SINCLAIR KNIGHT MERZ
SKM

Melbourne Water

Stormwater Recycling Feasibility Study

HIGH LEVEL ASSESSMENT OF OPTIONS REPORT

Final

8 June 07

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1. Introduction

1.1 Project Scope

Sinclair Knight Merz (SKM) has been engaged by Melbourne Water (MWC) to undertake the Water Supply Augmentation for Melbourne – Stormwater Recycling Feasibility Study. The scope of this investigation is to identify and investigate options for harvesting a minimum of 20 GL/year of stormwater for supply into the potable water supply network.

This project is being undertaken within the context of the Victorian Governments policy agenda contained in the *Sustainable Water Strategy Central Region Action to 2055* document. As highlighted in the document, the Government is specifically seeking to investigate large scale alternative supply options including Action 4.38:

- *Use of recycled water for industry through the Eastern Water Recycling Proposal (see Action 3.21)*
- *Desalination of seawater for drinking (see Action 3.27)*
- *Use of highly treated stormwater blending with drinking water (see Action 3.24)*

The *Sustainable Water Strategy Central Region Action to 2055* also states that stormwater is "the net increase in run-off and decrease in groundwater recharge resulting from the introduction of impervious surfaces such as roofs and roads within an urban development".

1.2 Purpose of Report

The Stormwater Recycling Feasibility Study involved identification and high level assessment of options. The purpose of this report is to document the analysis and outcomes of the High Level Assessment of options for stormwater recycling for supply into the potable supply network. The report is to identify whether any options should be progressed to a more detailed assessment.

1.3 Acceptance Criteria

Each option must comply with the following criteria:

- Water to be supplied to the potable network only
- Minimum yield to the potable network of 20GL/year
- Maintain environmental flow requirements in the catchment and its outfalls
- Construction must be feasible
- Water quality risks must be addressed
- Water must pass through an environmental buffer such as a reservoir or aquifer before treatment and supply into the Melbourne water supply system

1.4 Background Information

1.4.1 Stormwater Recycling Schemes

SKM undertook research into current and future Stormwater Recycling schemes both nationally and internationally with the aim of determining the feasibility of introducing stormwater recycling scheme for potable use into Melbourne. Three case studies of operating schemes were reviewed:

- Adelaide stormwater harvesting and Aquifer Storage and Recovery (ASR) scheme (1.1GL/year to potable substitution)
- Santa Monica stormwater recycling (SMURRF) (0.7GL/year for potable substitution)
- Singapore NEWater scheme, 14ML/day recycled water (recycled sewage and stormwater) to drinking water via shandying. This is approximately 1% of the total supply.

Of all these separate case studies, none currently employ direct potable reuse strategies; rather they employ potable substitution and/or indirect reuse in different forms. If Melbourne was to install a stormwater recycling system for direct potable use, this would be the largest such scheme operating in the world.

1.5 Guidelines and Regulations for Stormwater Recycling

The National Health and Medical Research Council (NHMRC) is currently writing the draft guidelines for stormwater recycling. These are expected to be published for comment during July 2007. As such any stormwater system would be developed and potentially operate without defined regulations until the guidelines are in place.

2. Options Development and Evaluation

2.1 Process for Development of Options for Assessment

The following options were identified at the ‘Options Identification Workshop’ as being viable opportunities for stormwater recycling into the potable supply. The workshop involved key stakeholders including MWC, Department of Sustainability and Environment and Department of Human Services and members of the SKM project team.

■ **Table 1 Options identified for Phase 1 High Level Assessment**

Option	Name	Description
Yarra River		
Options 1a	Dights Falls to Little Watsons Creek	- Pump from the Yarra River at Dights Falls - New storage at Little Watsons Creek - Integrate into Sugarloaf Reservoir and Winneke WTP
Option 1b	Templestowe to Little Watsons Creek	- Pump from the Yarra River at Templestowe - New storage at Little Watsons Creek - Integrate into Sugarloaf and Winneke WTP
Option 1c	Warrandyte to Little Watsons Creek	- Pump from the Yarra River at Warrandyte - New storage at Little Watsons Creek - Integrate into Sugarloaf and Winneke WTP
Option 1d	Dights Falls to Yering Gorge	- Recirculation of flows from Dights Falls to Yering Gorge to increase extraction at Yering Gorge pump station
Option 1e	Dights Falls to Aquifer Storage Transfer and Recovery (ASTR)	- Pump from the Yarra River at one or multiple spots - Store in ASTR - Treat and transfer to Preston Reservoir
Patterson River		
Option 2a	Patterson River to Cardinia	- Location near ETP/Pillars Crossing - New storage such as a turkey-nest next to the water course - Treatment and transfer to Cardinia Reservoir
Option 2b	Patterson River to ASTR	- Location near ETP - Storage via ASTR - Treatment and transfer to Cardinia Reservoir or network
Option 2c	Dandenong Creek to Cardinia	- Location near Police Road Basin - New storage such as a turkey-nest next to the water course - Treatment and transfer to Cardinia Reservoir
Maribyrnong River		
Option 3a	Maribyrnong to Greenvale	- Collect stormwater and store in dams on Maribyrnong River/tributaries at Arundel and/or Konagaderra. -Treat and transfer to Greenvale Reservoir
Option 3b	Maribyrnong to Yan Yean	- Collect stormwater and store in dams on Maribyrnong River/tributaries at Arundel and/or Konagaderra. - Treat and transfer to Yan Yean Reservoir
Stormwater Retarding Basins		
Option 4a	Harvest from retarding basin - Police Road	- Collect from retarding basins - Treat near the larger retarding basins and supply to network.
Option 4b	Retarding Basin harvesting network	- Collect from retarding basins - Inter-connect as network of smaller stormwater catchments - centralised treatment and connection into the water supply network

2.2 Method for Evaluation of Options

These options were evaluated in Phase 1 High Level Assessment utilising available data to draw preliminary conclusions regarding:

- Expected yield and typical range of water quality available from the proposed option.
- High level risk assessment based on knowledge of the catchment and measured data.
- High level risk mitigation strategy to deliver water suitable for potable use in Melbourne.
- Preliminary environmental and planning constraints analysis for each option.
- Order of magnitude estimates of capital and operating costs and the net present value of costs.

3. Water Quality

3.1 Available Data

MWC regularly measures water quality parameters in the urban streams and rivers. Typical indicators are shown in **Table 2**.

- **Table 2 Water Quality Parameters Measured**

Parameter	Parameter	Parameter	Parameter
Temperature (C)	Suspended Solids (mg/L)	PO4-filtered (mg/L P)	Chromium (mg/L)
Dissolved Oxygen (mg/L)	NO3 (mg/L as N)	Total Phosphorus (mg/L P)	Copper (mg/L)
Dissolved Oxygen (% sat.)	NO2 (mg/L as N)	E. coli	Lead (mg/L)
Electrical Conductivity (µS/cm)	NH3 (mg/L)	Arsenic (mg/L)	Nickel (mg/L)
pH	Total Kjeldahl Nitrogen (mg/L N)	Cadmium (mg/L)	Zinc (mg/L)
Turbidity (NTU)	Total Nitrogen (mg/L as N)		

These parameters provide a useful water quality profile providing some basis for risk assessment and mitigation measures, and the development of appropriate water treatment and infrastructure concepts suited to the recycling of stormwater in an urban potable water supply. More frequent and extensive sampling regimes with a more comprehensive suite of analyses will be necessary to properly assess the development and implementation of viable stormwater recycling schemes.

3.2 Risk Mitigation for Recycled Storm Water

3.2.1 Quantifiable Risk

The Australian Drinking Water Guidelines (ADWG) 2004 include the Framework for Management of Drinking Water Quality, which recommends a structured approach to water quality management based on a comprehensive risk management system that conforms to AS/NZS 4360:1999 Risk Management. Several risk assessment, mitigation and management models are appropriate including the HACCP model (Hazard Analysis and Critical Control Point). Key elements of this approach are:

- Identification of hazards or characterisation of the catchment and water sources
- Assessment of inherent (uncontrolled) risk from identified hazards – likelihood/consequence
- Implement control measures to mitigate inherent risks to acceptable levels
- Verify and validate outcomes by objective evidence of compliance at critical control points.
- Implement effective corrective actions and automate these where possible e.g. standby plant
- Implement effective emergency response plans and rehearse these
- Continuous improvement via research and development to improve system understanding and performance.

The indicators of risk given as ‘snap shots’ of water quality in the Yarra, Maribyrnong, Patterson and Werribee Rivers have been interpreted as follows:

- **Table 3 Indicative Water Quality Assessment**

Parameter / Risk	Comment
Salinity (EC)	The lower reaches of the Yarra River to Dights Falls and Dandenong Creek are low salinity (<150 µS/cm) compared to the Maribyrnong River which exceeds ADWG (>700 µS/cm) at times of low flow due too ingress of saline groundwater from basaltic plains – indicating a need for selective diversion and avoidance of on-stream storage; or conversely desalination.
Aeration (Dissolved oxygen)	Low DO levels were an issue in all seasons in the Yarra River, except during high flow conditions in winter. The quality of the water in Dandenong Creek at Pillars Crossing is poor in all flow and season conditions.
Water Clarity (Turbidity)	The turbidity was generally higher in high flow events. During high flow conditions the percentile trend for the Yarra River and Dandenong Creek are very similar, whereas in low flow the Yarra River at Warrandyte is noticeably lower than the other two sites. The ADWG and the SEPP (WoV) criteria are exceeded in a high percentage of samples for all three sites in both high and low flow conditions.
Nutrients (Total N and P)	Dandenong Creek had higher concentrations of nutrients than the Yarra River sites. However both waterways exceeded the SEPP (WoV) guidelines for nitrogen and phosphorus.
Heavy Metals (Ni, Cu, Cd, Pb)	The lead levels exceeded the ADWG on occasion, particularly Dandenong Creek at Pillars Crossing.

The water quality risks associated with collection of storm water runoff from urban areas, are virtually uncontrolled with hazards from pollutants introduced from air pollution, from land and paved surfaces in runoff, land management practices, waste disposal, accidental and uncontrolled discharges to the environment from house drains, industry and sewer spills/leakage; and groundwater discharges to water courses. In urban areas these pollution loads are much too large to be mitigated by the natural assimilation capacity of the catchment and in-stream environment.

To achieve the necessary environmental buffer either open storage or ASTR is required. An open storage is expected to result in algal blooms given the expected nutrient levels in untreated stormwater runoff. This storage/buffer also provides a barrier to short-circuiting risk in existing water supply reservoirs. This is an additional management response to unusual water quality events in the stormwater supply, and it provides an additional robust ‘link’ in a series of independent treatment steps that “*must include mechanisms or fail-safes to accommodate inevitable human errors without allowing major failures to occur*” (ADWG).

Multiple control points (barriers) are required to mitigate these risks sufficiently to enable storm water to be recycled into the potable supply.

3.2.2 Unquantifiable Risk – Need for Improved Monitoring

Much more comprehensive water quality data sets than those available will be required to provide any meaningful quantitative risk assessment. However, the water treatment processes proposed are well understood and considered appropriate at this preliminary assessment stage, and where uncertainty exists the ‘pre-cautionary principle’ has been applied.

The undefined water quality parameters that will require detailed assessment to determine the inherent risk of stormwater in these rivers include:

- *Pathogenic micro organisms* – specific bacterial, protozoan and viral species.
- *Chemical compounds* – inorganic, and organic compounds, particularly pesticides
- *'Horizon risks'* – Not included in ADWG e.g. Endocrine Disrupting Compounds including the general group 'Pharmaceutical and Personal Care Products'.
- *By-products of treatment processes* – for example: trihalomethanes (THMs) formed as disinfection by-products (DBPs) with known health implications from chronic exposure.

3.2.3 Water Quality Standards

For the purpose of this report compliance with the ADWG would be a minimum requirement with the additional provision that customers would not be subject to any discernable difference in residual risk or aesthetic water quality compared to the existing supply.

3.2.4 Control Measures

For this High Level Assessment the following barriers have been adopted based on initial discussions with MWC and a high level risk assessment of the expected water quality.

- Clarification of the diverted stormwater - to remove suspended solids and associated microbial, adsorbed organics, heavy metal contaminants, algae and colour.
- Environmental buffer storage or detention – to remove enteric bacteria and nutrients, assimilate pathogens and settleable solids and compounds that degrade readily in the environment with sufficient detention time – assumed to be not less than 90 days.
- Advanced water treatment processes - to reduce turbidity <0.5 NTU and colour< 15 TCU; to achieve >4 log reduction in pathogenic microbial species; reduction in nutrients to water supply storage levels; and removal of organic compounds (pesticides, trihalomethane (THM) precursors) and UV radiation for 3 log pathogen inactivation.
- Supply into existing MWC distribution reservoir – Silvan, Cardinia, Sugarloaf, Yan Yean, Greenvale or Preston Reservoirs.
- Augmentation of existing WTP if necessary – e.g. introduction of ozone-GAC treatment at Winneke WTP to remove algal toxins, taste and odours generated by increased frequency or concentration of algal blooms with introduction of the treated stormwater supply.
- Catchment Management – e.g. improved / rehabilitation of sewers, trade waste management, water quality management etc.

Figure 1 Water Treatment Barriers

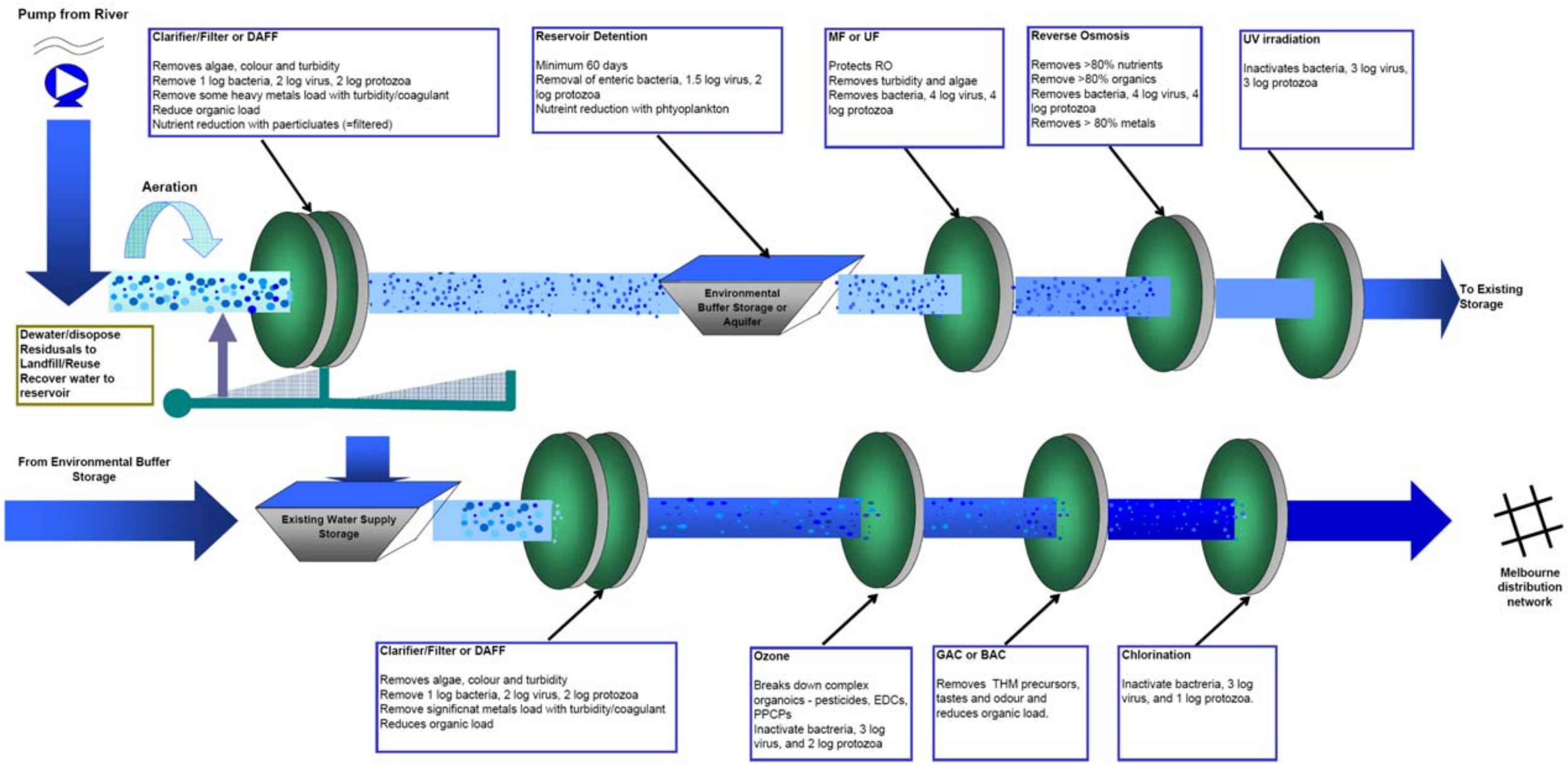


Figure 1 illustrates the flow diagram adopted for the appropriate water treatment processes prior to including stormwater into the MWC water supply system. This has been used as the basis for assessment of the identified options.

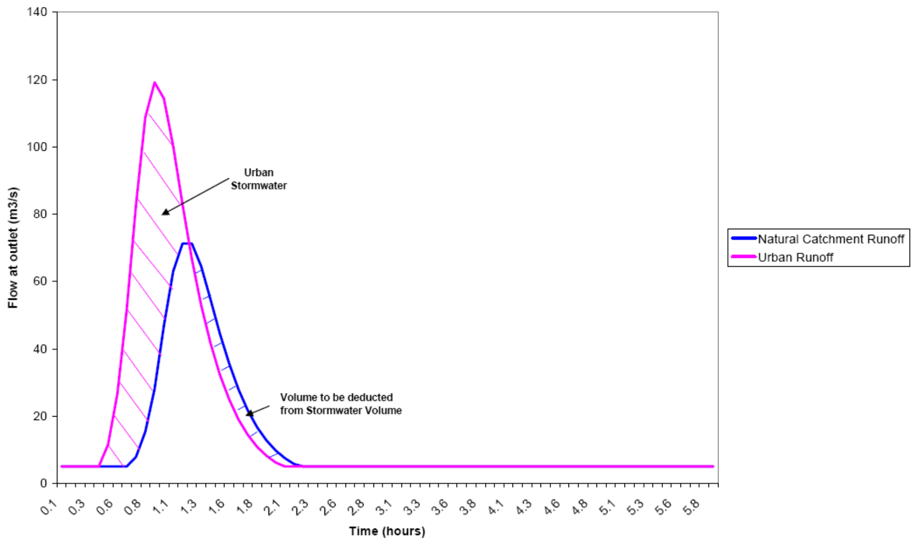
3.2.5 Customer Consultation/Perceptions

No consultation has been undertaken to date. This will be a necessary part of any strategy to introduce stormwater recycling as an augmentation of Melbourne's water supply. Customer perceptions will be critical in the acceptance/rejection of this source of supply should it prove viable from other perspectives.

4. Yield Analysis

4.1 Yield Definition

The Victorian Government's *Sustainable Water Strategy Central Region Action to 2055* states that stormwater is "the net increase in run-off and decrease in groundwater recharge resulting from the introduction of impervious surfaces such as roofs and roads within an urban development". **Figure 2** compares a typical hydrograph of a natural and an urban catchment, and illustrates the increase in stream flow due to urbanisation, this increase is termed "stormwater" in this context.



- **Figure 2 Conceptual Hydrograph of Urban Stormwater**

In order to accurately determine the urban stormwater yield, a calibrated rainfall runoff model would be required. Due to the time constraints of the project, this was not possible. The MWC report "*A discussion paper on: Stormwater harvesting from waterways and drainage systems*"

(Alluvium, November 2006) analysed five case studies for harvesting stormwater from urban and urban/rural catchments, finding that for the urban catchments, between 47% and 66% of stream flow was attributable to the urbanisation of the catchment. On this basis, a yield of 50% of the flow from the urbanised catchments of each river was adopted as the potential yield of "stormwater" for this scenario.

4.2 Climate Change

Flow data for the period from 1997 to 2006 was used in accordance with the recommendation of the *Sustainable Water Strategy Central Region* in order to allow for the predicted reduction in rainfall and runoff due to climate change.

4.3 Analysis Method

No REALM modelling or similar resource-reservoir-demand modelling was undertaken. The assumption is that distribution of supply is operated to make sufficient storage capacity available in existing reservoirs and proposed new storages to ensure the maximum yield can be harvested without spills from other storages, and hence is a net gain in yield. REALM modelling would be necessary should the study proceed further.

A spreadsheet model was developed to calculate the yield for each scenario based on daily flow data and the Environmental Flow Requirements for each river. The model calculates the yield as the volume by which the measured river flow exceeded Environmental Flow Recommendations, at that gauge, limited to the maximum flow diversion capacity of the pump station.

4.4 Yarra River

4.4.1 Urban Stormwater Yield Definition

The Yarra River catchment is made up of a forested upper catchment, a predominately rural mid-catchment and highly urbanised catchment in the lower reaches. Due to time constraints for the project, a simple method was determined by MWC for the Yarra River in order to isolate the highly urbanised runoff from the forested catchment and the developed rural catchment areas; the method is outlined below. It should be noted that this method was used as a first pass analysis.

Further to the stormwater definition in **Section 4.1,** MWC excluded flows in the Yarra River upstream of the Warrandyte gauge from consideration as "stormwater" because these areas are either forested (i.e "natural") or developed rural areas with urbanised centres, and "stormwater" yields are assumed to be minor. In order to estimate the flow from the highly urbanised areas, the flows at the Warrandyte gauge were subtracted from the flows at the downstream gauges Templestowe and Chandler Highway, i.e. none of the flows at Warrandyte are defined as "stormwater" under this scenario.

4.4.2 Environmental Flow Requirements

The Yarra River catchment is divided into two distinct ecological zones, the fresh water river reaches and the estuary. These two components have different environmental flow requirements.

4.4.2.1 River Fresh Water Flow Requirements

SKM undertook the study, '*Determination of the Minimum Environmental Water Requirement for the Yarra River*' (2005), for MWC. This study determined the environmental flow requirements for the freshwater section of the Yarra River, upstream of Dights Falls. Daily 'Recommended Environmental Flow' time series were generated from 1963 to 2003 for gauging locations along the Yarra River. These flows were allowed to pass in the spreadsheet model to predict yields from harvesting stormwater from the Yarra River for the period 1 January 1997 to 31 December 2003.

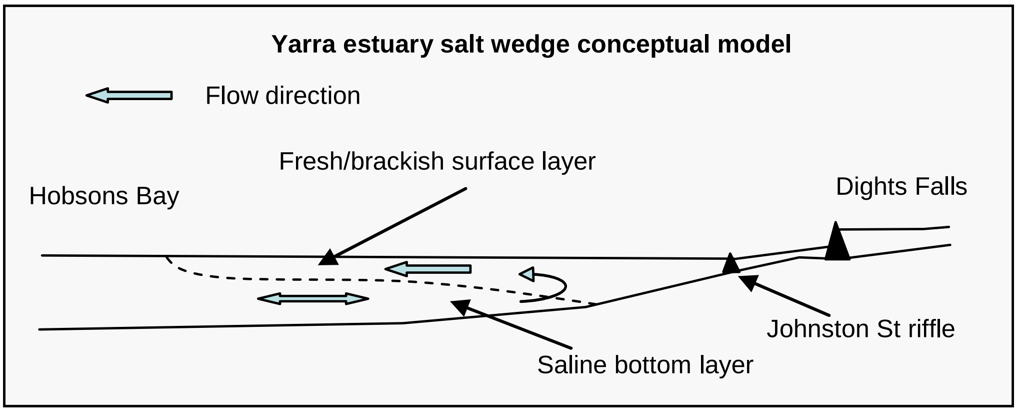
4.4.2.2 Riverine Water Quality Risk at Low River Flows

Extended periods of low flow conditions in summer pose considerable water quality risk to the ecology of the Yarra River. The major risks to ecosystem health include low dissolved oxygen, elevated temperatures, increased salinity and heavy metal bioaccumulation. In order to protect river health from such unacceptable risk, there would be no extractions during summer months 1st December to 31st March.

4.4.2.3 Estuary Flow Requirements

Within the Yarra Estuary the combination of river flows and ocean tides results in the establishment of a 'salt- wedge' where the water column is stratified with a surface layer of fresher river water overlaying more saline water (**Figure 3**). The tip of the salt-wedge migrates up and down the estuary depending upon the volume of river inflows and slowly mixes with the surface layer at the stratification interface.

- **Figure 3 Conceptual model of the salt wedge in the Yarra estuary**



The '*Determination of the Minimum Environmental Water Requirements for the Yarra River*' study did not make recommendations for the estuary, because a hydrodynamic estuary model was not available to model the estuary processes. For this project, SKM engaged Water Technology to develop a hydrodynamic model of the Yarra Estuary and to determine the specific estuary environmental flow requirements. The hydrodynamic modelling to date and observations from previous studies suggests that an inflow to the estuary of around 400ML/d is required to generate mixing of the salt wedge and reduce risks associated with stratification. On the basis of this, inflows to the estuary should be maintained above 400 ML/d, i.e pumping of stormwater should cease if river flow at the Chandler Highway gauge falls below 400 ML/d.

4.4.3 Other Losses

Other losses from any option developed include losses during water treatment and evaporation from new storages. The following losses were assumed:

- 10% loss through the water treatment process, as these are multiple treatment steps
- Average net evaporation rate for Melbourne applied to any new water storage

4.4.4 System Changes

MWC is currently augmenting the harvesting capacity of Yering Gorge Pump Station by installing a new 60ML/day pump station, due for commissioning in July 2007. The spreadsheet model predicts an average increase in yield of 12GL/year over the period 1997 to 2003, from this pump station. This extraction was deducted from the gauged river flows used to model the stormwater harvesting yield from the Yarra River, to prevent 'double counting' of this increased yield.

4.4.5 Yield Estimation

4.4.5.1 Yield Scenarios Modelled for Yarra River

Two diversion scenarios were modelled for a range of diversion pump station capacities:

- Storm Water Yield in accordance with the CRSWS Scenario (refer **Section 4.1**) and extraction of water when river flow is greater that the environmental flow recommendations, but cease diversions from start of December to end of March, and whenever flow is less than 400ML/day at Dights Falls (Chandler Highway gauge).
- Storm Water Yield in accordance with the CRSWS Scenario (refer **Section 4.1**)

4.4.5.2 Results of Preliminary Yield Estimates

The two scenarios detailed in **Section 4.4.5.1** were modelled to determine the yield for each alternative offtake location assumed to be at the existing gauge stations on the Yarra River.

The results from the spreadsheet models are given in **.**

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Table 4. The predicted yields assume that the diversion pump station has variable speed drives capable of harvesting any flow rate up to the pump station capacity and controlled from the measured flow at the corresponding river gauge.

- **Table 4 Estimated Potential Yields for period January 1997 to December 2003**

		CRSWS Definition		Reference Data	
Gauge Location	Diversion Capacity	Urban Stormwater Yield = 50% of (Gauged Flow-Warrandyte Gauge) Mitigate Summer Low Flow Risk and Estuary Risk Cease pumping at 400ML/day. No pumping Dec-March 10% loss through treatment, Evaporation losses	Urban Stormwater Yield = 50% of (Gauged Flow-Warrandyte Gauge) 10% loss through treatment, Evaporation losses	Maximum available Urban Stormwater 50% of (Gauged Flow-Warrandyte Gauge)	Median River Flow 1997-2003
	(ML/day)	Estimated Average Annual "Stormwater" Yield (GL/year)	Estimated Average Annual "Stormwater" Yield (GL/year)	(GL/year)	(GL/year)
Chandler Highway, Kew	100	6	13	34	287
	500	13	24		
	1000	14	27		
Fitzsimmons La, Templestowe	100	4	9	13	240
	500	5	11		
	1000	5	11		
Warrandyte	100	Na	Na	0	232
	500	Na	Na		
	1000	Na	Na		
Yering Gorge	100	Na	Na	0	171
	500	Na	Na		
	1000	na	na		

It should be noted that pump extractions greater than 1000ML/day, result in only a slight increase in estimated yield and hence are not considered to be viable for the infrastructure required.

4.4.6 Yarra Catchment Bulk Water Entitlements and Diversion Permits

MWC extractions from the Yarra River are limited to 400GL/year in accordance with the Water Act 1989 (Vic), this limitation is termed the "Yarra Cap". Currently an average of 360GL/year is diverted by MWC at Upper Yarra Reservoir, Maroondah Reservoir and Yering Gorge.

It is understood from discussion with MWC that the "stormwater" yield calculated from the method described above is to be considered "outside the Yarra Cap" if environmental flow requirements are met; and that this water could be diverted in addition to MWC's entitlement under the Cap. This is a very important issue and needs to be confirmed both in general terms, and in the context of drought periods when licensed diversions "under the Cap" are restricted.

MWC currently holds an extraction licence for the Yering Gorge pump station for up to 1000ML/day. Any new extraction would require the application for an additional extraction licence.

There are 1245 licences to extract water from the Yarra River catchment, totalling an overall bulk entitlement of 27.3GL/year. These Licences also represent an opportunity for increased harvesting by MWC as these are tradable. Evaluation of the feasibility of trading in these licensed volumes is beyond the scope of this phase of this study. In general any licence purchased may need to be diverted at or downstream of the existing licensed offtake.

4.5 Maribyrnong Catchment

4.5.1 Stormwater definition

The flow gauging for the Maribyrnong River was adopted as a fully developed catchment and hence the stormwater yield under this scenario was assessed as 50% of the gauged flow.

4.5.2 Existing Bulk Entitlements

The Maribyrnong River is a regulated river, relying on a combination of natural catchment flows and releases from Rosslynne Reservoir. The river supplies a large proportion of flow to urban bulk entitlements supplied from Rosslynne Reservoir. The river also supplies irrigation bulk entitlements of licensed diverters. Any additional flow harvesting cannot adversely impact on existing bulk entitlements.

4.5.3 Environmental Flow Requirements

Environmental flow recommendations for the fresh water section of the Maribyrnong River were determined in the Earthtech Report '*Environmental flow determination for the Maribyrnong River - Flow recommendations report*'. The daily flow time series from this report was used to estimate the additional yield from the Maribyrnong River. It is assumed that the Maribyrnong River estuary flow requirements are similar to the fresh water sections.

4.5.4 Yield Estimation for Stormwater harvesting from the Maribyrnong River

The yield analysis was undertaken using the same spreadsheet method as for the Yarra River analysis. **Table 5** details the estimated annual yield from the Maribyrnong River.

- **Table 5 Maribyrnong River - Assessment of Estimated Stormwater Yield**

Location	Median Annual River Flow (GL/year)	Maximum pump station capacity (ML/day)	Estimated Average Annual Yield (GL/year)
Keilor	19	100	7
		500	10
		1000	11

As can be seen in **Table 5**, the yield from the Maribyrnong does not meet the minimum yield requirement for this study of 20GL/year. This option has not been considered further.

4.6 Patterson River Catchment

4.6.1 Stormwater definition

The flow gauging for the Patterson River was adopted as fully developed catchment and hence the stormwater yield under this scenario was assessed as 50% of the gauged flow.

4.6.2 Environmental Flow Requirements

No environmental flow requirements are currently defined for the Patterson River. As such an assumption of the 20%ile low flow was assumed for the passing environmental flow.

4.6.3 Yield Estimation for Stormwater harvesting from the Patterson River

The location of the furthest reliable downstream flow monitor in the Patterson River catchment is at Hammond Road and is upstream of the Eumemering Creek inflow (see **Figure 4**). In order to account for the increase in flows between Hammond Road and Pillars Crossing, the flows were factored up by the percentage increase in catchment area. These assumptions need to be verified by reliable gauging records near Pillars Crossing, should this option progress.

Table 6 details the estimated annual yield from the Patterson River and Dandenong Creek at Hammond Road. Estimated yields from the 300ML/day and 500ML/day extractions from the Patterson River catchment would satisfy the 20GL/year acceptance criteria for this study.

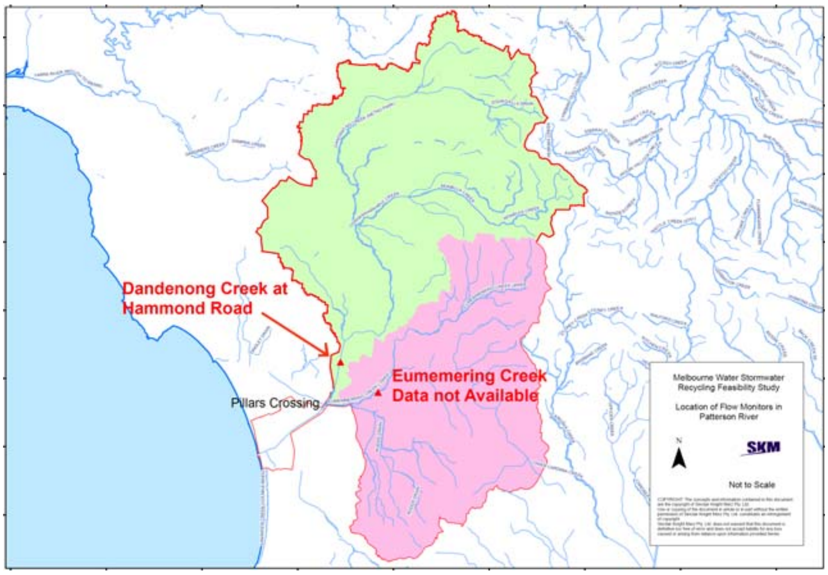
MWC is currently assessing the environmental flow requirements of Kananook Creek. Currently this flow requirement is being met via the Patterson River at 10ML/day with potential to increase to 25ML/day. **Table 6** gives the reduced yield available in brackets.

- **Table 6 Patterson River - Assessment of Estimated Yield 1997 to 2006**

Location	Diversion capacity (ML/day)	Urban Stormwater Yield = 50% of Gauged Flow less 20%ile Environmental Flow Estimated Average "Stormwater" Yield 10% Treatment loss (GL/year) (**)	Estimated Average Annual Yield 20%ile Environmental Flow 10% Treatment loss (GL/year)	Maximum Available Urban Stormwater 50% of gauged flow (GL/year)	Median Annual River Flow 1997-2006 (GL/year)
Hammond Road (Dandenong Creek)	100	8 (6)	12	27	62
	300	14 (12)	23		
	500	17 (14)	28		
Pillars Crossing*	100	11 (9)	16	44	103
	300	21 (18)	32		
	500	26 (22)	40		

*Results are factored for increased catchment area downstream of Hammond Rd gauge.

**MWC are currently investigating potential environmental flows to Kananook Creek (up to 25ML/day, approximately 9GL/year).



- **Figure 4 Location of Flow Monitors – Patterson River Catchment**

4.7 Potential Yield from Retarding Basins

A preliminary assessment was undertaken of the viability of harvesting significant stormwater yield from existing large retarding basins. The hypothesis underlying this option is that it may be more cost efficient to pump water from retarding basins than directly from streams, as it may be possible to derive an equivalent yield using significantly smaller pumps operating for longer periods. The Police Road Retarding Basin on Dandenong Creek was used to test this hypothesis.

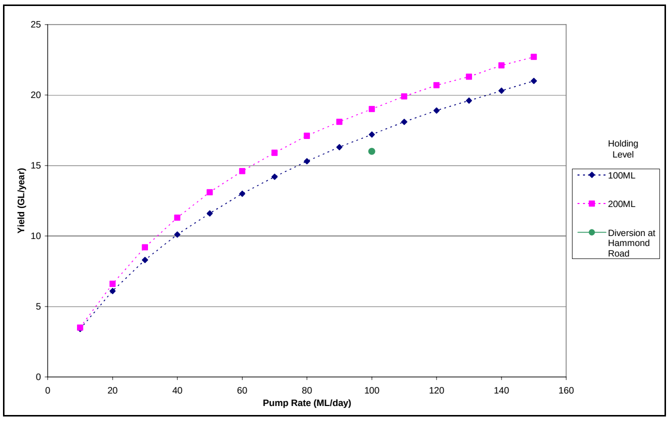
The potential yield was estimated by performing a spreadsheet based water balance over the basin for the 10 year period from January 1997 to January 2007. Yield was estimated based on: inflow, environmental flows, evaporation, storage, pump capacity, outflow rate and holding level.

Figure 5 shows the results of the yield estimation for harvesting from Police Road Retarding Basin on Dandenong Creek. Comparing these results with those from diverting 100 ML/day from Dandenong Creek at Hammond Road, shows that altering the operation of the basin results in only modest increases in yield for a given pump capacity.

There are a number of significant potential risks and disadvantages associated with schemes of this type, including:

- The cost of augmenting basin outlet work is likely to be high.
- The consequences of the gates failing to operate during a flood event may be severe.
- The viability of the wetland plants will be impacted by periods of lengthy inundation necessary for operation of the scheme.
- Opening the basin outlet gates rapidly in advance of an upstream flood event may result in a significant public safety risk in public areas along the downstream waterway.
- Any flood warning system will be imperfect, hence conservative control will be required, which will further reduce potential scheme yield.

From this example, it can be concluded that the increase in yield associated with pumping from retarding basins, relative to pumping directly from streams, is likely be insignificant compared to the significant disadvantages associated with such a scheme. Similar outcomes are expected to apply to other existing retarding basin sites in metropolitan Melbourne.



- **Figure 5: Yield Assessment Results (including comparison with Option 2c).**

5. Option Analysis

5.1 Compliance of Options with Minimum Yield Criterion

The options identified in **Section 2** have been assessed for compliance with the acceptance criteria of a minimum yield of 20GL/year, when constrained to comply with the definition of "stormwater" set by MWC in response to the Victorian Government's *Sustainable Water Strategy Central Region Action to 2055*, (Refer **Section 0**). **Table 7** summarises the results of yield assessment in relation to the acceptance criteria, with a view to identifying options that qualify for further consideration.

5.2 Options Development

Preliminary "desktop" design concepts were developed for the infrastructure required to implement a range of diversion capacities for each option.

The infrastructure requirements for each option are given in **Appendix A**. **Figure 6** through **Figure 18** given in **Appendix A,** show the general locations of the proposed infrastructure for each option. The cost estimates in **Section 7** are based on these infrastructure concepts.

Melbourne Water

Table 7 Option Acceptance

	Infrastructure Requirements	Diversion Capacity (ML/day)	Estimated Minimum Average Yield[1] (GL/year)	Yield Acceptance	Location assessment and Comment
Yarra River					
Options 1a Dights Falls to Little Watsons Creek **Figure 6** and **Figure 7** in **Appendix A**	▪ River intake and pump station from Yarra River at Dights Falls ▪ Transfer pipeline from Dights Falls to Little Watsons Creek (LWC) ▪ Storage inlet treatment plant ▪ Environmental buffer storage at LWC ▪ Storage outlet treatment plant ▪ Discharge into Sugarloaf Reservoir as feed to existing Winneke WTP ▪ Upgrade Winneke WTP as planned	100	6	Fails Criteria	▪ Possible offtake locations near Dights Falls ▪ MWC owned land at LWC and PAO to facilitate planning permit
		500	13	Fails Criteria	
		1000	14	Fails Criteria	
Option 1b Templestowe to Little Watsons Creek **Figure 8** and **Figure 9** in **Appendix A**	▪ River intake and pump station from the Yarra River at Templestowe ▪ Transfer pipeline from Templestowe to LWC ▪ Storage inlet treatment plant ▪ Environmental buffer storage at LWC ▪ Storage outlet treatment plant ▪ Discharge into Sugarloaf Reservoir as feed to existing Winneke WTP ▪ Upgrade Winneke WTP as planned	100	4	Fails Criteria	▪ Possible offtake locations near Templestowe ▪ MWC owned land at LWC and PAO to facilitate planning permit
		500	5	Fails Criteria	
		1000	5	Fails Criteria	

[1] Average Urban Stormwater Yield whilst meeting environmental flow requirements, no pumping between December and March and no extraction if Chandler Highway gauge is less than 400ML/day.

	Infrastructure Requirements	Diversion Capacity (ML/day)	Estimated Minimum Average Yield[1] (GL/year)	Yield Acceptance	Location assessment and Comment
Option 1c Warrandyte to Little Watsons Creek **Figure 10** and Figure 11 in **Appendix A**	▪ Offtake and pump station from the Yarra River at Warrandyte ▪ Transfer pipeline from Warrandyte to Little Watsons Creek (LWC) ▪ Storage inlet treatment plant ▪ Environmental buffer storage at LWC ▪ Storage outlet treatment plant ▪ Discharge into Sugarloaf Reservoir as feed to existing Winneke WTP ▪ Upgrade Winneke WTP as planned	100 500 1000	0 0 0	Fails Criteria Fails Criteria Fails Criteria	▪ No “stormwater” diversion available by definition ▪ Possible offtake locations near Warrandyte ▪ MWC owned land at LWC and PAO to facilitate planning permit
Option 1d Dights Falls to Yering Gorge **Figure 12** and Figure 13 in **Appendix A**	▪ Offtake and pump station from the Yarra River at Dights Falls ▪ Transfer pipeline from Dights Falls to Yering Gorge ▪ New offtake and pump station at Yering Gorge ▪ New storage at LWC ▪ 2 treatment plants next to Sugarloaf and LWC ▪ Discharge into Sugarloaf and processes thru existing Winneke WTP ▪ Upgrade Winneke WTP with UV filters on outlet	100 500 1000	6 13 14	Fails Criteria Fails Criteria Fails Criteria	▪ Possible offtake locations near Dights Falls ▪ MWC owned land at LWC and PAO to facilitate planning permit ▪ This option has environmental implications and would result in a change in water quality in the river and may have ecological impacts. It is considered that this scheme may only be viable for flows that are significantly less than the river flow. The 100ML/day scheme is the only acceptable optiont.
Option 1e Dights Falls to ASTR **Figure 14** and **Figure 15** in **Appendix A**	▪ Offtake and pump station from Yarra River at Dights Falls ▪ Transfer pipeline to bore field ▪ Injection and extraction bores ▪ Treatment plant near Docklands ▪ Transfer pipeline to Sugarloaf ▪ Upgrade Winneke WTP with UV filters on outlet	100 500 1000	6 13 14	Fails Criteria Fails Criteria Fails Criteria	▪ Possible offtake locations at Dights Falls ▪ No viable ASTR aquifer is located near the extraction point, so flow must transfer to Port Melbourne. There is no acceptable pipeline routes and may require tunnel. ▪ Possible water treatment plant locations identified in vacant land near Docklands
Patterson River					
Option 2a Patterson River to Cardinia **Figure 16** and **Figure 17** in **Appendix A**	▪ Offtake and pump station from Patterson River upstream of Pillars Crossing and transfer pipeline ▪ Storage inlet treatment plant ▪ New 90 day environmental buffer storage – earthen embankments ▪ Storage outlet treatment plant ▪ Transfer pipeline to Cardinia Reservoir ▪ Cardinia WTP (if necessary)	100 300 500	11 (9) 21 (18) 26 (22)	Fails Criteria Fails Criteria Meets Criteria	▪ Possible offtake locations at Pillars Crossing ▪ Possible water treatment plant and storage sites in open land near ETP/Pillars Crossing ▪ Some availability of MWC owned land for new infrastructure. ▪ Impact on Cardinia water quality not determined ▪ if nutrients too high may require Cardinia WTP. ▪ large plant (peak flows) ▪ Environmental flow requirements to Kananook Creek are yet to be defined, so yields may be further reduced.

	Infrastructure Requirements	Diversion Capacity (ML/day)	Estimated Minimum Average Yield[1] (GL/year)	Yield Acceptance	Location assessment and Comment
Option 2b Patterson River to ASTR **Figure 18** and **Figure 19** in **Appendix A**	▪ Offtake and pump station on Patterson River upstream of Pillars Crossing ▪ Transfer pipeline to ASTR bore field ▪ ASTR inlet treatment plant ▪ Injection and extraction bores ▪ ASTR outlet treatment plant ▪ Transfer pipeline to Cardinia ▪ Cardinia WTP (if necessary)	100	11 (9)	Fails Criteria	▪ Possible offtake locations at Pillars Crossing ▪ Possible water treatment plant and ASTR sites in open land near ETP/Pillars Crossing ▪ MWC owned land for new infrastructure. ▪ Impact on Cardinia water quality not determined – if nutrients too high may require Cardinia WTP – large plant (peak flows) ▪ Viable aquifer located near extraction point ▪ Environmental flow requirements to Kananook Creek are yet to be defined, so yields may be further reduced.
		300	21 (18)	Fails Criteria	
		500	26 (22)	Meets Criteria	
Option 2c Dandenong Creek to Cardinia	▪ Offtake and pump station at Police Road Retarding Basin ▪ Transfer pipeline to storage ▪ Storage inlet treatment plant ▪ New 90 day environmental buffer storage ▪ Storage outlet treatment plant ▪ Transfer pipeline and WTP to Cardinia Reservoir	100	16	Fails Criteria	▪ This option results in a reduced yield of similar water quality compared to Options 2a and 2b. ▪ Insufficient land in the vicinity of Police Road retarding Basin – would locate works as for options 2a and 2b
Western Melbourne					
Option 3a Maribyrnong to Greenvale	▪ Collect stormwater and store in dam on Maribyrnong River/tributaries at Arundel and/or Konagaderra. ▪ Treat and transfer to Greenvale Reservoir	100	5	Fails Criteria	▪ Land availability for Arundel or Kongaderra storage. ▪ Possible locations for treatment plants ▪ Not recommended to progress due to insufficient yield ▪ Low flows saline – excessive EC for MWC blend – local quality discrepancies
		500	8	Fails Criteria	
		1000	10	Fails Criteria	
Option 3b Maribyrnong to Yan Yean	▪ Collect stormwater and store in dams on Maribyrnong River/tributaries at Arundel and/or Konagaderra. ▪ Treat and transfer to Yan Yean	100	7	Fails Criteria	▪ Land availability for Arundel or Kongaderra storage. ▪ Possible locations for treatment plants ▪ Not recommended to progress due to insufficient yield ▪ Low flows saline – excessive EC for MWC blend – local quality discrepancies
		500	10	Fails Criteria	

	Infrastructure Requirements	Diversion Capacity (ML/day)	Estimated Minimum Average Yield[1] (GL/year)	Yield Acceptance	Location assessment and Comment
		1000	11	Fails Criteria	
Retarding Basins (distributed collection system)					
Option 4a Harvest from retarding basin - Police Road	▪ Collect from retarding basins ▪ Treat near the larger retarding basins and supply to network.	100	Additional 2GL/year	Fails Criteria	▪ Land availability at Police Road retarding basin is very limited. ▪ Impacts on intended function of retarding basin. ▪ Refer Section 4.7
Option 4b Retarding Basin harvesting network	▪ Collect from retarding basins ▪ Inter-connect as network of smaller stormwater catchments ▪ Centralised treatment and connection into the water supply network	Multiple 100ML/day offtakes	Not defined	Fails Criteria	▪ Large network of retarding basins would be required. ▪ Impacts on intended function of the retarding basin.

6. Environmental, Social and Planning Assessments

6.1 Assessment method

A high level desktop analysis of the options was undertaken to identify potential risks and impacts of each option on the following:

- Aquatic ecology
- Terrestrial ecology
- Statutory planning
- Cultural and heritage
- Social / Landscape / Visual
- Air and noise
- Contaminated land

Each element of each option was assessed and rated using a three colour scoring system:

- **Table 8 Scoring basis**

RED	YELLOW	GREEN
Major constraint potential	Medium constraint potential or lack of information available to assess.	Low constraint potential providing adequate mitigation measures are taken.

6.2 Assessment Results

The detailed assessments for each option were compiled to provide a single overall rating for each element and an overall assessment for the option. The results are given in **Table 9**.

Table 9 Summary of Environmental, Social and Planning Assessments

Project Aspect	Project Phase	Comments / Reasoning							
	Discipline	Option 1a Dights Falls to Little Watsons Creek	Option 1b Templestowe to Little Watsons Creek	Option 1c Warrandyte to Little Watsons Creek	Option 1d Dights Falls to Yering Gorge	Option 1e Dights Falls to ASTR	Option 2a Patterson River to Cardinia	Option 2b Patterson River to ASTR	
Offtake	Aquatic Ecology	Green	Yellow	Red	Red	Green	Green	Green	
	Terrestrial Ecology	Green Yellow	Yellow	Yellow Red	Green Red	Green *Yellow*	Green *Yellow*	Green *Yellow*	
	Planning	Yellow	Yellow	Yellow	Yellow	Yellow	Green	Green	
	Cultural & Heritage	Yellow Red	Green	Green	Red	Yellow Red	Yellow	Yellow	
	Social/landscape Visual	Yellow	Green Yellow	Yellow	Yellow	Yellow	Green	Green	
	Air and Noise	Green	Yellow	Green	Green	Green	Green	Green	
	Contaminated land	Green Yellow	Green Yellow	Green Yellow	Green Yellow	Green Yellow	Yellow	Yellow	
Treatment Plants	Aquatic Ecology	Green	Green	Green	Green	Green	Green Yellow	Green Yellow	
	Terrestrial Ecology	Green Yellow	Green Yellow	Green Yellow	Green Yellow	Green Yellow	Green Yellow	Green Yellow	Depends on specific site location
	Planning	Yellow	Yellow	Yellow	Yellow	Yellow	Green	Green	
	Cultural and Heritage	Yellow	Yellow	Yellow	Yellow	Yellow	Red	Red	High value heritage issues in Cranbourne Sands
	Social/landscape Visual	Green	Green	Green	Green	Yellow	Green	Green	Option 1g in urban area
	Air and Noise	Green	Green	Green	Green	Yellow	Green	Green	During construction
	Contaminated land	Green	Green	Green	Green	Green Yellow	Green	Green Yellow	Depends on plant location
Storage facility	Aquatic Ecology	Red	Red	Red	N/A	N/A	Green	N/A	
	Terrestrial Ecology	Red	Red	Red	N/A	N/A	*Yellow*	N/A	
	Planning	Red	Red	Red	N/A	N/A	*Yellow*	N/A	
	Cultural and Heritage	*Yellow*	*Yellow*	*Yellow*	N/A	N/A	*Yellow* Red	N/A	
	Social/landscape Visual	Red	Red	Red	N/A	N/A	Green	N/A	
	Air and Noise	Yellow Red	*Yellow* Red	*Yellow* Red	N/A	N/A	Green	N/A	
	Contaminated land	Green	Green	Green	N/A	N/A	Yellow	N/A	
Bore field	Aquatic Ecology					Green		Green	
	Terrestrial Ecology					Green		Green	
	Planning					Green *Yellow*		Yellow Red	

Project Aspect	Project Phase	Comments / Reasoning							
	Discipline	Option 1a Dights Falls to Little Watsons Creek	Option 1b Templestowe to Little Watsons Creek	Option 1c Warrandyte to Little Watsons Creek	Option 1d Dights Falls to Yering Gorge	Option 1e Dights Falls to ASTR	Option 2a Patterson River to Cardinia	Option 2b Patterson River to ASTR	
Bore field (cont)	Cultural and Heritage					Green *Yellow*		Green Yellow	
	Social/landscape Visual					*Yellow*		Green	
	Air and Noise					*Yellow*		Green	
	Contaminated land					Green		Green	This assumes the field is not contaminated
Transfer pipeline	Aquatic Ecology	Green	Green	Green	Green	Green	Green	Green	Assume all waterways are bored
	Terrestrial Ecology	Red	Red	Red	Red	Yellow	Red	Red	
	Planning	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	
	Cultural and Heritage	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	
	Social/landscape Visual	Yellow	Yellow	Green	Yellow	Yellow	Yellow	Yellow	Length of pipeline & proportion in urban areas
	Air and Noise	Yellow	Yellow	Green	Yellow	Yellow	Yellow	Yellow	
	Contaminated land	Green	Green	Green	Green	Green	Green	Green	Assume avoid contaminated land. Mitigation and in design costs
Overall rating		***Red for storage impacts*** ***Green/yellow for all others*** ***Green for estuary & River health***	***Red for storage impacts*** ***Green/yellow for all others*** ***Yellow for estuary & River health***	***Red for storage impacts*** ***Green/yellow for all others*** ***Red for estuary & River health***	***Red for Aquatic Ecology*** ***Green/Yellow' for all others***	***Green/Yellow except for cultural/ heritage (Red) and contaminated land (Yellow)*** ***From Yarra River options this is the best because pumping at bottom end protects River health & no new storage is needed.***	***Mainly green except for cultural/ heritage (Red) and contaminated land (Yellow)***		

7. Order of Magnitude Cost Estimates

7.1 Introduction

Order of Magnitude Cost estimates were developed for each option in order to compare the capital cost, operating cost and net present value. The costs are order of magnitude costs and for comparison cost purposes only.

7.2 Assumptions

The cost estimates and net present costs are based on the following assumptions:

- Costs given are +/-30%
- A contingency of 40% has been added to all capital cost and 15% to operational costs
- Costs are in 2007 dollars excluding GST
- Electricity costs $65/MWhr (base price + transmission)
- Electricity costs $35/MWHr greenhouse gas emission provision for abatements and offsets
- All options require an environmental buffer
- Pre-Environmental water treatment plant as per **Section** Error! Reference source not found.
- Post-Environmental water treatment plant as per **Section** Error! Reference source not found.
- All pump stations have three duty one standby pump except 1000ml/day which has 4 duty and 1 standby, with variable speed drives
- Investigation and approvals are 7.5% of total capital cost
- Project Management is 2.5% of total capital cost
- Commissioning if 0.5% of total capital cost
- Costs for crossing roads, rivers and creeks are $15,000/$20,000/$25,000 for 100/500/100 ML/day respectively
- Catchment management costs of $50,000,000 per option
- Chemical costs for pre and post treatment are:
  - $25/ml – Clarifier chemicals
  - $5/ml – Lime
  - $50/ml – DAFF Chemicals
  - $10/ml – Micro Filtration Chemicals
  - $100/ml – RO Chemicals
  - $10/tonne – Centrifuge polyelectrolyte
  - $50,000 to $200,000 - cleaning chemicals dependant on size of plant
  - $100,00 to $250,000 – Cartridge Filter Replacement

7.3 Cost Estimates

Table 10 summarises the capital and operating costs and gives the net present cost $/ML.

■ **Table 10 Option Cost Estimate Summary**

Yarra Catchment	Extraction (ML/day)	Estimated Average Annual Yield* (GL/year)	Capital Costs ($m)	Operating Costs ($m/year)	Net Present Cost** ($m)	Net Present Cost per ML*** ($m/ML)
Options 1a Dights Falls to Little Watsons Creek	100	6	$750	$20	$740	-$4,800
	500	13	$1,400	$45	$1,430	-$4,500
	1000	14	$1,700	$60	$1,800	-$3,000
Option 1b Templestowe to Little Watsons Creek	100	4	$600	$10	$540	-$6,300
	500	5	$1,200	$15	$1,020	-$9,000
	1000	5	$1,500	$20	$1,260	-$11,300
Option 1c Warrandyte to Little Watsons Creek	100	0	$800	$15	$700	$0
	500	0	$1,500	$20	$1,310	$0
	1000	0	$1,800	$20	$1,600	$0
Option 1d Dights Falls to Yering Gorge	100	6	$500	$10	$400	-$2,300
Option 1e Dights Falls to ASTR	100	6	$1,700	$25	$1,440	-$9,400
Option 2a Patterson River to Cardinia	100	11 (9)	$900 ($900)	$14 ($14)	$600 ($600)	-$2,200 (-$2,700)
	300	21 (18)	$1,100 ($1,100)	$21 ($21)	$800 ($900)	-$1,700 (-$2,000)
	500	26 (22)	$1,300 ($1,300)	$26 ($26)	$1,000 ($1,100)	-$1,700 (-$2,000)
Option 2b Patterson River to ASTR	100	11 (9)	$900 ($900)	$15 ($15)	$550 ($560)	-$2,000 (-$2,000)
	300	21 (18)	$1,100 ($1,100)	$25 ($25)	$860 ($880)	-$1,700 (-$2,000)
	500	26 (22)	$1,300 ($1,300)	$31 ($31)	$1,110 ($1,140)	-$1,800 (-$2,100)

*Average Annual Urban Stormwater Yield whilst meeting environmental flow requirements, no pumping between December and March and no extraction if Chandler Highway gauge is less than 400ML/day

**Net Present Cost determined using MWC net present value tax adjusted spreadsheet, over 25 years.

***Calculated on Net Present Cost divided by the annual yield for 25 years.

****NPC for internal comparison only. To compare to other options NPC/NPV assumptions need to be consistent.

8. Conclusion

8.1 Outcome of High Level Assessment

The objective of this study was to evaluate the options that were identified in the focus workshops as suitable for High Level Assessment to determine which, if any, of these options warrant more detailed consideration. The criteria that options are required to satisfy to be carried forward are that the scheme can:

- Incorporate adequate barriers to water supply hazards such that the recycled stormwater will be suitable for supply to the potable network.
- Provide a minimum yield to the potable network of 20GL/year for the average flows in the period 1997 to 2006.
- Maintain environmental flow requirements in the catchment source and its outfalls.
- Be constructed with acceptable environmental and social outcomes.

Table 11 lists the options against these criteria and identifies the options that qualify to be investigated further.

- **Table 11 Options Criteria Compliance**

Option	Suitable for Potable Supply	Minimum Yield of 20GL/year	Maintain Environmental Flows and risks	Construction Acceptable	Investigate Further?
Yarra Catchment					
Options 1a Dights Falls to Little Watsons Creek	Yes	No	Yes	Yes	**No**
Option 1b Templestowe to Little Watsons Creek	Yes	No	Yes	Yes	**No**
Option 1c Warrandyte to Little Watsons Creek	Yes	No	Yes	Yes	**No**
Option 1d Dights Falls to Yering Gorge	Yes	No	No, risk to water quality in the Yarra River	Yes	**No**
Option 1e Dights Falls to ASTR	Yes	No	Yes	Require a tunnel through inner suburbs	**No**
Patterson River Catchment					
Option 2a Patterson River to Cardinia	Yes	Marginal due to Kananook Creek Enviro flows	Yes	Yes, however large “on-ground” storage required	**No**
Option 2b Patterson River to ASTR	Yes	Marginal due to Kananook Creek Enviro flows	Yes	Yes	**No**

The outcomes of this High Level Assessment are that:

- All of the options identified can comply with the criterion of suitability for supply into the potable water supply network, providing sufficient water treatment stages are included, and the water passes through “environmental buffer” storage prior to entering any of MWC distribution storages.
- Of the options analysed, stormwater diversion from the Patterson River at Pillars Crossing can provide the required the minimum yield of 20GL/year in accordance with the stormwater definition (refer **Section 4.1**). The volume of water available depends on the other uses MWC

is investigating for the water, specifically the environmental flow requirements of Kananook Creek. These environmental flows are currently 10ML/day, potentially increasing to 25ML/day, making the compliance with the yield acceptance criteria for stormwater recycling from the Patterson Creek marginal.

- The reuse of stormwater from the Maribyrnong and Werribee Rivers do not meet acceptance criteria under any definition and hence were not investigated further.
- The construction of these schemes will present major challenges to deliver acceptable environmental and social outcomes. The areas of concern will be the works adjacent to and fronting the rivers, the location and impact of construction of the environmental buffer storage, and construction of pipelines or tunnels.

MWC and DSE now have sufficient information to determine whether a more detailed study should proceed and which options are to be included.

9. References

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Glossary

ARI - Average Recurrence Interval in peak flood flow
ASR – Aquifer storage and recovery
ASTR – Aquifer storage, transfer and recovery
ADWG – Australian Drinking Water Guidelines 2004
DAFF – dissolved air flotation and filtration – water treatment process
DBPs - Disinfection by-products
DHS - Department of Human Services
DO – Dissolved oxygen
DSE - Department of Sustainability and Environment
GAC - granular activated carbon system.
HACCP - Hazard Analysis and Critical Control Point)
MF – Membrane microfiltration - water treatment processs.
RO – Reverse osmosis – water treatment process.
SEPP – State Environment Protection Policy, State Government of Victoria, 2003
SMURRF - Santa Monica stormwater recycling
THM - Trihalomethane
UF – membrane ultrafiltration - water treatment process.
WoV – Waters of Victoria
WTP – Water treatment plant