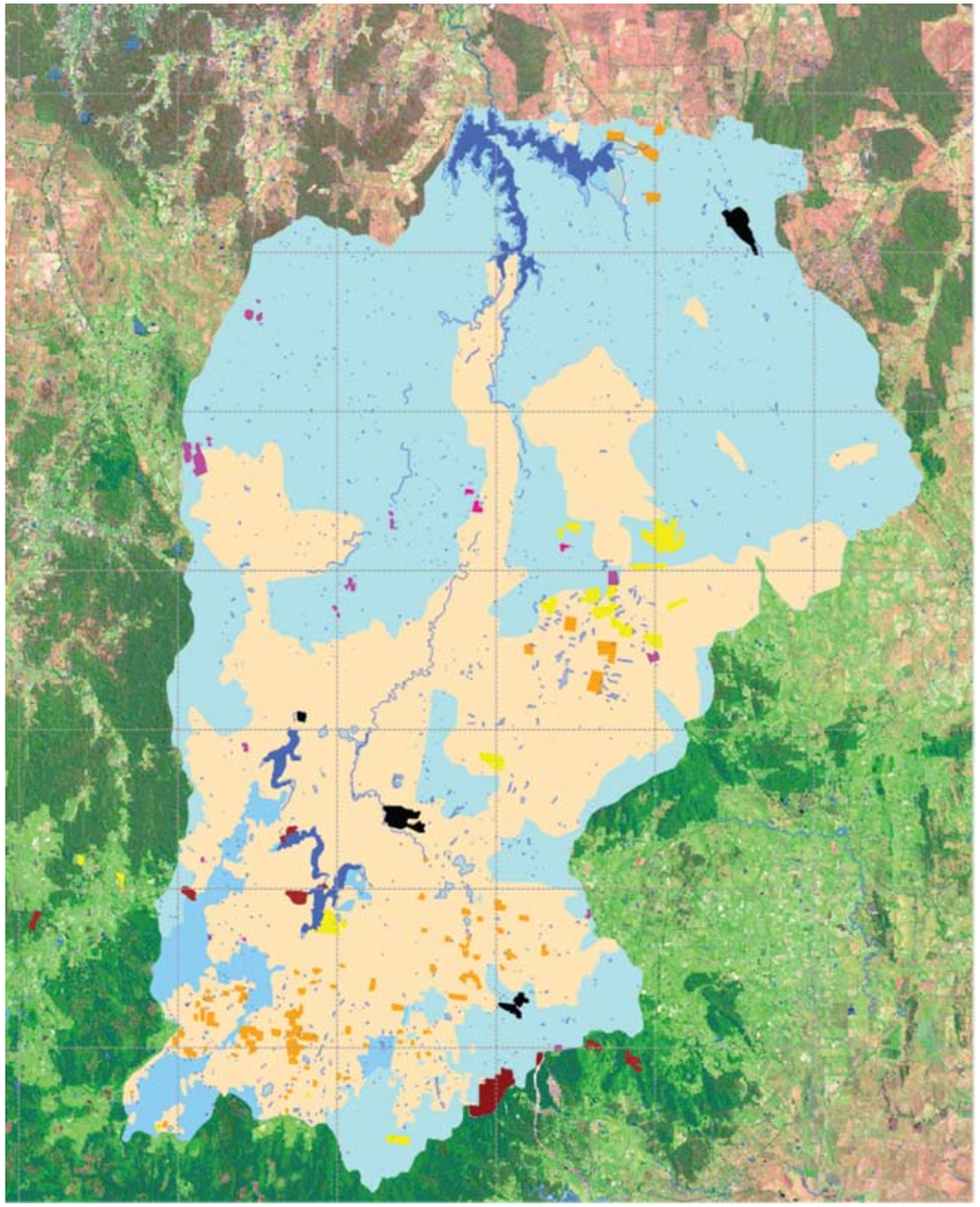


1 - Lake Eppalock

2 - Malmsbury Reservoir (Upper Coliban System)

3 - Lauriston Reservoir (Upper Coliban System)

4 - Upper Coliban Reservoir



Cropping (potentially high pesticide use)

Primarily pasture (lower pesticide use)

Horticulture/ Vineyards (potentially high pesticide use/)

Hancock and other Pine Plantations

Urban

BENDIGO CONTINUED

In March 2007, Goulburn Murray Water announced a blue green algal alert for Lake Eppalock and Laanecoorie Reservoir, advising the public to avoid direct bodily contact with water from Lake Eppalock. Five weeks later Goulburn Murray Water stated " we are pleased to see that the level of blue-green algae at Lake Eppalock and Laanecoorie Reservoir had reduced in recent weeks." (22)

During April 2007, water pumping from Lake Eppalock ceased due to levels of Manganese, ten times higher than normal being detected in the lake. Coliban Water announced in late March that they required 28 days to pump adequate volumes of water from Lake Eppalock into Sandhurst Reservoir, this followed a Ministerial direction to transfer 'environmental' water from the North Central Catchment Management Authority to Coliban Water.

In October 2008, Coliban Water announced that they had purchased 6900ML of water from New South Wales (probably Murrumbidgee River) which would guarantee Bendigo a supply of water until 2010. (By the time of printing this report could not determine the exact source of the water sent from NSW to Bendigo. The Murrumbidgee is heavily farmed in some locations). Inflows had dropped by 85% into storages between 2005-8. (23) Stage 4 water bans were implemented in Bendigo in September 2006.

In October 2008, Coliban Water announced that they had purchased 6900ML of water from New South Wales (probably Murrumbidgee River) which would guarantee Bendigo a supply of water until 2010. (By the time of printing this report could not determine the exact source of the water sent from NSW to Bendigo. The Murrumbidgee is heavily farmed in some locations). Inflows had dropped by 85% into storages between 2005-8. (23) Stage 4 water bans were implemented in Bendigo in September 2006.

On 1/2/08 Coliban Water announced that they would be increasing monitoring at Spring Gully after low levels of Blue Green Algae were detected in the storage, levels dropped back to 'normal' 5 days later. (24)

In 2008/9 Coliban Water wrote; "...The increased level of manganese (and iron) in some systems. These levels have increased either as a result of low storage levels (such as Lake Eppalock)...Extensive modifications are expected to be implemented, beginning in 2010, to the water treatment process at both Bendigo and Castlemaine water treatment plants to better manage the variable water quality from Lake Eppalock and Waranga Basin". (25)

The Water crisis was being seen by authorities of the Government as a potential vote winner if they acted responsibly.

However some people were questioning the role of the water authority in terms of forward planning.

Superpipe Saviour. "Labor's Superpipe saved Bendigo from running out of water last summer. And this summer the Superpipe will stop us running out of water again.... The 46.5km pipeline is able to transfer up to 20 billion litres of water each year from the Goulburn system to our system...The Superpipe has supplied 70% of Bendigo's urban water needs" (26)

"There is little doubt Bendigo would have run out of water if it was not for the Goldfields Superpipe...As recently as 2002, Coliban (Water) was selling perceived excess water into rural markets. It did not rain and hence the urgent need for the pipe...Bendigo has been using water from the Lake Eildon Water Quality Reserve over recent years; water now claimed by Melbourne for the North South Pipeline" (27)

What Pesticides Coliban Water test for (annually): 2,4-D, Chlordane, DDT (total isomers), Dieldrin, Aldrin, Epoxide, Heptachlor, Lindane.

(Note: Chlordane banned in 1997, DDT use banned in 1990, Dieldrin banned 1988, Aldrin banned 1994, Heptachlor banned 1997, Lindane dergistered in 1985). (8 pesticides tested, 6 deregistered = 2 currently used pesticides).

Organic Compounds tested for by Coliban Water (yearly): Benzo(a)Pyrene

Pesticides of most risk to water quality in the Bendigo Water Supply (Coliban and Campaspe River)

Land Use: 1. Pasture. 2. Cropping (lucerne), 3. Grapes. 4 Potatoes.

Herbicides: 2,4-D, Amitrole, Atrazine, Chlorthal Dimethyl, Clopyralid, Dicamba, Dichlobenil, Diquat, Diuron, Ethofumesate, Fluometuron, Glyphosate, Hexazinone, Imazapic, Imazethapyr, Isoxaben, MCPA, Metsulfuron Methyl, Molinate, Napropamide, Norflurazon, Oryzalin, Paraquat, Picloram, Prometryn, Propyzamide, Sethoxydim, Simazine, Tebuthiuron, Terbacil, Terbutryn, Thiobencarb.

Insecticides: Azinphos Methyl, Carbaryl, Diazinon, Dimethoate, Disulfoton, Emamectin, Endosulfan, Fenamiphos, Fenthion, Fipronil, Imidacloprid, Maldison, Methidathion, Methomyl, Parathion Methyl, Phosmet, Piperonyl Butoxide.

Fungicides: Azoxystrobin, Chlorothalonil, Cyprodinil, Dimethomorph, Fenarimol, Fenhexamid, Fludioxonil, Iprodione, Mancozeb, Metalaxyl, Metiram, Pyraclostrobin, Tebuconazole, Tebufenozide, Triadimefon.

Total Goulburn Catchment 'most at risk to water' Pesticides above Colbinnabbin Off-take for Goldfields Superpipe.

Now that Bendigo source drinking water from the Goulburn Catchment, pesticide scans should be increased in order to take account of pesticides used in the Goulburn Catchment.

COLIBAN/CAMPASPE

The location of Lake Eppalock at the junction of Coliban and Campaspe Rivers effectively marks a delineation of the upland and lowland aquatic environments of the river system. The majority of streams in the Campaspe catchment lie above Lake Eppalock. The Campaspe and Coliban provide about 75% of the inflow into Lake Eppalock, with smaller amounts provided by Wild Duck Creek and Mt. Ida Creek. Improved Pasture is the main land use above Lake Eppalock, with a small amount of horticulture and cropping.

Historically, the Lake Eppalock Catchment has suffered from land degradation, caused by gold mining, land clearing, over cultivation and the overgrazing by stock and rabbits. So severe were these problems that the Soil Conservation Authority targeted the catchment in the 1960's and 1970's in order to control these problems. However even after these works high loads of colloidal clays and suspended solids can still work their way through the catchment and into Lake Eppalock. Water quality in the Campaspe for instance gets worse the further downstream, with the quality of water above Malmsbury Reservoirs quite good, "...water quality at Redesdale (Station 406213) has been monitored since 1976 and at Ashbourne (Station 406208) since 1991. At Redesdale there is only a 17% ANZECC compliance for pH, an 8% compliance for TN and a 67% attainment for TP. Further upstream at Ashbourne, a high attainment for the ANZECC guidelines for DO, EC, TN and TP occurs (Water Ecoscience 1997)." (28)

" A more recent evaluation of the Coliban River concluded that much of the river has been degraded for many years by sand deposition and cattle grazing (DNRE 1997). There are also indications of a nutrient enrichment problem, likely to be the result of poor catchment and land use practices" (28)

The Coliban Water Supply System extends for over 100km and was initially constructed to supply towns that had been established during the gold rush with fresh water. Construction began on Malmsbury Reservoir in 1866, however water didn't flow from the reservoir until 1877. It was also enlarged between 1938-41. The Upper Coliban Reservoir was added to the system in 1903, with upgrades in 1917 and 1925. Lauriston Reservoir was constructed between 1938-1941.These three reservoirs supply the system along with an allocation from Lake Eppalock. Eppalock was constructed between 1960-62. The Coliban system is gravity fed, except for the water pumped from Eppalock to Bendigo.

Streamflow of the Campaspe and Coliban River was greatly impacted by the building of the Malmsbury, Lauriston and Upper Coliban Reservoirs and Lake Eppalock. Mean annual flow just below Malmsbury Reservoir had been reduced by half because of the Reservoirs.

In 1989 flows into Eppalock from the Campaspe and Coliban Rivers averaged 190,000ML, with approximately 60% of this occurring between August to October. Summer flows had tripled to meet demands of irrigation sector and winter flows had halved to compensate for this. Almost 20% of the annual outflow occurs between summer to March. Irrigation is by far the largest user of water in the catchment.

According to the Lake Eppalock Action Group in early 2008, historic average inflows into Lake Eppalock are; Campaspe River 43%, Coliban River 31.5%, Wild Duck Creek 15%, Mt Ida Creek 9%, other small streams 1.5%. Average stream flow from these sources and rainfall was 205,000 ML. Between 2001 and 2008 however, stream flow data showed 20,000ML average (90% loss of the long term average inflow). Levels in Lake Eppalock were as recently low as 7%, "unsustainable amounts of Sales Water and the supplementary deliveries made to the Waranga Western Channel during the period 2000 – 2002" were seen as a major reason why Lake Eppalock reached such perilous levels. (29)

"Past records show that Coliban's share of the water in Lake Eppalock to be 36,900ML per year, however due to the ongoing catchment and climate changes we should expect only 10% of that". (29)

"Since 1992... there has been a steady decline in the average long term rainfall and drought conditions have dominated since 1997. The last 9 years have the lowest average rainfall on record... Autumn rainfall averages in the Upper Campaspe Catchment have averaged 40% less over the last 14 years." (21)

"Based on river flow records of the previous dry sequence (1878 to 1952,) Lake Eppalock was expected to average inflows of 153,000ML per year. This is in stark contrast to the actual inflow into Lake Eppalock during the recent wet sequence (1952 to 1996) which has delivered an average of 206,000 ML inflow over the period 1962 to 1966 and is in further contrast to the last six years (dry sequence) where the inflow has averaged only 25,000ML per year" (21).

"During 1874 to 1952 the catchment averaged 153,000ML/per year)...1996 to 2007 yielded only 65,000ML/per year. 2001 to 2007 yielded only 20,000ML/per year. The author's apportion the reduced catchment yield in the following way; *Additional number of farm dams. 25,000ML/year. *Less autumn and winter rainfalls (less effective rainfall) 25,000ML/year. *All other listed factors 38,000ML/year" (21).

Pastures, particularly improved pastures, can be treated with a range of pesticides and fertilisers. At least 70 types of pesticides are registered for use on pastures in Victoria.

"In the Lake Eppalock catchment, it was found in 1994 that perennial pasture had been sown in 77% of properties in the past 30 years. More than 75% of the surveyed farmers thought that they would increase their sowing rates by an average of 21ha. (30). A census survey found that in 1996/7, the proportion of pasture area fertilised in the North Central Region was 22.3%. A total of 28.4% of farmers in the North Central Region applied fertiliser on farms. A further study found that half of respondents with a large proportion of perennial pasture were applying fertiliser annually or biannually. (30) 56% of perennial pasture growers said they practiced set stocking while the remainder had some system of moving their stock" (30).

Pasture improvement can result in increases in stock carrying capacity. Clover, cocksfoot, phalaris and in the south ryegrass are commonly grown. Native pastures are mainly used for wool production. Fat lambs and beef are common in the higher rainfall southern portion of the catchment. Dairying is limited to area near Goornong, cropping occurs mainly in portions of the flatter northern part of the catchment. Oats, wheat and barley grown in most areas, with oat crops commonly cut for hay. Potatoes grown near Trentham. Other crops grown include rape, peas and lupins grown in rotation with cereals and pastures.

On 20 August 2009, Goulburn Murray Water and the North Central Catchment Management Authority announced that they would be meeting residents over the following days to describe the availability of water over the availability of water over the next season. Under a worst case scenario the water supply in both the Loddon and Campaspe systems could be exhausted before June 2010.

There are some plantations in the headwaters of the Coliban system, hardwood (largest plantation near Upper Coliban Reservoir owned by EPFL) and softwood near Woodend owned by Hancock Victorian Plantations. Native forest logging has occurred in the headwaters of the Coliban system in the Wombat State Forest.

Coliban Channel - Elphinston

Lake Eppialock near junction of Coliban and Campaspe River (October 2009)

LAKE EPPALOCK

Lake Eppalock is managed by Goulburn Murray Water. Alert Level 2 for the Potentially toxic BGA Microcystis was reached in May 2003 as a result of low water levels, increased water temperatures and increased nutrients. Storage levels reached historic lows at Eppalock during 2003, dropping to 7% of capacity in May and remaining at this level until August. Eppalock reached a maximum capacity of 22% in October. Nitrogen levels peaked in September 2003. By June 2004, water storage levels dropped to 4.6% of capacity and Microcystis was again detected during the tear, with turbidity and electrical conductivity of the reservoir increasing.

Alert Level 3 for Toxigenic BGA was reached in May/June 2006 and increases in salinity also occurred during 2006. Alert Level 3 was also reached in February and March 2007 for Anabaena at levels higher than recorded in 2006. Storage levels reached <1% of capacity from April to July 2007 before reaching 7% by the end of year. The highest level of electrical conductivity was reached in July 2007. Nutrient and turbidity levels also increased. Of the 36 instances of BGA recorded at Lake Eppalock above 500 cells/mL, 61% of these occurred in 2005/6 and 2006/7 (8).

"Inflows into Lake Eppalock are not only influenced by the wet and dry sequences but are significantly reduced by Landcare activities, improved farming practices and other factors in the catchment" (21)

The longest BGA algal bloom to occur at Lake Eppalock occurred between the 1st of March 2007 and 4th of April 2007, lasting for a total of 34 days.

On the 31st of August 2007, the Goldfields Superpipe opened which transferred 20,000ML of water per year into the Eppalock to Bendigo Pipeline (not Lake Eppalock itself).

GOULBURN SYSTEM

The Goulburn River catchment is Victoria's largest being 1.6 million hectares in size or 7.1% of Victorian landmass. The Goulburn River is responsible for providing irrigation water to 200,000ha of farmland, with the Goulburn Murray Irrigation system being the largest in Australia, covering over 800,000 hectares.

With the construction of the Goldfields Superpipe, Ballarat and Bendigo are now sourcing a large portion of their drinking water from the Goulburn catchment.

The first major supply works were the construction of Goulburn Weir in 1890 and two diversion channels to the east and west. The Waranga Basin was constructed in 1905, with the Waranga Western Channel (WWC) also being constructed so that the Goulburn system could connect with the Loddon system. The WWC was later extended by another 170km to supplement the Wimmera-Mallee Stock and Domestic System. Lake Eildon was originally constructed in 1922 and enlarged in 1955. Lake Eildon is the Goulburn River's largest storage and supplies the southern section of the Goulburn Murray Irrigation District (GMID).

At Goulburn Weir, water is diverted into the East Goulburn Main Channel. It is also diverted into the Stuart Murray Canal and Cattanach Canals which transport water into Waranga Basin. Water is sent along the Waranga Western Channel in a north westerly direction. At its furthest point, water from the Goulburn system can be sent as far west as Ouyen, a distance of 600km from Lake Eildon.

"Extensive water quality information has been collected for the Goulburn Basin. In total, over 13,000 sites have been used to collect hydrologic and water quality data". (31)

According to the EPA (32) , the quality of the water from the Goulburn River deteriorates after leaving Lake Eildon. Water temperature for the Goulburn River downstream of Lake Eildon is up to 6.5C lower than if Lake Eildon hadn't been built, thereby affecting native fish. Scientists consider that the environmental health of Goulburn Weir and the Nagambie Lakes is poor to moderate.

The dominant land use in the Goulburn, is dryland agriculture. However the region also supports irrigated pasture and cropping where pesticides may be used. Some vineyards are also located near

Goulburn Weir, which may also be a source pesticide laden runoff. According to the Goulburn Broken Catchment Management Authority it also uses a variety of pesticides to control gorse, blackberry, broome and willow. Thousands of hectares of land are required to be controlled for weeds by the CMA, although in comparison to volumes used by agriculture this use would be small. Cropping would probably be the largest user of pesticides within the catchment

After a fish kill that occurred downstream of Goulburn Weir in 2004, the Victorian Government initiated an investigation by the Environment Protection Authority which was released to the public in September 2005. http://www.epa.vic.gov.au/envaudit/goulburn_river.asp

The 2005 EPA audit was limited to channels and drains and the way they discharge into streams. Agricultural practices and runoff were not discussed. Rodney Main Drain and Shepparton No.3 were included in the study, however both of these drains discharge downstream of the Goulburn Weir. Areas and land use upstream of Goulburn Weir, were not investigated by the EPA in their 2005 report.

The EPA report did say however;
"Issues regarding environmental quality are also outlined by the EPA in an assessment against the Victorian River Health Strategy.

Eildon Dam outlet structure to the limit of the influence of backwaters of the Goulburn Weir (south of Nagambie):
River impacted by flow regulation...reduced water quality.

Goulburn Weir backwaters above Kirwans Bridge (to the limit of the influence of the weir) including Lake Nagambie, and the eastern and western backwaters: River impacted by flow regulation, poor quality physical habitat, many aquatic weed species, degraded lake margin in most areas due to stock access, possible water quality and sediment quality problems.

Kirwans Bridge to Goulburn Weir:
... water quality poor, riparian zone condition generally good, but stock access generally uncontrolled, channel modification significant..."(32).

1

2

3

Goulburn River Catchment Map above Goulburn Weir.

1 - Goulburn Weir 2 - Puckapunyal 3 - Lake Eildon

- Cropping (potentially high pesticide use)
- Improved pasture (pesticide use)
- Vineyards (potentially high pesticide use)
- Hancock and other Pine Plantations
- Urban
- Bluegum Plantations

GOULBURN SYSTEM CONTINUED

"Turbidity levels in the Goulburn River are generally low (median less than 10 NTU) between Lake Eildon and Murchison... Suspended solids concentration is generally low (median less than 20mg/L) in the Goulburn River between Lake Eildon and Murchison. The Goulburn River has a naturally low suspended solid load and Lake Eildon and Lake Nagambie both serve as sediment traps....Index of Stream Condition (ISC) and sub-index scores indicates that the sites assessed along the Goulburn River below Lake Eildon are in poor to very poor condition, predominantly due to the altered hydrology of the river. Results indicate that the physical form and condition of the riparian zones are generally good (although conditions in the vicinity of Seymour are poor), as in the general condition of water quality.." (33)

A comparison of Goulburn River Water between Lake Eildon and Seymour was made in March 2008 by Melbourne Water.(31) Generally speaking, Electrical Conductivity, Colour, pH, Nitrogen, Phosphorus and Turbidity increases at Seymour, in comparison to Lake Eildon, showing slight a deterioration of water quality.

In May 2009 the Australian Conservation Foundation published a report stating that if clearfell logging was stopped in the headwater forests of the Goulburn system, "an additional water yield of 3807GL would be delivered into the Goulburn River over the next 100 years...The economic value of this water would be $1.68billion." (62). The major growers of plantations in the Goulburn Catchment are Hancock Victorian Plantations (~4100ha) and Midway Plantations Pty Ltd (~2000ha)). The potential water losses caused by the February 2009 bushfires in the Goulburn Catchment have not been quantified in this report.

Pesticides of most risk to Water Quality in the Goulburn River Catchment above Goulburn Weir.....

Land Use: 1. Pasture. 2. Grapes. 3. Cropping. 4. Turfgrass.

Herbicides:

2,4-D, Amitrole, Atrazine, Bromoxynil, Chlorthal Dimethyl, Clopyralid, Dicamba, Dichlobenil, Diquat, Dithiopyr, Diuron, DSMA, Ethofumesate, Fluometuron, Glyphosate, Halosulfuron-Methyl, Hexazinone, Imazapic, Imazethapyr, Isoxaben, MCPA, Mecoprop, Metsulfuron Methyl, MSMA, Napropamide, Norflurazon, Oryzalin, Paraquat, Picloram, Prometryn, Propyzamide, Rimsulfuron, Quinclorac, Sethoxydim, Simazine, Tebuthiuron, Terbacil, Terbutryn, Thiobencarb, Trifloxysulfuron Sodium.

Fumigant: Chloropicrin.
Plant Regulator: Trinexapac-Ethyl

Insecticides: Azinphos

Methyl, Carbaryl, Diazinon, Dimethoate, Disulfoton, Emamectin, Endosulfan, Fenamiphos, Fenthion, Fipronil, Imidacloprid, Maldison, Methidathion, Methomyl, Parathion Methyl, Phosmet, Piperonyl Butoxide, Thiamethoxam.

Fungicides:

Azoxystrobin, Chlorothalonil, Cyprodinil, Dimethomorph, Fenarimol, Fenhexamid, Fludioxonil, Iprodione, Mancozeb, Metalaxyl, Metiram, Propiconazole, Pyraclostrobin, Tebuconazole, Tebufenozide, Triadimefon.

Water Supply Network. Goulburn Weir to Colbinabbin

1. Colbinabbin
(water pumped from here to Ballarat and Bendigo)
2. Groves Weir Catchment
3. Waranga Western Channel
4. Waranga Basin
5. Stuart Murray Canal
6. Cattanach Canal
7. Goulburn Weir
8. Goulburn Weir Backwater
9. Lake Nagambie

- Cropping (potentially high pesticide use)
- Improved pasture (pesticide use)
- Vineyards (potentially high pesticide use/)

HISTORY

Goulburn Weir is a concrete and masonry structure, that allows for adequate water levels so that water can be diverted into the East Goulburn Main Channel, the Stuart Murray Canal and Cattanach Canal. When it is full the Goulburn Weir pool contains 25,000ML of water and is 1130ha in size.

Stuart Murray Canal: Water diverted into the Stuart Murray Canal either ends up in Waranga Basin or is diverted into the Central Goulburn area, via 5 separate off takes. Capacity at Goulburn Weir is 3500ML/day, but if Waranga Basin is above 380,000ML, Weir's capacity is 2000ML/day.
The Cattanach Canal has no irrigation diversions along its length and can divert up to 3690ML/day into Waranga Basin.

In regards to the management of Lake Nagambie; "...these assets are a critical part of the water infrastructure of northern Victoria and are the responsibility of Goulburn Murray Water".(34)

"It has been estimated that the catchment above Lake Nagambie, has pollution generation rates of 75,000t/yr. (including nitrogen 180ot/yr and phosphorus 25ot/yr. These estimates do not however include pollutants effectively trapped in 'in-line' storages at Lake Eildon and Goulburn Weir or substances deposited on floodplains. Lake Eildon and Goulburn Weir act as sediment and nutrient traps. Lake Eildon traps approximately 96-97% of pollutants entering the storage."(35)

"The Goulburn Weir near Nagambie and associated diversion channels to the east and west of the river, serving the Goulburn-Murray Irrigation district, have reduced the average annual down river flow there to ... less than half the pre-regulated flow." (36)

Nutrient and turbidity levels have generally increased at Lake Nagambie since 1998. Potentially toxic BGA were recorded at Lake Nagambie (Goulburn Weir) in 2002. Potentially toxic BGA were detected at Alert Level 1 on two occasions in January 2003 and Alert Level 3 in March 2003.

BGA levels at Lake Nagambie reached all time highs in 2006/7, particularly in February and March. During 2007 Lake Nagambie recorded the highest normal range of toxigenic BGA out of all the Goulburn storages. 70% of BGA algal counts above 500 cells/mL between 1992 and 2007 at Lake Nagambie occurred during 2006/7 (8).

"The 2002 expert panel's ecological review of Lake Nagambie and the Goulburn Weir Pool...identified septic tank systems in the Picnic Point area, run-off from the Tahbik area and other environmental issues as posing potential threats to the health of the lake and the weir pool" (32)

On January 14 2004, holiday makers reported large numbers of dead fish in the Goulburn River just downstream of Goulburn Weir. This was later confirmed by Goulburn Murray Water that thousands of dead fish were floating in the plunge pool, immediately below the concrete structure.

Several days later it was reported that 15km of the Goulburn River below the Goulburn Weir had dead and dying fish. Nine hypothesis were determined as being the cause of the dead fish. These were presented to the EPA. "The EPA later concluded that low Dissolved Oxygen and associated effects, including possible sulphide toxicity seem to be the most likely cause of the fish deaths downstream of Goulburn Weir". (32)

"Only two fish kill events have been reported downstream of Lake Eildon and upstream of Goulburn Weir between 1997-2004, at Whitehead Creek near Seymour and Katies Creek near Yea. Three incidents were reported at Lake Eildon and one on the Howqua River. Almost 20 other fish kills were reported, but downstream of Goulburn Weir". (32).

IN FEBRUARY 2004 MUSSELS WERE FOUND DEAD IN THE CATTANACH CANAL (NEAR THE OFF TAKE OF THE GOULBURN WEIR), ALTHOUGH AFTER AN INVESTIGATION BY THE EPA, RESULTS OF THEIR DEATHS WERE INCONCLUSIVE. (37) ON THE 12TH OF NOVEMBER 2004, THE ACTING VICTORIAN CHIEF HEALTH OFFICER JOHN CARNIE WARNED PEOPLE NOT TO EAT FISH CAUGHT IN THE GOULBURN WEIR POOL AND LAKE NAGAMBIE FOLLOWING SIX CASES OF GASTROINTESTINAL ILLNESS. (38)

PESTICIDES IN LAKE NAGAMBIE

Between 2004-6 (starting September 2004), Goulburn Murray Water conducted Pesticide Monitoring in their irrigation supply channels over their six irrigation areas in northern Victoria. One of the chosen reference points was at the Stuart Murray Canal/Goulburn Weir Nagambie. The insecticide Endosulfan and herbicide Atrazine were detected. Endosulfan was recorded at Nagambie in October, November and December 2005. However during these months Total concentrated endosulfan was highest at Nagambie out of all of the 5 sites in the 6 irrigation districts. According to the report "Endosulfan is registered for insect control on a number of crops including pome fruit, stone fruit and vegetables... Safe for all uses except aquaculture... The detection of Endosulfan at Nagambie may be related to growing vegetables (tomatoes) and fruit upstream of Nagambie". (39)

Endosulfan is also registered for use on cropping and it is more likely that the source of the Endosulfan was from a cropping enterprise, as this study has found that next to no pome fruit, stone fruit and vegetables are grown upstream of Lake Nagambie. It is also interesting to note that the Endosulfan detections (October 2005-November 2005) were above safe levels for aquaculture. Could Endosulfan also have been in the water during the fish kill event of January 2004?

Detected Pesticide summary for Goulburn Weir/ Nagambie September 2004-6 (39)

NOVEMBER 2004: TRACE LEVEL ENDOSULFAN. JANUARY 2005: ATRAZINE 0.002UG/L. FEBRUARY 2005: ATRAZINE 0.01UG/L. MARCH 2005: ATRAZINE 0.019UG/L. APRIL 2005: ATRAZINE 0.02UG/L. AUGUST 2005: ATRAZINE TRACE, COPPER 2.2UG/L. SEPTEMBER 2005: COPPER <0.9UG/L. OCTOBER 2005: ENDOSULFAN 0.0087UG/L. ATRAZINE TRACE, COPPER 1.3UG/L. NOVEMBER 2005: ENDOSULFAN 0.0186UG/L, ATRAZINE TRACE, COPPER <0.9UG/L. DECEMBER 2005: ENDOSULFAN 0.0021UG/L, ATRAZINE 0.042UG/L, COPPER <0.9UG/L. JANUARY 2006: ATRAZINE 0.033UG/L. FEBRUARY 2006: ATRAZINE 0.044UG/L, COPPER <0.9UG/L, MARCH 2006: ATRAZINE 0.0048UG/L, COPPER <0.9UG/L. APRIL 2006: ATRAZINE 0.036UG/L. (39)

"THE TOXICITY AND ECOTOXICITY OF ENDOSULFAN IS WELL DOCUMENTED. ENDOSULFAN IS HIGHLY TOXIC FOR HUMANS AND FOR MOST ANIMAL TAXA, SHOWING BOTH ACUTE AND CHRONIC EFFECTS AT RELATIVELY LOW EXPOSURE LEVELS. ACUTE LETHAL POISONING IN HUMANS AND CLEAR ENVIRONMENTAL EFFECTS ON AQUATIC AND TERRESTRIAL COMMUNITIES HAS BEEN OBSERVED UNDER STANDARD USE CONDITIONS WHEN THE RISK MITIGATION MEASURES HAVE NOT BEEN FOLLOWED. SEVERAL COUNTRIES HAVE FOUND THAT ENDOSULFAN POSES UNACCEPTABLE RISKS, OR HAS CAUSED UNACCEPTABLE HARM, TO HUMAN HEALTH AND THE ENVIRONMENT, AND HAVE BANNED OR SEVERELY RESTRICTED IT...ENDOSULFAN IS HIGHLY ACUTELY TOXIC VIA ORAL, AND DERMAL ROUTES OF EXPOSURE AND IT IS ASSOCIATED TO HUMAN POISONING..." (40)

Information on Endosulfan

PESTICIDES IN LAKE NAGAMBIE

In terms of risks to the residents of Ballarat and Bendigo, the levels of Atrazine and Endosulfan recorded in Lake Nagambie and Waranga Western Channel are well below the health levels set by the National Health and Medical Research Council in the Australian Drinking Water Standards. (56) The current health level for atrazine is set at 40 parts per billion (40ug/L) and Endosulfan at 30ug/L. However research from the United States has revealed that levels of Atrazine for example can chemically castrate amphibians at doses as low as 0.1 parts per billion, which is close to the levels reported at Lake Nagambie. The pesticide levels at Lake Nagambie are likely to dilute further at Waranga Basin, however Goulburn Murray Water have detected both Atrazine and Endosulfan at equivalent levels in Waranga Western Channel as were recorded at Lake Nagambie (39). Also of concern is that the water authority that provides drinking water to Nagambie and Colbinabbin, Goulburn Valley Water, has not reported finding pesticides at all at these locations. Both Endosulfan and Atrazine can interfere with hormones:

http://www.endo-society.org/journals/ScientificStatements/upload/EDC_Scientific_Statement.pdf

"In particular atrazine inhibits production of testesterone (the male sex hormone) and induces estrogen production (the female sex hormone), upsetting the balance between these two hormones. This effect of atrazine has been observed and published in fish, amphibians, reptiles and mammals. The result is chemical castration (demasculinisation) and feminisation. In fish, amphibians, and laboratory rodents, the decrease in testesterone results in decreased sperm counts, impaired fertility, and a reduction in masculine features. Similarly, atrazine exposure is associated with decreased sperm and reduced fertility in humans. The increase in estrogen by atrazine results in feminisation of males in fish, amphibians and reptiles. "Feminised" male fish and amphibians produce eggs and egg yolk and some males even grow ovaries (become hermaphrodites)" "The effective concentration in amphibians (0.1ppb) is 30 times lower than the current (US) EPA drinking water standard..." . (400 times lower than the current Australian Drinking Water Health Limit). (56)

Information on Atrazine

"THERE WAS A RELATIVELY SMALL RANGE OF CHEMICAL TYPES ANALYSED IN REACTION TO THE FISH DEATHS IN EARLY 2004. IT IS DIFFICULT TO SEE WHY SOME OF THESE CHEMICALS WERE CHOSEN ABOVE OTHERS MORE LIKELY TO BE USED IN THE AREA OR KNOWN TO BE TOXIC TO FISH. ... THERE APPEARS TO BE LITTLE OR NO COMMUNICATION BETWEEN RELEVANT AGENCIES WHEN TRYING TO OBTAIN THIS TYPE OF RELEVANT BACKGROUND INFORMATION...THE PRESENCE OF HERBICIDES OR FUNGICIDES WAS SEEMINGLY NOT PART OF THE ANALYSIS RESULTS RELEASED ON THE GMW WEBSITE..." (32).

"IT IS ACKNOWLEDGED THAT BIOCIDES USAGE UPSTREAM OF THE GOULBURN WEIR HAS THE POTENTIAL TO IMPACT UPON RIVER HEALTH. THIS IS THROUGH VITICULTURE (NUMEROUS VINEYARDS UPSTREAM OF THE GOULBURN WEIR), ANNUAL CROPPING (CEREALS AND OIL SEEDS) AND PASTURES (LUCERNE AND CLOVER PRODUCTION" (32).

Cattanach Canal

Kirwans Bridge at Goulburn Weir Backwater

AQUATIC WEEDS IN LAKE NAGAMBIE/GOULBURN WEIR

Goulburn Weir backwater also has problems with aquatic weeds, including Mexican Water Lily (Nymphaea mexicana) and Cabomba (Cabomba caroliniana) . Goulburn Murray Water started a weed control program in May - June 1996 when the lake was sprayed with Roundup biactive in dry conditions. About 210 litres of Glyphosate was used. Water lily clumps were targeted again in late November 1996 – March 1997 with Glyphosate rates of 6L/ha, meaning that 577 litres of Glyphosate was used. Glyphosate levels in the lake, pre-spraying were ⟨0.1mg/L. Samples taken in late 1996 showed Glyphosate levels of ⟨0.03mg/L.

Between November 1997 to March 1998, 361 litres of Nufarm Weedmaster 360 was applied. Glyphosate levels at one point in the lake increased to 0.038mg/L and then decreased to ⟨0.03mg/L after two days . From 1999 to 2003 another 2193.5 litres of herbicide (either Roundup Biactive, Roundup 360, and Weedmaster 360) was used in the lake. During 2000/1 monitoring found Glyphosate residues of ⟨0.03mg/L.

Monitoring of glyphosate post spraying in 2007 saw Glyphosate levels as high as 0.12mg/L post spray. No residues were detected 19-51 days after spraying. (42).

Terrestrial spraying also occurs near Goulburn Weir to control Pattersons Curse, grasses and eucalpyts. With Weedmaster Duo, Glyphosate and Agtryne/MCPA used.

“Comes et al (1976) found that 58% of glyphosate at distances of 8 and 14.4km downstream from the point of introduction in to the canal...however found that 63% of glyphosate in irrigation channels was lost to adsorption within 2km. Rates of loss are directly related to the amount of organic material and microbes present in the water column”. (43)

The other weed problem in Lake Nagambie is Cabomba (Cabomba caroliniana). Lake Nagambie and Lake Benalla are the only location in Victoria where this weed occurs. A major infestation was found at Lake Nagambie in 1996. Herbicides were trialled when the lake was lowered, however the herbicide that may best control Cabomba could be Carfentrazone (44), This herbicide may be used if other methods of control fail.

In 2000 it was reported that there had been a ten fold increase in Cabomba in the previous two years (from 6ha to 60ha). A limited herbicide regime occurred in Lake Benalla in 1999/2000 using dichlobenil, simazine and chelated copper. At this time there was no herbicide registered for Cabomba control in potable water supplies in Australia. (45)

GOULBURN MURRAY WATER ALSO INVESTIGATED THE USE OF A NUMBER OF HERBICIDES IN 1998 FOR CONTROL OF CABOMBA AT LAKE NAGAMBIE, WHICH AT THAT TIME COVERED 25HA. THE ONLY HERBICIDES REGISTERED FOR AQUATIC WEED CONTROL IN AUSTRALIA AT THAT TIME WERE 2,4-D AMINE, DIQUAT, GLYPHOSATE, AMITROLE AND ACROLEIN. IN THE UNITED STATES HOWEVER A LARGER RANGE OF HERBICIDES WAS AVAILABLE IN THE UNITED STATES INCLUDING; 2,4-D DIETHYLAMINE, DIQUAT, FLURIDONE, DIQUAT AND COMPLEXED COPPER, ENDOTHAL DIPOTASSIUM SALT (K2), ENDOTHAL K2 & COMPLEXED COPPER, ENDOTHAL DIMETHYLAMINE SALT. (46)

PUCKAPUYNAL

Puckapunyal Army base was established in 1939 and for some time was Australia's largest army camp. 1000 personnel can be housed at the site, which is 25% of the 4000 personnel that could be housed there in the mid 1960s.

It is the largest military training centre in Victoria. Initially 5,714ha of grazing land was compulsory acquired before the military base was opened in 1939. Both AIF and militia units trained there and today the field training area is larger than 40,000ha, which makes the base the largest landholder within the Goulburn catchment (after the Victorian State Government). Puckapunyal is best known however as the home of the School of Armour of the Royal Australian Armoured Corp who first moved there in 1941. The Royal Australian Armoured Corp (RAAC) is the Senior Arms Corp of the Australian Army.

School of Armour and 1st Armoured Regiment operates out of Puckapunyal. Concerns of pollution from lead or tungsten bullets or shells have not been evaluated in this report. Concerns over use of depleted uranium by the Australian army at Puckapunyal appear to be unwarranted.

According to a press release by the Victorian Peace Network 30 July 2006, "The Australian Defence Forces delayed receiving its purchase of second-hand US Abrams tanks until their DU-hardened armoury was replaced. On 10 March 2004 then defence Minister Robert Hill, in announcing the decision to purchase the Abrams M1A1 tank, said that the government had decided "not to get the depleted uranium armour" and "we don't have a plan to use projectiles that are made with depleted uranium". (47)

A Freedom of Information request was sent to the Department of Defence regarding water quality monitoring at Puckapunyal. In the response, the Department of Defence said that for most of the past few years, no water had been flowing through monitored streams at Puckapunyal. However some results were sent for the period June 2009 to October 2009.

It appears that the Department monitors water quality at 5 sites at Puckapunyal. Gardners Creek at Puckapunyal, Bylands Creek d/s Tooborac Road, Hawkers Creek u/s Range Control, Hawkers Creek u/s Baldwins Bridge and Gardners Creek at Mount Puckapunyal. The streams are monitored for Gauge Height, Electrical Conductivity, pH, Turbidity and rainfall.

Highest Readings at each site between June - October 2009.

GARDNERS CREEK AT PUCKAPUNYAL: EC @25OC 370 (OCTOBER 09), PH 6.5 (OCTOBER 09), TURBIDITY 98 (OCTOBER 2009).
BYLANDS CREEK D/S TOOBORAC ROAD: EC @25OC 235 (SEPTEMBER 09), PH 7.4 (SEP 09) - 6.63 (AUGUST 09), TURBIDITY 474 (JULY 2009).
HAWKERS CREEK U/S RANGE CONTROL: EC @25OC 305 (SEPTEMBER/OCTOBER 09), PH 7.5 (OCT 09) - 6.8 (JUNE 09), TURBIDITY 183 (JUNE 2009).
HAWKERS CREEK U/S BALDWINS BRIDGE: EC @25OC 131 (SEPTEMBER 09), PH 6.6 (OCT 09) - 5.5 (JUNE 2009), TURBIDITY 970 (JUNE 2009).
GARDNERS CREEK AT MOUNT PUCKAPUNYAL: EC @25OC 670 (SEPTEMBER 09), PH 6.8 (SEP 09) - 5.5 (JULY 2009), TURBIDITY 506 (AUGUST 2009).

From a summary of these short term results it appears that water monitored at Puckapunyal can be acidic and in places very turbid. According to the ANZECC Guidelines for Fresh and Marine Water Quality 2000, turbidity readings in lowland rivers should be between 6-50 NTU and in upland rivers between 2-25 NTU. The reading at Hawkers Creek in June is almost 20 times higher than the ANZECC Guidelines for lowland rivers. Hawker Creek discharges into Gardiners Creek about 2km before Gardiners Creek discharges into Major Creek, which is the largest drainage inside the Puckapunyal Commonwealth Area. Major Creek flows into the Goulburn River at Michellstown.

Bore Water is also tested at Puckapunyal at 25 locations. Bore water is tested for; water levels, conductivity, pH, temperature and Dissolved solids.

Water levels range from 4.8(?) to 35.5(?). Conductivity ranges from 1.06(?) to 20+(?). pH ranges from 6.18(?) to 9.83(/), Temperature ranges from 14(?) to 26.3 (?), Dissolved Solids range from 0.53(?) to 10+(?).

WARANGA BASIN

Waranga Basin is an off-stream storage, that draws off unregulated flows from the Goulburn River. It holds 412,000ML and was completed in 1905. It is used almost exclusively to supply irrigation demands mainly during summer and early autumn.

The Waranga Basin has 2 outlets, a minor outlet that provides up to 1850ML/day of water to the Central Goulburn 7 and 8 systems. Its major outlet is the Waranga Western Channel 4210ML/day. A portion of the WWC's can be diverted via the Central Goulburn Offtake 9, which is located a short distance from the main WWC outlet. This diversion capacity is 860ML/day, thereby reducing WWC rates to 4210ML/day. Both Ballarat and Bendigo now draw water from the WWC at the Colbinabbin pumping facility.

Waranga Basin has a strong seasonal pattern of water storage, with levels rising over the autumn-winter period and falling in spring-summer.

Most of the landuse immediately surrounding Waranga Basin is pasture with come cropping evident. It is feasible that contaminants could wash into Waranga Basin, particularly in times of heavy rain. It is also feasible that contaminants could enter Waranga Basin via the Cattanach and Stuart Murray Canals. Goulburn Murray Water does not conduct pesticide monitoring at Waranga Basin.

According to the Campaspe Planning Scheme; "Another issue of emerging importance is the pressure to develop land adjacent to Waranga Basin for agricultural purposes. There is a lack of controls in place to enforce appropriate buffer distances of agricultural activity from Waranga Basin. High use of fertilsers, pesticides and herbicides may have a detrimental impact on the quality of water in the Waranga Basin". (48)

Freedom of Information released to Friends of the Earth in late 2009, revealed in the years 2007 -9, approximately 240 litres of herbicide was used around the Waranga Basin to control grasses, briar rose, boxthorn, canegrass, floating pondweed and cumbungi. Approximately 3% of the herbicide used was Metsulfuron Methyl, with the remainder being Weedmaster (Glyphosate). (49)

Five occurrences of Blue Green Algae above 500 cells/mL were detected in Waranga Basin between 1992 and 2005. Six were detected in 2005/6 including Alert Level 2 in November 2005 and January 2006 (8) which were regarded as significant increases from historical concentrations.. Water levels in the basin were as low as 3% in 2003 and turbidity can be an problem.

WARANGA WESTERN CHANNEL / GROVES WEIR

Waranga Western Channel can be impacted by farming practices near Colbinabbin at Groves Weir, which includes the catchments of the Goborup and Wanalta Creeks. Groves Weir is located ~7km south east of Colbinabbin and is the only portion of the Waranga Western Channel between Waranga Basin and Colbinabbin that is connected, via waterway to surrounding country. All other sections of the Waranga Western Channel, where it crosses creeks and drainage lines, water flow is diverted under the Channel via drains and culverts. The Channel is also elevated so that surrounding farm runoff cannot flow into the channel. This however is not the case at Groves Weir. When full, Groves Weir and surrounding wetland is approximately 25ha in size. The wetland is fed via Wanalta Creek and Gobarup Creek. Wanalta Creek catchment, upstream of Groves Weir is dominated by native forests in the headwaters and cropping and pasture. Small plantation holdings also occur in the catchment.

Pesticides Most at Risk in Waranga Western Channel from Groves Weir Catchment

Land Use: 1. Pasture. 2. Cropping.

HERBICIDES: 2,4-D, AMITROLE, ATRAZINE, CHLORTHAL DIMETHYL, CLOPYRALID, DICAMBA, DIQUAT, DIURON, ETHOFUMESATE, GLYPHOSATE, HEXAZINONE, IMAZAPIC, IMAZETHAPYR, METSULFURON METHYL, MOLINATE, PICLORAM, PROPYZAMIDE, SETHOXYDIM, SIMAZINE, TEBUTHIURON, TERBACIL, TERBUTRYN, THIOBENCARB, MCPA, PARAQUAT, PROMETRYN.

INSECTICIDES: CARBARYL, DIAZINON, DIMETHOATE, DISULFOTON, ENDOSULFAN, FIPRONIL, IMIDACLOPRID, MALDISON, METHIDATHION, METHOMYL, PHOSMET.

FUNGICIDES: METALAXYL.

Spraying Oil container found near Groves Weir

Groves Weir/ Waranga Western Channel

LAKE EILDON

History: Year of completion 1956. Capacity 3,390,000ML (six times that of Sydney Harbour). Area submerged 13,382ha.
"Each year Goulburn Murray Water is able to tale up to 1919 Gigalitres of flow from the Goulburn River and release 1400 Gigalitres (GL) of water from Lake Eildon under the Bulk Entitlement (Eildon-Goulburn Weir) Conversion Order (the Bulk Entitlement) which came into effect on 1 July 1995." (32)
Major tributaries flowing into Lake Eildon include the; Big, Upper Goulburn, Jamieson, Howqua and Delatite Rivers.

Approximately 91% of water released from Lake Eildon is diverted for irrigation purposes. 60% of water in the Goulburn Murray Irrigation District comes from Lake Eildon. In December 2006, Goulburn Murray Water predicted that water levels in Lake Eildon would drop to 3.8% of full water supply by April 2007. (52)

Lake Eildon provides flood mitigation for the Goulburn Valley and supplies over half of the irrigation water used in the Goulburn Murray Irrigation District.

"Under natural conditions the average annual flow of the Goulburn River increased from 1,655,000ML at Eildon to 2,964,000ML passing Nagambie. The three months of greatest flow were July to September, accounting for 52% of the annual total, and the three months of least flow were January to March, accounting for 5%. Operation of the Eildon Reservoir had reduced the July to September flows passing Eildon to 33% of the annual total, allowing an increase of the January to March flows to 23% of the annual total." (36)

In mid 2005, the following statement about impact of drought on Lake Eildon was made; "Has high proportion of through-flow each year, so water quality is strongly influenced by Goulburn River quality. No noticeable long-term change in e-coli, temperature, turbidity, nitrogen; phosphorus may be decreasing". (53)

Direct effects include:
*Lake Eildon and Lake Nagambie act as sediment traps, capturing a high proportion of the suspended load carried by the river. However, a combination of a naturally low sediment yield, armouring of the river bed in the upper reaches and a generally stable river channel (Erskine et al. 1993, Chapter 5) means that the sediment trapping efficiency of Lake Eildon and Lake Nagambie is not currently a big risk to water quality (eg as a result of increased incision into the riverbed).
*Cold water releases from Lake Eildon

Trout farms are a source of nutrients to the Goulburn River but discharges are licensed with the EPA and there are ongoing efforts to reduce the loads being released. (33)

The Potentially toxic blue-green algae Microcystis Above Level 1, were recorded nine times in 2003 at Lake Eildon, peaking in January 2003. Lake Eildon's water level dropped to 8.5% of capacity in 2003 with a water temperature of 27 degrees. Previous breaches to Alert Level 1 also occurredS. torage capacity of Lake Eildon fell to an historic low of 5% in May 2007 but increased to 25% by December.

In 2008 Lake Eildon only reached a maximum level of around 14%. Increases in turbidity, phosphorus, Electrical conductivity and nitrogen seem also to be occurring. The peak occurrence of frequency of BGA at Bonnie Doon, Lake Eildon above 500cells/mL occurred in both 1993/4 and 2004/5.

Storage capacity of Lake Eildon has remained under 55% since 1999.

Compliance with the Victorian SEPPs 100 ecoli/100mL in a raw water supply. This level was exceeded several times at Lake Eildon between 1971-2001. Total coliforms and ecoli generally rose during summer months and following rainfall. Bacterial testing at Lake Eildon commenced in 1968, with ecoli levels peaking in May-June. The Lake is susceptible to faecal contamination, however is usually 'confined' to areas near source. High readings of ecoli 72,000/100mL were detected near Bonnie Doon Caravan Park in 1979.(54)

Lake Eildon and Goulburn Weir act as sediment and nutrient traps. Lake Eildon traps approximately 96-97% of pollutants entering the storage.(35), meaning that in terms of water quality the major impact on the Goulburn River will be downstream of Lake Eildon...

Gold mining.

Between 1867 to 1973 nearly 2500 tonnes of gold was produced in Victoria. Approximately 38% of the gold was produced by quartz reef mining, which used mercury in the gold recovery process. "Gold particles wetted by mercury adhere to each other and to copper plates that have been coated with mercury". (55) One ounce of mercury was lost for every one ounce of gold recovered, meaning that approximately 950 tonnes of mercury was deposited into Victorian soil, rivers and streams."The A-1 mine at Rasberry Creek, subject of the more detailed study, operated until 1976 and produced about 12 tonnes of gold. It discharged about 12 tonnes of mercury in its tailings. The Morning Star mine at Woods Point discharged 10 tonnes of mercury into the environment. The Monash team found high levels of mercury in sediments near the battery outlet of the A-1 mine... Contamination was also present in sediments further downstream in Rasberry Creek and Gaffneys Creek and the Goulburn River...In the Monash study, mercury concentrations in fish from the Upper Goulburn system and Lake Eildon were only about one-tenth of those in the invertebrate larvae near the A-1 mine. But the methylmercury concentrations in the fish were nearer to 10 times found in invertebrate larvae...a study presented ...by the Environment Protection Authority indicates that in Lake Eildon, at least, there are many fish containing mercury levels well above the statutory health limits...the fish analysed in the Monash study were very small and were from the headwaters of the Eildon. Even so, their mercury and methylmercury levels were approaching the NH&MRC limit." (55)

GLOSSARY

Aluminium: Can naturally leach into water supplies, but is also used as a coagulant in the water treatment process. Acid soluble aluminium concentrations above 0.2mg/L can cause milky coloured water in the distribution process. There is a causal link between aluminium concentrations and Alzheimer's disease. Aluminium has also been linked to Parkinson's Disease and can cause problems for people undertaking kidney dialysis.

Australian Drinking Water Guidelines:
The Australian Drinking Water Guidelines (ADWG) undergo a rolling revision process every few years. The last guidelines were published in 2004 and draft comments were sought in early 2010 for the latest version of the guidelines. The 2004 ADGW's were developed in collaboration with the NHMRC (National Health and Medical Research Council) and National Resource Management Ministerial Council (NRMMC). The Guidelines have a host of information regarding water quality and also include fact sheets outlining what the ADWG considers to be safe levels of substances in drinking water. Guideline levels and Health levels are included for numerous substances. Guideline Value meaning; "the concentration or measure of a water quality characteristic that, based on present knowledge, either does not result in any significant risk to the health of the consumer (health-related guideline value), or is associated with good water value (aesthetic guideline value)." (56)

Blue Green Algae (BGA): BGA is actually photosynthetic bacteria, also called 'cyanobacteria'. Some species of BGA can produce chemicals that taint drinking water,in some cases making it undrinkable. Some species of BGA can also produce toxins that can be hazardous to people and animals if consumed, inhaled or sking contact. BGA produce three types of toxin. 1) Hepatotoxins: associated with liver damage and increase some cancer risks. 2) Neurotoxins: can damage nerves and cause muscle tremors making breathing difficult. 3) Allergens: Cause skin rashes, eye irritations and possibly gastroenteritis. Different strategies are employed by water authorities to deal with BGA including physical controls, reducing nutrient inputs, restricting light, taking water from unaffected parts of reservoirs, chemical controls such as algicides. Treating BGA means adjusting flocculation, filtration, chlorination and using activated carbon.

"Alert Level Guidelines for Drinking Water Supply of Potentially Toxic Blue-Green Algae.

Alert Level	Cells mL-1
1	500-2,000
2	2,000-15,000
3	⇢15,000

" (7)

Bromate: A byproduct of the ozonation disinfection process and may cause a cancer risk if consumed over a long time.

Chlorine Disinfection Byproducts

Trihalomethanes: A by-product of disinfection through chlorination or chloramination,, where chlorine reacts to organic material.

Chloroacetic Acid: By-product of chlorine reacting with humic and fulvic acids in drinking water supplies.

Dichloroacetic Acid: By-product of chlorine reacting with humic and fulvic acids in drinking water supplies.

Trichloroacetic Acid: By-product of chlorine reacting with humic and fulvic acids in drinking water supplies.

Colour: Dependent on dissolved organic matter which contain fulvic and humic acids, which are created through soils and native vegetation. Apparent colour is usually measured before filtration.

Escherichia (Ecoli): Ecoli is common in animal and human faeces. It is tested for by water authorities to ensure that faecal contamination is not occurring. Disinfection can occur through chlorination and chloramination. Disinfection residual is maintained throughout the distribution network to ensure there is no regrowth of organisms.

FIRE:

In recent years the water supplies of Ballarat, Bendigo and Benalla have been impacted by bushfires. The most serious being the February 2009 fires that decimated a major portion of the headwaters of the Goulburn River system. Benalla had almost their entire water supply burnt out as a result of the January 2007 Tolmie fires.

Fires can impact on water quality in several ways most notably being increases of sediment and nutrients, which in turn impact on aesthetic quality of drinking water (eg turbidity and colour). Increases of nutrients (particularly phosphorus) can in turn heighten the risk of cyanobacterial blooms. Depending on the intensity of the fire, levels of iron and manganese may also increase, as can levels of suspended solids. This may require water authorities to increase chlorine treatment.

Use of fire retardants in water supplies which often consist of fertiliser like chemicals such as ammonium sulphate and ammonium phosphate is also of concern to people. Use of such fire retardants may also increase the risk of algae and cyanobacteria. Regrowth bush burnt by bushfires can reduce stream flows. In the short term an increase in water quantity may occur (often associated with poorer quality water), however as the burnt bush regenerates the young growing trees require a large quantity of water. Burnt Ash forests in higher elevations will consume more water than burnt mixed species located on lower elevations.

Glossary continued

Fluoride: The Health (Fluoridation) Act 1973 and the Department of Health determine that fluoride levels must not exceed 1.0mg/L (annual average) or individual samples above 1.5mg/L. There is often major community concern regarding fluoridation of water supplies. http://www.fluoridealert.org/

Hardness: Usually refers to the presence in water of calcium or magnesium, the origin of which is usually determined by geological factors. Hard water can form scale in kettles, irons and washing machines.

Iron: Usually found in water sourced from catchment soils. High iron levels in water can cause staining problems for plumbing fixtures and washing.

Lead: Lead has been a major problem in the Ballarat region (particularly in 2006/7) and also has caused some concerns in Bendigo. “Unlike most water contaminants, lead gets into water after it leaves a water treatment plant. Often this contamination is the result of water treatment changes meant to improve water quality that end up altering the water chemistry, destabilising lead-bearing mineral scales that coat service lines and corroding lead solder, pipes, faucets, and fixtures.” (57) Lead in water has been seen to be a major source of lead exposure. Corrosion from lead based solders in brass fittings and copper pipes is often the source of lead in drinking water. This problem is often worsened by people drinking and cooking with corroded water after a first use particularly in the morning. Lead based solder has been banned in Australia since 1989 so problems are most likely to be associated in businesses and homes with water fittings pre-dating 1989 Lead has been linked to impaired cognitive development in children and a number of other health problems.(Lead can also be a result of dissolution from natural sources).

Manganese: Manganese is found in the natural environment. Manganese in drinking water above 0.1mg/L can give water an unpleasant taste and stain plumbing fixtures and laundry.

Mg/L: milligrams per litre.

ML: Megalitre or one million litres of water.
GL: Gigalitre or 1000 Megalitres.

pH: Measures how acidic or alkaline the water is. Pure water is supposed to have a pH of 7.0. pH levels less than 7.0 are acidic, whilst pH levels above 7.0 are alkaline.

Safe Drinking Water Act

Act of Parliament passed in 2003 and has applied in Victoria since the 1st of July 2004. Under the act, water suppliers must prepare, implement and audit risk management plans in relation to their water supplies. Water storage managers must also disclose relevant water quality information. Irrigation water or packaged water do not come under this act. The legislation applies to the three Metropolitan water authorities, regional urban water authorities, Melbourne Water Corporation, Parks Victoria, the Victorian Alpine resorts management and rural water authorities.

Total Dissolved Solids (TDS): A measure of the combined content of organic and inorganic substances in water. The most common constituents of TDSs arecalcium, phosphates, nitrates, sodium, potassium and chloride.

Turbidity: The measurement of light scattering properties of water through the suspension of fine particles. Turbidity is measured through NTU’s (Nephelometric Turbidity Units).

Ug/L: Micrograms per litre. (In the metric weight system, a microgram is a thousandth of a milligram. Since a milligram is a millionth of a kilogram, and the microgram is a thousand times smaller, it is equivalent to a billionth of a kilogram. Microgram is abbreviated ug. Thus, a part per billion of solid measure is equal to a ug/kg. Similarly, a part per billion of a solid in a liquid is equal to a ug/l). http://extoxnet.orst.edu/tibs/partperm.htm

Lead has been linked to impaired cognitive development in children and a number of other health problems.(Lead can also be a result of dissolution from natural sources).

Waranga Western Channel

APPENDIX 1.

The Veterinary antibiotics most frequently used in Australian animal industries

Cattle: avoparcin, ceftiofur, cephalosporins, cloxacilin, erythromycin, monensin, neomycin, oleandomycin, polyethers, salinomycin, tetracyclines, tilmicosin, trimethoprim, tylosin. (58)

Cattle Hormone Products used to control oestrous cycle: Prostaglandins (e.g. Estrumate, Lutalyse, Prosolvin). Progesterones (eg CIDR, Crestar). Oestrogens (e.g Cidirol, Oestradiol), ODB capsules), Gonadotrophin-releasing hormones (e.g. Cystorelin). Steroidal estrogen hormones, estriadiol, estrone (break-down products), estriol have been linked to endocrine disruption in the environment.

List of antibiotics approved for use in dairy animals in the US

Amoxicilin, Ampicillin, Ceftiofur, Cephapirin Sodium, Benzathine, Cloxacillin Sodium, Benzathine Chlortetracycline, Oxytetracycline, Erythromycin, Florfenicol, Hetacillin, Neomycin, Novobiocin, Penicillin G, Penicillin G and Novobiocin, Penicillin G and Streptomycin, Pirlimycin, Spectinomycin, Sulfadimethoxine. (59)

APPENDIX 2

What Coliban Water, Central Highlands Water and North East Water Test For (according to water quality reports 2008-09).

CHWater: E.coli, Chloroacetic Acid, Dichloroacetic Acid, Trichloroacetic Acid, Triahalomethanes, Bromate (Clunes), Formaldehyde (Clunes), Aluminium (Acid Soluble), Turbidity, pH, Total Dissolved Solids, True Colour, Hardness, Iron, Zinc, Cadmium, Copper, Lead, Manganese, Nickel, Arsenic, Chromium, Cyanide, Fluoride, Mercury, Selenium.

ColibanWater: E.coli, Chloroacetic Acid, Dichloroacetic Acid, Trichloroacetic Acid, Triahalomethanes, Bromate (in applicable towns), Formaldehyde (in applicable towns), Aluminium, Turbidity, Fluoride, pH, Hardness, Iron, True Colour, Electrical Conductivity, Sodium, Chloride.

Tap Water: Arsenic, Cadmium, Chromium, Cyanide, Mercury, Nitrate, Selenium, Sulphate, Manganese, Copper, Lead, Nickel, Benzo(a)pyrene, 2,4-D, chlordane, DDT, Dieldrin, Aldrin, Epoxide, Heptachlor, Radionuclides (alpha), Radionuclides (beta), nitrite.

Raw Water: E.coli, coliform, pH, turbidity, colour, electrical conductivity, alkalinity, hardness, arsenic, cadmium, chromium, cyanide, fluoride, mercury, nitrate, selenium, sodium, sulphate, chloride, barium, boron, antimony, iron, manganese, copper, lead, zinc, nickel. BGA count, BGA ID, Biovolume, Chlorophyll a, Benzo(a)pyrene, 2,4-D, chlordane, DDT, Dieldrin, Aldrin, Epoxide, Heptachlor, Lindane

North East Water: E.coli, Chloroacetic Acid, Dichloroacetic Acid, Trichloroacetic Acid, Triahalomethanes, bromate, formaldehyde, aluminium, turbidity, fluoride, arsenic, copper, lead, manganese, chlorine dioxide (whitfield), chlorite, chlorate,

taps: 1,1-Dichloroethane, 1,1-Dichloroethene, 1,2-Dichloroethane, 1,2,3-Trichlorobenzene, 1,2,4-Trichlorobenzene, 1,2-Dichlorobenzene, 1,3-Dichlorobenzene, 1,4-Dichlorobenzene, 2,4,6-Trichlorophenol, 2,4-Dichlorophenol, 2-Chlorophenol, Ammonia, Antimony, Barium, Benzene, Benzo(a) pyrene, Boron, Cadmium, Carbontetrachloride, Chromium, CIS-1,2-Dichloroethene, Cyanide, Cyanogen Chloride, Ethylbenzene, Free Chlorine, Hexachloro-1,3-Butadiene, M-&_P-Xylene, Mercury, Methylene Chloride, Molybdenum, Nickel, Nitrate, Nitrite, Nox as N, O-Xylene, Pentachlorophenol, Plate Count 37C, Potassium, Selenium, Silver, Styrene, Sulphate, Temperature, Tetrachloroethene, Toulene, Total Chlorine, Total Coliforms, Trans-1,2-Dichloroethene, Trichloroethene, 2,4-D, Aldrin, Amitrole, Atrazine, cis-Chlordane, DDT, Dieldrin, Endosulfan 1, Endosulfan 2, Endosulfan Sulphate, Glyphosate, Heptachlor Epoxide, Hexazinone, Lindane, Methoxychlor, trans-chlordane.

APPENDIX 3

Blue-Green Algal Species Considered Potentially Toxic in Goulburn Murray Storages

Anabaena (Anabaenopsis)
Aphanizomenon
Cylindrospermopsis
Coelosphaerium
Lyngbya (Planktolyngbya)
Limnothrix
Microcystis
Nodularia
Oscilliatoria
Phormidium
Plantothrix
Plectonema
Rahpidiopsis (l)

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Friends of
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