APPENDIX D

EVALUATION OF OPTIONS, SCENARIOS AND STRATEGIES

This appendix outlines the iterative process undertaken in this study to develop and assess the long list of potential options, themed scenarios of options and region-wide water security strategies. In addition to explaining the role of the assessment criteria and MCA tool as inputs into the Triple Bottom Line (TBL) assessment process, this appendix also sets out:

- The rationale used to generate the long list of potential options;
- The TBL assessment outcomes and preliminary screening of the long list of potential options;
- The development of scenarios from the short list of options to test themed solutions;
- The TBL assessment outcomes for the themed scenarios and key understanding derived from testing of the scenarios that was used to identify the most appropriate regional and local solutions;
- The development of final water security strategies that address the long term water security needs of each of the Centroc towns with an identified need for water security improvement;
- The TBL assessment outcomes for the strategies that identifies the preferred strategy for recommendation; and
- Sensitivity analysis of the assumptions used in the above assessments to test the robustness of the preferred strategy.

D.1 DEVELOPMENT OF ASSESSMENT CRITERIA

Defining a standardised, measureable set of evaluation criteria that aligns with the study objectives is an important pre-cursor to the screening and assessment process. It allows for an effective comparison of the cost-benefit trade-off or value of the potential options, scenarios, and ultimately determination of the 'best' water security strategies.

The assessment criteria used in this study were based on the objectives agreed upon following consultations with the PRG and encompass the Triple Bottom Line (TBL) categories of Environmental, Economic and Social outcomes. Nine criteria were defined and used to screen the long list of options through a MCA process. These criteria are set out in Table D-1 below. Note that the "Water Saving" economic criterion used in options assessment is replaced with a "Cost per Percentage Point Improvement in Reliability" criterion when assessing scenarios and strategies.

Table D-1: Study Objectives and Assessment Criteria

OBJECTIVE	CATEGORY	CRITERIA
Protection of water for the environment	Environmental	Annual Water Consumption (ML/a)
		Requirement for Additional Entitlements
Minimise Infrastructure Footprint		Land use (ha)
Efficient water usage	Economic	Water Saving (ML)[1] Cost per percentage point improvement in reliability ($/% improvement)[2]
Efficient energy usage		Unit Energy Consumption (kWh/ML)
Minimise Financial Burden		Cost to Households ($/household)

[1] Used for options assessment

[2] Used for scenario assessment

OBJECTIVE	CATEGORY	CRITERIA
Equity and acceptability: looking for win-win opportunities	Social	Subjective scale of 1-5 to be developed with PRG
Cost effectiveness of management options		Cost per Unit of Water Provided ($/kL)
Improvement to Urban Water Reliability		Percentage of Node(s) Water Demand Met (%)

D.2 MULTI-CRITERIA ANALYSIS

The MCA is a decision making tool developed to assess potential solutions to a problem with a set of complex selection criteria. MCA is used in this study to assist in evaluating the relative extent to which a potential option or suite of options cater for the overarching objectives of the study. As such, the outcomes of MCA contribute to the preliminary analysis of potential options. MCA is also of particular importance in assessing non-quantitative measures that may not be as comparable between options such as equity and community acceptance.

In the MCA spreadsheets, each option, scenario or strategy was assigned a relative score from -3 to +3 for each criterion, where -3 represented the worst possible outcome for the criterion and +3 represented the most favourable. In some case, such as infrastructure related options (excluding the Managed Aquifer Recharge options), it was possible to automate the scoring system for the majority of criteria.

The automated scoring system for the MCA matrix worked on the basis of a ranked percentile approach of estimates derived from the option characterisation spreadsheet. For example, for the Cost Effectiveness criterion, the option with the median cost per kL of water provided is scored a 0, while the cheapest scoring a +3 and the most expensive cost scoring a -3. The remainder of the options are automatically scored based on a percentile distribution ranking using these three cost references. A more rigorous manual evaluation was conducted for all non-infrastructure options as well as for the more subjective Equity and Acceptability criterion.

In examining the MCA results, it is important to note a number of points relating to their interpretation and derivation:

- The MCA does not provide a 'right or 'wrong' answer and should not be seen as an exercise in engineering of mathematics – the scores have been used by the project team as a tool to provide summary information about a large number of options against a range of criteria;
- The MCA scores are not directly comparable between different option groups due to complex differences in characteristics and contribution to water security;
- The final score set obtained from MCA do not by themselves determine the 'best' options for short-listing, but rather act as one of many indicators of the extent to which a particular option fulfils the criteria relative to other similar options; and
- The cost efficiency or cost per unit volume of water delivered for any particular options should not be interpreted as the cost of supply from that option – the preliminary screening has assumed in most cases that water is only provided during times of drought and thus results in much higher unit costs than for full-time supply.

D.3 OPTIONS DEVELOPMENT

Conception of the potential options to improve Centroc's water security follows up from the high level review of current drought proofing strategies and existing water supply infrastructures conducted by the Infrastructure Asset Audit. The outcomes of the review helped to identify gaps in drought proofing measures in the area, and hence determine the scope and boundaries for potential options to amplify regional water security. The team also agreed that, to address water security issues of the various communities residing in Centroc, both a regional and local approach to solutions are necessary. This ensures that communities of differing sizes, proximity and access to water supply sources, and geographical locations are to a certain extent catered for by the study.

The potential options (Table D-2) developed broadly consider initiatives to manage water demand, diversification of water supply sources, town water security in the context of water use in the total system, and existing assets without constraints such as ownership. The options also encompass infrastructure and non-infrastructure solutions, which are adopted into the following categories:

- Policies, Water Conservation and Demand Management.
- Infrastructure
    - Recycling;
    - Groundwater;
    - Supply Amplification; and
    - Transfer Systems;

Table D-2: Long List of Potential Water Security Improvement Options

#	OPTION NAME	DESCRIPTION
Policies, Water Conservation and Demand Management		
1	Irrigation Efficiency – Shared Benefits	Implement water efficiency measures in the irrigation sector in exchange for access to some share of the water savings (water savings to be shared between irrigators and towns).
2	Improved Metering of Water Consumption	Improved metering program for surface and groundwater at the Lachlan and Macquarie systems allow for better monitoring of water availability.
3	Uniform Restriction Regime	A uniform water restriction regime will be imposed for townships.
4	Regional Water Conservation Implementation	Regional implementation of a standard package of water conservation measures.
5	Appropriate and Full Cost Recovery Pricing of Water Products	Ensuring that LWUs price water and sewerage services to fully recover the costs of providing the services. The DECCW Best Practice Guidelines require that at least 75% of costs be recovered from the usage charge component of a residential service rate.
6	Caps on Water Extraction	Imposing limitations on the amount of water extracted by end users.
7	Demand Management	See Regional Water Conservation Implementation.
8	Shared Water Efficiency Savings Between Water Users	Developing policies to facilitate shared savings produced by efficient water usage between the urban and other water users (analogous with the environmental buy-back scheme).
9	Scarcity Pricing	Pricing water product based the quantity available for consumption. Lower quantities will demand higher prices to discourage excessive consumption.
10	Restriction Policies Balancing	Balancing of restriction policies across the study area and between water users (urban and non-urban).

#	OPTION NAME	DESCRIPTION
11	Permanent Water Saving Rules	Low level restriction permanently in place in urban areas - includes prohibition of watering on hard surfaces plus ban on watering during periods of high evapo-transpiration.
12	Off-Grid Energy Sourcing	The installation of tri-generation plants with no transmission losses over traditional generators to power remote, large pumping stations. Promotes carbon neutrality in Councils' projects.
Infrastructure – Recycling		
13	Recycling Water - New Development - Bathurst	Dual reticulation of recycled wastewater to be supplied for all new developments.
14	Recycling Water - New Development - Condobolin	Dual reticulation of recycled wastewater to be supplied for all new developments.
15	Recycling Water - New Development - Forbes	Dual reticulation of recycled wastewater to be supplied for all new developments.
16	Recycling Water - New Development - Lithgow	Dual reticulation of recycled wastewater to be supplied for all new developments.
17	Recycling Water - New Development - Orange	Dual reticulation of recycled wastewater to be supplied for all new developments.
18	Recycling Water - New Development - Wellington	Dual reticulation of recycled wastewater to be supplied for all new developments.
19	Recycling Water - New Development - Young	Dual reticulation of recycled wastewater to be supplied for all new developments.
20	Recycling Water - Existing (Retrofit) - Oberon	Application of recycled wastewater at existing Oberon Timber Mill.
21	Recycling Water - Existing (Retrofit) - Parkes	Application of recycled wastewater for non-potable use at Parkes ring main.
22	Recycling Water - Existing (Retrofit) - Lake Cargelligo	Application of recycled wastewater for non-potable use at Lake Cargelligo ring main.
23	Recycling Water - Existing (Retrofit) - Condobolin	Application of recycled wastewater for non-potable use at Condobolin ring main.
24	Recycling Water - Existing (Retrofit) - Tottenham	Application of recycled wastewater for non-potable use at Tottenham ring main.
25	Recycling Water - Existing (Retrofit) - Yeoval	Application of recycled wastewater for non-potable use at Yeoval ring main.
26	Effluent Reuse - Mining	Application of recycled wastewater to existing and potential mining industry in the region, such as mines near Orange, Parkes, Blayney and Wellington.
27	Offset Schemes	See Irrigation Efficiency - Shared Benefits.
28	Bathurst Stormwater Harvesting	Potential for a stormwater harvesting scheme at Bathurst.
29	Orange Stormwater Harvesting	Development of scheme at Blackman's Swamp Creek to harvest, treat and return stormwater to water supply storages in Orange. This scheme is being commissioned in March 2009. Expansion to Rifle Range Creek and other sites can be considered in the future to accommodate larger capacities.
30	Oberon Stormwater Harvesting	Potential for a stormwater harvesting scheme at Oberon.
31	Parkes Stormwater Harvesting	Development of scheme at Parkes brick pit to harvest, treat and return stormwater to water supply storages in Parkes.
32	Lithgow Stormwater Harvesting	Development of stormwater harvesting scheme at Lithgow
Infrastructure - Groundwater		

#	OPTION NAME	DESCRIPTION
33	Managed Aquifer Recharge	The main purpose of Managed Aquifer Recharge (MAR) is to store excess water in aquifers for later use, while improving water quality by recharging the aquifers with high quality water.
34	Accessing Groundwater Pockets	Tapping into localised groundwater pockets can be used as a supplementary local water supply source. Groundwater pockets have been identified in Lachlan Shire 15-30km from Lake Cargelligo that Council is testing at the moment for ability to provide town water supply. Bores have also been identified and/or developed in Wellington, Forbes, Parkes, Molong and Orange. Groundwater options have been investigated for Lake Cargelligo, Forbes and Orange in this study.
Infrastructure – Supply Amplification		
35	Lake Rowlands Augmentation	The position of the Central Tablelands district at the head of the Lachlan River system at high altitude results in limited backup supplies in times of drought. Together with excess water inflow into Lake Rowlands, there is potential for augmenting the storage capacity of Lake Rowlands by erecting a new dam wall 2.5km from the existing wall.
36	Chifley Dam Augmentation	Despite having its capacity recently upgraded in 2002, Chifley Dam has been at or near full capacity at various periods during each subsequent year. This option investigates the feasibility of further augmenting Chifley to take utilise the high dam inflow.
37	Recommissioning Recreational Dams for Water Supply Use in Orange	Orange City Council has investigated the potential use of Gosling Creek Dam and Lake Canobolas for water supply use.
38	Bulk water storages	Bulk water storage dams to be located in the Lachlan and Macquarie catchments, such as Cranky Rock, Needles, Abercrombie and downstream of Boorowa on Boorowa River (Boorowa Dam augmentation). Minor storages have also been investigated to potentially supply Lake Cargelligo, Condobolin, Cowra, Forbes, Cumnock and Yeoval.
39	New storage dam upstream from Chifley (Upper Macquarie)	Construction of new bulk water storage upstream from Chifley Dam to regulate water and control potential losses occurring downstream.
40	Augmentation or Replacement of Duckmaloi Weir with a Dam	Potential source high in the Macquarie. Subcatchment of the Fish River.
41	Molong Creek Dam Augmentation	Enlargement of Molong Creek Dam capacity to improve water supply security of demand nodes relying on the source. Council has noted that raising the dam wall by 1m doubles the current dam capacity.
42	Off-stream Buckinbah Creek storage	Off-stream turkeys nest storage near Buckinbah Creek weir, north of Yeoval, is currently being considered. The storage will have a capacity of 22.5ML and is located 1.5km from Yeoval. Also see (#38)
43	Improving water security and quality of Lake Cargelligo's lakes – compartmentalising storage	Improvement of Lake Cargelligo's lake storages is being considered. This includes deepening of lake to reduce evaporation rate. Lake Brewster has recently undergone a similar improvement.
44	Regional pipeline network to replace farm dams with town water supply	Utilising regional pipeline network to also provide stock and domestic raw water to rural properties aims at reducing farm dams as a trade off. This will secure high security water, reduce evaporation losses and improve runoff into water bodies during storm events, thus providing environmental and water saving benefits.
Infrastructure – Transfer Systems		
45	Chifley Dam-Oberon Pipeline	Pipeline connection to supply water from Chifley Dam to Oberon.
46	Chifley-CT Water Pipeline via Blayney	Pipeline system to supply water from Chifley Dam to Central Tablelands Water network via Blayney.
47	Chifley-Orange Pipeline via CT Water to Supply Cowra & Orange	Pipeline system to supply water from Chifley Dam to Central Tablelands Water network, Cowra and Orange.

#	OPTION NAME	DESCRIPTION
48	Bathurst-CT Water Pipeline via Blayney	Pipeline connection from Bathurst to Central Tablelands Water network via Blayney.
49	CT Water-Orange Pipeline via Millthorpe	Pipeline connection from Central Tablelands Water network at Millthorpe to Orange.
50	Lake Rowlands Supply to Bathurst and Orange via Blayney	Pipeline system from Lake Rowlands to supply water to Bathurst and Orange via Blayney, as well as from Chifley back into CT Water via Blayney. This option will also include Lake Rowlands augmentation to meet the demand of the nodes.
51	Lake Rowlands-Orange Pipeline	Direct pipeline connection linking Lake Rowlands to Orange
52	Macquarie River-Orange Pipeline	Direct pipeline connection from a Macquarie River off-take to Orange
53	Winburndale-Bathurst Pipeline	Pipeline connection to supply water from Winburndale Dam to Bathurst.
54	Chifley-Bathurst Pipeline	Pipeline connection from Chifley Dam to Bathurst to close open channel water transfer and control losses.
55	Chifley-Orange via Bathurst	Pipeline system to supply water from Chifley Dam to Bathurst and beyond to Orange.
56	Burrendong to Orange Pipeline	A direct pipeline connection from Burrendong Dam to Orange.
57	Wyangala-CT Water Pipeline near Mandurama	Pipeline connection to supply water from Wyangala Dam to the Central Tablelands Water network near Mandurama.
58	Wyangala Dam-CT Water-Orange Pipeline via Cowra	Pipeline connection to supply water from Wyangala Dam to Orange via the CT Water network via Cowra.
59	Wyangala Dam-CT Water-Orange Pipeline via Carcoar	Pipeline connection to supply water from Wyangala Dam to Orange via the CT Water network via Carcoar.
60	Burrendong to Wellington Pipeline	A direct pipeline connection from Burrendong Dam to Wellington.
61	Molong Creek Dam-Orange Pipeline	Pipeline connection between Molong Creek Dam and Orange. This option can be combined with Molong Creek Dam augmentation.
62	Molong-Manildra Pipeline	Pipeline connection between Molong and Manildra.
63	Manildra-Cumnock-Yeoval Pipeline	Pipeline connection linking Manildra, Cumnock and Yeoval.
64	Wellington-Yeoval-Cumnock Pipeline	Pipeline system to supply water from Burrendong Dam via Wellington to Yeoval and Cumnock. This option also connects Lake Burrendong to the rest of the region.
65	Lake Endeavour-Manildra Pipeline	Pipeline connection between Lake Endeavour and Manildra.
66	Manildra-Parkes	Pipeline connection between Manildra and Parkes.
67	Eugowra-Forbes Pipeline	Pipeline connection to supply water from Eugowra to Forbes.
68	Forbes-Parkes Pipeline	Connection of the Central Tablelands Water network, Parkes pipeline system and the Forbes pipeline system to form a water grid and enable transfer of water where it is needed most, such as during a drought or a case of WTP failure.
69	Gooloogong-Forbes Pipeline	Connects existing Forbes 375mm pipe at corner of Grenfell Road and Lachlan Valley way, to Parkes Pump Station at Parkes, to 250mm CT Water Trunk Main C at Gooloogong.
70	Trangie-Tottenham Pipeline	Pipeline connection between Trangie Irrigation Scheme and Tottenham.
71	Parkes-Bogan Gate Pipeline	Pipeline connection between Parkes and Bogan Gate.
72	Bogan Gate-Fifield	Pipeline connection between Bogan Gate and Fifield.
73	Bogan Gate-Condobolin Pipeline	Pipeline connection between Bogan Gate and Condobolin.
74	Condobolin-Tullibigeal Pipeline	Pipeline connection between Condobolin and Tullibigeal.
75	Lachlan River-Lake Cargelligo Pipeline	Replacement of the existing water supply channel with a piped supply.

#	OPTION NAME	DESCRIPTION
76	Lake Cargelligo-Euabalong Pipeline	Pipeline connection between Lake Cargelligo and Euabalong via Murrin Bridge.
77	Ungarie-Weethalle Pipeline	Pipeline connection between Weethalle and Ungarie.
78	Goldenfields Water-Burcher Pipeline	Pipeline connection between Goldenfields bulk water supply to Burcher.
79	Young-Bendick Murrell Pipeline	Pipeline connection between Young and the Cowra water supply system via Bendick Murrell.
80	Young-Grenfell Pipeline	Pipeline connection between Young and Grenfell.
81	Wyangala-Crookwell Pipeline	Pipeline connection between Wyangala Dam and Crookwell.
82	Goulburn-Crookwell Pipeline	Pipeline connection between Crookwell and the Goulburn-Mulwaree water supply system.
83	Woodstock-Cowra Pipeline	Pipeline connection between CTW network and Cowra via Woodstock. This pipeline link is currently under construction.

Identification of potential transfer system options is based on four “big picture” objectives to address gaps in Centroc’s water supply networks. The objectives attempt to create an interconnecting water pipeline network across the region, as well as beyond the region to connect to other major water supply networks. The objectives can be generally described as:

1. Interconnect pipeline networks across the region to form a “water grid”;
2. Moving water between the Lachlan and Macquarie Rivers;
3. Connecting to the Murrumbidgee Catchment; and
4. Connecting to the Shoalhaven catchment.

Supply amplification options consider the value of constructing new bulk water storages in the upper catchments as well as augmentation of select existing storages, in particular those located in high rainfall areas. Supply amplification options are coupled with transfer system options to allow for water transfer to low water security areas during low supply periods. Recycling and groundwater infrastructure options have the potential to reduce pressure in potable water demand locally. The options include effluent recycling, stormwater harvesting, Managed Aquifer Recharge (MAR) and accessing local groundwater pockets to supplement surface water sources.

Non-infrastructure options include driving irrigation infrastructure efficiency to share the resulting water saving benefits, regulatory measures to manage water demand and efficiency such as appropriate policy setting, demand management programs and pricing regimes to enforce water conservation by both urban and non-urban users.

D.4 QUANTIFYING OF OPTION CHARACTERISTICS

In order to quantify the options screening criteria, a spreadsheet tool is developed to provide preliminary estimations of water, energy and cost efficiency of each option for the feasibility study. The spreadsheet characterises the potential options by utilising inputs from:

- Data compiled in the Component 1 of this study (Infrastructure Data Audit);
- Water Security Modelling outcomes, in particular the system throughputs required to secure water for the various demand nodes modelled in this study (see Appendix B); and
- Local knowledge and data collected from Centroc Council members and other stakeholder groups.

Where data is not available, professional engineering judgement based on knowledge and experience is used, particularly in cases such as asset types, quantity required and physical characteristics, capital and O&M costs, and energy efficiencies.

The assumptions used in the options characterisation process to allow consideration and relative comparison of the long list of options are outlined below.

D.4.1 COST RATE ASSUMPTIONS

- 2009/10 Engineering Construction Cost Index adopted as reference year.
- Discount rate at 6%p.a., assumed life of asset of 50 years, variable capital maintenance/depreciation rates of 1-5%.
- NSW Reference Rates Manual 2007 for Valuation of Water Supply, Sewerage and Stormwater Assets used to cost recycled water (ReW) treatment (assuming filters represent 15% of secondary plant capital cost), transfer pipelines, pump stations and required treatment works. This includes assumptions for
    - The prime cost of construction of the asset;
    - 15% survey, investigation, design and project management (SID) costs; and
    - 10% contingency costs.
- Dual reticulation costs (including reticulation and service reservoirs) assumed at $1200/tenement for utility, $500/tenement for developer, $250/tenement for customer.
- New and amplification of medium and large dam costs derived from best-fit correlation of data from previous investigations. Data used were sourced from investigations in NSW, QLD and ACT at Tennent, Tilleys Bridge, Coomera, Glendower, Zillmans Crossing, Cambroon, Traveston and Cedar Grove for new dams, and Lake Rowlands, Cotter, Borumba, Hinze and Wappa for storage augmentation.
- Costs for minor storages (assumed to be earthen clay and PE lined) were derived from previous experiences of in-house expertise.
- Inter-pipeline (break-pressure) tank cost assumed to be uniform at $100,000 per tank.
- All costs are strategic planning level assessment cost estimates only. They are only suitable for the comparison of options.

D.4.2 TRANSFER SYSTEM ASSUMPTIONS

- Preliminary pipeline design was conducted under the following rules:
    - Shortest possible route via roadway to take advantage of existing easements;
    - Avoid major elevation changes;
    - Maximum head of approximately 100m per segment to locate water pumping stations and inter-pipeline tanks;
    - Pipeline sizing is based on the capacity required to meet a target percentage of demand and utilisation frequency at the destination node. In some cases, such as Cumnock and Yeoval, the proposed pipeline options will replace the existing primary water supply source and therefore the transfer mains will provide 100% of the target node demand and be utilised 100% of the time;
    - Pumps are assumed to be operating at 80% efficiency;
    - Each pump station is assumed to have 2x (a main and a backup) installed pump set; and
    - Pipe friction loss (dynamic head) is assumed to be constant at 3m/km.
- Target demand and utilisation percentages for transfer system destination nodes determined based on:
    - Demands for the 21 urban demand nodes modelled using DSS (see Appendix B) and through Water Security Modelling (see Appendix C);

- Demands for towns and villages outside of the 21 urban demand nodes modelled were estimated using the assumptions of:
  a. 360L/p/day average water consumption (see Appendix B);
  b. Peak day Demand (PDD) estimated using the average multiplier of modelled urban demand nodes of 2.84 x Average Day Demand; and
  c. Number of residential properties estimated from ABS 2006 Census population and average household size data.
- Starting points for target demand and utilisation percentages, generally:
  a. Nodes with known reliability issues – 20% target node demand and 10% annual utilisation;
  b. Nodes with occasional reliability issues – 10% target node demand and 5% annual utilisation;
  c. Replacement of current water supply system – 100% target node demand and 100% annual utilisation; and
  d. Some localised modification of factors using previous knowledge or local information to allow variations in target node demands.

D.4.3 RECYCLED WATER THIRD PIPE SYSTEM ASSUMPTIONS

- Only demand nodes with >500 new greenfield residential lots development, within the 50-year planning horizon, were considered for ReW systems.
- ReW demand (toilets and outdoor) based on the number of new lots, approximated as average demand of 180L/p/day with 2.5 persons per lot and PDD:ADD ratio of 7 to 1.
- Assumed infrastructure required for a ReW system of:
  - Filter and disinfection facilities at PDD capacity;
  - Seasonal storage at 1-month ADD capacity at existing STP (assumed to have tertiary and nutrient removal capability);
  - Third pipe and service reservoirs; and
  - Non-potable plumbing for toilets and outdoor uses.
- ReW energy consumption assumed to be mainly derived from transfer systems consisting of 5km transfer main and 50m static head.

D.4.4 NEW STORAGE AND AMPLIFICATION ASSUMPTIONS

- A number of new dams and augmentation options, were based on information provided from reports of previous investigations, these include:
  - Lake Rowlands augmentation as per information supplied on a number of investigation reports by CTW;
  - Molong Creek Dam augmentation, considering information from Council that raising the current dam wall by 1m can double the dam capacity;
  - Replacing Duckmaloi weir with a dam of capacity up to 20,000 ML based on previous Council investigation study; and
  - Offstream Buckinbah Creek storage assumed to be 22.5ML turkeys nest dam located 1.5km away from Yeoval. A capital cost including pipelines and fittings of $900,000 in 2009 is used based on an investigation report provided by Council.

A summary of the option characterisation outcome, segregated by LGAs, is set out in Table D-2. Quantification of these options characteristics allowed for detailed and systematic comparisons to be made via the MCA tool.

Table D-2: Characterisation of the Long List of Potential Options by LGA (Infrastructure Only)

LGA	RELEVANT OPTIONS	REGIONAL OR LOCAL OPTION?	PIPELINES ONLY			ANNUAL WATER USED (ML)	ENERGY USE (KWHR/ML)	COST EFFECTIVENESS ($/KL)				FINANCIAL BURDEN ($/RESIDENTIAL PROPERTY)	NPV CAPITAL COST	TOTAL INFRASTRUCTURE FOOTPRINT (HA)
			TOTAL LENGTH (KM)	PIPE DIAMETER (MM)	RAW/ TREATED WATER?			CAPITAL	OM&D	TOTAL	TOTAL LESS AVOIDED			
Bathurst	13. Recycling Water – New Development – Bathurst	Local	5	300	N/A	-505.8 (saving)	1,739.0	$1.31	$0.65	$1.96	$1.46	$919	$10,227,064	0.01
	28, Bathurst Stormwater Harvesting	Local	5	500	N/A	1,325.0	1,203.9	$0.41	$0.36	$0.77	$0.27	$947	$8,277,417	0.01
	36. Chifley Dam Augmentation	Regional	-	-	N/A	618.6	0.0	$4.55	$1.44	$5.99	$5.99	$3,440	$44,401,090	150.00
	38. New Bulk Water Storage – Abercrombie River	Regional	-	-	N/A	662.5	0.0	$11.22	$3.54	$14.75	$14.75	$9,076	$117,133,621	300.00
	39. New Bulk Water Storage Upstream of Chifley	Regional	-	-	N/A	662.5	0.0	$11.22	$3.54	$14.75	$14.75	$9,076	$117,133,621	300.00
	45. Chifley-Oberon Pipeline	Regional	28	100	Raw	18.1	3,872.2	$9.46	$3.03	$12.49	$12.49	$2,429	$2,895,438	0.02
	45A. Winburndale-Oberon Pipeline	Regional	53	100	Raw	18.1	8,056.9	$20.61	$6.80	$27.41	$27.41	$5,628	$6,773,069	0.07
	45B. Winburndale-Lithgow Pipeline	Regional	52	200	Raw	39.0	8,272.1	$15.50	$5.53	$21.03	$21.03	$1,868	$10,334,610	0.06
	46. Chifley to Blayney – Supply CTW	Regional	48	150	Raw	22.9	4,462.1	$21.53	$5.17	$26.70	$26.70	$2,297	$8,061,499	0.03
	47. Chifley to Orange – Supply CTW + Cowra + Orange	Regional	81	375, 300	Raw	137.0	1,966.1	$4.58	$1.37	$5.96	$5.96	$606	$27,845,858	0.04
	48. Bathurst-CTW via Blayney Pipeline	Regional	35	300, 200	Raw	147.1	3,645.4	$5.10	$1.99	$7.10	$7.10	$389	$12,232,197	0.04
	50. Lake Rowlands Augmentation + Pipeline to Blayney – Supply Bathurst + Orange	Regional	21	300	Raw	183.2	0.0	$1.83	$0.29	$2.12	$2.12	$368	$143,161,329	170.00
	53. Winburndale-Bathurst Pipeline	Local	141	300, 200, 250	Raw	156.4	877.5	$22.18	$6.62	$28.80	$28.80	$1,461	$4,074,885	0.06
	54. Chifley-Bathurst Pipeline	Local	53	100	Raw	18.1	8,056.9	$20.61	$6.80	$27.41	$27.41	$5,628	$14,768,373	0.07
	54A. Bathurst-Orange Pipeline	Regional	55	300, 200	Raw	155.2	5,084.4	$7.58	$2.92	$10.49	$10.49	$782	$19,136,415	0.06
	55. Chifley-Bathurst-Orange Pipeline	Regional	74	600, 300, 200	Raw	6,658.1	1,556.8	$0.31	$0.29	$0.60	$0.60	$1,281	$33,904,788	0.07
Blayney	38. New Bulk Water Storage – Needles (Belubula River)	Regional	-	-	N/A	662.5	0.0	$11.22	$3.54	$14.75	$14.75	$9,076	$117,133,621	300.00
	46. Chifley to Blayney – Supply CTW	Regional	48	150	Raw	22.9	4,462.1	$21.53	$5.17	$26.70	$26.70	$2,297	$8,061,499	0.03
	47. Chifley to Orange – Supply CTW + Cowra + Orange	Regional	81	375, 300	Raw	137.0	1,966.1	$4.58	$1.37	$5.96	$5.96	$606	$27,845,858	0.04
	48. Bathurst-CTW via Blayney Pipeline	Regional	35	300, 200	Raw	147.1	3,645.4	$5.10	$1.99	$7.10	$7.10	$389	$12,232,197	0.04
	49. CTW-Orange Pipeline via Millthorpe	Regional	21	300	Raw	183.2	0.0	$1.83	$0.29	$2.12	$2.12	$368	$5,276,419	0.00
	50. Lake Rowlands Augmentation + Pipeline to Blayney – Supply Bathurst + Orange	Regional	21	300	Raw	183.2	0.0	$1.83	$0.29	$2.12	$2.12	$368	$143,161,329	170.00
	57. Wyangala-CTW Pipeline near Mandurama	Regional	36	600	Raw	2,849.1	3,510.6	$0.65	$0.61	$1.25	$1.25	$2,145	$29,338,629	0.03

LGA	RELEVANT OPTIONS	REGIONAL OR LOCAL OPTION?	PIPELINES ONLY			ANNUAL WATER USED (ML)	ENERGY USE (KWHR/ML)	COST EFFECTIVENESS ($/KL)				FINANCIAL BURDEN ($/RESIDENTIAL PROPERTY)	NPV CAPITAL COST	TOTAL INFRASTRUCTURE FOOTPRINT (HA)
			TOTAL LENGTH (KM)	PIPE DIAMETER (MM)	RAW/ TREATED WATER?			CAPITAL	OM&D	TOTAL	TOTAL LESS AVOIDED			
	58. Wyangala-CTW Pipeline via Cowra	Regional	35	600	Raw	2,849.1	2,798.6	$0.59	$0.49	$1.08	$1.08	$1,844	$26,512,106	0.02
	59. Wyangala-CTW Pipeline via Carcoar	Regional	63	600	Raw	2,849.1	7,875.7	$1.25	$1.44	$2.68	$2.68	$4,585	$56,568,955	0.06
	65. Lake Endeavour-Manildra Pipeline – Supply CTW	Regional	54	150	Raw	11.4	3,928.8	$47.21	$10.14	$57.35	$57.35	$2,438	$8,711,248	0.03
Boorowa		Not modelled in detail due to insufficient information but security improvement not expected to be required.												
Cabonne	25. Recycling Water – Existing (Retrofit) – Yeoval	Local	5	50	N/A	-8.6	1,739.0	$4.04	$2.06	$6.10	$5.60	$2,578	$546,767	0.01
	38. New Bulk Water Storage - Cumnock	Local	5	150	N/A	171.6	171.3	$1.18	$0.77	$1.95	$1.95	$16,517.68	$2,205,062	0.01
	38. New Bulk Water Storage - Yeoval	Local	5	150	N/A	171.6	171.3	$1.19	$0.77	$1.97	$1.97	$16,607.21	$2,240,112	0.01
	41. Molong Creek Dam Augmentation	Regional	-	-	N/A	618.6	0.0	$4.55	$1.44	$5.99	$5.99	$3,440	$44,401,090	150.00
	42. Off-Stream Buckinbah Creek Storage	Local	4	150	N/A	17.2	102.8	$5.53	$1.47	$7.00	$6.50	$5,917	$1,495,523	0.51
	61. Molong Creek-Orange Pipeline	Regional	17	300	Raw	134.3	2,232.0	$2.87	$1.25	$4.13	$4.13	$269	$6,280,489	0.03
	61A. Molong Creek Dam Augmentation + Molong Creek-Orange Pipeline	Regional	17	300	Raw	134.3	1,534.5	$5.80	$2.07	$7.86	$7.86	$490	$18,052,042	25.03
	62. Molong-Manildra Pipeline	Regional	20	80	Raw	2.1	2,460.3	$45.69	$11.14	$56.82	$56.82	$1,153	$1,730,439	0.02
	63. Manildra-Cumnock-Yeoval Pipeline	Regional	55	150	Raw	182.4	2,068.1	$3.68	$1.40	$5.08	$5.08	$46,243	$10,765,717	0.27
	64. Wellington-Yeoval-Cumnock Pipeline	Regional	56	150	Raw	182.4	2,057.3	$1.92	$0.87	$2.79	$2.79	$25,381	$11,254,900	0.28
	64A. Wellington-Yeoval Pipeline	Regional	40	150	Raw	182.4	3,169.3	$2.19	$0.82	$3.01	$3.01	$27,693	$6,507,989	0.02
	65. Lake Endeavour-Manildra Pipeline – Supply CTW	Regional	54	150	Raw	11.4	3,928.8	$47.21	$10.14	$57.35	$57.35	$2,438	$8,711,248	0.03
	66. Manildra-Parkes-Bogan Gate Pipeline	Regional	90	200, 100	Raw	37.5	2,278.0	$21.71	$4.79	$26.50	$26.50	$1,969	$15,018,726	0.03
	67. Eugowra-Forbes Pipeline	Regional	35	150	Raw	14.4	1,675.2	$23.37	$4.73	$28.10	$28.10	$1,770	$5,292,153	0.01
Cowra	38. New Bulk Water Storage – Cowra	Local	5	250	N/A	45.3	259.3	$5.90	$1.73	$7.63	$7.63	$3,134	$4,210,331	0.01
	46. Chifley to Blayney – Supply CTW	Regional	48	150	Raw	22.9	4,462.1	$21.53	$5.17	$26.70	$26.70	$2,297	$8,061,499	0.03
	47. Chifley to Orange – Supply CTW + Cowra + Orange	Regional	81	375, 300	Raw	137.0	1,966.1	$4.58	$1.37	$5.96	$5.96	$606	$27,845,858	0.04
	48. Bathurst-CTW via Blayney Pipeline	Regional	35	300, 200	Raw	147.1	3,645.4	$5.10	$1.99	$7.10	$7.10	$389	$12,232,197	0.04
	57. Wyangala-CTW Pipeline near Mandurama	Regional	36	600	Raw	2,849.1	3,510.6	$0.65	$0.61	$1.25	$1.25	$2,145	$29,338,629	0.03
	58. Wyangala-CTW Pipeline via Cowra	Regional	35	600	Raw	2,849.1	2,798.6	$0.59	$0.49	$1.08	$1.08	$1,844	$26,512,106	0.02

LGA	RELEVANT OPTIONS	REGIONAL OR LOCAL OPTION?	PIPELINES ONLY			ANNUAL WATER USED (ML)	ENERGY USE (KWHR/ML)	COST EFFECTIVENESS ($/KL)				FINANCIAL BURDEN ($/RESIDENTIAL PROPERTY)	NPV CAPITAL COST	TOTAL INFRASTRUCTURE FOOTPRINT (HA)
			TOTAL LENGTH (KM)	PIPE DIAMETER (MM)	RAW/ TREATED WATER?			CAPITAL	OM&D	TOTAL	TOTAL LESS AVOIDED			
	59. Wyangala-CTW Pipeline via Carcoar	Regional	63	600	Raw	2,849.1	7,875.7	$1.25	$1.44	$2.68	$2.68	$4,585	$56,568,955	0.06
	69. Gooloogong-Forbes Pipeline	Regional	45	150	Raw	14.4	1,722.9	$30.21	$5.92	$36.13	$36.13	$2,304	$6,939,351	0.01
	81. Wyangala-Crookwell Pipeline	Regional	120	80	Raw	7.5	7,710.8	$69.11	$15.29	$84.40	$84.40	$8,255	$8,873,426	0.06
	83. Woodstock-Cowra Pipeline	Regional	20	300	Treated	56.3	835.6	$6.24	$1.43	$7.67	$7.67	$1,192	$5,636,458	0.01
Forbes	15. Recycling Water – New Development – Forbes	Local	5	200	N/A	-269.4	1,739.0	$1.04	$0.66	$1.70	$1.20	$2,005	$4,421,996	0.01
	36. Accessing Groundwater Pockets – Forbes	Local	5	600	N/A	215.8	3,879.4	$1.68	$1.28	$2.97	$2.47	$2,077	$5,724,235	0.01
	38. New Bulk Water Storage – Forbes	Local	5	250	N/A	45.3	259.3	$7.70	$2.30	$10.00	$10.00	$4,110	$5,498,594	0.01
	67. Eugowra-Forbes Pipeline	Regional	35	150	Raw	14.4	1,675.2	$23.37	$4.73	$28.10	$28.10	$1,770	$5,292,153	0.01
	68. Parkes-Forbes Pipeline	Regional	26	150	Raw	28.7	932.4	$8.97	$2.04	$11.00	$11.00	$693	$4,061,518	0.01
	69. Gooloogong-Forbes Pipeline	Regional	45	150	Raw	14.4	1,722.9	$30.21	$5.92	$36.13	$36.13	$2,304	$6,939,351	0.01
Harden		Not modelled in detail but desktop assessment showed that security improvement not expected to be required.												
Lachlan	14. Recycling Water – New Development – Condobolin	Local	5	200	N/A	-225.5	1,739.0	$1.64	$0.76	$2.40	$1.90	$2,383	$5,841,910	0.01
	22. Recycling Water – Existing (Retrofit) – Lake Cargelligo	Local	5	80	N/A	-22.6	1,739.0	$6.65	$2.10	$8.75	$8.25	$1,797	$2,372,553	0.01
	23. Recycling Water – Existing (Retrofit) – Condobolin	Local	5	100	N/A	-48.6	1,739.0	$6.05	$1.78	$7.82	$7.32	$1,674	$4,634,341	0.01
	24. Recycling Water – Existing (Retrofit) – Tottenham	Local	5	50	N/A	-6.6	1,739.0	$4.28	$2.28	$6.56	$6.06	$1,561	$442,998	0.01
	35. Accessing Groundwater Pockets – Lake Cargelligo	Local	32	200	N/A	249.0	6,314.0	$1.65	$1.12	$2.77	$2.27	$7,094	$9,318,005	0.01
	38. New Bulk Water Storage – Lake Cargelligo	Local	5	250	N/A	45.3	259.3	$4.07	$1.15	$5.22	$5.22	$2,145	$2,903,347	0.01
	38. New Bulk Water Storage - Condobolin	Local	5	300	N/A	972.7	243.8	$0.21	$0.09	$0.29	$0.29	$1,250	$3,151,888	0.01
	70. Trangie-Tottenham Pipeline	Regional	58	50	Raw	0.7	1,888.7	$216.17	$36.75	$252.92	$252.92	$6,024	$2,238,584	0.01
	72. Fifield-Bogan Gate Pipeline	Regional	54	50	Raw	0.03	1,758.5	$3,970.59	$637.19	$4,607.78	$4,607.78	$124,062	$2,055,880	0.01
	73. Bogan Gate-Condobolin Pipeline	Regional	63	100	Raw	5.8	814.0	$51.35	$8.85	$60.19	$60.19	$1,571	$4,815,185	0.01
	74. Condobolin-Tullibigeal Pipeline	Regional	66	100	Raw	11.3	3,855.3	$28.61	$6.23	$34.84	$34.84	$3,568	$5,089,708	0.02
	75. Lachlan River-Lake Cargelligo Pipeline	Local	12	250	Raw	564.4	894.5	$0.31	$0.18	$0.48	$0.48	$2,480	$2,725,500	0.01
	76. Lake Cargelligo-Euabalong Pipeline	Regional	15	50	Raw	0.1	472.2	$267.99	$43.95	$311.94	$311.94	$7,753	$555,032	0.01
	77. Ungarie-Weethalle Pipeline	Regional	62	80	Treated	5.6	2,052.5	$42.46	$8.73	$51.19	$51.19	$1,311	$3,777,152	0.02
	78. Goldenfields Water-Burcher Pipeline	Regional	22	50	Treated	0.03	0.0	$1,811.35	$285.50	$2,096.85	$2,096.85	$56,456	$844,086	0.00
Lithgow	16. Recycling Water – New Development – Lithgow	Local	5	150	N/A	-148.9	1,739.0	$2.01	$0.89	$2.90	$2.40	$924	$4,712,810	0.01

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			TOTAL LENGTH (KM)	PIPE DIAMETER (MM)	RAW/ TREATED WATER?			CAPITAL	OM&D	TOTAL	TOTAL LESS AVOIDED			
	32. Lithgow Stormwater Harvesting	Local	1	300	N/A	360.3	1,284.2	$0.19	$0.24	$0.43	-$0.07	$328	$1,076,869	0.01
	45B. Winburndale-Lithgow Pipeline	Regional	52	200	Raw	39.0	8,272.1	$15.50	$5.53	$21.03	$21.03	$1,868	$10,334,610	0.06
Oberon	20. Recycling Water – Existing (Retrofit) – Oberon	Local	5	80	N/A	-22.6	1,739.0	$6.65	$2.10	$8.75	$8.25	$1,797	$2,372,553	0.01
	30. Oberon Stormwater Harvesting	Local	5	200	N/A	170.2	1,203.9	$0.96	$0.65	$1.60	$1.10	$2,781	$2,564,954	0.01
	40. Replacing Duckmaloi Weir with a Dam	Local	-	-	N/A	85.1	0.0	$70.07	$22.09	$92.16	$92.16	$79,858	$93,990,837	250.00
	45. Chifley-Oberon Pipeline	Regional	28	100	Raw	18.1	3,872.2	$9.46	$3.03	$12.49	$12.49	$2,429	$2,895,438	0.02
	45A. Winburndale-Oberon Pipeline	Regional	53	100	Raw	18.1	8,056.9	$20.61	$6.80	$27.41	$27.41	$5,628	$6,773,069	0.07
Orange	17. Recycling Water – New Development – Orange	Local	5	375	N/A	-729.6	1,739.0	$1.24	$0.59	$1.83	$1.33	$1,269	$14,312,107	0.01
	29. Orange Stormwater Harvesting	Local	5	450	N/A	1,096.9	1,203.9	$0.39	$0.36	$0.74	$0.24	$774	$6,660,725	0.01
	29A. Orange Stormwater Harvesting (Additional Catchments)	Local	5	750	N/A	2,468.0	1,203.9	$0.30	$0.30	$0.60	$0.10	$1,399	$11,618,738	0.01
	34. Accessing Groundwater Pockets – Orange	Local	5	100	N/A	54.8	3,879.4	$0.81	$0.70	$1.51	$1.01	$59	$701,265	0.01
	47. Chifley to Orange – Supply CTW + Cowra + Orange	Regional	81	375, 300	Raw	137.0	1,966.1	$4.58	$1.37	$5.96	$5.96	$606	$27,845,858	0.04
	49. CTW-Orange Pipeline via Millthorpe	Regional	21	300	Raw	183.2	0.0	$1.83	$0.29	$2.12	$2.12	$368	$5,276,419	0.00
	50. Lake Rowlands Augmentation + Pipeline to Blayney – Supply Bathurst + Orange	Regional	21	300	Raw	183.2	0.0	$1.83	$0.29	$2.12	$2.12	$368	$143,161,329	170.00
	51. Lake Rowlands-Orange Pipeline	Regional	50	300	Raw	183.2	3,893.0	$5.17	$1.77	$6.94	$6.94	$1,224	$15,219,105	0.03
	52. Macquarie River-Orange Pipeline	Local	28	300	Raw	183.2	3,186.3	$3.13	$1.27	$4.40	$4.40	$789	$9,442,985	0.03
	54A. Bathurst-Orange Pipeline	Regional	55	300, 200	Raw	155.2	5,084.4	$7.58	$2.92	$10.49	$10.49	$782	$19,136,415	0.06
	55. Chifley-Bathurst-Orange Pipeline	Regional	74	600, 300, 200	Raw	6,658.1	1,556.8	$0.31	$0.29	$0.60	$0.60	$1,281	$33,904,788	0.07
	56. Burrendong-Orange Pipeline	Regional	134	300	Raw	183.2	10,542.6	$13.70	$4.66	$18.35	$18.35	$3,233	$40,238,982	0.07
	61. Molong Creek-Orange Pipeline	Regional	17	300	Raw	134.3	2,232.0	$2.87	$1.25	$4.13	$4.13	$269	$6,280,489	0.03
	61A. Molong Creek Dam Augmentation + Molong Creek-Orange Pipeline	Regional	17	300	Raw	134.3	1,534.5	$5.80	$2.07	$7.86	$7.86	$490	$18,052,042	25.03
Parkes	21. Recycling Water – Existing (Retrofit) – Parkes	Local	5	250	N/A	-343.4	1,739.0	$1.80	$0.78	$2.58	$2.08	$2,447	$9,755,334	0.01
	31. Parkes Stormwater Harvesting	Local	5	500	N/A	1,373.7	1,203.9	$0.40	$0.36	$0.76	$0.26	$2,882	$8,736,224	0.01

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			TOTAL LENGTH (KM)	PIPE DIAMETER (MM)	RAW/ TREATED WATER?			CAPITAL	OM&D	TOTAL	TOTAL LESS AVOIDED			
	65. Lake Endeavour-Manildra Pipeline – Supply CTW	Regional	54	150	Raw	11.4	3,928.8	$47.21	$10.14	$57.35	$57.35	$2,438	$8,711,248	0.03
	66. Manildra-Parkes-Bogan Gate Pipeline	Regional	90	200, 100	Raw	37.5	2,278.0	$21.71	$4.79	$26.50	$26.50	$1,969	$15,018,726	0.03
	68. Parkes-Forbes Pipeline	Regional	26	150	Raw	28.7	932.4	$8.97	$2.04	$11.00	$11.00	$693	$4,061,518	0.01
	71. Parkes-Bogan Gate Pipeline	Regional	37	100	Raw	5.8	1,718.8	$30.66	$6.03	$36.69	$36.69	$941	$2,815,539	0.01
	72. Fifield-Bogan Gate Pipeline	Regional	54	50	Raw	0.03	1,758.5	$3,970.59	$637.19	$4,607.78	$4,607.78	$124,062	$2,055,880	0.01
	73. Bogan Gate-Condobolin Pipeline	Regional	63	100	Raw	5.8	814.0	$51.35	$8.85	$60.19	$60.19	$1,571	$4,815,185	0.01
Upper Lachlan	81. Wyangala-Crookwell Pipeline	Regional	120	80	Raw	7.5	7,710.8	$69.11	$15.29	$84.40	$84.40	$8,255	$8,873,426	0.06
	82. Goulburn-Crookwell Pipeline	Regional	46	80	Raw	8.3	2,306.2	$23.92	$5.48	$29.40	$29.40	$1,555	$3,311,578	0.03
Weddin	46. Chifley to Blayney – Supply CTW	Regional	48	150	Raw	22.9	4,462.1	$21.53	$5.17	$26.70	$26.70	$2,297	$8,061,499	0.03
	47. Chifley to Orange – Supply CTW + Cowra + Orange	Regional	81	375, 300	Raw	137.0	1,966.1	$4.58	$1.37	$5.96	$5.96	$606	$27,845,858	0.04
	48. Bathurst-CTW via Blayney Pipeline	Regional	35	300, 200	Raw	147.1	3,645.4	$5.10	$1.99	$7.10	$7.10	$389	$12,232,197	0.04
	57. Wyangala-CTW Pipeline near Mandurama	Regional	36	600	Raw	2,849.1	3,510.6	$0.65	$0.61	$1.25	$1.25	$2,145	$29,338,629	0.03
	58. Wyangala-CTW Pipeline via Cowra	Regional	35	600	Raw	2,849.1	2,798.6	$0.59	$0.49	$1.08	$1.08	$1,844	$26,512,106	0.02
	59. Wyangala-CTW Pipeline via Carcoar	Regional	62	600	Raw	2,849.1	7,875.7	$1.25	$1.44	$2.68	$2.68	$4,585	$56,568,955	0.06
	65. Lake Endeavour-Manildra Pipeline – Supply CTW	Regional	54	150	Raw	11.4	3,928.8	$47.21	$10.14	$57.35	$57.35	$2,438	$8,711,248	0.03
	80. Young-Grenfell Pipeline	Regional	48.9	80	Raw	2.9	2,028.2	$67.30	$15.06	$82.36	$82.36	$2,020	$3,086,302	0.03
Wellington	18. Recycling Water – New Development – Wellington	Local	5	250	N/A	-309.4	1,739.0	$1.14	$0.64	$1.78	$1.28	$3,033	$5,578,070	0.01
	38. New Bulk Water Storage – Wellington	Local	5	450	N/A	146.8	272.5	$1.32	$0.37	$1.69	$1.69	$1,360	$3,054,555	0.01
	56. Burrendong-Orange Pipeline	Regional	134	300	Raw	183.2	10,542.6	$13.70	$4.66	$18.35	$18.35	$3,233	$40,238,982	0.07
	60. Burrendong-Wellington Pipeline	Local	28	150	Raw	9.2	3,246.6	$31.82	$7.30	$39.12	$39.12	$2,046	$4,814,578	0.02
	64. Wellington-Yeoval-Cumnock Pipeline	Regional	56	150	Raw	182.4	2,057.3	$1.92	$0.87	$2.79	$2.79	$25,381	$11,254,900	0.28
	64A. Wellington-Yeoval Pipeline	Regional	40	150	Raw	182.4	3,169.3	$2.19	$0.82	$3.01	$3.01	$27,693	$6,507,989	0.02
Young	19. Recycling Water – New Development – Young	Local	5	250	N/A	-387.9	1,739.0	$1.05	$0.61	$1.65	$1.15	$2,205	$6,407,569	0.01
	79. Young-Bendick Murrell Pipeline	Regional	28.5	150	Raw	19.0	2,295.9	$17.34	$5.22	$22.55	$22.55	$593	$5,302,315	0.02
	80. Young-Grenfell Pipeline	Regional	48.9	80	Raw	2.9	2,028.2	$67.30	$15.06	$82.36	$82.36	$2,020	$3,086,302	0.03

LGA	RELEVANT OPTIONS	REGIONAL OR LOCAL OPTION?	PIPELINES ONLY			ANNUAL WATER USED (ML)	ENERGY USE (KWHR/ML)	COST EFFECTIVENESS ($/KL)				FINANCIAL BURDEN ($/RESIDENTIAL PROPERTY)	NPV CAPITAL COST	TOTAL INFRASTRUCTURE FOOTPRINT (HA)
			TOTAL LENGTH (KM)	PIPE DIAMETER (MM)	RAW/ TREATED WATER?			CAPITAL	OM&D	TOTAL	TOTAL LESS AVOIDED			
Central Tablelands Water	35. Lake Rowlands Augmentation	Regional	2.5	600	N/A	2,567.2	91.9	$2.72	$0.87	$3.59	$3.59	$5,507	$110,254,942	170.00
	46. Chifley to Blayney – Supply CTW	Regional	48	150	Raw	22.9	4,462.1	$21.53	$5.17	$26.70	$26.70	$2,297	$8,061,499	0.03
	47. Chifley to Orange – Supply CTW + Cowra + Orange	Regional	81	375, 300	Raw	137.0	1,966.1	$4.58	$1.37	$5.96	$5.96	$606	$27,845,858	0.04
	48. Bathurst-CTW via Blayney Pipeline	Regional	35	300, 200	Raw	147.1	3,645.4	$5.10	$1.99	$7.10	$7.10	$389	$12,232,197	0.04
	49. CTW-Orange Pipeline via Millthorpe	Regional	21	300	Raw	183.2	0.0	$1.83	$0.29	$2.12	$2.12	$368	$5,276,419	0.00
	50. Lake Rowlands Augmentation + Pipeline to Blayney – Supply Bathurst + Orange	Regional	21	300	Raw	183.2	0.0	$1.83	$0.29	$2.12	$2.12	$368	$143,161,329	170.00
	51. Lake Rowlands-Orange Pipeline	Regional	50	300	Raw	183.2	3,893.0	$5.17	$1.77	$6.94	$6.94	$1,224	$15,219,105	0.03
	57. Wyangala-CTW Pipeline near Mandurama	Regional	36	600	Raw	2,849.1	3,510.6	$0.65	$0.61	$1.25	$1.25	$2,145	$29,338,629	0.03
	58. Wyangala-CTW Pipeline via Cowra	Regional	35	600	Raw	2,849.1	2,798.6	$0.59	$0.49	$1.08	$1.08	$1,844	$26,512,106	0.02
	59. Wyangala-CTW Pipeline via Carcoar	Regional	63	600	Raw	2,849.1	7,875.7	$1.25	$1.44	$2.68	$2.68	$4,585	$56,568,955	0.06
	65. Lake Endeavour-Manildra Pipeline – Supply CTW	Regional	54	150	Raw	11.4	3,928.8	$47.21	$10.14	$57.35	$57.35	$2,438	$8,711,248	0.03

D.5 PRELIMINARY SCREENING OF POTENTIAL OPTIONS

The preliminary screening process for the long list of potential options followed the desktop characterisation of the options. Each characterised option was assessed primarily through the MCA decision-making tool against the assessment criteria shown earlier in Table D-1, and supplemented by local knowledge gathered from consultation with the PRG and the PSC.

Using economic, social and environmental criteria, each of the options under consideration was ranked. The ranking was achieved by assigning each of the options a relative score from -3 to +3 for each criterion, where -3 represented the worst possible outcome for the criterion and +3 represented the most favourable.

For example, for the Cost Effectiveness criterion, the option with the highest cost per kL of water provided is scored a -3, while the cheapest scoring a +3 and the median cost scoring a 0.

The outcomes of the preliminary screening of the long list are shown in The Screening column at the end of Table D-5 identifies the outcomes of the preliminary options assessment. For each option, the column notes whether a particular option has been

- Included for short-listing (+) and modelling; and/or
- Not included for short-listing:
    - As it is considered unfeasible (X); and/or
    - Additional information/investigation is required due to uncertainty (U); and/or
    - Better alternative(s) exists (B); and/or
    - Local/decentralised options are more appropriate (L or D);
    - The source is a potential emergency water supply only (E); and/or
- Would need to be considered on a case by case basis due to the opportunistic nature of the option (C).

The column also identifies the options that may potentially form a region-wide water grid (R). Options that are marked with “R, X” or “R, X, B” denote those that are unfeasible when evaluated independently, but may be considered effective as part of a regional water grid. To aid in understanding the options, the Cost Effectiveness dollar figure for each option is shown as an absolute value in its own column in Table D-5.

Options that were short listed were considered for further modelling and bundled into themed scenarios. On an engineering feasibility basis, options were considered for short listing if:

- They have the potential to contribute towards improving local water security; or
- They are a critical link to a region-wide strategy such as a regional water grid; and
- They are cost effective (<$5.00/kL of water supplied) to implement and in their provision of water security.

Investigative reviews were required for some non-engineering options in order to reach preliminary assessments of feasibility that were similar to their engineering counterparts. Reviews for the Irrigation Efficiency – Shared Benefits and Scarcity Pricing options are outlined below.

D.5.1 INVESTIGATION OF POLICY OPTIONS – IRRIGATION EFFICIENCY SHARED BENEFITS

The current study focuses primarily on the water security in urban areas of the Central West Region and on opportunities for improving water efficiency therein. This primary focus must be placed in the context that urban water use account for only a small fraction of water used in the Lachlan and Macquarie river systems (typically <5% (AWRA, 2005)). In this context, the investments in improvements in irrigation efficiency have the potential to provide additional water for all users.

Irrigation Efficiency – Sharing the Benefits

One criticism commonly levelled at buyback schemes, where licences are simply purchased by the Federal and State Governments and then effectively retired or utilised for environmental flows, is that they reduce the productivity of land use in the region with resulting flow-on effects through the local economy.

Investments in improved efficiency have the potential to increase the land use productivity in the region at the same time as providing water for other uses such as the environment or improved urban water security. In this study, the opportunities for the potential investment by urban water utilities in improving water efficiency has been examined, with the water savings achieved being shared between irrigators and water utilities. The investing water utilities could then utilise the water savings directly for access to additional water, or as offsetting flows to make the impact of new urban water security infrastructure "water neutral".

Irrigation Efficiency – How Much Water Can be Saved?

In a study undertaken by Pratt Water of irrigation efficiency opportunities in the Murrumbidgee river system, the potential savings and costs from improved efficiency in both off-farm (delivery) and on-farm systems were analysed. The Pratt Water study was unique in that it only considered true savings (i.e. recovery of water lost that could not be re-used e.g. evaporation, seepage to saline groundwater) and not savings where water was re-used elsewhere (e.g. discharge to river). The potential savings identified are summarised in Table D-3 below (Pratt Water 2004).

Table D-3: Potential Savings from Improved Irrigation System Efficiency

AREA	AVERAGE ANNUAL SUPPLY/DIVERSION (GL)	ESTIMATED SAVINGS (GL)	PERCENTAGE SAVING
Murrumbidgee Irrigation	1,253	349	28%
Coleambally Irrigation	630	173	27%
Private Irrigators	808	253	31%

These savings arise from a combination of measures involving improving on-farm technology (e.g. implementing centre pivot and drip irrigation and soil moisture monitoring systems), upgrading off-farm delivery systems (e.g. lining or piping canals), and improving metering and measurement.

Irrigation Efficiency – What are the Costs?

Costs for water savings vary significantly – depending on the type of efficiency work undertaken. In a Bureau of Resource Sciences (BRS) seminar presentation, Dr Shahbaz Khan (Khan, 2007) from CSIRO outlined the range of water savings measures and costs that could be implemented for both on-farm and off-farm systems in the Murrumbidgee and Coleambally Irrigation Areas. Dr Khan's estimates ranged from:

- $500 to $7,000 per ML for Off-Farm measures; and
- $50 to $7,000 per ML for On-Farm measures.

In the Pratt Water study, costs of various measures ranged from around $200/ML to $3,100 ML or more.

Converting Irrigation Efficiency into Improved Urban Water Security

The Murrumbidgee Irrigation and agricultural systems are quite different to those in the Lachlan and Macquarie. Hence, some degree of caution is needed in translating the results. It would be wise to be conservative in both the estimates of potential water savings and the costs of achieving these. Therefore, possible water savings of around 10% would be achievable from investments in irrigation efficiency, and that the capital cost of these investments could be in the order of $5,000 per ML saved.

However, it should be noted that the overall water savings could be higher and the costs could be considerably lower, depending on the specific projects undertaken. In his presentation, Dr Khan noted that on-farm efficiency savings varied across the landscape and that channel seepage varied both spatially and temporally.

For the conversion of irrigation efficiency improvements into improved urban water security improvements, the following assumptions have been made:

- Water efficiency improvements can be made for and investment of $5,000 per ML of water saved;
- The benefits of water efficiency savings would be shared equally between the investing urban water utilities and participating irrigators;
- Water targeted in any shared benefits scheme would be General Security water, with a conversion factor of four to be applied to convert to a High Security entitlement.

Given these assumptions, improvements in irrigation efficiency have the potential to deliver some of the most cost-effective improvements in urban water security.

Issues to be Addressed

At the current time, with a severe drought still effecting water security throughout the region, there is considerable uncertainty about how water sharing plans and entitlement regimes will function into the future. It is beyond the scope of the current study to address these issues, which may not be resolved for many years into the future. In this environment it is therefore not possible to simply outline a process for improved water security on the basis of simply gaining additional urban water entitlements on the basis of shared benefits. Even then, unless the urban communities are on run-of river supplies, it is still necessary to provide infrastructure to deliver that additional water security.

As a result, it is the recommendation of this study that improvements in irrigation efficiency be considered primarily as an offsetting mechanism for new infrastructure, particularly where that infrastructure will inherently remove additional water from river systems.

Other issues to be addressed include:

- An irrigation modernisation plan is being completed for the Jemalong Irrigation District from Australian Government funds. This modernisation plan will provide a blue-print for the district in terms of its strategic direction and future prospects. It should also outline the potential opportunities for water savings projects, the amounts of water likely to be saved and the possible costs. This plan will be a valuable additional reference for ongoing consideration of a shared benefits scheme;
- Investments in improved on-farm infrastructure need to be accompanied by training and development programs to enable producers to manage and operate their new systems. Audits of system performance are also important to ensure systems are able to deliver the efficiencies anticipated (Irrigation Australia, 2009);
- Investments in improved irrigation system efficiency are likely to provide additional general security water. Whether this water has a reliability profile that is suitable for town water supplies needs to be thought through. The process and requirements for converting general security water to high security water also needs to be assessed;
- Predictions of reduced rainfall and water supply reliability may mean that investments in irrigation efficiency may not yield the water savings that are anticipated as less water becomes available for irrigation in future;
- Water Utilities might not be the only organisations interested in obtaining water savings from investments in irrigation infrastructure. For example, the Federal Government would be a player in making investments to obtain water for environmental flows.

D.5.2 INVESTIGATION OF POLICY OPTIONS – SCARCITY PRICING

The National Water Commission (NWC) has highlighted improvement in urban water pricing as one of the explicit commitments made under the Commission's National Water Initiative (NWI) (NWC 2008a). In the 2007 Biennial Assessment and 2008 Council of Australian Government (COAG) Update Report on progress in water reform, the Commission has noted that the NWI provisions for urban water were insufficiently challenging. As a response, the Commission has identified a number of future reform policies that extends beyond the original actions specified under the NWI. Consideration of scarcity pricing in urban areas, as well as elimination of the inclining block tariffs are part of the future reform policies identified. This section reviews a scarcity pricing as a potential urban water pricing arrangement to be adopted by the Centroc Councils.

Review of scarcity-based pricing

Scarcity based pricing involves establishing a pricing system whereby water charges vary inversely with available supply. The objective of employing scarcity pricing is to seek a more efficient allocation of scarce water resource compared to current regulatory imposition of use-based restrictions (NWC 2008b). By formal economic definition, a resource can be considered scarce when its use has a positive opportunity cost or impacts upon the ability of others to consume it. In the short term, water can be scarce due to natural phenomena such as lack of rainfall, insufficient investment in new capacity to meet a growing demand, or there is a time lag in recognising the need for and augmenting infrastructure systems.

Two approaches can be adopted for scarcity based pricing of water:

1. Set usage charge component to lower than cost-recovery rate during periods of abundance and increase prices to higher than cost-recovery during periods of scarcity; and
2. Adjust fixed charge component to reflect the scarcity of water resources.

It is also possible to have a hybrid approach which incorporates adjustments in both the usage and fixed charge components. In this case, the usage charge component can be adjusted to respond to the scarcity level of water resources, while a negative fixed charge can be set to provide a form of rebate for low water consumers during dry periods as well as to encourage a reduction in overall consumption.

A review into the practical applications of scarcity based pricing, including the approaches outlined above, was conducted for this Water Security Study by drawing upon findings of previous investigations (Grafton and Kompas 2006; Huges et al 2008).

Grafton and Kompas (2006) proposed adjusting water prices every quarter depending on the amount of water in storage, and prices would be increased to a level that is sufficient to prevent water storage levels going below critical levels. Based on their modelling and estimates of price elasticity of demand for water, the paper suggests that scheduled prices as set by IPART may have to rise by upwards of 50% to take into account water scarcity. Where scarcity based price exceeds the marginal cost of alternative water supplies, it acts as a signal for introducing alternative supplies such as desalinated water.

The paper by Hughes et al (2008) investigated optimal scarcity pricing for the ACT. It concluded that optimal scarcity price is inversely related to storage levels, increases over time with demand growth, and decreases with introduction of new augmentation to water supply systems. The paper also claims that the optimal timing of supply augmentation depends heavily on whether the supply augmentation is rainfall dependent.

The review of scarcity based pricing approach in the context of the current CENTROC Water Security Study is summarised and set out in Table D-4. Under the Assessment column, cells are shaded green if it has a positive assessment against a criterion, red if it has a negative assessment and unshaded for a neutral comment.

Table D-4: Review of Scarcity Pricing

CRITERIA	REVIEW OF SCARCITY PRICING APPROACH
Efficiency	Restriction in demand achieved through price signals rather than quantity- and use-based restrictions and therefore is expected to represent a more efficient mechanism for managing resource scarcity
Economic Impact	May potentially exacerbate the business cycle for significant water-using consumers, for example, the agriculture sector will be impacted by substantial increases in operating costs which propagates to consumers through market prices of agricultural produce during dry periods
	Extended wet periods may mean that the ability of LWUs to raise revenue for capital works may be compromised due to less than full cost-recovery charge rates
	With an adjusted fixed charges approach, and given accurate price elasticity estimates, it is possible for LWU to achieve a secure revenue and full cost recovery
Practicality	Complex to plan as price fluctuation required to restrict demand to appropriate levels; additional administrative complexity.
	High uncertainty in determining price elasticity of water may lead to pricing that inaccurately reflects the scarcity of water resource
	Setting a scarcity price in advance that exactly clears the market would be virtually impossible
	May reduce the costs and difficulties in managing and enforcing quantitative restrictions
Transparency	Transparency can be provided if the methodology for calculating scarcity prices is publicly available and price changes are disseminated before they take effect
Equity	More significant financial burden on larger or low-income families; may need to set negative fixed charges or provide concessions and rebates to address this equity concern

Based on the review conducted for this study, there is inadequate support to recommend an independent scarcity pricing arrangement for the Council members of Centroc. In practice, scarcity based pricing would need to be combined with other elements of an overall pricing regime to achieve a more efficient allocation of scarce resource. The productive and efficiency incentives under scarcity pricing are also likely to depend heavily on being implemented within an institutional and regulatory framework that does not impede new supply capacity and that incorporated effective regulation of potential monopoly activities. The high variability in prices associated with the scarcity pricing arrangement will also likely make it better suited to larger urban centres that have the capacity to undertake the more detailed econometric analysis required to establish the pricing regime and absorb the economic impact of the pricing fluctuations.

Table D-5: TBL Assessment Results and Preliminary Screening of the Long List of Options

No	Option	Raw or Treated Water? (Pipeline Options Only)	Environmental		1	Economic		1	Social		1	Score	Cost per kL($)	Screening[3]
			Protection of Water for Environment	Infrastructure Footprint (Ha)	Purchase of Additional Entitlements	Efficient Water Usage	Efficient Energy Usage	Financial Burden ($ per Household)	Equity and Acceptability	Cost Effectiveness	Improvement to Urban Water Reliability			
Non-Infrastructure - Policies, Water Conservation and Demand Management														
2	Improved Metering of Water Consumption	N/A	3.0	0.0	3.0	3.0	2.0	3.0	3.0	2.0	2.0	**2.33**	**N/A**	**+**
7	Demand Management	N/A	3.0	0.0	3.0	3.0	3.0	3.0	3.0	2.0	1.0	**2.33**	**N/A**	**+**
4	Regional Water Conservation Implementation	N/A	3.0	0.0	3.0	3.0	2.0	3.0	3.0	2.0	1.0	**2.22**	**N/A**	**+**
11	Permanent Water Saving Rules	N/A	3.0	0.0	3.0	3.0	2.0	3.0	3.0	2.0	1.0	**2.22**	**N/A**	**+**
1	Irrigation Efficiency – Shared Benefits	N/A	3.0	0.0	3.0	3.0	2.0	2.0	3.0	2.0	1.0	**2.11**	**N/A**	**+, I**
5	Appropriate and Full Cost Recovery Pricing of Water Products	N/A	3.0	0.0	3.0	3.0	2.0	3.0	3.0	2.0	0.0	**2.11**	**N/A**	**+**
3	Uniform Restriction Regime	N/A	2.0	0.0	3.0	3.0	2.0	3.0	3.0	1.0	1.0	**2.00**	**N/A**	**+**
8	Shared Water Efficiency Savings Between Water Users	N/A	3.0	0.0	3.0	3.0	2.0	3.0	3.0	0.0	1.0	**2.00**	**N/A**	**+**
10	Restriction Policies Balancing	N/A	1.0	0.0	3.0	3.0	2.0	3.0	2.0	2.0	1.0	**1.89**	**N/A**	**C**
9	Scarcity Pricing	N/A	2.0	0.0	3.0	3.0	2.0	3.0	-1.0	3.0	1.0	**1.78**	**N/A**	**U, B**
6	Caps on Water Extraction	N/A	3.0	0.0	3.0	3.0	2.0	3.0	-3.0	3.0	1.0	**1.67**	**N/A**	**X**
12	Off-Grid Energy Sourcing	N/A	3.0	0.0	3.0	0.0	3.0	0.0	2.0	-2.0	0.0	**1.00**	**N/A**	**C**
Infrastructure – Recycling														
26	Recycling Water - Mining	N/A	N/A	N/A	0.0	0.0	N/A	N/A	2.0	N/A	N/A	**N/A**	**N/A**	**C, M**
27	Offset Schemes	N/A	N/A	N/A	0.0	0.0	N/A	N/A	2.0	N/A	N/A	**N/A**	**N/A**	**C, I**
13	Recycling Water - New Development - Bathurst	N/A	2.9	-0.6	0.0	0.0	-0.33	-0.48	2.0	1.4	2.1	**0.79**	**$2.03**	**+**
17	Recycling Water - New Development - Orange	N/A	3.0	-0.9	0.0	0.0	-0.33	-0.81	2.0	1.7	2.1	**0.75**	**$1.83**	**+**
15	Recycling Water - New Development - Forbes	N/A	2.6	-0.4	0.0	0.0	-0.33	-1.41	2.0	1.8	2.1	**0.72**	**$1.70**	**+**
16	Recycling Water - New Development - Lithgow	N/A	2.5	-0.4	0.0	0.0	-0.33	-0.56	2.0	1.1	2.1	**0.72**	**$2.90**	**+**
19	Recycling Water - New Development - Young	N/A	2.9	-0.6	0.0	0.0	-0.33	-1.63	2.0	2.0	2.1	**0.71**	**$1.65**	**+**
32	Lithgow Runoff Harvesting	N/A	-1.7	-0.1	0.0	0.0	0.85	-0.07	2.0	2.9	1.9	**0.64**	**$0.43**	**+**
18	Recycling Water - New Development - Wellington	N/A	2.7	-0.6	0.0	0.0	-0.33	-2.07	2.0	1.7	2.1	**0.62**	**$1.78**	**+**
14	Recycling Water - New Development - Condobolin	N/A	2.6	-0.4	0.0	0.0	-0.33	-1.78	2.0	1.3	2.1	**0.61**	**$2.40**	**+**
21	Recycling Water - Existing (Retrofit) - Parkes	N/A	2.8	-0.6	0.0	0.0	-0.33	-1.89	2.0	1.2	2.1	**0.59**	**$2.58**	**+**
24	Recycling Water - Existing (Retrofit) - Tottenham	N/A	2.1	-0.1	0.0	0.0	-0.33	-1.07	2.0	0.2	2.1	**0.55**	**$6.56**	**+**
23	Recycling Water - Existing (Retrofit) - Condobolin	N/A	2.4	-0.1	0.0	0.0	-0.33	-1.15	2.0	-0.3	2.1	**0.52**	**$7.82**	**+**
22	Recycling Water - Existing (Retrofit) - Lake Cargelligo	N/A	2.3	-0.1	0.0	0.0	-0.33	-1.22	2.0	-0.4	2.1	**0.50**	**$8.75**	**+**
20	Recycling Water - Existing (Retrofit) - Oberon	N/A	2.3	-0.1	0.0	0.0	-0.33	-1.22	2.0	-0.4	2.1	**0.50**	**$8.75**	**+**
25	Recycling Water - Existing (Retrofit) - Yeoval	N/A	2.2	-0.1	0.0	0.0	-0.33	-1.96	2.0	0.3	2.1	**0.47**	**$6.10**	**+**
29	Orange Stormwater Harvesting	N/A	-2.3	-0.9	0.0	0.0	0.93	-0.37	2.0	2.6	1.9	**0.42**	**$0.74**	**+**
30	Oberon Stormwater Harvesting	N/A	-1.0	-0.4	0.0	0.0	0.93	-2.00	2.0	2.0	1.9	**0.39**	**$1.60**	**+**
28	Bathurst Stormwater Harvesting	N/A	-2.4	-0.9	0.0	0.0	0.93	-0.52	2.0	2.4	1.9	**0.38**	**$0.79**	**X**
29A	Orange Stormwater Harvesting - Additional Catchments	N/A	-2.6	-1.2	0.0	0.0	0.93	-0.96	2.0	2.8	2.1	**0.35**	**$0.60**	**+**
31	Parkes Stormwater Harvesting	N/A	-2.5	-0.9	0.0	0.0	0.93	-2.04	2.0	2.5	1.9	**0.21**	**$0.76**	**+**
Infrastructure – Groundwater														
34	Accessing Groundwater Pockets - Orange	N/A	0.0	-0.1	0.0	0.0	-1.81	0.00	-2.0	2.1	2.1	**0.05**	**$1.51**	**L, E**
34	Accessing Groundwater Pockets - Forbes	N/A	-1.5	-1.1	0.0	0.0	-1.81	-1.52	-2.0	0.9	0.9	**-0.68**	**$2.97**	**L, E**
33	Managed Aquifer Recharge	N/A	1.0	-0.5	0.0	-1.0	-1.0	-1.0	-2.0	-2.0	0.0	**-0.72**	**N/A**	**C**
34	Accessing Groundwater Pockets - Lake Cargelligo	N/A	-1.6	-1.5	0.0	0.0	-2.63	-2.48	-2.0	1.2	2.1	**-0.76**	**$2.77**	**L, E**
Infrastructure - Supply Amplification														
37	Recommissioning Recreational Dams for Water Supply Use in Orange[4]	N/A	N/A	N/A	0.0	0.0	N/A	N/A	-1.0	N/A	N/A	**N/A**	**N/A**	**E**
43	Improving Water Security and Quality of Lake Cargelligo's Lakes - Compartmentalising Storage	N/A	N/A	N/A	0.0	0.0	N/A	N/A	2.0	N/A	N/A	**N/A**	**N/A**	**U, L**
44	Regional Pipe Network to Replace Farm Dams with Town Water Supply	Raw	N/A	N/A	0.0	0.0	N/A	N/A	-1.0	N/A	N/A	**N/A**	**N/A**	**X, I**
38	New Bulk Water Storage - Condobolin	N/A	-2.3	-0.6	0.0	0.0	2.04	-0.78	-3.0	3.0	2.1	**0.06**	**$0.29**	**L**
42	Off-Stream Buckinbah Creek Storage	N/A	0.6	-2.7	0.0	0.0	2.26	-2.41	1.0	0.0	0.9	**-0.04**	**$7.00**	**U, L**
38	New Bulk Water Storage - Wellington	N/A	-0.7	-0.9	0.0	0.0	1.75	-0.92	-3.0	1.9	0.9	**-0.11**	**$1.69**	**L**

[3] X = Not feasible, excluded from short list; + = Included in WATHNET model; U = Uncertain, further information/investigation required; L = Excluded from WATHNET model, local approach instead; B = Better alternative(s) available; D = Consider decentralised options; R = Part of regional water grid bundle; E = potential emergency supply; C = considered on a case by case basis; M = potential mutual benefits with mining activities; I = potential mutual benefits with irrigation

[4] Works to be commenced at Suma Park dam in 2010 are for dam safety purposes. Although capacity will be increased, previous assessments completed for this work indicated it is not expected to result in significant increased yield.

No	Option	Raw or Treated Water? (Pipeline Options Only)	Environmental		1	Economic		1	Social		1	Score	Cost per kL($)	Screening[3]
			Protection of Water for Environment	Infrastructure Footprint (Ha)	Purchase of Additional Entitlements	Efficient Water Usage	Efficient Energy Usage	Financial Burden ($ per Household)	Equity and Acceptability	Cost Effectiveness	Improvement to Urban Water Reliability			
38	New Bulk Water Storage - Cumnock	N/A	-1.1	-0.4	0.0	0.0	2.11	-2.74	-3.0	1.6	2.1	**-0.15**	**$1.99**	**L**
38	New Bulk Water Storage - Yeoval	N/A	-1.1	-0.4	0.0	0.0	2.11	-2.74	-3.0	1.6	2.1	**-0.15**	**$1.99**	**L**
41	Molong Creek Dam Augmentation	N/A	0.0	-2.7	0.0	0.0	3.00	-0.59	-1.0	-1.2	0.9	**-0.18**	**$17.91**	**X**
38	New Bulk Water Storage - Lake Cargelligo	N/A	0.3	-0.6	0.0	0.0	1.82	-1.55	-3.0	0.5	0.9	**-0.19**	**$5.22**	**L**
38	New Bulk Water Storage - Cowra	N/A	0.3	-0.6	0.0	0.0	1.82	-2.11	-3.0	-0.1	0.9	**-0.32**	**$7.63**	**L**
35	Lake Rowlands Augmentation	N/A	-2.6	-2.8	0.0	0.0	3.00	-2.33	-1.0	0.7	1.8	**-0.36**	**$3.21**	**R, +**
38	New Bulk Water Storage - Forbes	N/A	0.3	-0.6	0.0	0.0	1.82	-2.26	-3.0	-0.6	0.9	**-0.39**	**$10.00**	**L**
36	Chifley Dam Augmentation	N/A	-1.9	-2.8	0.0	0.0	3.00	-2.18	-2.0	0.3	0.9	**-0.52**	**$5.99**	**+**
40	Replacing Duckmaloi Weir with a Dam	N/A	-0.2	-2.9	0.0	0.0	3.00	-2.96	-1.0	-2.7	0.9	**-0.64**	**$92.16**	**U**
39	New Bulk Water Storage Upstream of Chifley	N/A	-1.9	-2.9	0.0	0.0	3.00	-2.59	-2.5	-0.9	0.9	**-0.77**	**$15.80**	**X, B**
38	New Bulk Water Storage - Abercrombie	N/A	-1.9	-2.9	0.0	0.0	3.00	-2.59	-3.0	-0.9	0.9	**-0.82**	**$15.80**	**X**
38	New Bulk Water Storage - Needles	N/A	-1.9	-2.9	0.0	0.0	3.00	-2.59	-3.0	-0.9	0.9	**-0.82**	**$15.80**	**X**
38	New Bulk Water Storage - Cranky Rock	N/A	-1.9	-2.9	0.0	0.0	3.00	-2.59	-3.0	-0.9	0.9	**-0.82**	**$15.80**	**X**
Infrastructure - Transfer Systems														
49	CTW-Orange Pipeline via Millthorpe	Raw	-0.8	0.0	0.0	0.0	3.00	-0.11	1.0	1.4	1.6	**0.67**	**$2.36**	**R, +**
75	Lachlan River-Lake Cargelligo Pipeline	Raw	-1.8	-1.1	0.0	0.0	1.30	-1.92	1.0	2.7	2.1	**0.26**	**$0.60**	**U**
53	Winburndale-Bathurst Pipeline	Raw	-1.7	-1.5	0.0	0.0	-1.07	-0.15	2.0	2.3	2.1	**0.22**	**$1.27**	**X, B**
54	Chifley-Bathurst Pipeline	Raw	-2.9	-1.3	0.0	0.0	0.78	-1.67	1.0	2.9	2.1	**0.11**	**$0.39**	**+**
68	Parkes-Forbes Pipeline	Raw	0.5	-1.4	0.0	0.0	1.37	-0.33	1.0	-0.8	0.1	**0.05**	**$11.72**	**X, B**
83	Woodstock-Cowra Pipeline	Treated	-0.1	-1.3	0.0	0.0	1.60	-0.70	1.0	-0.2	0.1	**0.05**	**$7.67**	**R, +**
78	Goldenfields Water-Burcher Pipeline	Treated	2.0	0.0	0.0	0.0	3.00	-2.93	1.0	-2.9	0.1	**0.03**	**$2,096.85**	**+**
55	Chifley-Bathurst-Orange Pipeline	Raw	-3.0	-2.5	0.0	0.0	0.71	-0.85	1.0	2.6	1.7	**-0.03**	**$0.64**	**X, D**
76	Lake Cargelligo-Euabalong Pipeline	Raw	1.9	-0.1	0.0	0.0	1.67	-2.52	1.0	-2.9	0.1	**-0.09**	**$311.94**	**X, B**
73	Bogan Gate-Condobolin Pipeline	Raw	1.5	-1.3	0.0	0.0	1.45	-1.11	1.0	-2.5	0.1	**-0.09**	**$72.10**	**R, X, B**
61	Molong Creek-Orange Pipeline	Raw	-0.3	-2.0	0.0	0.0	-1.22	-0.04	1.0	0.6	0.6	**-0.14**	**$4.59**	**R, X, B**
61A	Molong Creek Dam Augmentation + Molong Creek-Orange Pipeline	Raw	-0.3	-2.7	0.0	0.0	0.63	-0.22	1.0	-0.6	0.7	**-0.16**	**$8.76**	**X, B**
47	Chifley to Orange - Supply CTW + Cowra + Orange	Raw	-0.4	-2.3	0.0	0.0	-0.77	-0.29	1.0	0.1	0.8	**-0.20**	**$6.63**	**X, B**
52	Macquarie River-Orange Pipeline	Raw	-0.8	-2.0	0.0	0.0	-1.74	-0.44	1.0	0.6	1.6	**-0.21**	**$4.90**	**U, E**
71	Parkes-Bogan Gate Pipeline	Raw	1.5	-1.1	0.0	0.0	-0.70	-0.63	1.0	-2.1	0.1	**-0.22**	**$43.95**	**R, X, B**
58	Wyangala-CTW Pipeline via Cowra	Raw	-2.6	-1.9	0.0	0.0	-1.59	-1.30	1.0	2.3	1.8	**-0.25**	**$1.20**	**+**
50	Lake Rowlands Augmentation + to Blayney - Supply Bathurst + Orange	Raw	-0.6	-2.3	0.0	0.0	1.52	-1.00	1.0	-1.9	0.7	**-0.28**	**$31.75**	**X, B**
67	Eugowra-Forbes Pipeline	Raw	1.0	-1.2	0.0	0.0	-0.48	-1.19	1.0	-1.8	0.1	**-0.29**	**$29.93**	**X**
82	Goulburn-Crookwell Pipeline	Raw	1.2	-1.9	0.0	0.0	-1.15	-1.04	1.0	-1.7	0.6	**-0.33**	**$29.52**	**X**
79	Young-Bendick Murrell Pipeline	Treated	0.9	-1.8	0.0	0.0	-1.44	-0.26	1.0	-1.4	0.0	**-0.34**	**$25.42**	**U, X**
64	Wellington-Yeoval-Cumnock Pipeline	Raw	-1.1	-2.6	0.0	0.0	-0.85	-2.81	1.0	1.0	2.1	**-0.36**	**$2.97**	**R, +**
48	Bathurst - CTW via Blayney Pipeline	Raw	-0.5	-2.2	0.0	0.0	-2.11	-0.18	1.0	-0.3	0.8	**-0.38**	**$7.81**	**X, B**
64A	Wellington-Yeoval Pipeline	Raw	-1.1	-1.8	0.0	0.0	-1.66	-2.85	1.0	0.8	2.1	**-0.38**	**$3.20**	**X, B**
77	Ungarie-Weethalle Pipeline	Treated	1.6	-1.6	0.0	0.0	-1.37	-0.89	1.0	-2.3	0.1	**-0.39**	**$63.80**	**X**
57	Wyangala-CTW Pipeline near Mandurama	Raw	-2.6	-2.2	0.0	0.0	-2.03	-1.59	1.0	2.2	1.8	**-0.39**	**$1.39**	**+**
62	Molong-Manildra Pipeline	Treated	1.7	-1.7	0.0	0.0	-1.52	-0.67	1.0	-2.4	0.0	**-0.39**	**$67.68**	**R, X**
51	Lake Rowlands-Orange Pipeline	Raw	-1.4	-2.1	0.0	0.0	-1.96	-0.74	1.0	0.0	1.6	**-0.41**	**$6.94**	**R, X, B**
69	Gooloogong-Forbes Pipeline	Raw	1.0	-1.6	0.0	0.0	-0.55	-1.74	1.0	-2.0	0.1	**-0.41**	**$38.49**	**X, B**
45	Chifley-Oberon Pipeline	Raw	0.8	-1.7	0.0	0.0	-2.26	-1.81	1.0	-0.8	0.9	**-0.44**	**$13.27**	**X, B**
63	Manildra-Cumnock-Yeoval Pipeline	Raw	-1.1	-2.6	0.0	0.0	-1.00	-2.89	1.0	0.4	2.1	**-0.44**	**$5.40**	**R, X, B**
80	Young-Grenfell Pipeline	Treated	1.7	-1.9	0.0	0.0	-0.92	-1.44	1.0	-2.6	0.0	**-0.47**	**$88.99**	**X, B**
70	Trangie-Tottenham Pipeline	Raw	1.8	-1.4	0.0	0.0	-0.62	-2.44	1.0	-2.8	0.1	**-0.48**	**$252.92**	**X**
72	Fifield-Bogan Gate Pipeline	Raw	2.0	-1.4	0.0	0.0	-0.40	-3.00	1.0	-3.0	0.1	**-0.51**	**$4,607.78**	**X, D**
66	Manildra-Parkes-Bogan Gate Pipeline	Raw	0.4	-2.1	0.0	0.0	-1.30	-1.37	1.0	-1.7	0.1	**-0.54**	**$29.27**	**X, B**
60	Burrendong-Wellington Pipeline	Raw	1.4	-1.7	0.0	0.0	-2.18	-1.48	1.0	-2.2	0.1	**-0.57**	**$49.03**	**X, B**
46	Chifley to Blayney - Supply CTW	Raw	0.6	-2.1	0.0	0.0	-2.41	-1.70	1.0	-1.5	0.9	**-0.59**	**$28.70**	**U**
74	Condobolin-Tullibigeal Pipeline	Raw	1.2	-1.6	0.0	0.0	-2.48	-2.22	1.0	-2.0	0.9	**-0.59**	**$43.42**	**X**
45B	Winburndale-Lithgow Pipeline	Raw	0.3	-2.3	0.0	0.0	-2.92	-1.33	1.0	-1.4	0.9	**-0.63**	**$22.79**	**U**
54A	Bathurst-Orange Pipeline	Raw	-0.6	-2.4	0.0	0.0	-2.55	-0.41	0.0	-0.7	0.8	**-0.66**	**$11.58**	**R, +**
65	Lake Endeavour-Manildra Pipeline - Supply CTW	Raw	1.1	-2.0	0.0	0.0	-2.33	-1.85	1.0	-2.3	0.1	**-0.69**	**$61.66**	**X, B**
59	Wyangala-CTW Pipeline via Carcoar	Raw	-2.6	-2.4	0.0	0.0	-2.85	-2.30	1.0	0.9	1.8	**-0.72**	**$2.98**	**+**
45A	Winburndale-Oberon Pipeline	Raw	0.8	-2.6	0.0	0.0	-2.77	-2.37	1.0	-1.6	0.9	**-0.74**	**$29.12**	**U**

No	Option	Raw or Treated Water? (Pipeline Options Only)	Environmental		1	Economic		1	Social		1	Score	Cost per kL($)	Screening[3]
			Protection of Water for Environment	Infrastructure Footprint (Ha)	Purchase of Additional Entitlements	Efficient Water Usage	Efficient Energy Usage	Financial Burden ($ per Household)	Equity and Acceptability	Cost Effectiveness	Improvement to Urban Water Reliability			
81	Wyangala-Crookwell Pipeline	Raw	1.3	-2.4	0.0	0.0	-2.70	-2.55	1.0	-2.6	0.9	**-0.78**	**$84.74**	**X, B**
56	Burrendong-Orange Pipeline	Raw	-0.8	-2.5	0.0	0.0	-2.99	-2.15	1.0	-1.3	1.6	**-0.79**	**$20.43**	**X, B**

D.6 DEVELOPING SCENARIOS OF OPTIONS

A series of themed scenarios were formed from the short listed options. Each of the scenarios embodied a particular theme, ranging from a region-wide water grid to various sub-modules of the grid to water recycling and stormwater harvesting at major urban centres. Each of these scenarios was modelled to test the relative water security improvement outcomes and cost estimates.

Table D-6 sets out the scenarios modelled, the options bundled into each scenario, as well as the characterisation outcomes of the scenarios. The scenarios are:

- Scenario 1: Regional Water Grid – a region wide water supply network that is reasonably cost effective and consisting of only pipelines to provide water security to the Centroc region.

- Scenario 2: Recycling and Stormwater Harvesting – opportunistic recycling and stormwater harvesting facilities for towns with >500 new developments expected within the forecast horizon, as well as those identified to have the potential for retrofitting existing developments. Stormwater harvesting was considered where water supply storages are located in close proximity to stormwater collection sources, such as in Lithgow, Orange, Parkes and Oberon.

- Scenario 3: Lake Rowlands Regional Network – supplementing a regional supply network consisting of the Central Tablelands Water network, Orange, Cowra, Parkes and Forbes using an augmented Lake Rowlands storage.

- Scenario 4: Chifley Dam Regional Network – supplementing a regional supply network consisting of the Central Tablelands Water network, Orange and Cowra using the Chifley Dam.

- Scenario 5: Irrigation Efficiency – Shared Benefits – investment into improved irrigation efficiency systems by Centroc to share the savings in water with the irrigation industry.

- Scenario 6: Preferred Local Options – a selection of local options aimed at filling water security gaps arising from the regional approach. Modelling has determined the reliability of local supply system and the preferred local solutions were determined here by comparing a number of options for river-side towns against the TBL assessment criteria. The comparisons were made for the following towns and villages:

    - Lithgow and Oberon, between:
        a. Pipeline from Chifley Dam to Oberon (Scenario 6a); and
        b. Recycling in Lithgow and Oberon, stormwater harvesting in Oberon and Winburndale-Lithgow Pipeline (Scenario 6b).
    - Cumnock and Yeoval, between:
        a. Pipeline connection from CTW to Cumnock, Yeoval from Manildra (Scenario 6c); and
        b. New minor storages at Cumnock and Yeoval (Scenario 6d).
    - Orange, between:
        a. Accessing local groundwater pockets (Scenario 6e);
        b. Pipeline connection from CTW to Orange from Millthorpe (Scenario 6f);
        c. Augmenting Molong Creek Dam and pipeline connection to Orange (Scenario 6g); and
        d. Pipeline from a Macquarie River offtake to Orange (Scenario 6s).
    - Forbes, between:
        a. Pipeline connection from CTW to Forbes from Gooloogong (Scenario 6h);

    b. New minor storage at Forbes (Scenario 6m); and
    c. Accessing local groundwater pockets (Scenario 6q).

- Cowra, between:
    a. Pipeline connection from CTW to Cowra from Woodstock (Scenario 6i); and
    b. New minor storage at Cowra (Scenario 6n).
- Lake Cargelligo, between:
    a. Pipeline connection from Lachlan River weir pool to a new minor storage at Lake Cargelligo (Scenario 6j);
    b. New minor off-stream storage at Lake Cargelligo only (Scenario 6o); and
    c. Accessing local groundwater pockets (Scenario 6q).
- Wellington, between:
    a. Pipeline connecting Burrendong Dam to Wellington to minimise transfer losses (Scenario 6l); and
    b. New minor storage at Wellington (Scenario 6r).

Table D-6: Details of Thematic Scenarios for Further Modelling

#	THEMATIC SCENARIOS	OPTIONS INVOLVED	TOTAL PIPELINE LENGTH (KM)	ENERGY USE (KWHR/ ML)	NPV CAPITAL COST	ANNUALISED TOTAL OM&D COST ($/A)	COST EFFECTIVENESS – RELIABILITY ($/% IMPROVEMENT IN RELIABILITY)	FINANCIAL BURDEN ($/RESIDENTIAL PROPERTY)	IMPROVEMENT IN URBAN WATER RELIABILITY	TOTAL INFRASTRUCTURE FOOTPRINT (HA)
1	Regional Water Grid	• Lake Rowlands Augmentation • Chifley-Oberon Pipeline • Chifley-Bathurst Pipeline • Chifley to CTW Pipeline via Blayney • Blayney-Millthorpe Pipeline (CTW Trunk Mains X and F duplication) • CTW-Orange Pipeline via Millthorpe • Orange-Molong Creek Pipeline • Molong-Manildra Pipeline • Manildra-Cumnock-Yeoval Pipeline • Yeoval-Wellington Pipeline • Manildra-Parkes Pipeline • Parkes-Bogan Gate Pipeline • Bogan Gate-Condobolin Pipeline • Lake Rowlands to Gooloogong Pipeline (CTW Trunk Mains P and C duplication) • Gooloogong-Forbes Pipeline • Woodstock-Cowra Pipeline (under construction)	571	2,390.8	$330,295,378	$10,056,584	$1,353	$2,658	14.8%	170.26
2	Recycling and Stormwater Harvesting	• Recycling Water – New Development – Bathurst, Condobolin, Forbes, Lithgow, Orange, Wellington, Young • Recycling Water – Retrofitting – Oberon, Parkes, Lake Cargelligo, Condobolin, Tottenham, Yeoval • Stormwater Harvesting – Orange (additional catchments), Oberon, Parkes, Lithgow	81	1,347.8	$88,033,897	$2,897,468	$864	$1,337	25.6%	0.08
3	Lake Rowlands Regional Network	• Lake Rowlands Augmentation • Lake Rowlands-Millthorpe Pipeline (CTW Trunk Mains D and F duplication) • CTW-Orange Pipeline via Millthorpe • Lake Rowlands to Gooloogong Pipeline (CTW Trunk Mains P and C duplication) • Gooloogong-Forbes Pipeline (including connection to Parkes) • Woodstock-Cowra Pipeline (under construction)	205	2,590.7	$227,399,744	$7,912,116	$2,243	$4,429	6.8%	170.11
4	Chifley Dam Regional Network	• Chifley-Bathurst Pipeline • Chifley to CTW Pipeline via Blayney • Blayney-Millthorpe Pipeline (CTW Trunk Mains X and F duplication) • CTW-Orange Pipeline via Millthorpe • Orange-Molong Creek Pipeline • Woodstock-Cowra Pipeline (under construction)	153	1,712.9	$77,146,652	$4,659,049	$2,139	$1,338	4.7%	0.08
5	Irrigation Efficiency - Shared Benefits	• Irrigation Efficiency – Shared Benefits	0	0.0	$2,098,692	$0	$35	$73	10.1%	0.00

#	THEMATIC SCENARIOS	OPTIONS INVOLVED	TOTAL PIPELINE LENGTH (KM)	ENERGY USE (KWHR/ ML)	NPV CAPITAL COST	ANNUALISED TOTAL OM&D COST ($/A)	COST EFFECTIVENESS – RELIABILITY ($/% IMPROVEMENT IN RELIABILITY)	FINANCIAL BURDEN ($/RESIDENTIAL PROPERTY)	IMPROVEMENT IN URBAN WATER RELIABILITY	TOTAL INFRASTRUCTURE FOOTPRINT (HA)
6	Preferred Local Options	• Chifley Dam-Oberon Pipeline • New bulk water storages at Cumnock, Yeoval, Condobolin, Lake Cargelligo, Cowra, Forbes, Wellington • Lachlan River-Lake Cargelligo Pipeline • Woodstock-Cowra Pipeline (under construction)	130	2,999.3	$43,606,184	$2,548,641	N/A	$2,871	N/A	0.20
6a	Chifley Dam to Oberon Pipeline	• Chifley-Oberon Pipeline	43	7,477.6	$12,848,202	$1,136,366	$126	$4,182	97.3%	0.04
6b	Winburndale to Lithgow Pipeline + Recycling + Stormwater Harvesting	• Recycling Water – New Development – Lithgow • Recycling Water – Existing (Retrofit) – Oberon • Stormwater Harvesting – Lithgow • Winburndale-Lithgow Pipeline	68	3,601.2	$25,032,414	$657,500	$152	$1,487	97.3%	0.07
6c	Pipelines to Cumnock and Yeoval	• Lake Rowlands to Manildra Pipeline (Trunk Mains P, C and U duplication) • Manildra-Cumnock-Yeoval Pipeline	144	5,660.8	$22,857,419	$545,596	$13,503	$39,376	22.7%	0.08
6d	New Storages at Cumnock and Yeoval	• New Minor Storage at Cumnock • New Minor Storage at Yeoval	10	171.3	$4,445,174	$174,272	$2,924	$22,475	23.5%	0.05
6e	Groundwater for Orange	• Accessing Groundwater Pocket – Orange	5	3,879.4	$698,943	$38,279	$73	$78	2.7%	0.01
6f	CTW Connection to Orange	• Lake Rowlands to Millthorpe Pipeline (Trunk Mains D and F duplication) • Millthorpe-Orange Pipeline	57	1,967.8	$35,115,545	$878,622	$2,836	$2,949	2.7%	0.02
6g	Molong - Orange Link	• Molong Creek Dam Augmentation • Molong Creek-Orange Pipeline	17	2,359.4	$23,640,481	$776,517	$1,229	$1,051	4.6%	25.03
6s	Macquarie River offtake to Orange Pipeline	• Macquarie River-Orange Pipeline	28	3,547.1	$24,745,571	$1,300,273	$2,545	$2,724	2.7%	0.03
6h	CTW Connection to Forbes	• Lake Rowlands to Gooloogong Pipeline (Trunk Mains P and C duplication) • Gooloogong-Forbes Pipeline	120	4,075.3	$44,950,008	$745,717	$4,099	$7,889	10.0%	0.06
6m	New Storage at Forbes	• New Minor Storage at Forbes	5	161.9	$6,617,372	$125,920		$2,393		0.03
6p	Groundwater for Forbes	• Accessing Groundwater Pocket – Forbes	5	3,879.4	$5,692,982	$275,451	$1,397	$2,792	5.0%	0.01
6i	CTW Connection to Cowra	• CTW Network to Cowra via Woodstock Pipeline (under construction)	20	835.6	$2,466,702	$25,736	$197	$496	9.8%	0.01
6n	New Storage at Cowra	• New Minor Storage at Cowra	5	208.9	$5,577,321	$106,800		$1,254		0.00
6j	Lachlan River to Lake Cargelligo Pipeline + Off Stream Storage	• Lachlan River to Lake Cargelligo Pipeline • New Minor Storage at Lake Cargelligo	19	730.4	$4,415,482	$141,542	$5,491	$1,913	5.0%	0.06
6o	New Storage at Lake Cargelligo	• New Minor Storage at Lake Cargelligo	5	259.3	$1,644,151	$26,867		$1,190		0.00
6q	Groundwater for Lake Cargelligo	• Accessing Groundwater Pocket – Lake Cargelligo	32	6,314.0	$9,303,814	$278,138	$11,338	$7,880	5.0%	0.00
6l	Burrendong to Wellington Pipeline	• Burrendong-Wellington Pipeline	28	4,069.3	$11,660,311	$899,213	$5,483	$9,001	5.0%	0.02
6r	New Storage at Wellington	• New Minor Storage at Wellington	5	272.5	$3,046,623	$53,417		$1,355		0.00
6k	New Storage at Condobolin	• New Minor Storage at Condobolin	5	243.8	$2,192,992	$64,712	$839	$897	7.7%	0.04

D.7 TBL ASSESSMENT OF SCENARIOS

A TBL assessment approach similar to that used to complete the preliminary screening of the long list of options was used to evaluate the scenarios. The results of the water security modelling assessment (see Appendix C) and the assessment of the capital and operating costs of each option were important inputs to the TBL process. Table D-7 sets out the outcomes of the TBL assessment of scenarios.

The key outcomes from the TBL assessment of the themed scenarios are summarised below:

- The Irrigation Efficiency - Shared Benefits scenario performs comparatively well, followed by the Recycling and Stormwater Harvesting scenario. However, the relative certainty of the water security improvement to be obtained is poor for these two scenarios compared to those including regional grids. Nevertheless, an opportunity remains for the opportunistic adoption of a shared benefits approach between individual member Council's and irrigation interests that may be identified in an Expression of Interest process similar to that implemented by the Commonwealth government. Similarly, the potential to use this option to provide for the environmental requirements downstream of new dams should also be considered in parallel to the design process of any new or augmented storage.

- Comparison of local scenarios identified the preferred options for a number of towns:

    - Chifley Dam to Oberon pipeline (Scenario 6a) is significantly cheaper and more cost effective than the Lithgow stormwater harvesting/water recycling scheme (Scenario 6b). It improves water security of Oberon with the potential to supplement supply to Lithgow. There may also be the opportunity to increase the volume of water supplied to Lithgow from Clarence Colliery, although the potential yields from this option are unclear and this option was not evaluated in this report. There may also be opportunities to supplement supply to power stations from other sources which would reduce the reliance of Delta Electricity on Oberon Dam and improve the security for both Lithgow and Oberon. Further investigation on the Fish River Water Supply would be required to confirm this.

    - The construction of minor storages for supply of Cumnock and Yeoval – compared to extending a pipeline link from the CTW network via Manildra. Both Cumnock and Yeoval have sizeable catchment areas which are suitable for locating bulk water storages. The storage options will also include construction of a treatment plant to treat water for the villages.

    - Constructing off-stream storages are the preferred local options for river-side towns and villages compared to pipeline links and groundwater solutions. The local water storages should prevent total failure of the supply system by supplementing the provision to towns when water levels in the primary storage reach certain pump marks. This outcome applied to:

        a. Lake Cargelligo – compared to the next highest scoring pipeline from the Lachlan River weir pool to the town's WTP, followed by the groundwater solution which is the most expensive local option for Lake Cargelligo.

        b. Condobolin – the off-stream storage option was the only local option investigated for Condobolin and scores favourably (0.65) against all other local options.

    - Pipeline connection from Burrendong Dam to Wellington is the preferred local option for Wellington over the minor off-stream storage.

    - Lake Rowlands connection to Orange via Millthorpe, including duplication of CTW's transfer system, provides the greatest improvement in reliability and is the preferred long term solution for Orange. It is costly when considered as a standalone local option but will be incorporated as part of a regional network. The pipeline from Macquarie River off-take and groundwater local options can be considered as short to medium term solutions in the form of emergency supplies.

As there is considerable uncertainty around the hydrology of both Orange and Molong, consideration has been given to the Molong-Orange connection. At this point it is not clear the link is required, however it should be maintained as a potential option of lower priority for implementation.

- The Lake Rowlands connection to Forbes and Parkes via Gooloogong, including duplication of CTW's transfer system, as part of the regional network is the recommended long term solution. Groundwater may be an option for emergency supplies.

The outcomes of the assessment provided insight into the feasibility and water security improvement capabilities of various regional and local solutions. The project team subsequently utilised this insight to develop viable region-wide strategies to address the water security needs of all the towns with a need for security improvement.

Table D-7: TBL Assessment of Thematic Scenarios

Relevant Urban Centres (Comparison of Local Solutions Only)	No	Option	Environmental		1	Economic		1	Social		1	Total Capital NPV	Annualised Total OM&D ($/a)	Cost Effectiveness ($/% improvement in reliability)	Score
			Protection of Water for Environment	Infrastructure Footprint	Purchase of Additional Entitlements?	Cost Effectiveness	Efficient Energy Usage	Cost of Water Supplied ($ per kL)	Equity and Acceptability	Financial Burden on Households	Improvement to Urban Water Reliability				
		Indicator:	Additional Extraction (kL/household/annum)	Hectares	NA	($/% improvement in reliability)	(kWhr/ML)	($ per kL)	NA	($/residential property)	Improvement in Reliability (%)				
Non-Local/ Region-Wide Scenarios	1	Regional Water Grid	0.6	-2.2	0.0	0.1	-0.6	-0.8	-1.0	-0.2	-0.4	$330,295,378	$10,056,584	$1,353	-0.49
	2	Recycling and Stormwater Harvesting	3.0	-1.0	0.0	1.6	1.2	0.8	2.0	1.6	-2.5	$88,033,897	$2,897,468	$864	0.74
	3	Lake Rowlands Regional Network	-1.8	-2.0	-1.0	-1.1	-1.0	-2.6	-1.0	-2.0	0.8	$227,399,744	$7,912,116	$2,243	-1.29
	4	Chifley Dam Regional Network	-1.4	-0.8	0.0	-0.8	0.4	2.4	-1.0	1.4	2.0	$77,146,652	$4,659,049	$2,139	0.25
	5	Irrigation Efficiency - Shared Benefits	3.0	3.0	0.0	3.0	3.0	3.0	2.0	3.0	-0.1	$2,098,692	-	$35	2.21
	6	Preferred Local Options	-2.0	-1.2	0.0	N/A[5]	-1.2	2.2	0.0	-0.8	N/A	$43,606,184	$2,548,641	N/A	-0.33
Oberon and Lithgow	6a	Chifley Dam to Oberon Pipeline	-1.2	0.4	0.0	2.5	-3.0	-0.4	0.0	-1.8	-3.0	$12,848,202	$1,136,366	$126	-0.72
	6b	Winburndale to Lithgow Pipeline + Recycling + Stormwater Harvesting	2.2	-0.4	0.0	2.3	-1.6	-2.4	0.0	1.0	-2.8	$25,032,414	$657,500	$152	-0.19
Cumnock and Yeoval	6c	Pipelines to Cumnock and Yeoval	-2.6	-0.6	0.0	-3.0	-2.6	-2.2	1.0	-3.0	-2.0	$22,857,419	$545,596	$13,503	-1.67
	6d	New Storages at Cumnock and Yeoval	-3.0	0.2	0.0	-1.8	2.6	-1.4	1.0	-2.8	-2.3	$4,445,174	$174,272	$2,924	-0.83
Orange	6e	Groundwater for Orange	2.4	2.0	0.0	2.8	-2.0	1.0	1.0	2.8	3.0	$698,943	$38,279	$73	1.44
	6f	CTW Connection to Orange	-0.8	1.4	0.0	-1.6	-0.2	-0.2	1.0	-1.0	3.0	$35,115,545	$878,622	$2,836	0.18
	6g	Molong - Orange Link	1.6	-1.8	0.0	0.4	-0.4	-1.2	1.0	2.2	2.3	$23,640,481	$776,517	$1,229	0.45
	6s	Macquarie River offtake to Orange Pipeline	-0.8	0.8	0.0	-1.3	-1.4	0.0	1.0	-0.4	3.0	$24,745,571	$1,300,273	$2,545	0.10
Forbes	6h	CTW Connection to Forbes	2.0	-0.2	0.0	-2.0	-2.4	-2.8	1.0	-2.4	0.1	$44,950,008	$745,717	$4,099	-0.75
	6m	New Storage at Forbes	0.8	1.0	0.0	N/A	2.8	-0.6	1.0	0.6	0.0	$6,617,372	$125,920	N/A	0.62
	6p	Groundwater for Forbes	1.0	1.8	0.0	-0.4	-1.8	-2.0	1.0	-0.6	1.8	$5,692,982	$275,451	$1,397	0.09
Cowra	6i	CTW Connection to Cowra	2.6	1.6	0.0	2.0	1.4	-3.0	1.0	2.6	0.4	$2,466,702	$25,736	$197	0.96
	6n	New Storage at Cowra	1.4	3.0	0.0	N/A	2.4	0.4	1.0	1.8	0.0	$5,577,321	$106,800	N/A	1.11
Lake Cargelligo	6j	Lachlan River to Lake Cargelligo Pipeline + Off Stream Storage	-2.2	0.0	0.0	1.8	1.6	2.6	1.0	0.8	0.6	$4,415,482	$141,542	$5,491	0.69
	6o	New Storage at Lake Cargelligo	1.8	3.0	0.0	N/A	2.0	-1.8	1.0	2.0	0.0	$1,644,151	$26,867	N/A	0.89
	6q	Groundwater for Lake Cargelligo	-1.6	3.0	0.0	-2.8	-2.8	-1.6	1.0	-2.2	1.8	$9,303,814	$278,138	$11,338	-0.57
Wellington	6l	Burrendong to Wellington Pipeline	-2.8	1.2	0.0	-2.3	-2.2	2.0	1.0	-2.6	1.8	$11,660,311	$899,213	$5,483	-0.43
	6r	New Storage at Wellington	1.2	3.0	0.0	N/A	1.8	0.2	1.0	1.2	0.0	$3,046,623	$53,417	N/A	0.93
Condobolin	6k	New Storage at Condobolin	-2.4	0.6	0.0	1.8	2.2	2.8	1.0	2.4	0.6	$2,192,992	$64,712	$839	1.00

[5] Scenarios with N/A marked against their "Cost Effectiveness" criterion contain options that are aimed at preventing water supply systems from being empty. This is achieved by constructing additional storages that will be used to supplement the urban demands when their primary storage reaches 20% capacity in the model. The trade-off between actual pump mark and storage sizes will be determined at the detailed design stage. These options do not reduce the probability of a restriction being imposed on a supply storage and therefore has no score on the particular criterion.

D.8 DEVELOPING REGION-WIDE WATER SECURITY STRATEGIES

The process of assessing the long-list of potential options and evaluating the thematic scenarios culminated in the development of six region-wide water security strategies. Each of the strategies addresses the long term water security needs of each of the towns with an identified need for water security improvement. The strategies consider water requirements until the year 2059.

Table D-8 sets out details of the six water security strategies developed to address the regional water security needs. The strategies are:

- Strategy F1: Regional Water Grid + Local Options – this strategy is an extension of the initial Regional Water Grid scenario to include the pipeline connection from Lachlan River to Lake Cargelligo as a local solution.

- Strategy F2: Lake Rowlands Regional Network + Local Options – this strategy is an extension of the initial augmented Lake Rowlands Regional Network scenario to include new minor storages for the river-side towns of Cumnock, Yeoval, Wellington, Condobolin and Lake Cargelligo, as well as a pipeline connection from Lachlan River to Lake Cargelligo as local solutions.

- Strategy F2a: Lake Rowlands Regional Network + Local Options + Cadia Hill – this strategy further extends Strategy F2 to include the potential supply to the mine at Cadia Hill. The pipeline capacity from Belubula Creek to Cadia Hill has been constructed but is currently not transferring water supply to the mine.

- Strategy F3: Chifley Dam Regional Network + Local Options – this strategy is an extension of the initial Chifley Dam Regional Network scenario to include new minor storages for the river-side towns of Cumnock, Yeoval, Wellington, Condobolin and Lake Cargelligo, as well as a pipeline connection from Lachlan River to Lake Cargelligo as local solutions.

- Strategy F3a: Chifley Dam Regional Network + Local Options + Cadia Hill – this strategy further extends Strategy F3 to include the potential supply to the mine at Cadia Hill. The pipeline capacity from Belubula Creek to Cadia Hill has been constructed but is currently not transferring water supply to the mine.

- Strategy F4: Lake Rowlands & Chifley Dam Regional Network + Local Options + Cadia Hill – this strategy combines both an augmented Lake Rowlands and Chifley Dam to supplement the supply to regional urban demands as well as potentially to the mine at Cadia Hill. The strategy also includes new minor storages for the river-side towns of Cumnock, Yeoval, Wellington, Condobolin and Lake Cargelligo, as well as the pipeline connection from Lachlan River to Lake Cargelligo as local solutions.

The infrastructure options involved in each water security strategies are also visually represented by Figure D-1 to Figure D-6 further below.

Table D-8: Details of Final Region-Wide Water Security Strategies

#	WATER SECURITY STRATEGY	OPTIONS INVOLVED	TOTAL PIPELINE LENGTH (KM)	ENERGY USE (KWHR/ ML)	NPV CAPITAL COST	ANNUALISED TOTAL OM&D COST ($/A)	COST EFFECTIVENESS – RELIABILITY ($/% IMPROVEMENT IN RELIABILITY)	FINANCIAL BURDEN ($/RESIDENTIAL PROPERTY)	IMPROVEMENT IN URBAN WATER RELIABILITY	TOTAL INFRASTRUCTURE FOOTPRINT (HA)
F1	Regional Water Grid + Local Options	• Lake Rowlands Augmentation • Chifley-Oberon Pipeline • Chifley-Bathurst Pipeline • Chifley to CTW Pipeline via Blayney • Blayney-Millthorpe Pipeline (CTW Trunk Mains X and F duplication) • CTW-Orange Pipeline via Millthorpe • Orange-Molong Creek Pipeline • Molong-Manildra Pipeline • Manildra-Cumnock-Yeoval Pipeline • Yeoval-Wellington Pipeline • Manildra-Parkes Pipeline • Parkes-Bogan Gate Pipeline • Bogan Gate-Condobolin Pipeline • Lake Rowlands to Forbes Pipeline via Gooloogong (including duplication of trunk mains P and C) • Woodstock-Cowra Pipeline • Lachlan River-Lake Cargelligo Pipeline	585	1,872.4	$349,481,564	$9,268,433	$1,470	$2,632	15.9%	170.27
F2	Lake Rowlands Regional Network + Local Options	• Lake Rowlands Augmentation • Lake Rowlands to Orange Pipeline via Millthorpe (including duplication of trunk mains X and F) • Orange-Molong Creek Pipeline • Lake Rowlands to Forbes and Parkes Pipeline via Gooloogong (including duplication of trunk mains P and C) • Woodstock-Cowra Pipeline • New minor storage at Cumnock • New minor storage at Yeoval • New minor storage at Condobolin (off-stream from Lachlan River) • New minor storage at Lake Cargelligo • Lachlan River-Lake Cargelligo Pipeline • Burrendong-Wellington Pipeline • Chifley-Bathurst Pipeline • Chifley-Oberon Pipeline	343	1,687.3	$253,101,055	$7,659,179	$1,103	$3,516	15.9%	170.31

#	WATER SECURITY STRATEGY	OPTIONS INVOLVED	TOTAL PIPELINE LENGTH (KM)	ENERGY USE (KWHR/ ML)	NPV CAPITAL COST	ANNUALISED TOTAL OM&D COST ($/A)	COST EFFECTIVENESS – RELIABILITY ($/% IMPROVEMENT IN RELIABILITY)	FINANCIAL BURDEN ($/RESIDENTIAL PROPERTY)	IMPROVEMENT IN URBAN WATER RELIABILITY	TOTAL INFRASTRUCTURE FOOTPRINT (HA)
F2a	Lake Rowlands Regional Network + Local Options + Cadia Supply	• Lake Rowlands Augmentation • CTW Trunk Mains X and F duplication • CTW-Orange Pipeline via Millthorpe • Orange-Molong Creek Pipeline • Lake Rowlands to Forbes and Parkes Pipeline via Gooloogong (including duplication of trunk mains P and C) • Woodstock-Cowra Pipeline • New minor storage at Cumnock • New minor storage at Yeoval • New minor storage at Condobolin (off-stream from Lachlan River) • New minor storage at Lake Cargelligo • Lachlan River-Lake Cargelligo Pipeline • Burrendong-Wellington Pipeline • Chifley-Bathurst Pipeline • Chifley-Oberon Pipeline	359	1,396.3	$261,501,055	$7,797,509	$1,099	$3,516	15.9%	170.31
F3	Chifley Dam Regional Network + Local Options	• Chifley to CTW Pipeline via Blayney • CTW Trunk Mains X and F duplication • CTW-Orange Pipeline via Millthorpe • Orange-Molong Creek Pipeline • Lake Rowlands to Forbes and Parkes Pipeline via Gooloogong (including duplication of trunk mains P and C) • Woodstock-Cowra Pipeline • New minor storage at Cumnock • New minor storage at Yeoval • New minor storage at Condobolin (off-stream from Lachlan River) • New minor storage at Lake Cargelligo • Lachlan River-Lake Cargelligo Pipeline • Burrendong-Wellington Pipeline • Chifley-Bathurst Pipeline • Chifley-Oberon Pipeline	383	2,459.3	$194,518,950	$7,450,557	$912	$2,526	15.9%	0.34

#	WATER SECURITY STRATEGY	OPTIONS INVOLVED	TOTAL PIPELINE LENGTH (KM)	ENERGY USE (KWHR/ ML)	NPV CAPITAL COST	ANNUALISED TOTAL OM&D COST ($/A)	COST EFFECTIVENESS – RELIABILITY ($/% IMPROVEMENT IN RELIABILITY)	FINANCIAL BURDEN ($/RESIDENTIAL PROPERTY)	IMPROVEMENT IN URBAN WATER RELIABILITY	TOTAL INFRASTRUCTURE FOOTPRINT (HA)
F3a	Chifley Dam Regional Network + Local Options + Cadia Supply	• Chifley to CTW Pipeline via Blayney • CTW Trunk Mains X and F duplication • CTW-Orange Pipeline via Millthorpe • Orange-Molong Creek Pipeline • Lake Rowlands to Forbes and Parkes Pipeline via Gooloogong (including duplication of trunk mains P and C) • Woodstock-Cowra Pipeline • New minor storage at Cumnock • New minor storage at Yeoval • New minor storage at Condobolin (off-stream from Lachlan River) • New minor storage at Lake Cargelligo • Lachlan River-Lake Cargelligo Pipeline • Burrendong-Wellington Pipeline • Chifley-Bathurst Pipeline • Chifley-Oberon Pipeline • Belubula Creek-Cadia Hill pipeline (already available)	399	1,955.6	$202,918,950	$7,588,888	$905	$2,526	15.9%	0.35
F4	Lake Rowlands & Chifley Regional Network + Local Options + Cadia Supply	• Lake Rowlands Augmentation • Chifley to CTW Pipeline via Blayney • Lake Rowlands to Orange Pipeline via Millthorpe (including duplication of trunk mains X and F) • Orange-Molong Creek Pipeline • Lake Rowlands to Forbes and Parkes Pipeline via Gooloogong (including duplication of trunk mains P and C) • Woodstock-Cowra Pipeline • New minor storage at Cumnock • New minor storage at Yeoval • New minor storage at Condobolin (off-stream from Lachlan River) • New minor storage at Lake Cargelligo • Lachlan River-Lake Cargelligo Pipeline • Burrendong-Wellington Pipeline • Chifley-Bathurst Pipeline • Chifley-Oberon Pipeline • Belubula Creek-Cadia Hill pipeline (already available)	407	1,640.1	$324,222,846	$10,120,449	$1,389	$3,129	15.9%	170.41

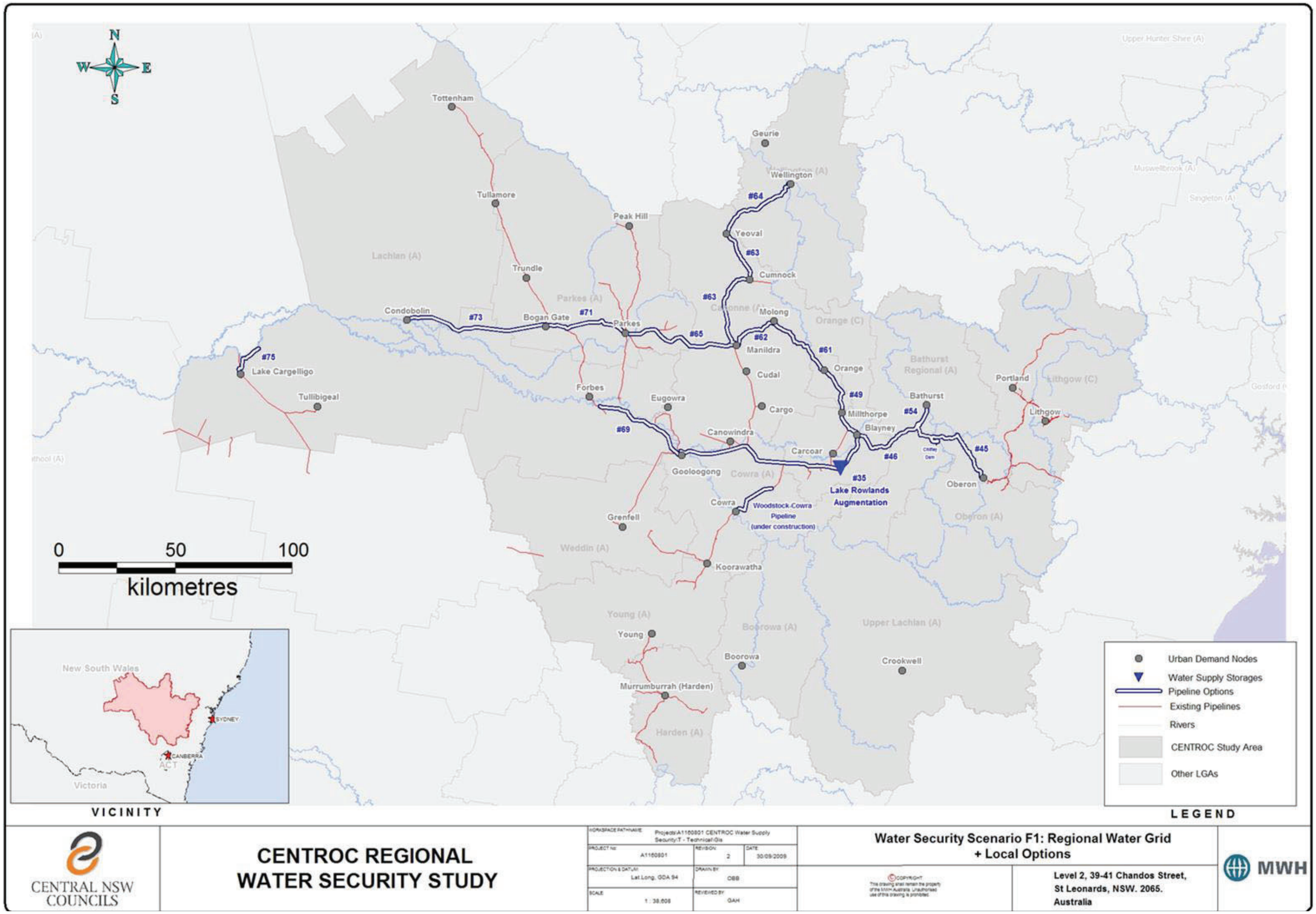

Figure D-1: Final Strategy F1: Regional Water Grid with Selected Local Solutions

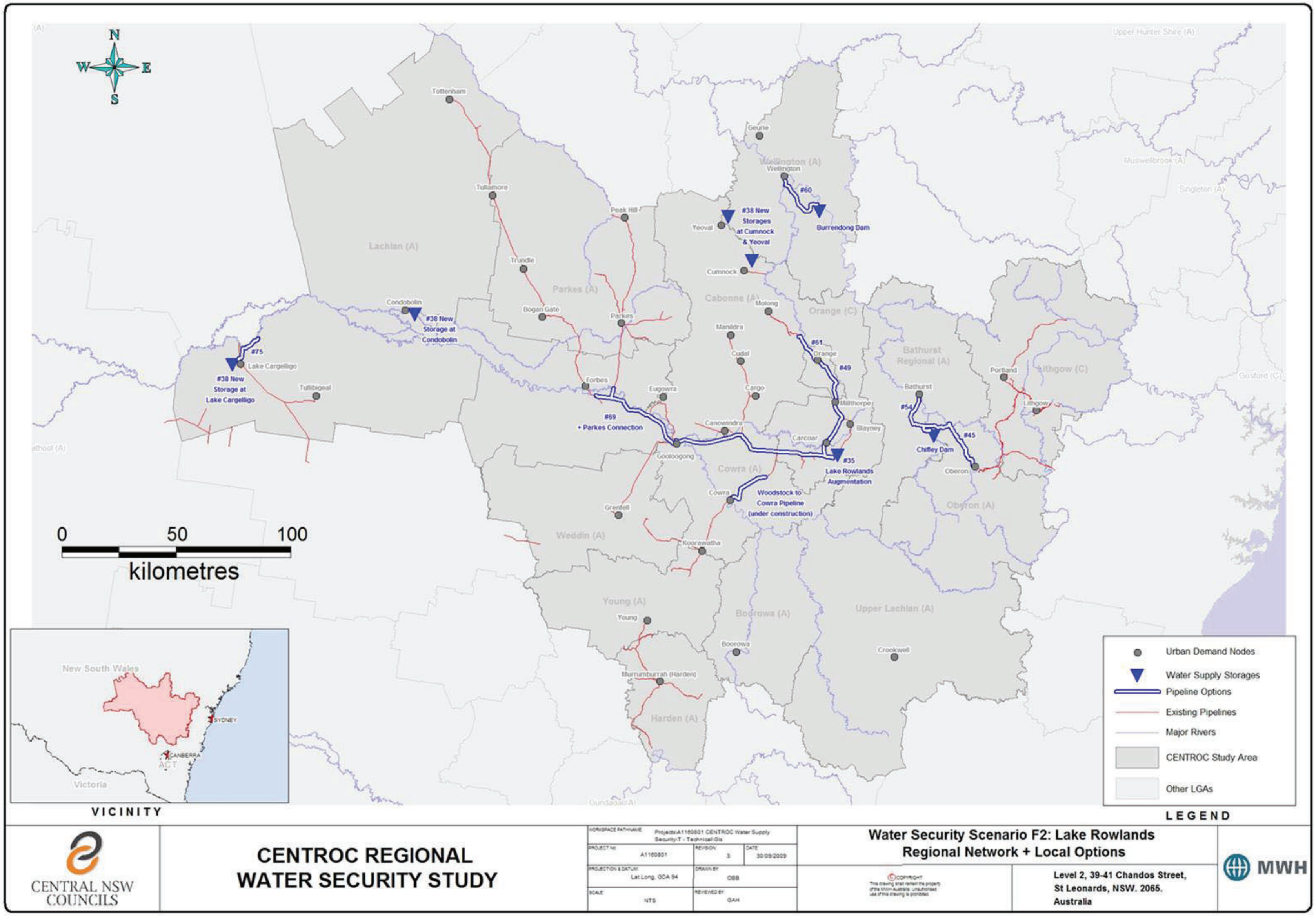

Figure D-2: Final Strategy F2: Lake Rowlands Regional Supply with Selected Local Solutions

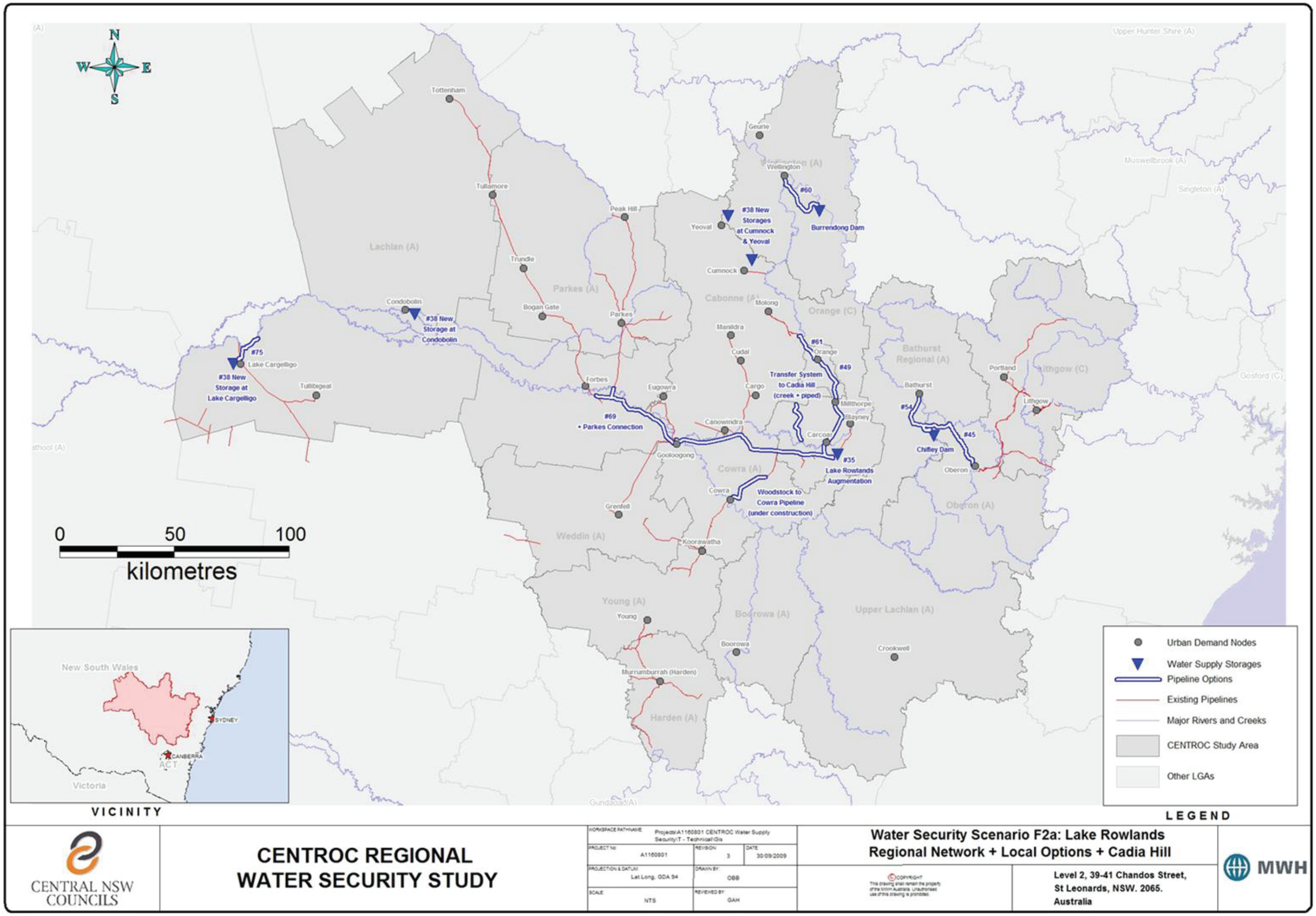

Figure D-3: Final Strategy F2a: Lake Rowlands Regional Supply (Including Cadia Hill) with Selected Local Solutions

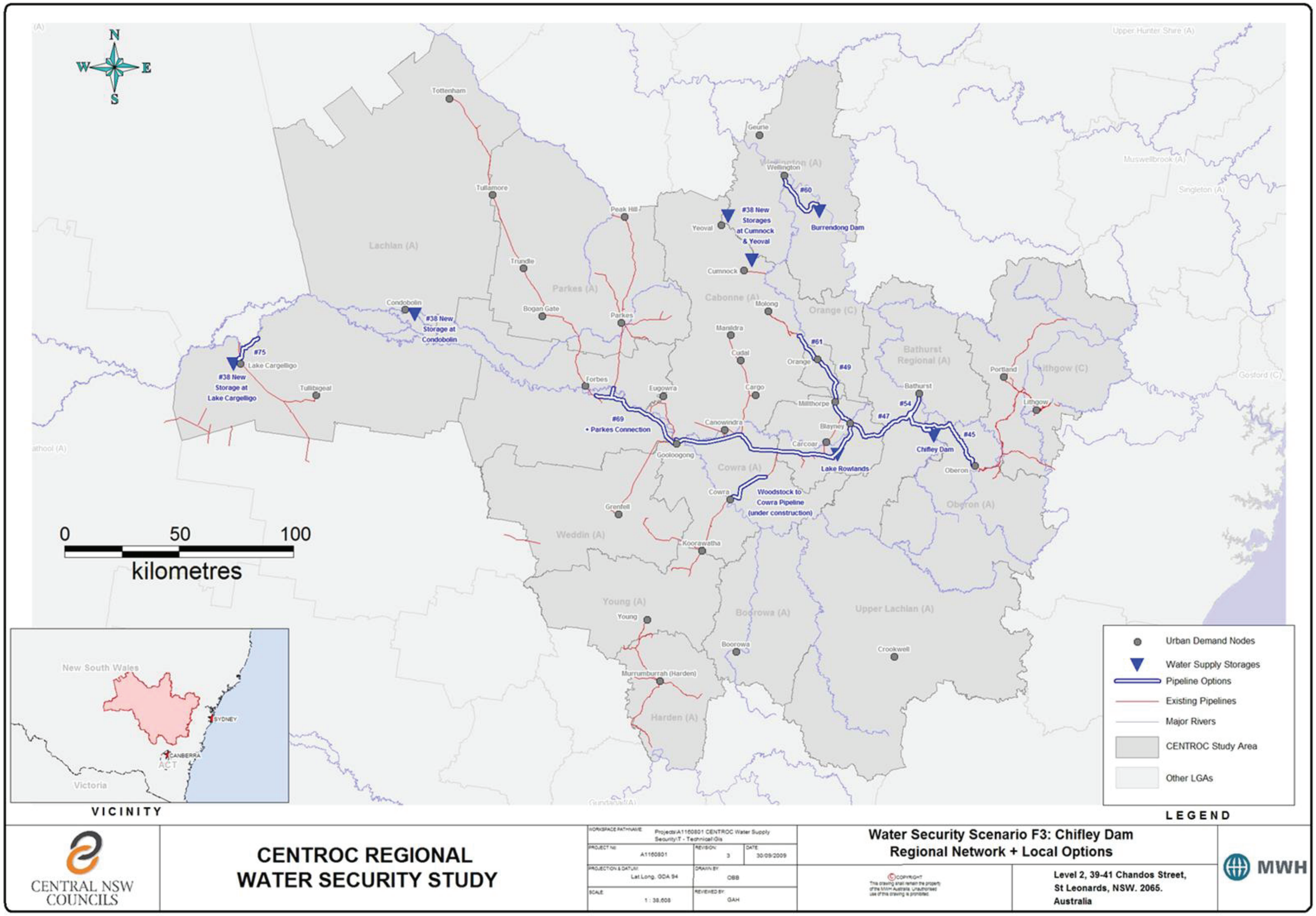

Figure D-4: Final Strategy F3: Chifley Dam Regional Supply with Selected Local Solutions

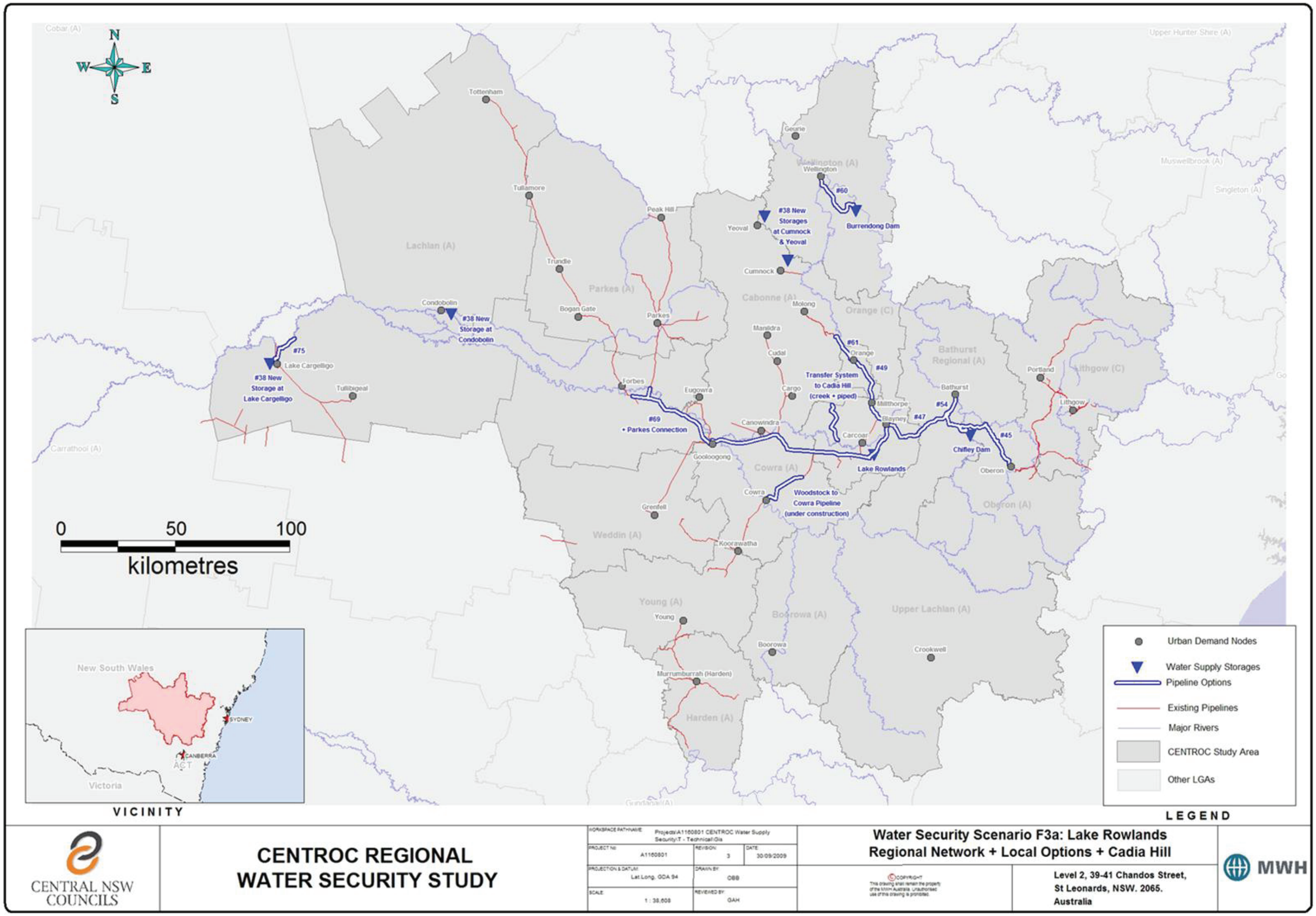

Figure D-5: Final Strategy F3a: Chifley Dam Regional Supply (Including Cadia Hill) with Selected Local Solutions

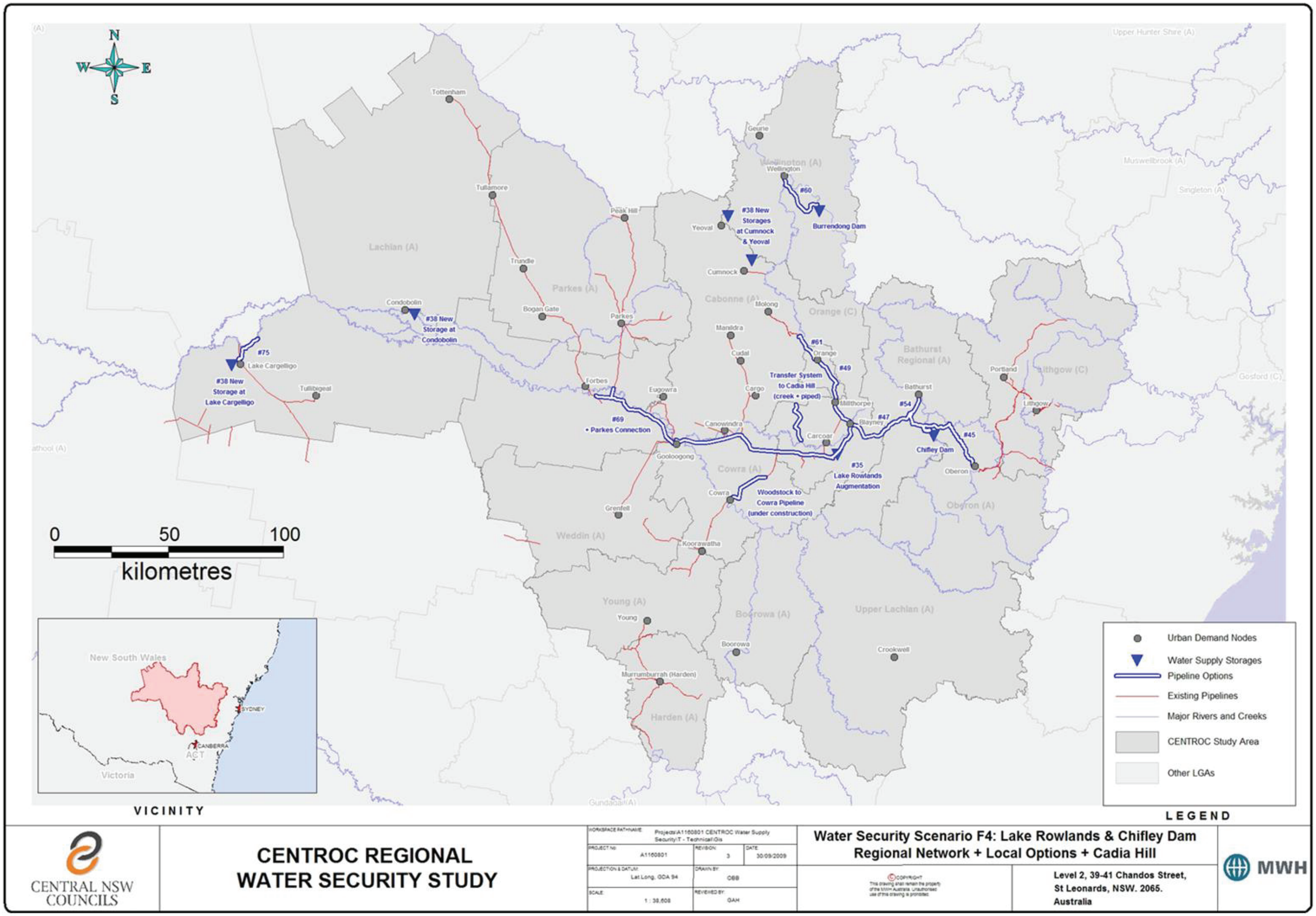

Figure D-6: Final Strategy F4: Lake Rowlands and Chifley Dam Regional Supply (Including Cadia Hill) with Selected Local Solutions

D.9 TBL ASSESSMENT OF STRATEGIES

A final TBL assessment was conducted to evaluate the region-wide water security strategies. The results of the water security modelling assessment and the assessment of the capital and operating costs of each option were again important inputs to the TBL process.

As each of the region-wide strategy addresses the water security need of all the urban demand nodes identified for modelling, the TBL assessment here focuses on identifying the preferred strategy for recommendation.

The outcomes of the TBL assessment of the region-wide strategies are summarised below:

- Strategy 1, the Regional Water Grid has a negative score, indicating that it does not positively contribute to the achievement of the identified study objectives. This outcome is mainly driven by the performance of this strategy against the economic criteria.
- Whilst the assessment indicates some differential between Strategy 2 and Strategy 3, with a higher score (a better result) for Strategy 3, neither strategies take into account the potential for mutual benefit to the mining sector from the provision of additional water demand requirements to Cadia mine.
- Although Strategy 2a scores marginally better, for the level of accuracy of the inputs to the TBL assessment, Strategies 2a and 3b are very close. Therefore, it is important to consider the driving factors behind scores to understand the trade-offs to be encountered in decision making.
- Both strategies have the same impact on environmental criteria 1 (protection of water for the environment) and environmental criteria 3 (purchase of additional entitlements), which relate to extractions, as the same demands are being met.
- Strategy 3a rates better than Strategy 2a on environmental criteria 2 (infrastructure footprint) as Strategy 2a contains the building of an augmented Lake Rowlands, which will have a significant footprint.
- In terms of economic criteria, Strategy 2a performs significantly better in relation to the efficiency of energy usage criteria (economic criteria 2). This is a result of the fact that significant energy would be required to transfer water between the Upper Macquarie and the Upper Lachlan valleys. The pumping capacity required to transfer the water would need to overcome 180m elevation to transfer the water and this would consume considerable energy. By contrast, Lake Rowlands is 170m higher and would be able to provide water by gravity.
- In terms of the first and third economic criteria, the cost of water supplied, Strategy 3a is cheaper from a cost perspective essentially because it is estimated that the NPV of total costs of providing the pipeline link from Chifley Dam are in the order of $45m lower (base cost with no contingency allowance or escalation) than the costs of building the new dam.
- In terms of the social criteria, the options perform similarly in terms of security improvement, but differ for the equity and acceptability and financial burden to households criteria. While the provision of improved water supply security has benefits for the region as a whole, it is recognized that the connection of the Upper Macquarie to the Upper Lachlan is not socially acceptable for many of the members of Centroc and raises community concerns around the level of service they will receive. Similarly, the provision of water to mining entities is also less socially acceptable in some communities.

In the end, as with any TBL assessment, the results indicate that there are trade-offs between the cost and infrastructure footprint (in favour of Strategy 3a) against the elevation and therefore energy performance of Strategy 2a. The trade-off essentially comes down to the choice of a large new pipeline or an augmented dam.

Although equally weighted here, the energy consumption associated with operating 3a may be of greater concern considering the link between energy consumption, climate change and water supply security and the increasing pressure to regulate to minimise emissions.

In addition, there are implementation issues associated with the transfer pipeline (Strategy 3a) in that new easements (not all of which are expected to be alongside roads) will be required whereas the pipelines required to get extra water from Lake Rowlands (Strategy 2a) into the system (excluding those pipes common to both options like the links to Orange and Forbes) would be aligned with existing easements.

The TBL assessments provided an objective and engineering oriented evaluation of the water security strategies. However, there were a number of other complicating factors not incorporated into the MCA that needed to be considered in order to thoroughly evaluate and identify the most appropriate and preferred regional strategy. These factors are discussed in the sensitivity analysis section further in this appendix.

Table D-9: TBL Assessment of Region-Wide Water Security Strategies

No	Option	Environmental		1	Economic		1	Social		1	Total Capital NPV	Annualised Total OM&D ($/a)	Cost Effectiveness ($/% improvement in reliability)	Score	Ranking After Sensitivity Analyses
		Protection of Water for Environment	Infrastructure Footprint	Purchase of Additional Entitlements	Cost Effectiveness	Efficient Energy Usage	Cost of Water Supplied ($ per kL)	Equity and Acceptability	Financial Burden on Households	Improvement to Urban Water Reliability					
	Indicators:	Additional Extraction (kL/household/ annum)	Hectares	N/A	($/% improvement in reliability)	(kWhr/ML)	($ per kL)	N/A	($/residential property)	Improvement in Reliability (%)					
F1	Regional Water Grid + Local Options	0.4	-2.4	0.0	-0.6	0.2	-1.0	1.0	0.0	-0.6	$349,481,564	$9,268,433	$1,470	-0.33	6
F2	Lake Rowlands Regional Network + Local Options	0.4	-2.6	0.0	0.6	0.6	0.6	2.0	-1.4	-0.6	$253,101,055	$7,659,179	$1,103	-0.04	3
F3	Chifley Dam Regional Network + Local Options	0.4	-1.4	0.0	1.1	-0.8	1.4	0.0	0.4	-0.6	$194,518,950	$7,450,557	$912	0.05	4
F2a	Lake Rowlands Regional Network + Local Options + Cadia Supply	0.4	-2.8	0.0	0.8	1.0	1.6	2.0	-1.4	-0.6	$261,501,055	$7,797,509	$1,099	0.12	1
F3a	Chifley Dam Regional Network + Local Options + Cadia Supply	0.4	-1.6	0.0	1.3	0.0	1.8	-1.0	0.4	-0.6	$202,918,950	$7,588,888	$905	0.08	2
F4	Lake Rowlands + Chifley Regional Network + Local Options + Cadia Supply	0.4	-3.0	0.0	-0.1	0.8	1.2	0.0	-1.2	-0.6	$324,222,846	$10,120,449	$1,389	-0.28	5

D.10 SENSITIVITY ANALYSIS

The long-term and strategic nature of this study means that there are elements of uncertainty that may influence the water security outcomes modelled and/or the selection of the preferred final strategy. These sources of uncertainty include:

- The potential impact of climate change on temperatures, rainfall and runoff may impact on the nature of water demand and water availability. Climate change is viewed as a significant risk to water resource security and is a required element of consideration for urban water planning consistent with the Federal Government National Water Initiative (see Appendix E);
- The trend of the costs of energy increasing over time may impact on the expected capital and operating costs;
- The potential impact of higher levels of population growth (ie, growth at levels greater than the adopted WRI Scenario C for Centroc) driving greater levels of town water demand;
- Potential variations in the cost estimates of key infrastructure elements.
- The potential need for the strategy to be flexible enough able to accommodate the water needs associated with other sectors, particularly mining, that are likely to arise in the Centroc region.

Sensitivity analyses of the above factors were conducted to investigate their impacts on the modelling outcomes on the preferred strategy. The key findings of the sensitivity analysis are outlined here.

D.10.1 CLIMATE CHANGE SENSITIVITY

Climate change is expected to increase temperatures and reduce runoff. The climate change scenario developed for this study indicated that all strategies considered were able to cope with climate change, although there is still some uncertainty over the potential climate change impacts. In a situation where climate change impacts are more acute than those estimated in this study, the interconnection of the Upper Macquarie town supplies and those of the Upper Lachlan may need to be considered as an additional element of the region-wide strategy.

At this point, the connection provided by the Chifley-Blayney Pipeline is the recommended approach. However, in the event of an emergency situation in Orange, it may be necessary to put in place the pipeline connection between Orange and the Macquarie River. This may provide an opportunity for an alternative pipeline connection between Bathurst and Orange along the Macquarie River.

More details on this assessment are available in Appendix C.

D.10.2 ENERGY COST SENSITIVITY

The increase in energy costs, whilst considerably small relative to the capital costs and not uniform across the region-wide strategies, can potentially be significant enough to result in the choice of an alternative strategy. Analysis was conducted on average energy increases of 25%, 50% and 100% over the forecast horizon. Outcomes of the analysis are set out in Table D-10 below.

Strategy F3a is less energy efficient and therefore its scores progressively dropped in response to increases in energy costs. Strategy F2a is more energy efficient and this is reflected in its ranking under this sensitivity test.

Table D-10: Impact of Energy Cost Increases on Annual OM&D Costs and TBL Assessment

No	Strategy	Annualised Total OM&D ($/a)				Score				% Change in Annualised Total OM&D ($/a)			Ranking
		Base ($0.12/ kWhr)	+25%	+50%	+100%	Base ($0.12/ kWhr)	+25%	+50%	+100%	+25%	+50%	+100%	
F1	Regional Water Grid + Local Options	$9,268,433	$10,008,335	$10,748,238	$12,228,043	-0.33	-0.44	-0.40	-0.35	8%	16%	32%	5
F2	Lake Rowlands Regional Network + Local Options	$7,659,179	$8,429,379	$9,199,579	$10,739,980	-0.04	-0.13	-0.15	-0.15	10%	20%	40%	3
F3	Chifley Dam Regional Network + Local Options	$7,450,557	$8,398,354	$9,346,150	$11,241,742	0.05	-0.08	-0.12	-0.21	13%	25%	51%	4
F2a	Lake Rowlands Regional Network + Local Options + Cadia Supply	$7,797,509	$8,587,798	$9,378,087	$10,958,665	0.12	0.01	0.03	0.05	10%	20%	41%	1
F3a	Chifley Dam Regional Network + Local Options + Cadia Supply	$7,588,888	$8,556,773	$9,524,658	$11,460,428	0.08	-0.01	-0.01	-0.03	13%	26%	51%	2
F4	Lake Rowlands + Chifley Regional Network + Local Options + Cadia Supply	$10,120,449	$11,120,946	$12,121,443	$14,122,437	-0.28	-0.37	-0.37	-0.39	10%	20%	40%	6

D.10.3 POPULATION SENSITIVITY

Bathurst has completed an Integrated Water Cycle Management Strategy which assumed higher levels of growth than utilised in this region-wide study which adopted the Centroc Board resolved growth forecasts for the region.

Modelling as part of the Bathurst IWCM, which allowed for a population of some 22,000 more people by 2059, demonstrated that this supply remains secure. It is recognised that the community of Bathurst have made an investment in the security of their water supply and there is a community expectation that a high level of service be maintained. Any sharing of this security would need to recoup the investment and have to maintain the surety of the supply to Bathurst and not jeopardise the security of this supply.

Sensitivity testing of the connection between the Upper Macquarie and the Upper Lachlan, sourced from Chifley Dam Bathurst, was conducted as part of this study. The assessment suggests that this source would be less able to meet the supplementary demands of the towns to be connected under Strategy 3a if higher than anticipated growth rates occur. It should be noted however, that the growth expectations of Bathurst significantly exceed those predicted by the NSW Department of Planning and Local Government.

Sensitivity testing was also carried out on Strategy 2a to test the ability of this strategy to support a higher level of growth than anticipated (ie, to mimic a situation closer to the WRI B forecast). The testing indicated, that whilst restrictions may be in place more often, this strategy is still able to deliver considerable security improvement with the greater population.

D.10.4 INFRASTRUCTURE COSTS

The cost estimates provided in this report are suitable for strategic planning purposes only. One of the key areas of uncertainty in the cost estimates, which is difficult to account for at the strategic planning level, are the costs associated with dam construction.

The costs used in the TBL assessment were derived from a survey of industry data for a wide variety of dam types. They were not tailored specifically for conditions at the site of the proposed Lake Rowlands augmentation. CTW provided data which indicates that site specific cost estimates for the upgrade are in the vicinity of $45 million capital ($2006, GHD, 2006).

As illustrated in the table, this cost difference has a significant impact on the TBL results, favouring options including the augmentation of Lake Rowlands

Table D-11: TBL Assessment Results for the Region-Wide Strategies – Sensitivity to Lower Lake Rowlands Augmentation Cost

No	Option	Environmental		1	Economic		1	Social		1	Total Capital NPV	Score	Ranking
		Protection of Water for Environment	Infrastructure Footprint	Purchase of Additional Entitlements	Cost Effectiveness	Efficient Energy Usage	Cost of Water Supplied ($ per kL)	Equity and Acceptability	Financial Burden on Households	Improvement to Urban Water Reliability			
	Indicators:	Additional Extraction (kL/household/ annum)	Hectares	N/A	($/% improvement in reliability)	(kWhr/ML)	($ per kL)	N/A	($/residential property)	Improvement in Reliability (%)			
F1	Regional Water Grid + Local Options	0.4	-2.4	0.0	-0.1	0.2	-0.6	1.0	0.6	-0.6	$285,887,630	-0.17	6
F2	Lake Rowlands Regional Network + Local Options	0.4	-2.6	0.0	1.3	0.6	1.4	2.0	-0.8	-0.6	$189,507,121	0.19	2
F3	Chifley Dam Regional Network + Local Options	0.4	-1.4	0.0	0.6	-0.8	1.0	0.0	0.0	-0.6	$194,518,950	-0.09	4
F2a	Lake Rowlands Regional Network + Local Options + Cadia Supply	0.4	-2.8	0.0	1.6	1.0	2.2	2.0	-0.8	-0.6	$197,907,121	0.33	1
F3a	Chifley Dam Regional Network + Local Options + Cadia Supply	0.4	-1.6	0.0	0.8	0.0	1.6	-1.0	0.0	-0.6	$202,918,950	-0.04	3
F4	Lake Rowlands + Chifley Regional Network + Local Options + Cadia Supply	0.4	-3.0	0.0	0.1	0.8	1.2	0.0	-0.4	-0.6	$260,628,912	-0.16	5

D.10.5 MINING DEMAND SENSITIVITY

Accurate forecasts of mining water demand over time are commercially sensitive and difficult to make due to the exploratory nature of mine development.

During the course of the study, a number of potential future demands in the mining sector were identified through discussions with the mining representatives on the PRG, the Department of Minerals and mining entities in the region. The volume of these potential demands was estimated on the basis of discussions with the existing and future mining operators in the region. These additional demands and their approximate locations are outlined in Table D-12.

Table D-12: Additional Mining Demands in CENTROC Supply Area

APPROXIMATE LOCATION	ANNUAL DEMAND (ML)	DAILY DEMAND (ML)	SUPPLY LOCATION
Orange	15,000	40	Regional water network (Lake Rowlands)
Parkes	4,200	12	Regional water network (Parkes)
Blayney	3,600	10	Regional water network (Lake Rowlands)
Molong	3,000	8	Regional water network (Lake Rowlands)

Under the current climate regime, connection to an augmented Lake Rowlands (Strategy 2a) will meet the needs of an additional 10 ML demand in proximity to the existing CTW system.

The WATHNET model for the core supply system for Strategy 4 (augmented Lake Rowlands plus connection of Chifley Dam) was run, with supply to the core regional network supplying water to:

- Bathurst
- Oberon;
- Lithgow;
- Existing Central Tablelands System;
- Orange;
- Molong;
- Cowra; and
- Parkes.

Water was firstly provided by Lake Rowlands and then by Chifley Dam in the event that Lake Rowlands water was not available. Mining demands were assumed to be unrestricted. The results of the analysis (Table D-13) suggest that:

1. In the event that the additional mining demands materialised, and augmented Lake Rowlands would have insufficient water without connection to Chifley Dam or some other source;

2. Without a restriction regime on mining operations, there is a significant risk of supply failure – even with Chifley Dam connected to the supply.

In conclusion:

1. If Chifley Dam were not available to supplement supply from Lake Rowlands, and to help avoid the supply risk failure, additional mining demands would need to be met from either increasing the planned size of the amplification of Lake Rowlands, or by supply from the major dams (Wyangla or Burrendong). This would also impact on the sizing (and therefore costs) of the raw water transfer network;

2. Mining demands would require an agreed water restriction and supply regime that would balance the benefits of continued operation with the need to maintain water security.

Table D-13: Impact of Additional Mining Demands on Supply Security for Strategy 4 – Augmented Lake Rowlands and Chifley Dam Regional Supply

SOURCE SUPPLYING	PRIMARY SUPPLY TO	PROBABILITY OF LEVEL 1 RESTRICTIONS IN ANY YEAR	PROBABILITY OF TOTAL SYSTEM FAILURE
Chifley Dam	Bathurst, Oberon (permanent) Lithgow (supplementary)	4.7%	0.4%
Lake Rowlands	Blayney, Millthorpe, Carcoar, Lyndhurst, Mandurama, Garland (permanent) Orange, Molong, Parkes, Forbes, Cowra (supplementary)	4.9%	4.0%

Financial commitment would need to be sought from the mining sector prior to investment in larger assets and this assessment does not consider the need for the mining sector to acquire additional water allocations.

APPENDIX E

WATER MANAGEMENT STRUCTURES