Secondary Water Use Inquiry – Cost Analysis

Working Paper

Prepared for the:

Independent Competition and Regulatory Commission

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1. Executive Summary

The Independent Competition and Regulatory Commission is undertaking an investigation into the costs of various secondary water use options and potable water options. The investigation seeks to identify the whole-of-life costs (to the extent possible) associated with each option compared to the expected volume of water produced by each option.

The options assessed were grouped within three categories, that is, public water options, private water options and Government programs. The results of the analysis for each category are presented below.

1.1 Public Water Options

Figure 1 below presents a summary of the results from the analysis for public water options.

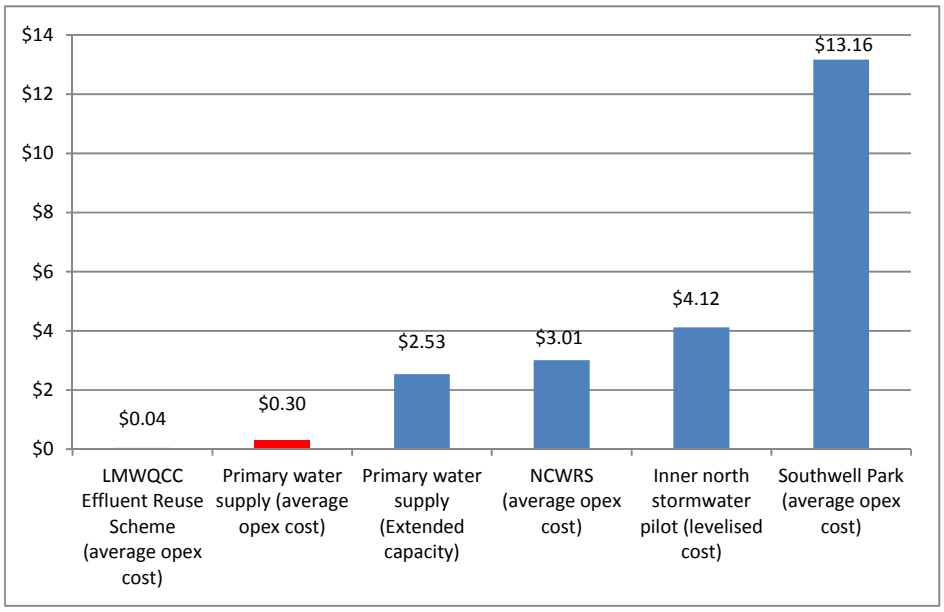

Figure 1 Summary of Costs for Secondary Water Sources – Public water options

1.2 Private Water Options

Figure 2 below presents a summary of the results from the analysis for private water options.

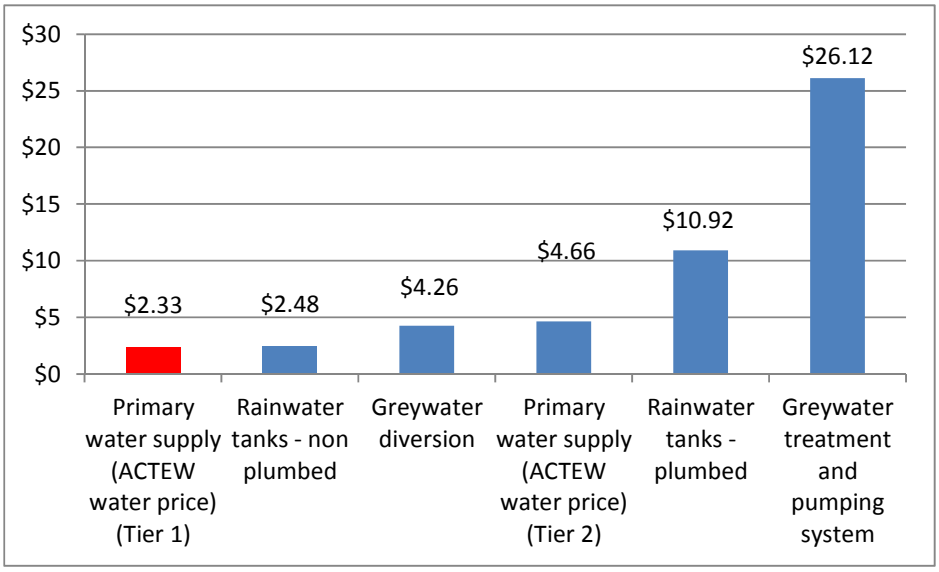

Figure 2 Summary of Costs for Secondary Water Sources – Private water options

1.3 Government Programs

An analysis of the ACT Government expenditure on particular rebates and subsidies programs indicated that the cost to Government for each kilolitre of water saved (for the 2009 year analysed) was:

- RainSmart program = $6.31 / kL
- ToiletSmart program = $1.80 / kL
- IrrigationSmart program = $7.70 / kL

2. Project Approach

2.1 Background

The Independent Competition and Regulatory Commission (ICRC) is undertaking an inquiry into secondary (recycled) water use in the ACT. A key part of the inquiry is an analysis of the various costs (in $/kL) of water sourced from different water–reuse options including stormwater, treated sewage effluent, water conservation and demand management measures, rainwater, greywater, groundwater, and water trading.

2.2 Scope

The scope of the review encompassed the following tasks:

1) Calculate levelised–costs for each of the alternative water supply options listed in section 4. The calculation of levelised–cost should use a bottom–up approach consisting of actual and/or estimates of lifecycle capital and operating and maintenance costs applicable to implementing each water–reuse option.[1]
2) Provide an estimate of the marginal cost (or suitable proxy of it) for the ACTEW mains water supply and an estimate of the expected cost of expanding the capacity of the mains water supply.
3) Review secondary sources which have cited levelised–costs that are applicable to implementing a water–reuse option in the ACT.
4) Prepare a report on tasks 1, 2 and 3, containing:
   a) a summary of the relevant costs used to calculate levelised–costs, including the range of each cost item, obtained from secondary sources;
   b) a summary of the calculated levelised–costs for all water reuse options, a description of the methodology used and a statement of its strengths and limitations as a method for comparative analysis;
   c) an estimate of the marginal cost of, or some proxy for, the ACTEW mains water supply and how this was calculated; and
   d) a complete set of cost figures and estimates used to produce the levelised costs and marginal costs.

The source of the figures used to develop the levelised-costs was clearly identified as one of the following, in decreasing order of preference, levels:

- Level 1 – Actual costs from completed projects
- Level 2 – Actual / budgeted completion costs for current projects
- Level 3 – Tendered costs for projects awaiting construction
- Level 4 – Budgeted costs for proposed projects

[1] Where insufficient data was available to calculate a levelised cost, average operating costs have been quoted. Care should be taken when comparing levelised and operating costs as operating costs do not include a capital cost component.

- Level 5 – Budgeted costs for planned projects

2.3 Focus Projects

The scope of the project focussed on a number of specific options across three categories, namely:

1) Public water options
   a) Primary water supply
      i) Existing mains water supply operating cost
      ii) Expanding the existing mains water supply
   b) Southwell Park Sewer Mining Facility
   c) Lower Molonglo Water Quality Control Centre
   d) Fyshwick Treatment Plant/North Canberra Water Reuse Facility
   e) Canberra Integrated Urban Waterways pilot stormwater project
      i) Inner North
2) Private water options
   a) Rainwater Tanks
      i) Plumbed-in
      ii) Non plumbed-in
   b) Greywater
      i) Direct diversion devices
      ii) Household storage, treatment and pumping systems
3) Government Programs
   a) Rebates and subsidies

2.4 Methodology

Our approach can be summarised in the following five steps:

1) Prepared information request to submit to the agencies responsible for managing each of the focus projects listed above. This includes the Environment and Sustainable Development Directorate of the ACT Government, ACTEW Corporation, Queanbeyan City Council[2] and private companies and suppliers of rainwater and greywater services.
2) Conducted interviews with the various agencies to discuss the projects, availability of costing data, and subsequently received the majority of data requested within the project timeframe.
3) Assessed and analysed the data to determine levelised-cost figure identifying data sources, reliability, and any assumptions made in the data.
4) Prepare a draft working paper (this report) which summarises the process followed and the figures calculated. The report also provides a wider perspective on levelised-costs by identifying comparators used in other jurisdictions around Australia.
5) Prepare final working paper incorporating, where relevant, the comments received on the draft version, undertaking any additional analysis required, and incorporating any additional

[2] Interviews with Queanbeyan City Council indicated that the secondary water project options identified were at an early planning stage and reliable cost estimates were not available. Therefore, no further analysis of these options was undertaken.

information provided by the relevant agencies outside the timeframe required to submit the draft report.

2.5 Key Assumptions

The following table outlines some of the key assumptions and parameter values used in the analysis. In general though, the majority of the data provided already included allowances for the parameters listed below.

Parameter	Value
Discount Rate	5%
Contingency range	15%-20%
Consultant fees (proportion of expenditure)	16%
Capex administration costs (proportion of expenditure)	4%
Capex insurance costs (proportion of expenditure)	1%

2.6 Project Limitations

The process of developing the results presented in this paper has been difficult with problems encountered in gathering information on the projects considered. In general, the information was not readily or easily available, historical information was hard to obtain and was rarely updated, while current information was constantly being updated and adjusted.

Where data was available, the quality and consistency of the data, along with the widely varying assumptions and cost factor inclusions and exclusions made the comparison of costs between options extremely difficult.

3. Public Water Options

This section provides a summary of the data used to develop the levelised or operating costs for each of the public secondary water options identified in section 2.3 above. A number of the projects originally intended for analysis were not considered in detail due to a lack of available information. The remaining projects are discussed in the sections following.

3.1 Summary of Results

The following table shows the results of the analysis process for the secondary water options.

Table 1 Summary of Levelised / Operating Costs for Public Water Options

Option & Sub-option	Facility Details	Total Cost PV [$]	Total Volume PV [GL]	Levelised Cost [$/kL]
Stormwater	**ESDD**			
Inner North	Flemington Rd, Dickson, Lyneham Ponds	$32,924,392	8.0	$4.12
Treated Sewage Effluent	**ACTEW**			
Southwell Park	Sewer Mining Facility			$13.16
Lower Molonglo	Water Quality Control Centre			$0.04
Fyshwick-North Canberra	Treatment Plant/Water Reuse Facility			$3.01
Primary Water Supply	**ACTEW**			
Existing mains water supply	Existing network supply			$0.296
Expanding the existing mains water supply	Tantangara releases captured via Murrumbidgee to Googong system			$2.529

3.2 Canberra Integrated Urban Waterways pilot stormwater project

3.2.1 Inner North

Background

The Inner North pilot project covers the Flemington Road, Dickson and Lyneham stormwater ponds and the pipework and pumps that connect these ponds. The pilot projects have a number of current and future potential clients and some further infrastructure is required to connect these customers.

Key Data Sources

1) A key source of data for this option was provided by the Environment and Sustainable Development Directorate, ACT Government on 07 March 2012. This presents the results of a levelised costing assessment undertaken for the Inner North non-potable water supply scheme as at 06 December 2011. This data source has been rated as a **Level 2 source**. This source was updated twice with new information, however the updated data was in a different format to the original making direct comparison of changes difficult. A number of assumptions were made in regards to the data used in the analysis and these are outlined briefly in the following sections.
2) The second key source of data was additional information provided by the Environment and Sustainable Development Directorate, ACT Government on 07 March 2012. This file outlines the proposed staging, and value, of construction works for the Inner North to match customer demands, which are also quantified. The data provided represents a best guess estimate of the cost of connecting customers to the proposed stormwater reticulation system. This data source has been rated as a **Level 5 source**.

Other Data Sources

Further information was provided by Environment and Sustainable Development Directorate, ACT Government. This information was a final sketch plan of proposed infrastructure at the Dickson and Lyneham stormwater ponds and some associated infrastructure. The plan represents the final detail design phase prior to tenders being called for construction. This data source has been rated as a Level 4 source.

Cost Assumptions

1) Capital costs include relevant tanks, pumps and pipes but not other storages (i.e., the ponds and tanks that would have been installed irrespective of the stormwater pilot).
2) The installation of tanks by end-users was assumed to occur in three stages with stage 1 construction in year zero of the analysis (2012); stage 2 construction in year one; and stage 3 construction in year two of the analysis (2014). These three stages are a best estimate of take up of customers, pending availability of funds for tank installation by end–users.
3) Capital expenditure for all pumps and pipes and other capital (as required to service the complete project) was assumed to be installed in Stage 1, year zero of the analysis (2012).
4) Volumes supplied have been staged to match the estimated scheduling identified in key source 2 and the results of discussions between ESDD and the ICRC. The proposed schedule sees stage 1 customers connecting in year one (2013), stage 2 customers connecting in year two (2014) with the remainder connecting in year three (2015). This take-up schedule is dependent on availability of funding sources.

5) Operations and maintenance costs for stages 1, 2 and 3 are incrementally increased to match the increases in volumes and hence the increase in energy usage required to transport the increased volumes. It was assumed, as discussed in point 3 above, that the pumps and pipe works required to connect stage 2 and 3 customers are installed in stage 1 and hence the increase to operations costs is purely a result of increases in energy usage by the pumps. The annual administration costs (included in operations and maintenance costs) were estimated at about $200,000 per annum.

Results

Description	Value	Year
Inner North Stage 1+2+3		
Capital costs – Stage 1 ($)	16,182,988	Year 0
Capital costs – Stage 2 ($)	3,457,650	Year 1
Capital costs – Stage 3 ($)	1,532,580	Year 2
Replacement costs ($)	4,263,686	Years 15, 30 and 45
Operations / Maintenance ($)	132,091	Year 1
	144,480	Year 2
	167,999	Year 3 to 50
Operating expenditure ($)	303,184	Years 1 to 50
Volumes (GL/yr) Stage 1	0.20	Year 1
Stage 2	0.29	Year 2
Stage 3	0.46	Year 3 to 50
Levelised Costs Stage 1	$7.44	
Stage 2	$5.94	
Stage 3	$4.12	

Note: Stage 3 represents a fully completed project with all expected customers connected. The levelised cost figure for Stage 3 is quoted as the overall levelised cost for this option in the summary of results in section 3.1. The results above represent a best estimate of levelised costs based on information available at this time.

3.3 Treated sewage effluent recycling

3.3.1 Southwell Park Sewer Mining Facility

Background

The Southwell Park pilot project is no longer operational however it was designed to be a demonstration project for sewer mining technologies.

Key Data Sources

1) The key source of data for this option was the file *77 - ACTEW June 2008 Recycled Water Strategy for Canberra.pdf*. This report was prepared by ActewAGL and outlines various strategies to increase the use of recycled water in Canberra and included a review of existing systems including Southwell Park. The data provided in this source represents operating cost data only, as at June 2008 or before. The figures in this report were confirmed in an email from ACTEW Corporation on 29 February 2012. This data source has been rated as a **Level 1 source**, however it is noted that the operating cost figures were taken from the 2005/06 and 2006/07 financial years.

Other Data Sources

No other data sources were identified or provided for this project. Information on capital works and asset replacement values for the facility were requested however the facility was constructed some fifteen years ago and no current figures were provided.

Cost Assumptions

1) The costs provided for Southwell Park represented long term operating costs only and did not include any allowance for asset replacement or maintenance costs. The figures are to be considered a lower bound levelised cost representing the minimum likely cost.

Results

Description	Value
Annual Operating Cost	$0.50 million
Annual production	38,000 kL
Operating cost per kL	$13.16 / kL

3.3.2 Lower Molonglo Water Quality Control Centre Effluent Reuse Scheme

Background

The Lower Molonglo Water Quality Control Centre is the primary sewage treatment plant in Canberra, treating sewage to a high standard before the majority is discharged back into the river system. A small volume of water is pumped from the centre to a number of customers for irrigation use.

Key Data Sources

1) The key source of data for this option was the file *77 - ACTEW June 2008 Recycled Water Strategy for Canberra.pdf*. This report was prepared by ActewAGL and outlines various strategies to increase the use of recycled water in Canberra and included a review of existing systems including the Lower Molonglo Water Quality Control Centre. The data provided in this source represents operating cost data only, as at June 2008 or before. The figures in this report were updated in an email from ACTEW Corporation on 01 March 2012. This data source has been rated as a **Level 1 source**, and it is noted that the updated operating cost figures were taken from the last two financial years.

Other Data Sources

No other data sources were identified or provided for this project.

Cost Assumptions

1) The costs provided for the Lower Molonglo Water Quality Control Centre represent operating costs only and are made up of two components, firstly the cost to treat sewage at the centre and secondly, the cost to pump treated water to the customers. The figures do not include any allowances for cost of capital, depreciation, asset replacement or maintenance and are to be considered lower bound levelised costs.
2) Given that the operating cost to treat sewage at the Lower Molonglo Water Quality Control Centre is required irrespective of whether customers are supplied or not, this cost has been excluded from the analysis. Thus the only cost considered is the additional cost of delivering recycled water to the customers (pumping costs).

Results

Description	Value
Annual Operating Cost – Pump effluent to customer	$0.04 / kL

3.3.3 North Canberra Water Reuse Facility

Background

The North Canberra Water Reuse Facility takes treated effluent from the Fyshwick Wastewater Treatment Plant, provides further treatment and then supplies the water to a number of sporting fields and other customers for irrigation. Solid wastes from the Fyshwick plant are treated at the Lower Molonglo Water Quality Control Centre.

Key Data Sources

1) The key source of data for this option was the file *77 - ACTEW June 2008 Recycled Water Strategy for Canberra.pdf*. This report was prepared by ActewAGL and outlines various strategies to increase the use of recycled water in Canberra and included a review of existing systems including the Fyshwick / North Canberra scheme. The data provided in this source represents operating cost data only, as at June 2008 or before. The figures in this report were updated in an email from ACTEW on 29 February 2012. This data source has been rated as a **Level 1 source** (the updated operating cost figures are taken from the last two financial years).

Other Data Sources

No other data sources were identified or provided for this project.

Cost Assumptions

1) The costs provided for the Fyshwick / North Canberra scheme represent operating costs only and are made up of two components, firstly the cost to treat sewage effluent at the Fyshwick Wastewater Treatment Plant and secondly, the further cost of treatment provided as part of the North Canberra scheme. The figures do not include any allowances for cost of capital, depreciation, asset replacement or maintenance and are to be considered lower bound levelised costs.
2) From the information available, it appears that all of the effluent produced by the Fyshwick Wastewater Treatment Plant is used in the North Canberra scheme. As such the entire operating cost of Fyshwick can be added to the calculations.

Results

Description	Value
Annual Operating Cost – Fyshwick STP	$1,304,000 / yr
Annual Operating Cost – NCWRS	$441,000 / yr
Annual Production – Fyshwick STP	1,650,000 kL/yr
Annual Production – NCWRS	199,000 kL / yr
Operating Cost $ / kL – Fyshwick STP	$0.79 / kL
Operating Cost $ / kL – NCWRS	$2.22 / kL
Total Operating Cost	$3.01 / kL

3.4 Existing Potable Water System

Background

The development of a marginal cost for supplying additional water from the ACTEW potable water reticulation network provides a baseline comparison against the secondary water sources identified above. The following sections outline the process of developing the marginal cost specifically for the existing potable water system (within existing capacities) including the assumptions made regarding inclusion or exclusion of certain cost components.

Key Data Sources

The key data source for this information was ACTEW Corporation (email dated 01 March 2012) which provided a list of supply sources for Canberra and region and provided estimates of the long term marginal costs for these systems. These costs are based on long term operation of the existing sources. Operating costs for the Murrumbidgee to Googong transfer, which is not yet constructed, are expected figures. This data source has been rated a **Level 1 source**, with the exception of data related to the Murrumbidgee to Googong transfer which is rated a **Level 3 source.**

Cost Assumptions

1) Marginal costs are based on long term operating costs and represent the sum of the marginal cost to supply water at the outlet of the relevant water treatment plant (that is, Mt Stromlo or Googong) and the marginal cost to supply water from the treatment plants to the customer meter. The components of this process are outlined in more detail below.
2) The marginal costs for the Bendora to Town, Cotter to town and Murrumbidgee to Town options are based on treatment at Mt Stromlo Water Treatment Plant. The marginal costs for the Googong to town, Cotter to Googong Bulk Transfer additional cost, and the Murrumbidgee to Googong transfer are based on treatment through Googong Water Treatment Plant.
3) The marginal costs of the Cotter to Googong Bulk Transfer ($0.057 / kL) have been added to the marginal cost of the Googong to Googong WTP ($0.059 / kL) to determine the Total Operating Cost ($0.116 / kL).
4) The marginal costs of the Murrumbidgee to Googong transfer ($0.130 / kL) have been added to the cost of the Googong to Googong WTP ($0.059 / kL) to determine the Total Operating Cost ($0.189 / kL).
5) The marginal or operating costs do not include allowances for cost of capital, depreciation, reticulation maintenance or operations costs, nor any other retail costs.
6) The marginal costs for each of the supply sources have been collated to determine an average overall supply cost. This average supply cost has been weighted to account for the volumes of water supplied through each source. The overall supply cost calculated and referenced in the summary of results therefore represents a weighted average.
7) ACTEW provided details of the total operating cost per customer for the reticulation network from the outlet of the water treatment plants to the customer meter. The operating cost per kL was calculated by taking the total water consumption figures for Canberra (taken from ACTEW website http://www.actewagl.com.au/Environment/Water-statistics-and-weather/Water-consumption-and-rainfall.aspx), dividing this by the total number of customers to give an average consumption in kL per customer and then dividing this figure into the provided operating cost per customer.

8) The total operating cost per customer to the meter can then be added to the cost of supply to the water treatment plant to give an overall average cost to supply from source to meter. This process is presented in the results section below.

Results

The results for the operating costs from the respective source to the outlet of the water treatment plant are shown in the table below.

Supply System (Dam / river to respective WTP)	Modelled Supply Volume 2012 (GL/yr)	Marginal Cost ($ / kL)	Total Operating Cost ($ / kL)	Weighted Average Operating Cost ($ / kL)
Bendora to Mt Stromlo WTP	31.09	0.050	0.050	**$0.066**
Cotter to Mt Stromlo WTP	3.16	0.147	0.147	
Murrumbidgee to Mt Stromlo WTP	2.51	0.202	0.202	
Googong to Googong WTP	21.07	0.059	0.059	
Cotter Googong Bulk Transfer to Googong Dam	0.78	0.057	0.116	
Murrumbidgee to Googong Dam	0.0024	0.130	0.189	

The results for the operating costs from the outlet of the water treatment plant to the customer meter are shown in the table below.

	2010/11
Total operating expenditure	$8,228,227
Approx total volume (ML)	40,923
Customer numbers	150,310
Operating cost per customer	$54.74
Approx customer use (kL)	272.26
Approx cost per customer per kL	$0.20
Depreciation (as at 11/12)	
Assumed depreciation in	$1,177,793
earlier years (same as 11/12)	
Total operating cost per customer	$ 62.58
Adjusted cost per customer ($/kL)	**$ 0.23**

The adjusted cost per customer (from the water treatment plants to the meter) presented in the table above is then added to the operating costs from the respective sources to the water treatment plant, and the following summary figures are developed.

Source Option	Operating Cost $/kL
Bendora to Mt Stromlo WTP to Meter	$0.28
Cotter to Mt Stromlo WTP to Meter	$0.38
Murrumbidgee to Mt Stromlo WTP to Meter	$0.43
Googong to Googong WTP to Meter	$0.29
Cotter Googong Bulk Transfer to Googong Dam to Meter	$0.35
Murrumbidgee to Googong Dam to Meter	$0.42

Summary	Operating Cost $/kL
Weighted Average Operating Cost ($ / kL) (Source to Meter)	$0.296

3.5 Extended Capacity Potable Water System

Background

This option assesses the marginal cost of supplying additional water outside of the capacity of the existing system. This option assumes that a new supply source is required and specifically investigates the cost of the Tantangara bulk transfer scheme given its position as the likely next available bulk water source augmentation option.

Key Data Sources

The data for this option has been provided by ACTEW Corporation on 27 February 2012 and is based on current and previous water entitlement purchases. This data has therefore been rated as a **Level 2 source**.

Cost Assumptions

1) Cost allowance for purchasing water is based on recent purchase costs (it therefore assumes that the existing Tantangara water entitlements held by ACTEW have been utilised fully)
2) Allowance has been made for administrative costs and fees and charges however the salary cost for a full time senior manager is not included as the marginal increase in costs to deal with additional volume purchases is small.
3) No allowance has been made to account for the potential to sell water entitlements in years when they are not required.
4) Current prices for water do not reflect future prices as there is significant variation in the market depending on current climate, number of buyers/sellers, and other similar issues.

Results

Description	Value
Water entitlement purchase	$2,100 / ML
Fixed fees and charges	$100,000 / year
Total purchase cost ($ / kL)	$2.110
Add Total Operating Cost for Murrumbidgee to Googong to Meter ($ / kL)	$0.419
Total Operating Cost for Tantangara Option ($ / kL)	$2.529

4. Private Water Options

4.1 Summary of Results

The following table shows the results of the analysis process for the private water options.

Table 2 Summary of Levelised / Operating Costs for Private Water Options

Option & Sub-option	Facility Details	Total Cost PV	Total Volume PV	Levelised Cost
		[$]	[GL]	[$/kL]
Rainwater	**Private**			
Plumbed in	Irrigation systems, toilet flushing	$9,422	0.000069	$10.92
Non plumbed in	Irrigation systems	$1,124	0.000036	$2.48
Greywater	**Private**			
Diversion Devices	Direct diversion	$1,934	0.000454	$4.26
Treatment Devices	Storage, treatment & pumping	$22,540	0.000863	$26.12
Potable Water				
ACTEW Tier 1	Potable water price			$2.33
ACTEW Tier 2	Potable water price			$4.66

The private water supply options identified above have been compared with the tiered price that a private customer would pay for potable water.

4.2 Rainwater

This set of option represents the costs associated with the purchase and maintenance of a typical household level rainwater tank system. Two typical systems were assessed, the first representing a plumbed in system (for toilet flushing and irrigation) and the second representing a non plumbed in system (for irrigation only).

The plumbed in system comprised an average tank with around 3000-4000 litres capacity, a small pump, and the various filters, first flush devices, outlets and taps required to facilitate the use of the rainwater tank as a supply source for a typical household level garden irrigation system and for toilet flushing. The non plumbed in system comprised a similar tank however with only a connection point for a tap or hose and no pumps or pipes.

4.2.1 Plumbed In Option

Key Data Sources

1) A key source of data for this option was a retail quote from a tank supplier for the supply of a 3600 litre capacity steel tank, pump, outlets and screens including delivery. The data provided in this source represents a retail quote as at 24 February 2012. This data source has been rated as a **Level 1 source**.
2) Another key source of data for this option was a second quote from a second tank supplier for the supply of a 3000 litre capacity polyethylene tank with pump, outlets and screens including delivery. The data provided in this source represents a website quote as at 23 February 2012. This data source has been rated as a **Level 1 source**.
3) Installation costs for the rainwater tanks were based on costs for similar size greywater system. Additional costs relating to plumbed in system covered pipes and labour costs however these have not been tested. Overall, this data source has been rated as **Level 5 source**.
4) A final key source of data was an online Stratco Rainwater Calculator with web address http://www.stratco.com.au/products/rainwater_tanks/Calculator/rainwatertanks.asp. This tool allowed the determination of estimated usage based on household connections including toilets, laundry, irrigation systems, car washing, hot water tank, and others. This data has been rated as a **Level 4 source**.

Other Data Sources

No other data sources were used for this option.

Cost Assumptions

1) Capital costs for the tanks and associated items were based on the retail / website quotes provided in the sources. The average price of the two tanks was used in the analysis. A contingency allowance on the capital expenditure covers any potential variation in installation costs, particularly for plumbed in system.
2) Installation costs (included in capital expenditure) were estimated based on a quote for a similar size greywater system (refer section 4.3.2 below). Additional costs were allowed for the plumbed in system to cover cost of pipes and labour to connect to toilet however these costs were not specifically tested.
3) It was assumed that the rainwater tank and peripheral items would last the expected twenty year asset life however the pumps used in the quotes would require replacement every five years.

4) No other ongoing operational or maintenance costs have been included in the analysis including the electricity required to run the systems. It was estimated that this figure would represent only a very small cost per year and would have a negligible impact on the analysis.
5) Demand for water from the rainwater tank system was calculated using the Stratco online tool identified above. It was thought that a typical household system was likely to use rainwater in the toilet and through an irrigation system and as such the demands were calculated with these assumptions.

Results – Plumbed In Option

Description	Value	Year
Capital expenditure ($)	$6,700	Year 0
Replacement expenditure ($)	$1,207	Every five years
Operating expenditure ($)	$0	
Volumes (GL/yr)	0.00007	Every year
Levelised Cost	$10.92 / kL	

4.2.2 Non Plumbed In Option

Key Data Sources

1) A key source of data for this option was an online price guide from a tank supplier for the supply of a 1000 litre capacity poly tank including delivery. The data provided in this source represents an online search as at 24 February 2012. This data source has been rated as a **Level 2 source**.
2) Installation costs for the rainwater tanks were based on costs for similar size greywater system. This data source has been rated as **Level 4 source**.
3) A final key source of data was an online Stratco Rainwater Calculator with web address http://www.stratco.com.au/products/rainwater_tanks/Calculator/rainwatertanks.asp. This tool allowed the determination of estimated usage based on household connections including toilets, laundry, irrigation systems, car washing, hot water tank, and others. This data has been rated as a **Level 4 source**.

Other Data Sources

No other data sources were used for this option.

Cost Assumptions

1) Capital costs for the tanks and associated items were based on the website quotes provided in the sources. A contingency allowance on the capital expenditure covers any variation in installation costs.
2) Installation costs (included in capital expenditure) were estimated based on a quote for a similar size greywater system (refer section 4.3.2 below).

3) It was assumed that the rainwater tank and peripheral items would last the expected twenty year asset life. As such this option has not ongoing replacement costs.
4) No other ongoing operational or maintenance costs have been included in the analysis.
5) Demand for water from this system was calculated using the Stratco online tool identified previously. It was thought that a typical non plumbed in system was likely to be used simply for basic garden irrigation with the system connected through a hose.

Results – Non Plumbed In Option

Description	Value	Year
Capital expenditure ($)	$1,124	Year 0
Replacement expenditure ($)	$0	
Operating expenditure ($)	$0	
Volumes (GL/yr)	0.000036	Every year
Levelised Cost	$2.48	

4.3 Greywater

4.3.1 Direct diversion devices

Background

This option identifies the costs to install a very simple greywater diversion device at a household. Diversion devices are the simplest method of reusing greywater and involve a basic filter, temporary storage, pump and connections to allow use through an irrigation system.

Key Data Sources

1) The key source of data for this option was a website quote for a Grey Water Gator 240 Litre grey water diversion system supplied by Just Water Solutions through the website http://greywatergator.com/categories/GREYWATER/Grey-Water-Gator/ . The data provided at this source represents retail quotes for actual systems valid for 2012. This data source has been rated as a **Level 1 source**.

Other Data Sources

No other data sources were used for this option.

Cost Assumptions

1) The levelised cost was calculated using the retail price of the system, quoted at the source (excluding delivery) compared to the estimated demand from a typical household irrigation system (refer rainwater tank option in section 4.2.1 above).
2) No allowances were made for electricity costs, or other ongoing operations and maintenance costs. These costs were thought to be relatively small and unlikely to have an impact on the analysis. In practice, these simple systems are often not maintained regularly and are only likely to be cleaned by the householder.
3) Given the above, it is likely that the system would be replaced if faulty and as such an allowance has been made for complete system replacement every five years.

Results

Description	Value	Year
Capital expenditure ($)	$594	Year 0
Replacement expenditure ($)	$594	Every five years
Operating expenditure ($)	$0	
Volumes (GL/yr)	0.000036 GL/yr	
Levelised Cost ($/kL)	$4.26 / kL	

4.3.2 Household storage, treatment and pumping systems

Background

This option represents the costs associated with a more advanced greywater system whereby the greywater is fully treated and stored for future use. The available uses for the water are increased with the level of treatment involved and would be analogous to rainwater systems (dependent of course on the relevant legislative conditions), that is, use for toilet flushing and for household irrigation systems.

Key Data Sources

1) The key source of data for this option was a retail quote received from Ozzi Kleen Pty Ltd and subsequent discussions with the Sales Manager. The data provided in this source represents retail quotes and estimates of associated costs as at March 2012. This data source has been rated as a **Level 1 source**.

Other Data Sources

No other data sources were used for this option.

Cost Assumptions

1) The levelised cost for this option was based on a top of the range greywater system with full treatment, pumps, valves, backup connection to the potable water system, full electronic controls and programming for typical irrigation systems and including rain sensors to limit irrigation. The capital cost for this option represents a retail quote.
2) Installation costs for the system were provided on a confidential basis recognising that each system requires an on-site evaluation to determine accurate costs.
3) Ongoing maintenance costs were provided and were based on a three monthly visit by Ozzi Kleen contractors to service the system, top up chlorination, and prepare a maintenance report for submission to the relevant regulator.
4) Asset replacement costs were estimated based on expected asset lives however these may vary significantly depending on the level of use of the system.
5) System demands were calculated based on the rainwater demand example (refer section 5.4.1 above) and assumed connection to toilet and garden irrigation.

Results

Description	Value	Year
Capital expenditure ($)	$14,860	Year 0
Replacement expenditure ($/yr)	$240 - $4,350	
Operating expenditure ($)	$300	Every year
Volumes (GL/yr)	0.000069 GL/yr	
Levelised Cost ($/kL)	$26.12 / kL	

5. Government Programs

5.1 Rebates and Subsidies

Background

The ACT Government operates a variety of rebates and subsidies that are intended to encourage more efficient water use in residential properties. The specific programs considered in this report are the RainSmart, ToiletSmart and IrrigationSmart programs. The GardenSmart program was originally included in the analysis however invalid results for the expected volume of water saved (negative savings) through the program led to this program being removed from the analysis.

Key Data Sources

1) A key source of data for this option was information provided by the Sustainability Programs group within the Environment and Sustainable Development Directorate, ACT Government. This information outlined program expenditure and administration costs (salaries and on-costs) for the programs under review. The data provided in this source represents actual costs recorded for each program for the 2009/10 and 2010/11 financial years and budgeted costs for the 2011/12 and 2012/13 financial years. This data source has been rated as a **Level 1 source** (for 2009/10 and 2010/11 actual data only).
1) The second key source of data was the file *Think Water Act Water evaluation_Final Report_ISF_111107.pdf*. This file presents the results of an Institute for Sustainable Futures' evaluation of savings in electricity, greenhouse gases and water under the Think Water Act Water strategy over the period to 30 June 2010. The data provided represents statistical analysis of water consumption to calculate savings / efficiencies attributable to the various rebate and subsidy programs put in place over the period covered. This data source has been rated as a **Level 4 source**.
2) The third key source of data was the file *URS IrrigationSmart Pilot Report.pdf*. This report presented the results of a pilot project conducted by URS for the ACT Government identifying the water efficiency and behavioural change benefits of a review of domestic automatic watering systems. The data presented results from the pilot program which was conducted between September 2009 and April 2010 and estimated the annual water savings from the use of, review and reprogramming of domestic automatic watering systems (specifically drip irrigation systems). This data source has been rated as a **Level 4 source**.

Other Data Sources

No other data sources were identified / provided for this option.

Cost assumptions

1) The cost of the three programs under review were calculated by first extracting the estimated annual savings achieved under each program from the relevant sources, then determining the number of households engaged in the respective programs allowing assessment of the total water savings calculated against the total cost of the program (including actual program expenditure and salaries plus on-costs for the administration of the program).

2) Costs were only calculated for the 2009/10 financial year as this was the only year where data was available for both the cost of the program, the estimated water savings and the number of households taking up the programs.
3) The number of households taking up the RainSmart and ToiletSmart programs in 2009/10 was determined from base data for *Figure 4-1 Cumulative uptake of the Think Water, Act Water efficiency programs* taken from page 34 of the ISF report (key source 1). Actual numbers were received from the Sustainable Programs group on cumulative take up rates for the period.
4) The number of households involved in the IrrigationSmart pilot project was taken directly from the URS source and represented the current numbers as at 30 June 2010.
5) Volumes for the RainSmart and ToiletSmart programs have been discounted over 20 years and over 10 years for the IrrigationSmart program.

Results

Rebate / Program	Expected Savings (kL/household/yr)	No. of Households for 2009/10	Total Volume PV	Cost to Govt ($/ kL)
RainSmart	16.7	192	0.0400	$6.31
ToiletSmart	31.2	1055	0.4102	$1.80
IrrigationSmart	33	43	0.0110	$7.70

6. Other Results for Levelised Costs

This section summarises additional data sources identified which have cited or investigated levelised costs for infrastructure similar to the projects identified in this review. These sources have originated from the Australian Capital Territory, New South Wales, Victoria and South Australia. The following sections provide a brief outline of the data source / project and the levelised cost developed.

Care should be taken in comparing the figures identified below with the figures specific to the projects identified in earlier sections of this report. There is significant variation in the methods by which the levelised costs / operating costs are calculated with a wide range of inclusions and exclusions and assumptions made. This variation is such that no direct comparison of figures is possible and the figures below should be viewed simply as examples of different methods for calculating levelised costs / operating costs.

6.1 Treated Sewage Effluent Recycling

Location	Use of recycled water	Price Charged ($/kL)	Real cost ($/kL)	Drinking water ($/kL)	Source
Springfield QLD	Residential - toilet flushing, garden	43c	$1.45	Per quarter: 90c for 100-150kL	1
Rouse Hill NSW	Residential - toilet flushing, garden	28c	$3.00-$4.00	98c	1
Olympic Park, NSW	Residential supply - toilet flushing, garden, laundry	83c	$1.60 (operating costs only)	98c	1
Mawson Lakes, SA	Residential - toilet flushing, garden watering	77c	Not available	$1.03 for >125kl	1
Western Treatment Plant (Werribee) VIC	Residential, horticultural, agribusiness		$2.68		2
Melbourne Eastern Treatment Plant	Integrated amenity and residential use		>$3.00		3

Source 1: Dimitriadis, 2005, *Issues encountered in advancing Australia's water recycling schemes*, Research Brief no. 2 2005-06, Science, Technology, Environment and Resources Section.

Source 2: ATSE, 2004, *Water Recycling in Australia*, a review undertaken by the Australian Academy of Technological Sciences and Engineering (ATSE), pg 79

Source 3: ATSE, 2004, *Water Recycling in Australia*, a review undertaken by the Australian Academy of Technological Sciences and Engineering (ATSE), pg 152

In June 2008 Marsden Jacobs Associates completed a report for the then Department of the Environment, Water, Heritage and the Arts that assessed the economic feasibility of meeting the Commonwealth Government's 2007 election promise to implement a national wastewater recycling target of 30 per cent by 2015. As part of this study, Marsden Jacobs developed an economic model that estimated the levelised cost associated with meeting the shortfall between current recycling volumes and the target. The levelised costs were calculated for each state to take into account the various jurisdictional differences that affect costs.

The table below presents a summary of the state based assumed levelised costs.

Table 8: Assumed costs per kilolitre

Location	*Assumed levelised cost*	*Notes*
NSW	$2.50	Uses upper end of range of Sydney Water estimates for IPR.[1] NSW has noted a lack of agricultural demand for recycled water close to existing plants.
Victoria	$3.00	Lower end of costs, Eastern Treatment Plant.[2]
Queensland	$2.40	Western Corridor Recycled Water Business Case, 6 per cent real discount rate[3]
Western Australia	$2.25	Mid range of costs for GWR[4].
South Australia	$1.40	Costs for large-scale recycling[5]
Tasmania	$1.75	Based on upper end of costs for large-scale recycling estimated in SA reflecting lower volume throughputs.[6]
Northern Territory	$1.75	Upper end of costs for large-scale recycling reflecting lower volume throughputs.[6]
ACT	$1.93	Extra cost for additions to in-progress demonstration scheme.[7]

Table Sources:
1. Sydney Water, *Indirect potable recycling and desalination - a cost comparison.*
2. AWCRRP Seminar Presentation (2004) 'The Big Picture'. We assume that expanded recycling will occur through this or similar schemes.
3. Western Corridor Business Case, April 2007: www.enable.qld.gov.au/library/pdf/WCRWP_Business_Case.pdf
4. http://www.thinking50.com.au/go/create/water-recycling/recycled-water-for-drinking-groundwater- replenishment . For a small addition (7GL/a) a lower cost may be achievable.
5. SA Government "Waterproofing Adelaide Information Sheet: Large Scale Wastewater Reuse" (unit cost derived based on 6% return and 50 year average asset life for treatment and pipes).
6. Tasmania and the Northern Territory have no identified publicly available recycling costs. As such, we have drawn on similarly sized projects elsewhere.
7. MJA analysis, based on http://www.actew.com.au/publications/factsheets/waterpurificationscheme.aspx

Information reference: MJA, 2008, *National Snapshot of Current and Planned Water Recycling and Reuse Rates*, Final Report prepared for the Department of the Environment, Water, Heritage and the Arts, June 2008.

6.2 General Levelised Cost Analysis

The table below sets out the levelised costs of various supply and demand side initiatives, assuming a 30-year analysis period and a 9% discount rate. The figures in the table essentially represent the approximate costs of undertaking the various initiatives compared to the volume of water saved.

Option Type	Typical levelised cost to community ($/kL)
Pricing variation	$0.02
Restrictions	$0.05-$0.10
Showerhead Giveaway	$0.10-$0.20
Residential indoor assessment/retrofit	$0.20-$0.30
Active leakage control	$0.20-$0.50
Tap timers/education	$0.20-$0.50
Non-residential efficiency	$0.40-$0.60
Residential outdoor assessment (retic systems)	$0.50-$0.70
Toilet retrofit	$0.70-$0.80
Typical augmentation	$0.80-$1.00
Typical reuse	$0.90-$1.50

Source: Howe and White, 1998, *Water Efficiency and Reuse: A Least Cost Planning Approach*, Proceedings of the 6th NSW Recycled Water Seminar, November 1998, pg 117.

The following table presents the results of a 2001 Least Cost Planning study conducted by Sydney Water Corporation to determine what options could reduce customer demand for water at least cost to the community.

Option	Est Demand Reduction (2001) (L/pp/day)	Levelised Cost ($ / kL)
Pricing	1.95	$0.0018
Restrictions	1.79	$0.063
Smart Showerhead Program	0.72	$0.140
Residential indoor assessment and retrofit	3.41	$0.190
Community residential assessment and retrofit	1.47	$0.250
Active Leakage Control	7.18	$0.300
Non-residential program	2.94	$0.420
Hospitality (2000 Olympics) Program	1.26	$0.420

Tap timer kit	0.22	$0.490
Wollongong industrial reuse	2.28	$0.530
Kurnell industrial reuse	1.82	$0.650
Residential outdoor assessment	0.29	$0.670
Washing machine rebate	0.44	$0.700

Source: Howe and White, 1998, *Water Efficiency and Reuse: A Least Cost Planning Approach*, Proceedings of the 6th NSW Recycled Water Seminar, November 1998, pg 118.

The following table presents the results of a Sydney Water Corporation 2001 investigation into the levelised costs of a selection of reuse and rainwater tank supply options.

Option	Est Demand Reduction (2001) (L/pp/day)	Levelised Cost ($ / kL)
Wollongong Industrial Reuse	2.28	$0.530
Kurnell industrial reuse	1.82	$0.650
Potable reuse (116 ML/day)	27.6	$0.770
Bondi STP reuse	0.14	$0.930
Golf course (seven (7)) reuse	0.29	$1.470
Rainwater tanks (80% of houses)	12.70	$2.110
Greywater reuse systems (80% of houses)	9.93	$2.440

Source: Howe and White, 1998, *Water Efficiency and Reuse: A Least Cost Planning Approach*, Proceedings of the 6th NSW Recycled Water Seminar, November 1998, pg 119.

This table below shows levelised costs for rainwater tanks based on roof area and tank size.

Table 9: Levelised cost of rainwater tanks (indoor and outdoor use) ($/kL) Melbourne

Tank size	2 kL		5 kL		10 kL		Price of mains water
Roof area	50 m2	200m2	50m2	200m2	50m2	200m2	
Cost ($/kL)	8.40	3.00	9.12	2.63	10.41	2.64	0.81-1.55+

Source: Moran, 2008, *Water Supply Options for Melbourne*, Institute of Public Affairs, Occasional Paper, August 2008.