Review of Revised Modelling Outputs

Review of supply mix optimisation

3603-83

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Essential Services Commission of South Australia

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1 Introduction

The purpose of this short report is to provide recommendations to the Essential Services Commission of South Australia (ESCoSA) regarding the appropriateness of revised water supply modelling outputs prepared by SA Water. This report is preceded by the following documents which should be read in conjunction with this report:

- Review of SA Water supply mix optimisation, Cardno, April 2013 (Draft)
- Independent Review of Draft Cardno Report, Tonkin Consulting, April 2013
- Commentary accompanying Tonkin Consulting's independent review report provided by SA Water, April 2013.

Note that the first report, the *Review of SA Water supply mix optimisation, Cardno, April 2013 (Draft)* was provided to SA Water in Draft format. This report was finalised without any changes to its content. SA Water expresses concern[1] that it has "raised numerous errors and issues" with this report which it has not seen as being addressed. However, we do not consider this to be the case as we have been careful throughout this review to state clearly where our statements reflect our opinion rather than reflecting matters of fact. Further, we acknowledge in this report (see Section 2.1) that some of the judgements made by us in the first review report have been found to not fully reflect actual circumstances in the light of further information provided by SA Water. However, we have always been careful to set out the evidence on which our judgements have been made and the limitations of these judgements and believe that all conclusions made by us in this review have been transparently derived and are justified based on the information available.

[1] *SA Water response on Cardno* report, received by email 10 May 2013.

2 Summary of findings of review of HOMA model

2.1 Findings from initial review of HOMA model and SA Water response

The Cardno *Review of supply mix optimisation report* drew the following conclusions regarding SA Water's HOMA Model and its application to determine the supply mix for SA Water's RBP submission:

- The model does not effectively take account for the increased flexibility in bulk water transfer provided to SA Water by the NSISP.
- The manner in which WTP demand is largely based on historic records with coarse manual, monthly adjustments does not adequately reflect the operational flexibility available to SA Water in practice. The model does not appear to have the ability to select lower cost WTPs over higher cost WTPs.
- The constraint that the Anstey Hill WTP can only be supplied by the Mannum-Adelaide pipeline (from the River Murray) throughout the year with the exception of four months between February and May may overestimate the volume of water required from the River Murray.
- System flows do not account accurately for system losses in transmission mains and natural losses beyond evaporation. This can result in an underestimation of pumping volumes and an underestimation of the catchment inflows.
- The model works on average month inputs and monthly time steps. This does not correlate directly to system operation where operating parameters are typically changed much more frequently – hourly, daily or weekly. SA Water produces a weekly operating instructions report. This will lead to variation between actual operation (where parameters can be varied more regularly) and modelled results which is fixed for a month at a time.
- The median catchment inflows determined from SA Water's reservoir water balance from the last 10 years was reasonable for use for the purposes of RBP modelling.
- There are a number of sources of inaccuracy in SA Water's water mass balance for its reservoirs. SA Water has not quantified these inaccuracies or determined whether they introduce any bias into its estimates to our knowledge.
- It appears that fixed electricity costs for pumping are not included in HOMA. This constraint is likely to underestimate the cost of pumping water (from the River Murray) and therefore possibly 'overuses' this source in preference to other sources.
- The WTP operating costs in HOMA do not reflect actual costs and are very unlikely to reflect relative costs. However, as noted, the configuration of the model is such that it does not appear to have the ability to select lower cost WTPs over higher cost WTPs in any case.

The SA Water response to the Cardno report, based on the Tonkin Consulting report, discusses these conclusions and provides further information and analysis to support the following key countering conclusions:

- The monthly time step used in the HOMA model is appropriate for the three year span of the RBP scenario.
- Improvements to SA Water's reservoir water balance will require costs that will realise only 'marginal benefits'. However, SA Water, via Tonkin Consulting, note that regular updating of reservoir storage and area curves 'will potentially be beneficial'.
- The omission of fixed electricity costs will not impact of the selection of the optimal supply source given the magnitude of the cost difference between the Mount Lofty Ranges reservoirs and pumping from the River Murray.

- The decision to not utilise lower cost water from the Millbrook Reservoir in preference to higher cost water pumped from the River Murray because of concerns over *cryptosporidium* in this reservoir is considered to be prudent by Tonkin Consulting.

SA Water makes other comments on the review report but we do not consider these to be material in the overall context of this review which is to provide advice on the optimal mix of water supply sources for the three year regulatory period.

The SA Water response also confirms that:

- The modelling results included in its RBP scenario includes volumes of water that are unnecessarily pumped from the River Murray and lost as spill from the bulk water supply system. This is confirmed in the Tonkin Consulting report (p.11):

  Through discussions with SA Water an improvement to the current modelled assumption has been identified. When remodelled this is anticipated to reduce the pumping from the River Murray by a volume less than 4.1 GL.

- There is no operating constraint that prevents the Hope Valley WTP from being utilised. SA Water suggests that the modelling result which finds that this plant should not be operated for extended periods is due to the need to maximise utilisation of water from the ADP. This is set out in the Tonkin Consulting report (p.12) as follows

  From interviews with SA Water staff, Tonkin Consulting understands that the primary reason that restrictions were imposed within the modelling on the operation of the Hope Valley WTP was to enable maximum utilisation of the ADP water during the ADP proving period and not as concluded by Cardno "due to concerns over Cryptosporidium risks" (Cardno, 2013).

  In our expert opinion it is anticipated that the additional modelling requested by ESCOSA will show that if Hope Valley WTP is operated at its full capacity, the volume of water produced will be well in excess of customer demand and that demand will become the limiting factor.

- *Water* treatment *plant costs are not part of the optimisation considered by the HOMA model.* This is confirmed as follows:

  …the HOMA modelling work has been utilised to determine an estimate of the ***annual volume of water*** *not cost) that is to be pumped from the River Murray. Costing estimates have then been determined separately utilising SA Water's financial models.* (emphasis in original).

We appreciate SA Water's response to the draft report and the further information it provides. Due to time constraints, we have not analysed each claim and counter claim in detail. However, we note, importantly, that the SA Water response confirms our original conclusion that the HOMA model is not able to fully optimise the mix of supply sources available. Therefore, we do not consider that the supply mix presented by SA Water for the RBP represents an optimised, least cost mix of supply sources.

SA Water in its response to the draft version of this report raises concerns over the above statement that we have not analysed each claim and counter claim in detail. We understand this concern given the importance of this review but reiterate that due to time constraints we have had to focus on material areas only. SA Water raises in its response the example of the South Para system which we acknowledge is an example where our judgement on the operation of the system was not correct in light of analysis provided by SA Water. However, in the context of the review, we have not made recommendations regarding this system and therefore have not revisited this conclusion in the review report. As the SA Water responses to this report will be made publically available we consider that this provides an appropriate means for correcting this conclusion based on the further information available.

One area that we feel is significant to raise at this point is the under use of the Millbrook Reservoir due to SA Water's concerns over *cryptosporidium*. We do not believe that the information presented by SA Water supports the operating strategy of not using this reservoir for eight months of the year. That is, we have not been provided with analysis that justifies the use of higher cost water from the River Murray as being more beneficial than the reduced risk from *cryptosporidium* from not using this source, noting that SA Water has numerous operational strategies and controls available to it to mitigate the risks posed by the possible presence of *cryptosporidium*. We are aware that many water authorities across Australia manage *cryptosporidium* risk on a daily basis without resorting to blanket bans on supply sources. However, given the information asymmetries inherent in this review, we acknowledge that SA Water is best placed to assess and balance the health risk to its customers with the higher customer bills that will result from its operating strategy (i.e. the strategy to use water pumped from the River Murray in preference to water collected from rainfall runoff in the Millbrook Reservoir catchment. In SA Water's RBP supply scenario, this water is lost to the system over Gorge Weir).

2.2 Assessment of HOMA against leading practice

We have been asked by ESCoSA to provide an assessment of HOMA against leading practice for the optimisation of supply from water sources. To establish leading practice, we have conducted a short literature survey[2]. In assessing the HOMA against leading practice the following points of context are important to bear in mind:

- HOMA has been put forward by SA Water as having produced modelled outputs for the three year period 2013/14 to 2015/16 that represent the optimal mix of supply sources available. Optimal in this context means least cost.
- The modelled outputs are based on assumptions and operating constraints such as assumed levels of inflows to SA Water's reservoirs over the three year period and the operating regime for the Adelaide Desalination Plant. These assumptions are unlikely to reflect what actually occurs over the three year period. However, reasonable assumptions are necessary for modelling purposes.
- HOMA uses monthly time steps of input data and also produces monthly time steps of output data. SA Water has informed us that it currently uses these outputs for weekly operational planning as well as for longer term planning. The context of this review is to inform a three year price period. Therefore, we are primarily interested in the ability of HOMA to optimise the supply mix in the short and medium term and not the long term. An important long term consideration that is outside of the scope of this review, for example, is the impact of changing rainfall patterns on reservoir inflows.

Table 2-1 summarises our assessment of HOMA against leading practice for the optimisation of supply from water sources.

Table 2-1 Summary of costs for modelled scenarios

Feature of leading practice	Assessment of HOMA
Includes all supply sources	HOMA include all major supply sources, supply pipelines and water treatment plants. Restrictions and demand management are accounted for outside of HOMA by modifying the demand applied to the model.
Integrate supply sources with the distribution network	HOMA is not integrated with the distribution network and in particular the NSIS. The interface is water treatment plant production volumes which are based on historic demand levels.
Use small time steps, tending toward real-time control to	HOMA only operates on monthly time steps although SA

[2] Important references include:

- Z. F. Rao, J. Wicks and S. West, *Optimising water supply and distribution operation*. Proceedings of the ICE - Water Management. Volume 160, Issue 2, pages 95-101.
- Cui, Lijie and Kuczera, George. *Optimisation of Water Supply Headworks Operation Using Parallel. Genetic Algorithms*. In: Boyd, MJ (Editor); Ball, JE (Editor); Babister, MK (Editor); Green, J (Editor). 28th International Hydrology and Water Resources Symposium: About Water; Symposium Proceedings. Barton, A.C.T.: Institution of Engineers, Australia, 2003: 2.291-2.298
- M.D.U.P Kularathna , T. S. C. Rowan , H. Schultz-Byard, D. R. Broad, D. McIver, D. Flower, B. Baker, B. G. Rhodes and P. J. Smith. *Multi-Objective Optimisation using Optimizer WSS to Support Operation and Planning Decisions of Melbourne Water Supply System*. 19th International Congress on Modelling and Simulation, Perth, Australia, 12–16 December 2011, Congress Proceedings.

match supply with demand which fluctuates continually. At the most advanced, integrate supply optimisation with SCADA for monitoring and control.	Water has informed us that these monthly modelling results are used for weekly operations planning. HOMA has no ability to undertake dynamic modelling or integrate with SCADA.
Include real costs and actual tariff structure	HOMA does not include real costs or actual tariff structures. Costs are indicative only. SA Water has noted that it does not consider this to be an issue as the disparity in the costs of its sources means that costs only need be relatively correct.
Allow testing of scenarios	A strength of HOMA is that it allows different scenarios to be run and compared.
Use genetic algorithms for optimisation which allow many complex factors to be included in the optimisation	HOMA uses linear programming for optimisation. This approach is appropriate for the scope and purpose of HOMA which has a straightforward optimisation objective and where the modelled system can be represented relatively simply. If the scope of HOMA was to include more of the supply network and include more complex factors, such as tariff structures, which we suggest is leading practice, then we do not believe that a linear programming approach would be suitable.

Based on the above assessment, we believe that HOMA does not display many of the features of leading practice supply mix optimisation models.

SA Water counters the above conclusions by noting:

- *Cardno continue to misunderstand the use of HOMA in weekly operations planning. As detailed in the Input to Opex Assumptions document provided to ESCOSA, HOMA is a linearly programmed, water balance model that provides an optimal operating scenario for the bulk-water supply system from the current month to the end of the financial year. By calculating volumes of pumping needed over longer time periods, HOMA is able to minimise pumping costs across entire financial years. This optimal strategy from HOMA then informs operational decision-making about the optimal periods in which to utilise infrastructure allowing capital projects and day-to-day maintenance to be scheduled around the optimal operation.*
- *Given the above misunderstanding, Cardno then confuse water balance models such as HOMA with real-time operational models, such as hydraulic models which "use small time steps, tending toward real-time control to match supply with demand which fluctuates continually". These types of models are designed to inform and optimise short term operations, examining peak flows in detailed sections of a distribution network.*

We do not agree with the above statements because the purpose of our review is to test HOMA against its ability to provide an optimal (least cost) solution. We appreciate that HOMA works well within the purpose defined for it by SA Water. However, we have noted in the above table what we consider to be leading practice for supply optimisation and this is the criteria we test HOMA against. This difference in objectives is perhaps exemplified by SA Water referring to HOMA in its response as a 'water balance model' where we note in setting out the context of this assessment against leading practice that HOMA has been put forward as a tool for optimising the supply mix.

We are aware that SA Water has developed a supply and distribution optimisation model that meets most, or all, of the above criteria. However, SA Water has informed us that this model has not been accepted for use and therefore, the modelling outputs produced by HOMA are appropriate for basing its supplying planning on in the RBP period.

3 Further modelling undertaken by SA Water of Scenarios 1 -4

3.1 Recommendations leading to modelling of Scenarios 1 – 4

Based on the review report, and the SA Water response, the following recommendations were made for SA Water to incorporate in revised modelling:

1. Increase the use of Millbrook Reservoir though Hope Valley WTP.
2. The SA Water undertake logical testing of modelled outputs so that unreasonable results such as River Murray water being spilled over weirs and lost to the system are avoided.
3. Allowing increased transfers from the Happy Valley and Hope Valley WTPs to northern extremities of the water supply systems through the NSISP to minimise the volume of spill.

The basis of these recommendations is that:

- Water drawn from Millbrook Reservoir and treated at the Hope Valley WTP will have a lower marginal cost then water drawn from the River Murray. Therefore, using this water in areas currently supplied by the River Murray should result in cost savings compared with the supply mix presented by SA Water.
- Water supplied from Hope Valley WTP will have a lower marginal cost than water drawn from the River Murray and therefore using this water in northern regions such as demand node D-LP should result in cost savings compared with the supply mix presented by SA Water.
- Unnecessary loss of water out of the system should be avoided.

Because of the rigidities in HOMA, it is not possible to express these objectives simply. Instead, scenarios need to be tested that reflect these objectives as different combinations of treatment plant supply to the various demand nodes. The resulting supply mix then needs to be input to various cost models to determine the cost associated with each scenario. This is a time consuming process and therefore SA Water requested that the number of scenarios for them to model be limited. Accordingly, the following two reconfigurations of the demand-supply balance were put forward to SA Water to adopt:

1. Strategy 1 – Make greater use of the Hope Valley WTP by applying the demand node assignations set out in Table 3-1.

Table 3-1 Demand node assignations for operating Strategy 1

Demand node	Anstey Hill	Hope Valley	Happy Valley
103N		1.0	
51N	0.3	0.5	0.2
103C		1.0	

2. Strategy 2 – Make greater use of water from the Hope Valley WTP. Supply demand node D-LP 25% from Little Para WTP and 75% from Happy Valley WTP. (This node had been supplied 100% from Little Para WTP in the RBP scenario).

These strategies were combined with a request from ESCoSA that the impact of having the ADP produce water or not produce water also be modelled. Therefore, the four scenarios summarised in Table 3-2 were modelled.

Table 3-2 Summary of Scenarios modelled by SA Water

	ADP in operation?	Strategy 1 applied?	Strategy 2 applied?
1	y	Y	y
2	y	Y	N
3	n	Y	Y
4	n	Y	N

3.2 Modelled outputs provided by SA Water

SA Water provided the outputs of the scenarios requested to be modelled. This included numerous data files. Table 3-3 summarises the cost of each scenario compared to the scenario included by SA Water in its RBP.

Table 3-3 Summary of costs for modelled scenarios

$m	2013/14	2014/15	2015/16	Total 3 Reg Years	Variance
RBP	*201.26*	*186.40*	*178.23*	565.89	
Scenario 1	*200.93*	*187.90*	*181.00*	569.84	3.95
Scenario 2	*201.98*	*189.44*	*183.77*	575.19	9.31
Scenario 3	*175.71*	*177.63*	*182.02*	535.36	-30.53
Scenario 4	*175.89*	*178.85*	*184.39*	539.12	-26.76

The cost savings in Scenario 3 and 4 are due to the absence of the costs of operating the ADP. Therefore, only Scenario 1 and 2 are comparable to the RBP scenario. However, the RBP scenario includes for environmental flows which are not included in Scenario 1 and 2. Therefore, any comparison to the RBP Scenario must account for the impact of environmental flows. Despite them not including any allowance for environmental flows, both Scenarios 1 and 2 result in higher costs then the RBP scenario.

Scenario 1 will only be considered further at this point in time given that it has a lower total cost than Scenario 2.

Table 3-4 compares Scenario 1 with the RBP Scenario for the following key operating parameters:

- Pumping from the River Murray
- Spills over weirs that are lost to the system
- Water treatment plant production volumes
- Pumping along the NSIS
- Costs components.

Table 3-4 Comparison of RBP Scenario and Scenario 1 (total for 2013/14 to 2015/16)

	RBP Scenario	Scenario 1	Variance
Murray River pumping (GL)			
MW	81.55	80.40	- 1.15
SRS	34.04	32.40	- 1.64
MA	91.64	59.42	- 32.22
MBO	61.71	66.88	5.17
EM	24.45	16.06	- 8.39
Total	*293.39*	*255.16*	- *38.23*
Overflows (GL)			

	RBP Scenario	Scenario 1	Variance
Overflow at Barossa Weir	6.71	-	- 6.71
Overflow at Gorge Weir	45.84	-	- 45.84
Overflow at Clarendon Weir	52.26	60.12	7.86
Overflow at Myponga	4.64	4.64	- 0.00
Total	*109.46*	*64.76*	*- 44.69*
WTP production (GL)			
Barossa	38.06	32.25	- 5.81
Little Para	27.41	14.11	- 13.30
Anstey Hill	63.01	48.82	- 14.19
Hope Valley	36.58	74.30	37.72
Happy Valley	133.77	142.56	8.79
ADP	99.20	99.20	-
Total	*398.03*	*411.24*	*13.20*
NSIS flows (GL)			
Central (D103C -> D103N)	-	-	-
Western (D51S -> D51N)	19.00	9.00	-10.00
Eastern (D170S -> D170N)	35.40	64.91	29.51
Northern (D-170N -> DLP)	13.40	33.17	19.77
Total	*67.80*	*107.08*	*39.28*
Costs ($M)			
OX0014 (NSIS)	21.41	28.90	7.49
OX0047 (Carbon)	29.63	28.05	- 1.58
OX0015 (Electricity)	90.03	87.45	- 2.57
OX0028 (Allwater)	269.63	270.24	0.61
OX0029 (ADP)	155.19	155.19	-
Total	*565.89*	*569.84*	*3.95*

This analysis shows that:

- Scenario 1 results in 29 GL of water less pumped from the Murray over the 3 years. There is also 8.4 GL of water less pumped along the EM link. The biggest reduction is 32.2GL less along the Mannum-Adelaide pipeline but this is offset by 5.17GL more pumping along the MBO pipeline
- Overflows from weirs in Scenario 1 total 64.8GL which is significantly less than the 109GL lost at weirs in the RBP scenario. There are no losses in Scenario 1 from the Gorge Weir but spills from the Clarendon Weir are 60.1GL in Scenario 1 compared to 52.3GL in the RBP scenario.
- Scenario 1 leads to a total of 13GL more water being treated at WTPs despite the overall demand not changing.
- Barossa, Little Para and Anstey Hill WTPs treat 33GL less water between them. The difference is made up by Hope Valley (+37GL) and Happy Valley (+8.8GL).

The most important result from this analysis is that the higher cost of Scenario 1 is driven by the cost of operating the NSIS pipeline. Operating costs for the NSIS pipeline are $7.49M greater in Scenario 1 than the RBP Scenario. This is due to the significant increase in water moved along the Eastern (D170S -> D170N) and Northern (D-170N -> DLP) sections of the NSIS in Scenario 1 compared to the RBP Scenario. On inspection, it appears that this is due to the recommendation made in Strategy 2 to make greater use of water from the Hope Valley WTP by supplying demand node D-LP 25% from Little Para WTP and 75% from Happy Valley WTP. Water from Happy Valley WTP needs to travel along the eastern and northern sections of the NSIS to be delivered to demand node DLP.

4 Modelling of Scenario 5 and further operating scenarios

The analysis in Section 3 of this report indicates that it is likely that proposed Strategy 1, to make greater use of water from Hope Valley WTP, results in lower volumes of water pumped from the River Murray and lower operating costs compared to the supply mix scenario included by SA Water in its RBP. To test this, SA Water was asked to model Strategy 1 by itself without the constraint of maximising water transfers to the north.

The modelling of this scenario did result in lower operating costs, totalling $2.50M across the RBP period. However, it should be noted that this scenario does not include specific allowance for environmental flows which are included in the RBP scenario.

This scenario also results in a reduction of 7.3%, or 19.5GL, of water pumped from the River Murray compared to the RBP Scenario. Table 4-1 compares River Murray pumping volumes under these two scenarios. Note that the Millbrook Transfer is not pumping from the River Murray but transfer of water from the Mannum-Adelaide pipeline west.

Table 4-1 Comparison of River Murray pumping volumes for RBP Scenario and Scenario 5

	Total in RBP Scenario	Total Scenario 1	Variance
Morgan-Whyalla	81.55	86.45	4.90
Swan Reach – Stockwell	34.04	26.47	- 7.57
Mannum – Adelaide	91.64	86.19	- 5.45
Murray Bridge – Onkaparinga	61.71	50.32	- 11.39
Millbrook Transfer	24.45	24.18	- 0.27

SA Water noted that it felt that Scenario 5 was not more optimal than the RBP Scenario for the following two reasons:

1. *Environmental Flows*

   The RBP includes an additional 4.1 GL of water pumped along Mannum-Adelaide Pipeline from the River Murray for the provision of e-flows at Gumeracha Weir. It also includes water pumped along the Murray-Bridge Onkaparinga Pipeline for provision of 9.24 GL per annum for e-flow releases at Clarendon Weir. Scenario 5 modelling does not include any pumping from the River Murray for the provision of e-flows (as per ESCOSA's request). This is therefore not a true comparison with the RBP position.

2. *Assumptions for network configuration*

   The constraints that have been requested to be modelled place very specific limitations on the network configuration. This network configuration results in approximately 10GL of ADP water being "wasted" to Happy Valley reservoir. This will result in additional costs, and the associated impact to prices, (which extend beyond the regulatory period) to retreat this water. SA Water considers the more prudent approach is to adopt the position as per the RBP which is to push this high quality ADP water to the northern extremities of the water system. This is not feasible with the network configuration specified for Scenario 5.

   On the basis of the above observations, SA Water concludes that "when these two factors are considered SA Water's proposal in the RBP is still the most prudent and efficient supply mix optimisation."

On the basis of the environmental flow volumes provided by SA Water, the RBP scenario would appear to be a lower cost scenario. However, SA Water did not provide detailed output spreadsheets for Scenario 5 to allow this to be confirmed by us therefore we accept that it is correct.

SA Water's second point is that by using the operating configuration specified, 10 GL of water produced at the ADP is not able to be used directly in the distribution system and is instead 'wasted' to the Happy Valley reservoir. SA Water states that "this will result in additional costs, and the associated impact to prices, (which extend beyond the regulatory period) to retreat this water". We note the following regarding these statements:

- It is not clear why this water is 'wasted' when it is stored in a reservoir adjacent to a treatment plant from which it can be readily used in future.
- It is not clear how this would result in 'additional costs…to retreat' this water. We suggest that the appropriate comparison is the cost of re-treating ADP water compared to treating raw River Murray or raw catchment water. Given that ADP is of a higher quality than raw water, we believe that it is likely to be cheaper to re-treat ADP water compared to raw water from other sources.

We acknowledge that SA Water would have to deal with problems of public perception if it was recognised that 'wasting' ADP water was in fact cheaper than using it beneficially in the distribution system. We also acknowledge that we may have overlooked important constraints in the operating environment given the significant information asymmetries inherent in this review.

SA Water, in commenting on the draft of this report stated that the above comment "brings into question all other statements in the (*this*) report"[3]. We do not believe that this is the case. This purpose of this statement is to qualify our conclusions because of the information available to us. We do not see how a qualifying statement on a single scenario tested in this review could extend to all of the report. Further, we note that SA Water in its comments on this draft report did not question the accuracy of the above conclusions.

A final point to be made is that 'Scenario 5' is just one combination of demand node assignations for three water treatment plants that have been trialled by SA Water at our request. This combination has been suggested based on our judgement and observations. We have been limited in the combinations that we have been able to test given the time taken to run each scenario. We are very appreciative of SA Water's assistance in modelling this scenario and others. Ideally, however, we would have liked to have trialled multiple combinations of demand assignments between the Anstey Hill, Hope Valley and Happy Valley WTPs but this has not been possible. We believe that this highlights the rigidity of HOMA in how modelling is undertaken and the constraint this places on optimisation, as discussed in Section 2.2.

[3] *SA Water response on Cardno* report, received by email 10 May 2013.

5 Recommendations

We have reviewed SA Water's supply mix optimisation model, HOMA, to provide advice to ESCoSA as to whether the supply mix included in SA Water's RBP submission represented an optimised outcome. We have set out the reasons why this scenario is not an optimal mix of supply sources. We have sought to identify alternative operating strategies that will lead to a more optimal outcome and these have been tested by SA Water. The limited time available for this review has meant that further testing of scenarios has not been possible.

While SA Water has reservations regarding some of the conclusions drawn from the further modelling, , we believe that the following should be taken into account by ESCoSA to determine an optimal mix of supply sources as the basis for planning the regulatory period:

- Pumping of water from the River Murray that is unnecessarily lost to the bulk water supply system should be eliminated from an optimal supply mix.
- Whether a supply strategy that makes greater use of water from the Hope Valley WTP may lead to a more optimal outcome as discussed in Section 4.
- Whether a different optimisation model with increased capability in line with leading practice may lead to a more optimal outcome. An assessment of HOMA against leading practice is presented in Section 2.2.

APPENDIX A
DETAILED COMPARISON OF RBP SCENARIO AND SCENARIO 1

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	RBP Scenario				Scenario 1				Variance			
	13/14	14/15	15/16	Total	13/14	14/15	15/16	Total	13/14	14/15	15/16	Total
Murray River pumping (GL)												
MW	26.93	27.12	27.50	**81.55**	26.47	26.79	27.14	**80.40**	- 0.46	- 0.33	- 0.36	**- 1.15**
SRS	11.12	11.13	11.79	**34.04**	10.68	10.82	10.90	**32.40**	- 0.44	- 0.31	- 0.89	**- 1.64**
MA	25.04	30.00	36.60	**91.64**	16.68	20.02	22.72	**59.42**	- 8.36	- 9.98	- 13.88	**- 32.22**
MBO	16.64	16.77	28.30	**61.71**	16.64	16.77	33.47	**66.88**	-	-	5.17	**5.17**
EM	6.14	9.12	9.19	**24.45**	5.33	5.39	5.34	**16.06**	- 0.81	- 3.73	- 3.85	**- 8.39**
Total	***85.87***	***94.14***	***113.38***	***293.39***	***75.80***	***79.79***	***99.57***	***255.16***	***- 10.07***	***- 14.35***	***- 13.81***	***- 38.23***
Transfers (GL)												
Overflow at Barossa Weir	2.24	2.24	2.24	**6.71**	-	-	-	**-**	- 2.24	- 2.24	- 2.24	**- 6.71**
Overflow at Little Para	-	-	-		-	-	-		-	-	-	
Oveflow at Gorge Weir	22.21	22.20	1.43	**45.84**	-	-	-	**-**	- 22.21	- 22.20	- 1.43	**- 45.84**
Overflow at Clarendon Weir	17.07	25.95	9.24	**52.26**	27.87	32.25	-	**60.12**	10.80	6.30	- 9.24	**7.86**
Overflow at Myponga	0.68	2.02	1.94	**4.64**	0.68	2.02	1.94	**4.64**	- 0.00	0.00	-	**- 0.00**
	42.20	***52.41***	***14.85***	**109.46**	***28.55***	***34.27***	***1.94***	***64.76***	***- 13.65***	***- 18.14***	***- 12.91***	***- 44.69***
WTP production (GL)												
Barossa	12.66	12.39	13.01	**38.06**	8.18	11.06	13.01	**32.25**	- 4.48	- 1.33	-	**- 5.81**
Little Para	4.28	9.54	13.59	**27.41**	1.81	4.91	7.39	**14.11**	- 2.47	- 4.63	- 6.20	**- 13.30**
Anstey Hill	18.21	21.89	22.91	**63.01**	17.38	15.68	15.76	**48.82**	- 0.83	- 6.21	- 7.15	**- 14.19**
Hope Valley	-	12.38	24.20	**36.58**	24.43	24.77	25.10	**74.30**	24.43	12.39	0.90	**37.72**
Happy Valley	30.79	42.64	60.34	**133.77**	19.59	49.96	73.01	**142.56**	- 11.20	7.32	12.67	**8.79**
ADP	64.80	34.40	-	**99.20**	64.80	34.40	-	**99.20**	-	-		
Total	***130.74***	***133.24***	***134.05***	***398.03***	***136.19***	***140.77***	***134.27***	***411.24***	***5.45***	***7.53***	***0.22***	***13.20***
NSIS flows												
Central (D103C -> D103N)				**-**	-	-	-	**-**	-	-	-	**-**
Western (D51S -> D51N)	13.90	5.10	-	19.00	2.96	3.00	3.04	9.00	-10.94	-2.10	3.04	-10.00
Eastern (D170S -> D170N)	23.20	11.90	0.30	35.40	25.26	21.73	17.92	64.91	2.06	9.83	17.62	29.51
Northern (D-170N -> DLP)	9.00	4.40	-	13.40	16.16	10.55	6.46	33.17	7.16	6.15	6.46	19.77
Total	**46.10**	**21.40**	**0.30**	**67.80**	**44.38**	**35.28**	**27.42**	**107.08**	**-1.72**	**13.88**	**27.12**	**39.28**
Costs												
OX0014 (NSIS)	9.41	7.20	4.80	21.41	10.14	9.71	9.05	28.90	0.73	2.51	4.25	7.49
OX0047 (Carbon)	8.88	9.40	11.35	29.63	8.37	8.69	11.00	28.05	- 0.51	- 0.71	- 0.35	- 1.58

	RBP Scenario				Scenario 1				Variance			
	13/14	14/15	15/16	Total	13/14	14/15	15/16	Total	13/14	14/15	15/16	Total
OX0015 (Electricity)	25.79	29.33	34.91	90.03	24.63	28.78	34.04	87.45	- 1.16	- 0.55	- 0.87	- 2.57
OX0028 (Allwater)	86.16	90.55	92.92	269.63	86.78	90.80	92.66	270.24	0.62	0.25	- 0.26	0.61
OX0029 (ADP)	71.02	49.92	34.25	155.19	71.02	49.92	34.25	155.19	-	-	-	-
Total	**201.26**	**186.40**	**178.23**	**565.89**	**200.93**	**187.90**	**181.00**	**569.84**	**- 0.33**	**1.51**	**2.77**	**3.95**