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# Logging and Water: Implications for Melbourne

A Doctors for Native Forests report.
This project funded by the Myer foundation.

Embargoed until 9 September 2002

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Report will be available online at: www.doctors.forests.org.au

## Summary

Melbourne is facing a shortage of water. The city's catchments, located high in the Yarra Ranges to the north east of Melbourne, can only supply a limited amount of water. As the city grows and demand increases, the ability of these catchments to meet consumption levels will become increasingly problematic. If consumption continues at current rates, the city is projected to be using the entire volume of the present system by the year 2012. Clearly, action needs to be taken to increase security of supply.

Water resource assessments have not factored in the risk of reduced water supplies due to global warming. The possible effects of global warming further increase the need to increase security of supply.

Two measures are available to increase security of supply: to repair the capacity of the catchments and supply system, and to reduce demand for water. While reducing wastage and increased recycling are obvious measures to most people, catchment management issues are essentially out of sight and little understood. Improved management of land use activities within the catchments, and in particular logging, has the potential to save large volumes of water, at least as significant as any other measure to increase supply security.

Australia's most extensive studies of the effect of logging on water have taken place in Melbourne's water supply catchment region. Logging has been clearly shown to reduce water yield from forested areas by up to 50%, 30 years after logging and is projected to take 150 years to return to pre-logged levels. This water loss results because mature forests use very little water, allowing large amounts of water to flow into streams and catchments, while a new growing forest after logging uses large amounts of water, leaving little left over to flow into streams and water supplies.

Existing catchment studies are summarised, while a modelling framework is developed to explore gaps in information on the potential effect of historical and planned logging in the Thomson, Tarago and Yarra Tributary catchments. The basis of the model is the forest age/yield curve developed by Watson et al (1999). The Watson et al (1999), and Kuczera (1985) curves formed the basis of the water yield impact assessment undertaken for State Government in the Otway forests. In order to be additionally conservative, only the Watson et al (1999) yield curve has been used in this study.

A combination of existing studies and the modelling undertaken reveals that considerable water yield reductions are predicted to occur. If logging continues, it is projected that in the long term 60,000 ML water will be lost per annum compared to what a mature forest would produce. This volume of water is equivalent to the water used by 250,000 Melbourne households per year, or 200 times what is currently being used in the Burnley Tunnel per year.

This projected volume of water provides an indication to land and water managers, Government, and the community of the implications of logging in Melbourne's water supply. The considerable size of the projected water loss highlights the need for an extensive study quantifying the impacts of logging in Melbourne's water supply catchments, and the need for logging practices to be taken into consideration when assessing water resources and catchment management.

## *1. Introduction*

Melbourne is fortunate to have been founded with foresight for water resources. By 1890, two of the city's catchments had been protected, followed by an additional two soon afterwards (O'Shaughnessy & Jayasuriya 1989). In recent decades, the increased demand for access to forest timber resources has resulted in extensive logging of water supply catchments.

Australia's longest running studies on the effect of catchment logging and bushfire on water supply have been carried out in the mountain ash forests of Victoria's Central Highlands. This research program has illustrated the significant negative consequences of logging in water supply catchments.

Today, as Melbourne approaches the limits of its available water supply, there is an increasing need for community awareness and debate over the management of our water supply catchments.

## *2. Melbourne's Limited Water Supply*

A series of forested catchments high up in the Yarra Ranges to the North East of Melbourne provide the city with water. These catchments have a limited capacity, estimated at about 570, 000 megalitres (ML) per year. As the city grows, its demand for water is increasing by around 0.9% each year. If Melbourne's water consumption continues to grow at present rates, it is projected to be using all available water by the year 2012 (WRSCMA 2001).

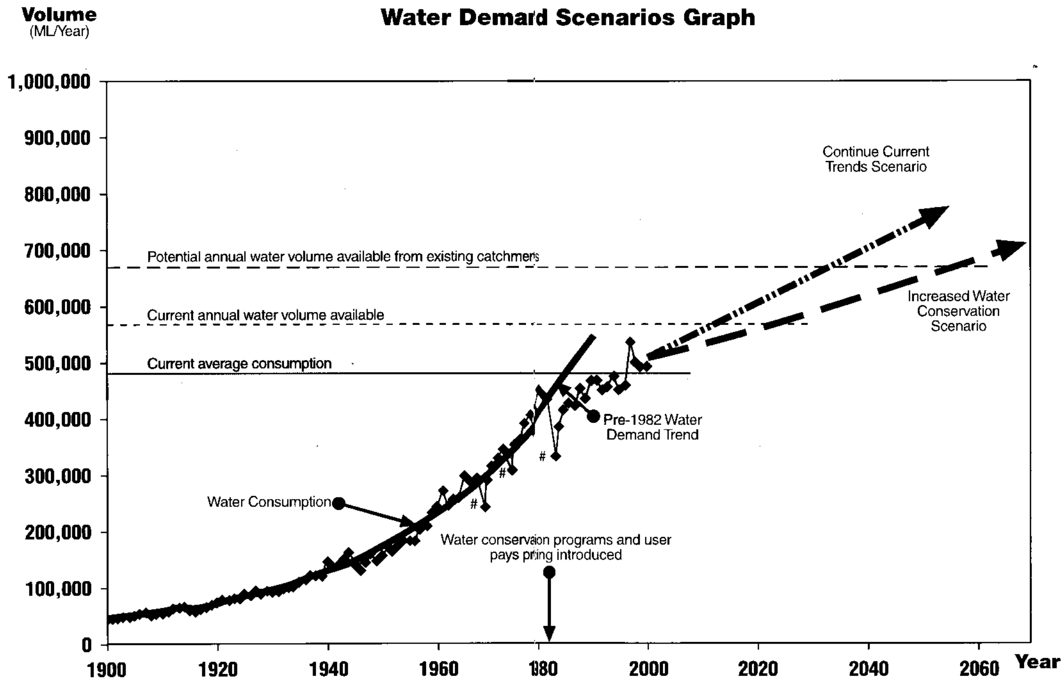



Illustration 1. Water consumption in the Melbourne Supply System. (WRSMA 2001)

Clearly, Melbourne is reaching the limits of its water supply, and action to increase water security needs to be taken. In this context, the Water Resources Strategy Committee for the Melbourne Area is planning measures to assure future supply. The Committee is investigating a number of options to increase water supply and decrease consumption. These are further discussed in section 4.

## *3. The Importance of Healthy Catchments*

The supply of clean water is emerging as one of the biggest, possibly the biggest issue the world has to face over the next 50 years (Harris G 2002). An estimated 2.3 billion people, 41% of the worlds population, currently live in areas with inadequate water (UNEP, WBCSD, WRI 2002). By 2025, 3.5 billion people or about half the worlds population are projected to face water shortages because they live in river basins with inadequate clean water (UN 2002).

The supply of abundant clean water underpins the health, wellbeing and lifestyle of all Victorians. We rely on healthy catchments for water supply, water purification, agriculture, fisheries, protection of flora and fauna, tourism and recreation.

The healthiest catchments tend to be those least disturbed by land uses such as agriculture, land clearing, logging and urban development. These activities can reduce water quality, and in the case of logging – reduce the volume of water flowing into water supplies.

A well managed catchment, as the source of supply, is crucial to planning for secure water resources. As catchments come under increasing pressure from detrimental activities, there is a tendency to look for answers in increasingly sophisticated water treatment. While treatment may provide a short term solution, it is not necessarily the best or even the most cost effective approach.

The New York department of environment and conservation estimates that the expenditure of US $1.5 billion in catchment management has allowed the City of New York to cancel proposed water treatment plants with an estimated cost of US $6.7 billion (BREC 1998)

In 1998, high levels of the gastrointestinal parasites Cryptosporidium and Giardia were detected in Sydney's drinking water. The cause of contamination was investigated as part of an independent inquiry chaired by Peter McClellan, QC. The inquiry concluded that much of Sydney's drinking water supply contains significant sources of Cryptosporidium and Giardia. Despite treatment systems operating efficiently, significant numbers of organisms passed into the drinking water supply. Although there was cause for concern about the contamination, it was unlikely that any person suffered illness from ingesting the parasites. The inquiry determined that improved coordination and integration of catchment management is a priority for protecting drinking water quality, and that solely investing in enhancements to water treatment systems is not necessarily the best solution (EPA 2001).

## *4. Global Warming and Water Supply*

An international network of 2,500 scientists has recently agreed that global warming is occurring and is due to human activities (Macquarie University 2001).

According to Dr Graeme Pearman, Chief of Atmospheric Research, CSIRO:

> Observations are providing reliable evidence that the Earth has warmed by about 0.6 degrees Celsius through the twentieth century and that warming is clearly visible in Australian measurements (CSIRO 2000)

Global warming will potentially reduce streamflow due to reduced rainfall, altered rainfall patterns, increased evaporation and increased plant transpiration (WRSCMA 2002). Annual and seasonal changes in climate will alter the frequency and severity of major drought periods, while changes in rainfall and other climate variables can result in large variations in expected water storage volumes and consumer demand (WRSCMA 2002).

A CSIRO study, commissioned by the State Government, predicts less rainfall is likely for Victoria. The study concludes that there could be a decrease in rainfall of 9% by 2030 and 25% by 2070 across most of Victoria (CSIRO 2002)

Scientists have concluded that global warming could significantly reduce streamflows in South Eastern Australia. CSIRO's Atmospheric Research and Land and Water Unit, in collaboration with Hassell and Associates and government agencies, modelled the impacts of global warming on the Macquarie River catchment in NSW, to indicate possible effects of the enhanced greenhouse effect on catchments in south-eastern Australia (Jones *et al.* 2001). The research concluded that climate change poses a significant risk (up to a 20% reduction in flows) to water supply within the next thirty years and a substantial risk (up to a 45% reduction in flows) within the next seventy years (Jones *et al.* 2001).

The need of crops and ecosystems for water will increase as temperatures and evaporation rise, particularly if there is also the predicted decrease in winter precipitation in southern states (ENRC 2001).

According to Dr Barrie Pittock, former head of the CSIRO's Climate Impact Group, global warming is inevitable. He has stated that:

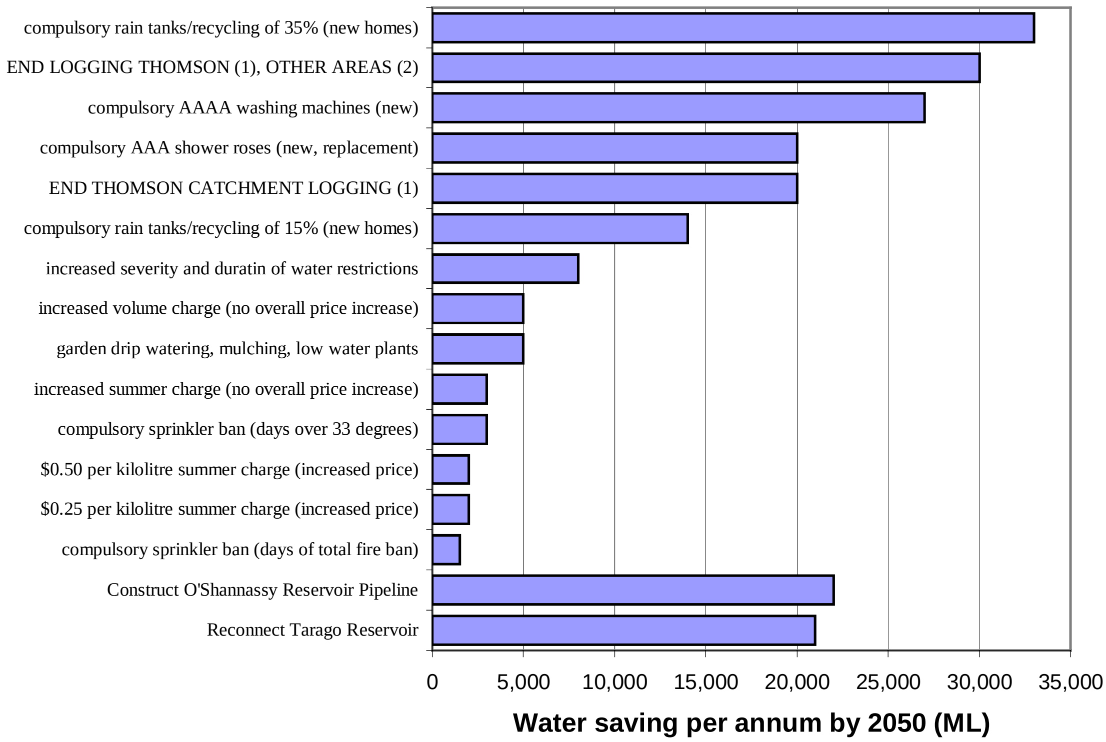
> The whole management of salinity and environmental flows in rivers will be seriously affected over a period of 20-30 years by the magnitude of the climate change we anticipate (Stevenson 2001)

A reduction in the supply of water due to global warming has not been factored in to the State Government's current water resource assessment. Global warming increases the risk of a water supply shortage, providing an additional incentive to increase the security of water supplies.

## *5. Measures to Increase Water Security*

A range of measures are available to increase water security, both by increasing the capacity of the supply system, and by reducing the consumption of water.

**measures to increase water security**




Notes:

1. Assumes a gradual phase out of logging by 2020
2. Other areas include the Tarago and Yarra Tributary catchments. The volume of water saved assumes an end to logging in these catchments in 2003 (see appendix 1 for details)

The source of all other water volumes is WRSCMA (2002)

From the above graph, it can be seen that logging in the Thomson catchment significantly impacts on water yield. Removing logging from the Thomson catchment needs to be seriously considered as a measure for increasing security of supply. If logging were phased out of the Thomson catchment by 2020, this would result in a saving of 20,000 ML per annum by the year 2050 (WRSCMA 2002). If logging ceased in the Tarago and Yarra Tributaries in 2003, this would result in an approximate saving of 10, 000 ML per annum by 2050 (for further detail and calculations see Appendix 1). Combining the immediate cessation of logging in the Tarago / Yarra Tributary catchments in 2003 with the gradual phase out of logging in the Thomson catchment by 2020 is predicted to result in a 30,000 ML annual saving by 2050 – a very significant measure in increasing water supply security.

## *6. Land Use in Melbourne's Water Catchments*

A number of the catchments are strongly protected against detrimental land use activities including: Upper Yarra, O'Shannassy, Coranderrk, Maroondah and Wallaby Creek. However, detrimental land uses are permitted in a number of other catchments:

**Thomson River catchment:** The vast majority of the catchment comprises public forest open to logging operations, with some of this area unavailable due to Code of

Forest Practice restrictions or non dedicated reserves. The Baw Baw National Park covers a small proportion of the catchment. A negligible proportion of the catchment is private land.

**Tarago River catchment**: The majority of the catchment comprises public forest open to logging operations, with some of this area unavailable due to Code restrictions or non dedicated reserves.. A smaller proportion of the catchment is private land, mostly cleared for agricultural purposes.

**Cement Creek catchment:** About half of this catchment comprises public forest open to logging operations, with some of this area unavailable due to Code restrictions or non dedicated reserves. The Yarra Ranges National Park also covers about half of the catchment. A tiny proportion of the catchment is private land.

**Armstrong Creek catchment:** The vast majority of this catchment comprises public forest open to logging operations, with some of this area unavailable due to Code restrictions or non dedicated reserves. The Yarra Ranges National Park covers a very small proportion of the catchment.

**Starvation Creek catchment:** The entire catchment comprises public forest open to logging operations, with some of this area unavailable due to Code restrictions or non dedicated reserves.

**McMahons Creek catchment**: The entire catchment comprises public forest open to logging operations, with some of this area unavailable due to Code restrictions or non dedicated reserves.

## *7. Logging in Melbourne's Water Catchments*

### *7.1 Historical and planned clearfell logging*

A total of 20,180 hectares of forest (equivalent to 9,100 MCG football fields) has been, or is planned to be, clearfell logged in Melbourne's water supply catchments (URS 2002).

Table 1. Logging in Melbourne's water supply catchments

| **Catchment** | **Area already logged[1] (hectares)** | **Total area planned to be logged[2] (hectares)** |
|---|---|---|
| Thomson | 1570 | 9460 |
| Starvation | 430 | 6320 (Starvation, McMahons, Armstrong, Cement combined) |
| McMahons | 170 | |
| Armstrong | 60 | |
| Tarago | 710 | 4400 |

1. Calculated from: State Forest Resource Inventory (benchmark date 2000) Department of Natural Resources and Environment. Note: catchments may be more extensively logged than indicated above as the SFRI does not necessarily identify every logged area.

2. The Department of Natural Resources and Environment, quoted in URS Forestry (2002) Catchment Timber Substitution Study.

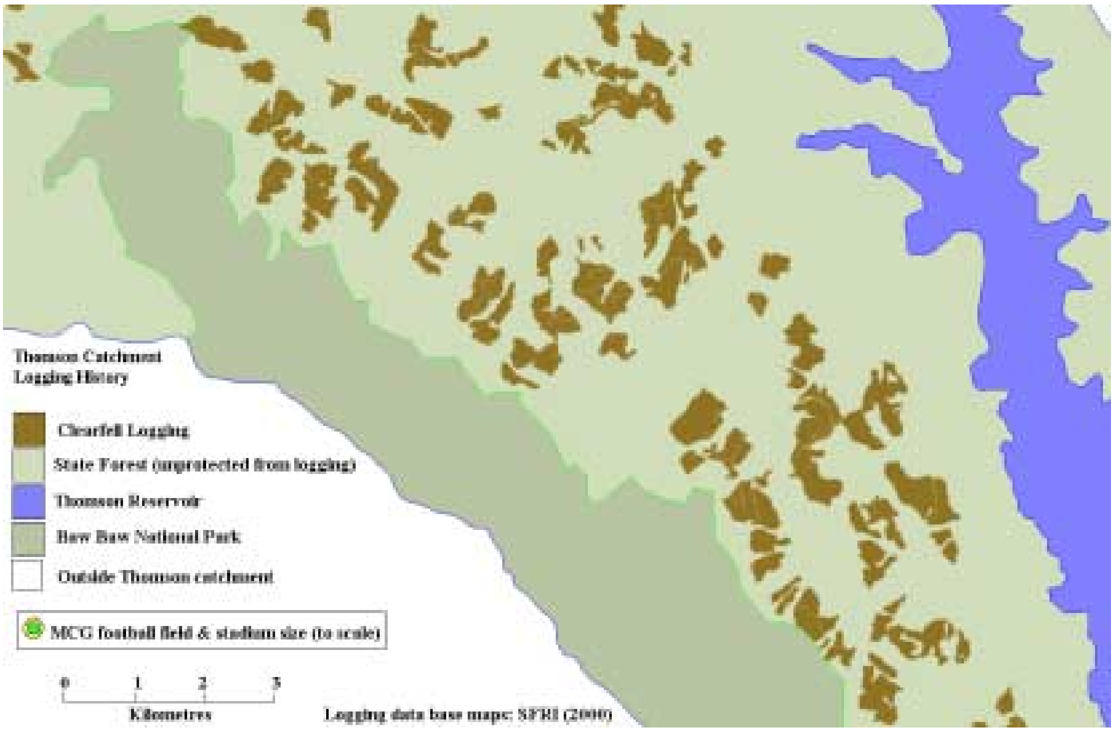



Illustration 3. Logged areas in the Thomson catchment. Source data SFRI (2000). Note: SFRI data does not necessarily identify all logged areas – the logged area could exceed that depicted.

### *7.2 The implications of logging for water supply*

Logging has been shown to significantly reduce the volume of water flowing into streams and water supplies (O'Shaughnessy & Jayasuriya 1991). Mature forests consume very little water, allowing large amounts of water to flow into streams and rivers, while a new growing forest after logging consumes large amounts of water, leaving little left over to flow into streams and water supplies (Vertessy et al. 1998).

Logging has been clearly shown to reduce water yield from forested areas by up to 50%, decades after logging (O'Shaughnessy & Jayasuriya 1991) and is projected to take 150 years to return to pre-logged levels (Kuczera 1985).

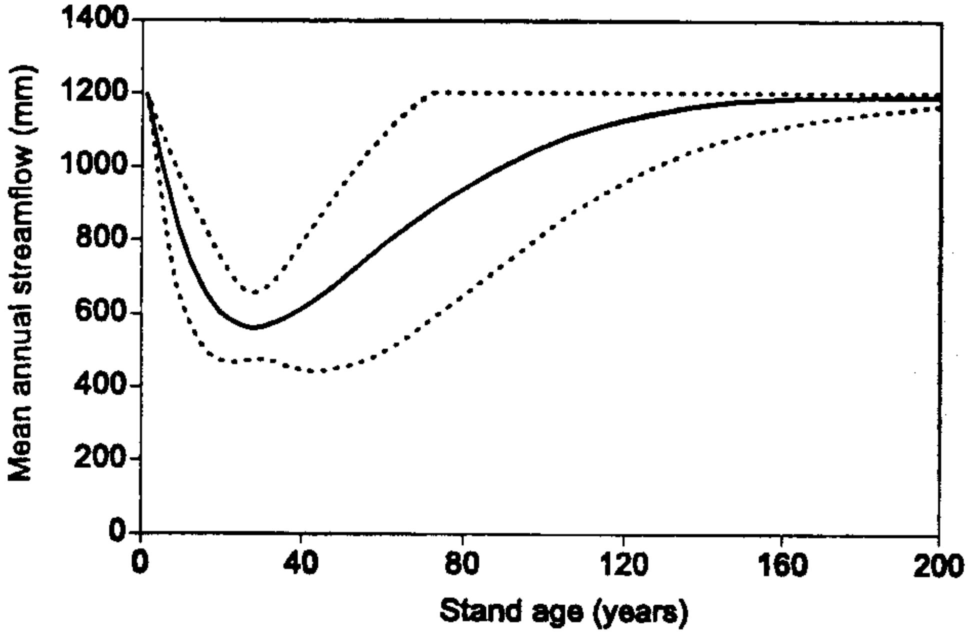



Illustration 4. The Kuczera forest age / yield curve. (Vertessy 1999)

The scale of catchment logging operations has, and will have, considerable implications for the supply of water to Melbourne. If logging continues in the Thomson catchment alone, compared to a gradual phase out by the year 2020, 20,000 ML of water is projected to be lost per annum by 2050 (WRSCMA 2002). In the long term, if logging continues in the Thomson catchment 40,000ML per year is predicted to be consumed due to the nature of a new growing forest compared to mature forest (RSA 1992 with adjustments by the Author, See appendix 1).

There are no figures available on the projected loss of water due to logging in Melbourne's other water supply catchments – Tarago and the Yarra Tributaries (Armstrong, Cement, McMahons, Starvation). The additional loss from these catchments has been predicted here, and is estimated to be 10,000 ML per annum by 2050, and 20,000ML per annum in the long term (for further detail see appendix 1).

Totalling water yield projections across all catchments, logging over the last decade in the Thomson, Yarra Tributaries and Tarago catchments is predicted to consume a total of 37,000ML of water (see Appendix 1 for calculations). If logging continues in the catchments, the long term consumption of water is estimated to reach 60,000 ML per year, which includes a long term component in the Thomson (adjusted from RSA 1992) and long term predictions in the Tarago and Yarra Tributaries (see Appendix 1 for calculations). This volume is equivalent to the water used by 250,000 Melbourne households over one year (or equivalent to 200 times what is currently used in the Burnley Tunnel).

Although the author has been careful to take a conservative approach to modelling water yield impacts, as in all calculations of the kind and scope undertaken here, significant uncertainty exists. Given the approximate nature of age/yield curves and the value and significance of the water resource involved, comprehensive state of the art modelling of logging impacts on water yield is warranted, such as that of the Cooperative Research Centre for Catchment Hydrology's Macaque model.

### *7.3 A management emphasis of wood over water*

While the negative impact of logging within Melbourne's water supply has been recognised by scientists and land managers for decades, detrimental land management practices remain largely unchanged. Logging rotations are set at 63 years (Thomson) and 57 years (Tarago). These rotations minimise catchment water yield while maximising catchment wood production, indicating that the catchments are being managed in favour of wood over water.

Table 2. Logging rotations within Melbourne's water supply catchments.

| **Catchment** | **Area logged or planned to be logged (1) [hectares]** | **Planned rate of logging (2) [hectares/year]** | **Rotation length [years]** |
|---|---|---|---|
| Thomson | 9460 | 150 | 63 |
| Tarago | 4400 | 78 | 57 |
| Yarra Tributaries | 6320 | 67 | 95 |

(1) URS (2002)
(2) URS (2002)

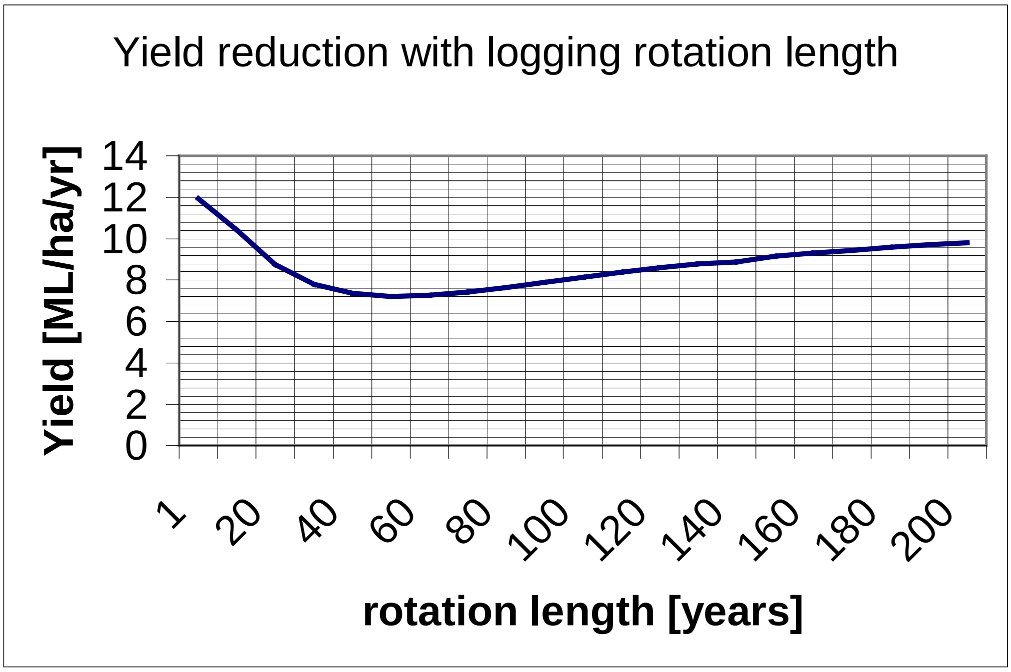


Illustration 4. The influence of logging rotations on water yield. Source: O'Shaughnessy & Jayasuriya (1987). Developed for a Mountain ash forest 2000mm rainfall.

## *7.4 The implications of logging for water quality*

Logging is a risk to water quality in two primary ways. Firstly, the risk of sediment flow from logged areas into streams. Secondly, the reductions in water quality that can result as streamflow rates diminish after logging.

Although sediment itself is not generally regarded as a health risk, sediment can affect water colour and taste and have more serious water quality implications. The greatest sediment hazards are the roads and log landings associated with logging - not the clearfell areas themselves. Sediment production rates of 90 tonnes/ha/annum have been measured from roads in the Maroondah catchment in the Central Highlands (Haydon et al. 1991). Erosion rates of 120 tonnes/ha/annum have been measured from log landings in the Cuttagee catchment in NSW (Croke et al. 1999). These enormous movements of sediment are a clear risk to water quality. Land managers attempt to stop the movement of these sediments before they reach waterways, and progress has been made in recent years with vegetation buffers beside streams and improved road construction. However, these prescriptions generally reduce but do not eliminate sediment flows into streams. In a review on the performance of forestry buffers in reducing flows of sediment from hillslopes and roads, Hairsine (1997, 1997b) found that a 6m buffer trapped 95% of sediment and 50% of phosphorous. It is also important to bear in mind that typical logging operations do not necessarily reflect the tightly managed logging in experimental catchments. Breaches of forestry codes designed to protect water quality are common. Large movements of sediment within a catchment are always a risk. For example, in the Tarago catchment, sediment flowed past six successive crossbars on a track (designed to reduce sediment) and pushed 46m through a buffer into a stream (Dignan 1999). Clearly, large sources of sediment are always a risk to water quality.

Logging operations may also increase the risk of more serious water quality problems. In 1991, a toxic blue-green algal bloom erupted in the Tarago Reservoir, and was believed to be associated with past land use practices in the catchment. A study into the incident determined that phosphorous was the key nutrient in the algal bloom, which is usually associated with sediment because it has a strong affinity for soil and organic particles. Sediment sources were then identified as the primary cause of the water quality decline(Hairsine 1997). The researchers identified the two main sources of sediment likely to be contributing to the water quality decline as agriculture and logging (Hairsine 1997).

Decreased water quality, such as increased sedimentation and turbidity (suspended sediment) are known to reduce the effectiveness of filtration and disinfection – requiring higher level treatment at greater cost. Thomson water is probably the least susceptible of the unprotected catchments to sedimentation because it goes through a two reservoir system with long residence times allowing sediments to largely settle to the bottom. The Tarago is more susceptible to water quality declines with increased sedimentation because it is a small single reservoir system with short residence times. The Yarra Tributary catchments are probably most susceptible of all as stream offtakes are highly susceptible to reductions in water quality. The current management practice of ceasing water harvesting in a catchment while logging operations are taking place may reduce the change of pollutants entering the supply system, however this measure to maintain water quality occurs with a significant loss in water yield when water harvesting ceases during the operation.

## *8. Catchment Logging and Economics*

A thorough and comprehensive study of the economics of logging in the Thomson catchment, was carried out by consultants Read Sturgess and Associates in 1992. The consultants concluded that removing logging in the catchment would leave the Victorian taxpayer $147 million dollars better off because the value of water produced by the catchment far outweighed that of logging (RSA 1992).

The logging industry enjoys the unique benefit of being the only consumer in the Melbourne system who do not pay for water. In water catchments on public land, the logging industry pay fees which vary with tree species, log grade and distance from mills, however there is no charge for the volume of water consumed (NRE 2001).

A formal economic analysis is beyond the scope of this report. In this section, an investigation of water prices and the cost of reducing demand intends to highlight the economic issues associated with logging. Formal economic analyses use a variety of sophisticated methods to determine a 'true' value for water. Such an approach was used by Read Sturgess, who estimated the price consumers would be prepared to pay for water and then deducted the cost of supplying that water. A crude method has been adopted here based on the actual administered prices currently being charged to provide a perspective of the scale of the economic impact of catchment logging.

In purely economic terms, water could be valued as the price people pay (administered) minus the cost of supply to the tap. If logging occurs in a catchment, additional costs include replacing the water from other sources, and/or the cost of reducing demand. This economic approach has an artificially narrow focus, ignoring increased treatment costs due to reductions in water quality, damage to river ecosystems, implications for other river dependant industries etc. Even though this approach is simplistic, it illustrates some of the economic implications of catchment logging.

**Table 3 Predicted water yield changes attributable to logging in the last decade, and water prices**

| Catchment | Predicted long term water loss attributable to logging in the years 1990-2000 [ML] | Price Melbourne households currently pay for this volume of water[3] [$] | Component Melbourne households currently pay 'in stream'[4] [$] |
|---|---|---|---|
| **Thomson** | 14,000[1] | 9,600,000 | 7,800,000 |
| **Tarago** | 3000[2] | 2,000,000 | NA |
| **Yarra Tributaries** | 20,000[1] | 13,800,000 | NA |

Notes:

1. See appendix 1. for calculations
2.See Appendix 1 for calculations. This figure is relatively small because the shortness of the logging rotation attributes a greater proportion of the yield changes to 2 rotation logging and not that from 1992-2000. However, yield would be significantly reduced below that should the forest be permitted to mature.
3. Current retail price for water to a Melbourne household starts at $690 per ML (WRSCMA 2001)
4. The only cost of pumping and disinfection from the Thomson River to the tap was estimated at $25.25 by Read Sturgess and Associates (1992). The capital costs for existing headworks and distribution infrastructure are ignored because they would not vary if logging was removed from the Thomson (Read Sturgess and Assoc 1992). Assuming an inflation rate of 10% this equates to $65.50 in 2002 dollar value. Non-revenue water (system losses) are currently about 12% (WRSCMA 2001). I.e. (690 - 65.50)/1.12 = $ 557 per ML in stream

**Table 4 Predicted water yield changes if catchment logging continues, and water prices**

| **Catchment** | **Predicted water loss [ML]** | **Price Melbourne households currently pay for this volume of water[4] [$]** | **Component Melbourne households currently pay 'in stream'[5] [$]** |
|---|---|---|---|
| **Thomson** | 20,000 per year (by the year 2050[1]) | 13,800,000 | 11,200,000 |
| | 40,000 per year (long term[2]) | 27,600,000 | 22,300,000 |
| **Tarago** | 20,000 per year (Tarago & Yarra Tribs combined long term[3]) | 13,800,000 | NA |
| **Yarra Tributaries** | | | |

Notes:
1. Assumes a gradual phase out of logging by the year 2020 (WRSCMA 2002)
2. Read Sturgess and Associates (1992)
3. See appendix 1 for calculations
4. Current retail price for water to a Melbourne household starts at $690 per ML (WRSCMA 2001)
5. The only cost of pumping and disinfection from the Thomson River to the tap was estimated at $25.25 by Read Sturgess and Associates (1992). The capital costs for existing headworks and distribution infrastructure are ignored because they would not vary if logging was removed from the Thomson (Read Sturgess and Assoc 1992). Assuming an inflation rate of 10% this equates to $65.50 in 2002 dollar value. Non-revenue water (system losses) are currently about 12% (WRSCMA 2001). I.e. (690 - 65.50)/1.12 = $ 557 per ML in stream

THE THOMSON

The volume of water predicted to be consumed by logging in Melbourne's catchments is considerable. Logging over the last decade in the Thomson catchment is predicted to consume a total of approximately $8 million dollars worth of water (equivalent to a years water use by 5800 Melbourne households).

If logging continues in the Thomson catchment, and is not gradually phased out by 2020, the consumption of water will have reached $11 million dollars worth per year by 2050 (equivalent to 70 times what is currently used in the Burnley Tunnel per year).

Using the water yield reduction projections of Read Sturgess and Associates (1992) with adjustments (see appendix 1), if logging continues in the Thomson catchment the long term consumption of water, relative to what a mature forest could produce, will reach 40,000ML worth $22 million dollars per year (equivalent to 130 times what is currently used in the Burnley Tunnel per year).

Logging in the Thomson catchment reduces supply and increases the need to use additional catchments such as the Tarago and Yarra Tributaries. However, these catchments are also being logged – further reducing supply security. While comprehensive study of the Thomson catchment has taken place, the situation in the Tarago and Yarra Tributaries is less clear.

## THE YARRA TRIBUTARIES

The Yarra Tributaries do not directly feed in stream reservoirs, rather, a proportion of flows are diverted from river off takes. The amount of water taken from these stream diversions varies at different times, and so the relationship between streamflow and water transfer is not straightforward. This makes the business of determining economic implications very complex. However, it is clear that reductions in streamflow after logging diminishes the volume of water available for diversion to water supplies. Furthermore, under an agreement between Melbourne Water and The Department of Natural Resources and Environment, logging is rotated around the catchments. Under the agreement, water is not diverted in the year in which the catchment is logged. This arrangement is presumably in place to avoid sediment and turbidity resulting from logging entering the supply system. As a result of logging, no water can be diverted – reducing supply.

With dependence upon the Yarra Tributaries increasing with increasing demand for water, the economic implications of logging in this catchments will become more important with time.

From the point of view of a residential household in Melbourne, water from the Yarra Tributaries is the same price as that from elsewhere in the system – yet the logging industry consume water in these catchments for free.

Logging in the Yarra Tributary catchments over the last decade is predicted to consume a total of 20,000ML of water (see appendix 1 for calculations). This consumption figure is purely in terms of increased water consumption by new growing forests and does not include any water losses due to catchment closures after logging. A Melbourne household would be required to pay $13.8 million dollars for this amount of water. This is not to say that the economic value of the water loss to logging is $13.8 million dollars, this is a statement of the comparative value of that volume of water to other consumers.

If logging continues in both the Yarra Tributaries and the Tarago, it is projected that the consumption of water will reach approximately 20,000 ML per year in the long term. A Melbourne household would be required to pay $13.8 million dollars per year for this amount of water.

## TARAGO

The Tarago Reservoir is not currently connected to the Melbourne supply system. The Reservoir was disconnected from the supply in 1995 when water quality dropped to a point where it could no longer be used (WRSCMA 2002). These water quality problems appear to be associated with a number of past land management practices within the catchment, including logging (Hairsine 1997).

Reconnecting the Tarago has been considered for some time, however it requires a water treatment plant to be constructed , at an initial capital cost of $20 million plus ongoing operational costs (WRSCMA 2002). It is interesting to note that the reservoir would increase supply by 21,000 ML per year, while slowly phasing logging out of the Thomson catchment would save 20,000 ML. This illustrates the sort of economic implications that flow from logging water supply catchments.

With the proposed re-connection of the reservoir, the history of logging in the catchment becomes relevant to water supply because of the long term yield reduction following logging. Logging over the last decade in the catchment is predicted to consume a total of 3000ML of water (see appendix 1 for calculations). The actual yield reduction to Melbourne may actually be greater than this figure because, if the reservoir is connected some time after logging it will miss the short lived increase in yield after logging while capturing the long term reductions. This figure is relatively small because the short rotations in the Tarago quickly pass yield reductions to the next rotation. However, yield in the catchment would be significantly reduced below that should the forest be permitted to mature.

COMBINED CATCHMENT FIGURES

Logging over the last decade in the Thomson, Yarra Tributaries and Tarago catchments is predicted to consume a total of 37,000ML of water. In Melbourne today, this volume of water would cost $25 million dollars at the tap and is equivalent to the water used by 150,000 Melbourne households per year.

If logging continues in the catchments, the long term consumption of water is predicted to reach 60,000 ML per year, which includes a long term component from the Thomson (adjusted from RSA 1992) and long term predictions the Tarago and Yarra Tributaries (See appendix 1 for calculations). In Melbourne today, this volume of water would cost $40 million dollars at the tap and is equivalent to the water used by 250,000 households (or equivalent to 200 times what is currently used in the Burnley Tunnel per year).

Notes:

1. The average annual consumption per Melbourne household in 2000 was 0.24 ML (WRSCMA 2001).
2. The volume of water used in the Burnley Tunnel peaked at 2.2ML per day [800ML per year] in November 2000, but has fallen back to 0.8ML per day [290 ML per year] (AGE 23.07.02)

## *9. The Future*

Decisions made today about the management of logging in water supply catchments have major long term implications. Logging an area of forest is expected to have such long term effects on water yield, expected to be 150 years, that the effect of continued logging accumulates. Continued logging also negates the benefits of increasing water yields as 1939 fire regrowth matures. This can be clearly seen in the yield loss projections. Logging over the last decade is predicted to result in the loss of 37,000ML of water *in total.* While continued logging is predicted to result in a long term water loss, relative to mature forest, of 60,000 ML *per year.* The long term water loss is expected to be much more massive than anything we may be witnessing today. As Melbourne's consumption continues to grow, this increasing loss to logging can only become increasingly important to Melbourne's water resources.

## *10. Findings*

1. Melbourne has a limited supply of water. If consumption continues at current rates, the city will be using the entire volume of the present system by the year 2012.
2. Global warming is projected to reduce streamflows by up to 20% in the next thirty years, and by up to 45% in the next seventy years. The possible effects of global warming further increase the need to increase security of supply.
3. At least 2940 hectares of forest (equivalent to 1300 MCG football fields) has already been clearfelled in Melbourne's water supply catchments, while a total of 20,180 hectares (equivalent to 9,100 MCG football fields) is planned to be logged.
4. Logging over the last decade in the Thomson, Yarra Tributaries and Tarago catchments is predicted to consume a total of 37,000ML of water. In Melbourne today, this volume of water would cost $25 million dollars at the tap and is equivalent to the water used by 150,000 Melbourne households over one year.
5. If logging continues in the catchments, the long term consumption of water is estimated to reach 60,000 ML per year. In Melbourne today, this volume of water would cost $40 million dollars at the tap and is equivalent to the water used by 250,000 households over one year (or equivalent to 200 times what is currently used in the Burnley Tunnel over one year).
6. If logging continues in the Thomson catchment alone, and is not gradually phased out by 2020, the consumption of water will have reached $11 million dollars (current in stream price at administered price) per year by 2050 (equivalent to 70 times what is currently being used in the Burnley Tunnel).
7. Unlike any other consumer in the Melbourne system, the logging industry does not pay for the water consumed as a result of logging operations. The value of this water is considerable.
8. Catchment management is favouring wood over water values with logging rotations set at 63 years in the Thomson and 57 years in the Tarago. These rotation lengths reduce water yields to an absolute minimum, while amplifying wood volumes.
9. Sediment and nutrient flows associated with logging may decrease water quality in the Tarago and Yarra Tributary catchments. Water in these catchments is more sensitive to pollution than the Thomson catchment because water flows more quickly and directly into the supply system.

## 11. Recommendations

1. Given the importance of the water resources from the unprotected catchments to Melbourne and the Gippsland Lakes, removing logging should be considered as an option for increasing security of supply. Minimising logging operations offers significant opportunities for increasing water security, at least as significant as any other measure identified.
2. In the context of greater uncertainty due to global warming, all available measures should be considered to protect security of supply.
3. At the very least, royalties paid by the logging industry for access to publicly owned forest catchments should reflect the cost of water consumed.
4. Given the approximate nature of age/yield curves and the value and significance of the water resource involved, comprehensive state of the art modelling of logging impacts on water yield is warranted, such as that of the Cooperative Research Centre for Catchment Hydrology's Macaque model.

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## *Appendix 1. Predicted Water Consumption by logging in the Thomson, Tarago and Yarra Tributaries*

Background

There are no available figures on the volume of water projected to be lost to logging in the Tarago and Yarra Tributary catchments. The Thomson has been the subject of extensive study, however only a small amount of water loss data is publicly available. The volume of water lost in these catchments is likely to be important to Melbourne's water resources. A brief analysis is undertaken to provide an indication of the approximate magnitude of this water loss.

Data and Methodology

Land use information was underpinned by the State Forest Resource Inventory - benchmark date 2000 (Department of Natural Resources and Environment). Catchments are as identified in the Central Highlands Comprehensive Regional Assessment (Vic RFASC 1997). All land use cartography was calculated with a CAD system.

The forest age/yield curve developed by Watson et al. (1999) has been adapted as illustrated in SKM (2000) and Watson et al (1999), being conservative where inconsistencies in the illustrations occurred. The Watson et al (1999) yield curve was used in the assessment of logging impacts on water yield in the Otways in a project commissioned by the Department of Natural Resources and Environment and undertaken by consultants Sinclair Knight Merz. This model has also been adopted here. Although forest age/yield curves are a simplification of complex natural forest catchments, they have been widely used to predict water yield changes after logging throughout Australia and overseas. A crude modelling framework is used to provide a plausible estimate of water loss.

<u>Assumptions & approach</u>

1) Assume that the age yield curve developed by Watson et al. (1999) in the Maroondah catchment for a rainfall of 1995mm can be applied to the forests of the Thomson, Tarago and Yarra Tributary catchments. This is likely to a more conservative approach than using the Kuczera curve as the Watson et al (1999) curve includes an initial yield increase and a smaller initial yield reduction. Although the yield curve has been applied without calibration against actual stream flow, its accuracy should be enough to provide a reasonable indication of flow changes.
2) The Watson et al (1999) yield curve is assumed to apply equally to Alpine Ash, Mountain Ash forests and mixed species forests. This should be reasonably accurate. Recent modelling predicts similar water yield impacts in both alpine ash and mountain ash forest types (Peel et al 2000). Although there is likely to be a significant variation in mixed species forests from the Watson et al (1999) yield curve, the component of mixed species forest to be logged appears relatively small in the context of the crude nature of se calculations, .
3) In some calculations, to be very conservative, logging in mixed species forests is assumed to have no affect on yield. In reality, logging in these forests is expected to affect yield in a similar manner to ash forests. It is assumed that the percentage of non ash sawlogs provides an indication of logging in mixed species forest. 'Messmate' and 'other' species to be logged in each catchment are identified in (URS 2002)as: a negligible mixed species component in the Thomson, 20% mixed forest component in the Yarra Tributaries, and 10% mixed forest component in the Tarago.
4) For the Tarago and Yarra Tributary catchments, assume an average annual rainfall of 1100mm. This should be conservative as actual rainfall in the catchments appears significantly higher than 1100mm. The Tarago catchment is has a mean annual rainfall of 1403mm (Peel et al 2000b). Peel et al (2000b) also identify a number of nearby catchments as having rainfall above 1100mm e.g. La Trobe 1350mm, Woori Yallock 1169 mm (low elevation), Acheron 1578mm. Warbuton has a mean annual rainfall of 1344mm (Srikanthan et al 2001) and the elevation at Warburton is 170m – a low elevation compared to the catchments. The Tarago, Armstrong, Cement, McMahons, and Starvation Creek catchments are all identified as having rainfall above 1100mm on the map 'Port Phillip Mean Annual Rainfall' (NRE 1994)
5) Average annual rainfall in the Thomson catchment is assumed to be 1500mm. This should be conservative given most of the mountain/alpine ash resource

occurs in areas of rainfall above 1500mm, observed using the rainfall map of Peel et al (2000) and commercial forest type map in VicRFASC (1997).

6) Scale the Watson et al. (1999) curve to the rainfall of the study catchment.
7) Assume no bushfires take place in the catchments in the study period
8) A sensitivity analysis has not been undertaken. It is apparent that the yield response is sensitive to some parameters such as rotation length. The implications of this sensitivity on results is beyond the scope of this project.

## A1.1 Predicted water loss due to logging over the last 10 years in the Thomson, Tarago and Yarra Tributaries

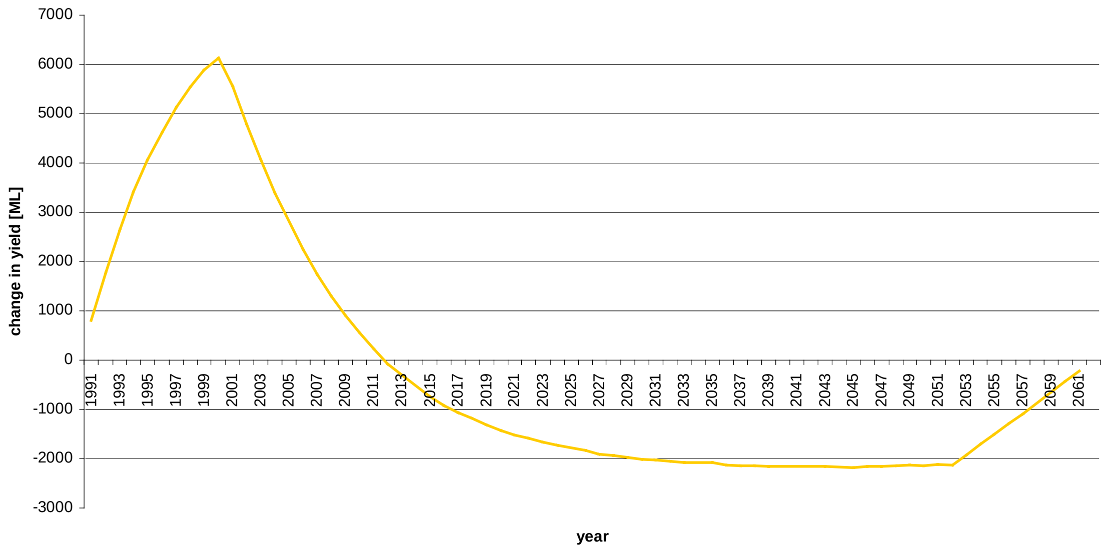
**<u>THOMSON</u>**
Assumptions 1,2, 3,5,6, 7, 8

Area of the Thomson already logged = 1570 Hectares (calculated from SFRI 2000) Note: catchments may be more extensively logged than indicated as the SFRI does not necessarily identify every logged area.

Logging is planned to continue on a 63 year rotation (URS 2002), therefore historical logging will consume water for 63 years from the date of logging.

If it is assumed that historical logging has taken place at the current planned rate of 150 ha per year (URS 2002), then logging 1570 hectares would have taken place 1991 – 2000. It is assumed that the mixed species forest component is negligible. Comparing the change in water yield as a result of this logging with that should the entire area consist of 1939 fire regrowth with an already diminished yield produces a difference in yield illustrated below. Over the entire period that historical logging is projected to have an effect (1991 – 2061), logging is predicted to reduce water yield by 14,000 ML compared to 1939 regrowth.

**Predicted Thomson yield change attribuatable to logging 1991-2000, relative to yield from 1939 regrowth.**




**<u>TARAGO</u>**

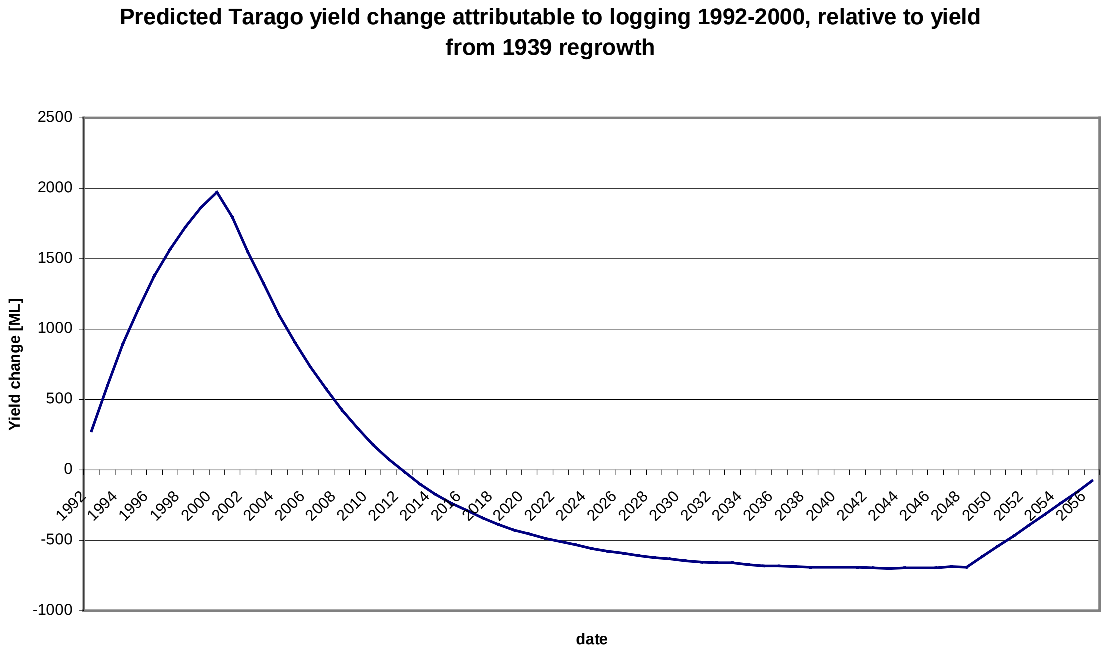
Assumptions 1,2,3, 4,6, 7, 8

Area of the Tarago already logged = 710 Hectares (calculated from SFRI 2000) Note: catchments may be more extensively logged than indicated as the SFRI does not necessarily identify every logged area.

Logging is planned to continue on a 57 year rotation (URS 2002), therefore historical logging will consume water for 57 years from the date of logging.

If it is assumed that historical logging has taken place at the current planned rate of 78 ha per year (URS 2002), then logging 710 hectares would have taken place 1992 – 2000. Only the component of that logging assumed to be ash (70.2 ha/year) is recognised as affecting yield. Comparing the change in water yield as a result of this logging with that should the entire area consist of 1939 fire regrowth with an already diminished yield produces a difference in yield illustrated below.

Over the entire period that historical logging is projected to have an effect (1992 – 2056), logging is would reduce water yield by 3000 ML compared to yield from 1939 regrowth. This figure is relatively small because the shortness of the logging rotation attributes a greater proportion of the yield changes to 2 rotation logging and not that from 1992-2000. However, yield would be significantly reduced below that should the forest be permitted to mature.




## YARRA TRIBUTARIES

Assumptions 1,2,3, 4,6, 7, 8

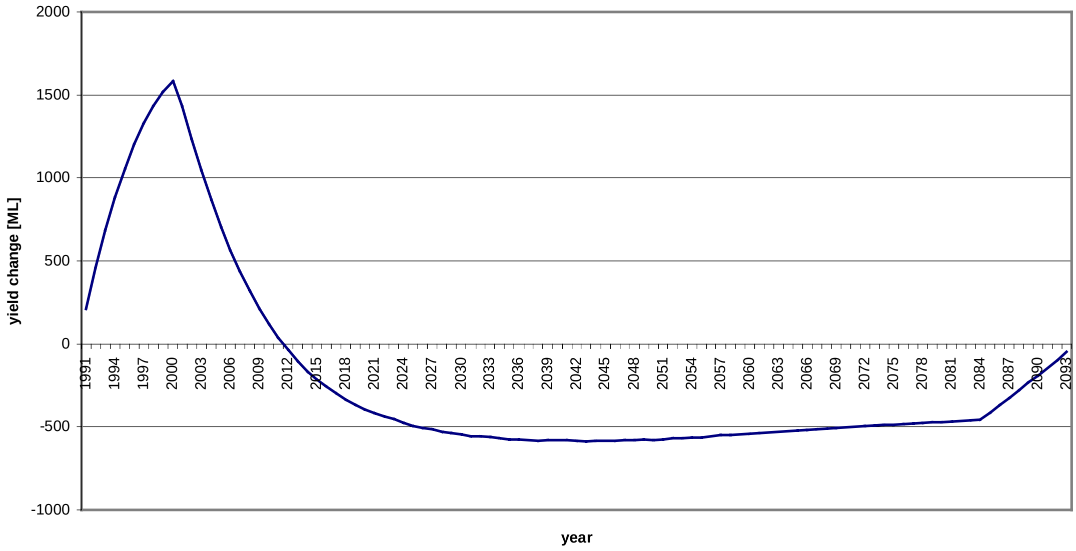
Area of the Yarra Tributaries already logged = 660 Hectares (calculated from SFRI 2000) Note: catchments may be more extensively logged than indicated as the SFRI does not necessarily identify every logged area.

Logging is planned to continue on a 95 year rotation (URS 2002), therefore historical logging will consume water for 95 years from the date of logging.

If it is assumed that historical logging has taken place at the current planned rate of 67 ha per year (URS 2002), then logging 660 hectares would have taken place 1991 – 2000. Only the component of that logging assumed to be ash (53.6 ha/year) is recognised as affecting yield. Comparing the change in water yield as a result of this logging with that should the entire area consist of 1939 fire regrowth with an already diminished yield produces a difference in yield illustrated below.

Over the entire period that historical logging is projected to have an effect (1991 – 2093), logging is would reduce water yield by 20,000 ML compared to yield from 1939 regrowth.

**Predicted Yarra Tributary yield change attributable to logging 1991-2000 relative to yield from 1939 regrowth**




## A1.2 Predicted water loss from continued logging in the Thomson, Tarago and Yarra Tributaries

**THOMSON**

A gradual phase out of logging in the Thomson catchment by 2020 is predicted to provide an additional 20,000ML of water each year by 2050 (WRSCMA 2002).

If logging ceased in the Thomson altogether, it was predicted that the long term benefit relative to logging on 80 year rotations would be an additional 59,000 ML per year (Read Sturgess and Associates 1992). However Read Sturgess (1992) used a net productive area of 20604 hectares, of which 12 634 was Ash, and 7970 mixed species. A conservative approach to these projections might be to use the smaller net productive area of 9460 hectares (URS 2002), and assuming that the mixed species component is a negligible area.

Read Sturgess (1992), in equation 3.3, scale the Kuczera curve down for mixed species – L = 1.15 for mixed species compared to L = 6.1 for ash. Assuming constant rainfall and allocating the net productive area to each forest type results in about 12% being the mixed species component ie. 7080 ML per year is due to mixed species logging and 51,920 due to ash. But the URS (2002) net productive area is still smaller than this ash area, so, assuming again that rainfall is constant across the area. The yield loss could be scaled down to this net productive area.
= 9460/12634 * 51920 = 38 000 ML / annum. Approximate yield loss in the long term due to logging 9460 hectares of Ash in the Thomson catchment

**TARAGO AND YARRA TRIBUTARIES**

Apply the modified yield curve to area of the catchment identified as available for logging, at the rate identified in URS (2002). Compare the volume of water produced should this forest be permitted to mature (assuming this entire area to be 1939 fire regrowth), compared to that should logging continue to 2050.

Calculations

1. Tarago Catchment

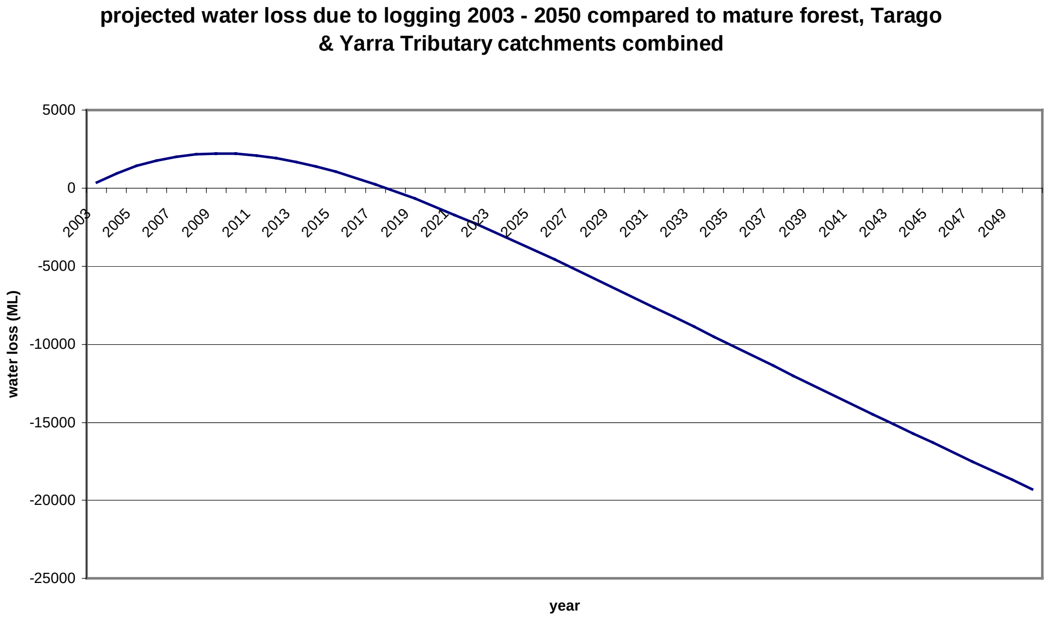
Total area logged or planned to be logged = 4400 hectares (URS 2002)
Average logged each year = 78 hectares (URS 2002)
Area already logged = 710 Hectares (calculated from SFRI 2000) Note: catchments may be more extensively logged than indicated as the SFRI does not necessarily identify every logged area.
By 2050, the area logged will be 710 +78* 47 = 4376 ha. Therefore still on first rotation.

2. Yarra Tributaries

Total area logged or planned to be logged = 6320 hectares (URS 2002)
Average logged each year = 67 hectares (URS 2002)
Area already logged = 660 Hectares (calculated from SFRI 2000) Note: catchments may be more extensively logged than indicated as the SFRI does not necessarily identify every logged area.
By 2050, the area logged will be 660 +67* 47 = 3809 ha. Therefore still on first rotation.

3. Calculations for Tarago and Yarra Tributaries combined

Assuming an annual logging rate of 67 + 78 = 145 hectares and scaling the Watson et al (1999) yield curve to rainfall of 1100mm gives the result illustrated below. Note: mixed species forest has been included in these calculations because mixed forests are estimated to be less than around 15% of the logged area (see assumption 3.), water yield changes in mixed forests have been observed at diminished levels to ash forests, and in the context of these calculation, the differences to results are assumed to be relatively minor.




Results indicate that logging in the catchments would reduce yield by approx 19,000ML compared to a mature forest. However, much of the Tarago and Yarra Tributary catchments are 1939 fire regrowth.

The age yield curve of Watson et al (1999) indicates that in 2050, 110 year old fire regrowth from 1939 would be expected to be losing around 2.3 ML/ha/annum more than a mature forest, for a rainfall of 1995mm.
Scaling to rainfall of 1100mm = 2.3*1100/1995 = 1.27 ML/ha/annum
Total area up for logging in the Tarago & Yarra Tribs between 2003 – 2050
= 145 * 47 = 6815 ha
Yield loss to unlogged 1939 regrowth compared to mature forest in 2050
= 6815 * 1.27 = 8700ML
Therefore ceasing logging in 2003 would save approximately 19000 – 8700 = 10,000 ML per year by 2050.

There is some doubt about the accuracy of the shape of the age yield curve of Watson et al. (1999) in comparison the Kuczera curve (Watson et al. 1999). The above calculation has been repeated for the Kuczera curve as a comparison.
The Kuczera curve, as tabulated in O'Shaughnessy & Jayasuriya (1987) indicates that in 2050, 110 year old fire regrowth from 1939 would be expected to be losing around 1.03 ML/ha/year more that mature forest, for a rainfall of 2000mm.
Scaling to rainfall of 1100mm = 1.03*1100/2000 = 0.57 ML/ha/annum
Total area up for logging in the Tarago & Yarra Tribs between 2003 – 2050
= 145 * 47 = 6815 ha
Yield loss to unlogged 1939 regrowth compared to mature forest in 2050
= 6815 * 0.57 = 3900ML
Therefore ceasing logging in 2003 would save approximately 19000 – 3900 = 15,000 ML per year by 2050.

The above calculations are approximate, using a crude analysis of rainfall. These figures intended to provide a reasonable indication of the effect of logging within the Tarago and Yarra Tributary catchments, given no figures are currently available. A physically based model, such as the Macaque model developed by the Cooperative Research Centre for Catchment Hydrology would provide far more accurate results. Application of such a model would be easily justified given the magnitude of the potential water loss to logging within Melbourne's water catchments.