DEWNR Review of Mount Lofty Ranges Reservoir Inflow Estimates, as Proposed by SA Water to ESCOSA

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In accordance with the ESCOSA Terms of Reference at Attachment 1, this document provides a review of the Mount Lofty Ranges (MLRs) Reservoir Inflow Estimates from SA Water, as received by DEWNR on 7th March 2013 and included as Attachment 2. In addition to the document provided at attachment 2, SA Water also provided DEWNR with the spreadsheet files called: *'Information on Mount Lofty Ranges Inflow Data, Res Inflows DEWNR.xlsx'* and *'0809dataDEWNR.xlsx'*, which are not attached to this report due to their size. Attachment 2 and the aforementioned spreadsheets are herein referred to as 'SA Water's MLRs Reservoir Inflow Submission'.

Headings below are reflective of the Term of Reference for the review.

1 The appropriateness of the hydrological methodology adopted by SA Water in estimating MLRs inflow for the Regulatory Business Proposal [to ESCOSA]

1.1 Sources of information used in these estimates

The sources of information used in the SA Water MLRs Reservoir Inflow Submission for the 10-year period preceding 30 June 2012 (2002/2003 to 2011/2012) include:

- Reservoir water levels
- Water level - storage relationships to convert water level to storage volume
- Daily rainfall and evaporation
- Estimates of spill
- Bulk water transfer volumes (intake and offtake volumes)

A check of a sample of the input data provided indicates that the water levels, level-storage relationships, rainfall data, evaporation rates and spill estimates appear to be relevant and up-to-date.

In the absence of further information on how bulk water transfer volume data was collected, DEWNR is unable to comment on the accuracy of this data. Historically, bulk water infrastructure operators have recorded scour openings manually for the time and size of the opening, although it appears that recorded in-situ measurements have been taking place in the recent period.

The SA Water MLRs Reservoir Inflow Submission also refers briefly to two other longer periods of data (117 years and 30 years) to illustrate how the estimation of inflows can change by examining different periods of data (refer

to the table on page 2 of the SA Water submission at Attachment 2) . DEWNR has not reviewed the methods, data and assumptions used to arrive at the figures provided in the table for 117 and 30 years, as this information was not submitted for review in SA Water's submission.

1.2 KEY ASSUMPTIONS USED IN THESE ESTIMATES

The SA Water MLRs Reservoir Inflow Submission assumes that the inflows over the past 10 years are most representative of the next five years. SA Water has undertaken recent work that has suggested there has been a relatively recent reduction of inflows to MLRs reservoirs when compared to similar previous climate sequences (more than 10 years ago), potentially due to changes in catchment processes and/or increases in unregulated water usage. DEWNR has, and will continue to work closely with SA Water to understand these changes and their impact on reservoir inflows, and the catchment more broadly. While some of this recent work is in the final stages of internal and peer review (eg. a piece of work commissioned by SA Water in partnership with DEWNR, currently referred to as the "unpublished Clark 2011 Report"), other aspects of this work have not yet progressed to this stage. In the meantime, while this work progresses, and for the purpose of the RBP to ESCOSA, DEWNR supports SA Water's approach of estimating the past 10 years of inflows.

Beyond the key assumption discussed above, it is unclear from the SA Water MLRs Reservoir Inflow Submission as to what other key assumptions have been made, as the focus of the SA Water submission relates largely to results and conclusions from the data presented.

The mean and median data provided for the 10-year period (2002/2003 to 2011/2012) have been calculated using a reservoir water balance methodology. The data, methodology and the results for this 10-year period are provided in the SA Water MLRs Reservoir Inflow Submission and appear appropriate. However, the results provided for the other two periods (117 years and 30 years) cannot be reviewed by DEWNR at this time, as the methodology used and the assumptions made to obtain these results were not provided.

As evaporation, rather than net evaporation, is used for the evaporative losses, it has been assumed that rainfall on the reservoir is negligible. This is likely to overestimate the evaporative losses, and hence overestimate the inflows required to replace this volume in the water balance. However, this is likely to be a small fraction of the total volumes calculated.

1.3 *METHODOLOGY* USED IN ARRIVING AT THESE ESTIMATES

By measuring or deriving values for the variables outlined at Section 1.1, a daily reservoir water balance was carried out for the 10 year period. The largest unmeasured term in such a water balance is the inflow figure to the reservoir being assessed. This is due to lack of measured stream flow data immediately upstream of the reservoirs and the complexity of bulk water transfers. Despite this estimation and/or derivation of some of these terms in the reservoir water balance, it is considered that the method adopted by SA Water for the RBP to ESCOSA is appropriate to retrospectively estimate the catchment inflow term.

While DEWNR broadly supports the methodology adopted by SA Water for the RBP to ESCOSA, the following points require clarification:

- As discussed above, the catchment inflow figures provided by SA Water are appropriate estimates based on a water balance that combines measured and derived values. The estimated nature of these figures may not be apparent from the terminology used in the SA Water submission, ie. "actual historic inflow".
- The SA Water MLRs Reservoir Inflow Submission states that the estimate of inflows over the 10 year period of 113 GL/annum is based on a statistical analysis of actual historic inflows. However, this statistical analysis appears to have been quite limited (to calculations of mean and median) and would likely benefit from the future inclusion of estimations of confidence or uncertainty intervals, among other areas of statistical analysis.
- DEWNR is unable to comment on the results provided in the report for the two other periods (117 years and 30 years), as the methodology used and the assumptions made to obtain these results are not provided.

2 EXPLANATION OF WHY THE SA WATER MLR INFLOW ESTIMATES (FROM THE RBP) DIFFER FROM THE ORIGINAL ESTIMATES PROVIDED BY DEWNR

The main differences in the estimates supplied to ESCOSA for their determination stem from the different types of model used by the two Agencies:

- SA Water has, for the previous 10 year period, used a reservoir water balance model with inflow and storage estimates and live data streamed from SCADA devices to retrospectively estimate inflows, for its operational/forecasting purposes.
- DEWNR has used a catchment rainfall-runoff hydrological modelling platform that simulates catchment runoff based on climate inputs, for the State's long term catchment-scale water planning purposes.

DEWNR's approach to the modelled estimate:

As DEWNR is responsible for large scale planning and water management across the spectrum of Natural Resources Management (NRM) interests (eg. on-farm irrigation, water extractions from streams and rivers, maintenance of water dependent ecosystems, etc), it is usually reliant on the development of conceptual hydrological planning models. Such models are tasked with producing long-term stream flow estimates as well as estimation of flow regimes varying from year to year and season to season.

These hydrological models are required to estimate these hydrological fluxes across broad landscapes and temporal units and are often required to perform outside the range of recorded or known information. Recorded data from a limited number of sites is fed into these models for calibration and validation of the conceptual understandings of the catchment processes. As such, assumptions must be made within these models where such data is unavailable at the time.

Such assumptions include:

- the size of farm dams
- rainfall and evapotranspiration patterns across the landscape
- demand from various water sources
- fluxes of water within and between the various conceptual components of the landscape (soil water, groundwater recharge, surface flows etc.)

These assumptions are often made on the basis of studies presented in literature that may be limited in their spatial and temporal coverage and scaled up to the area of interest. Nonetheless, the estimates made in these assumptions are generally considered to be within reasonable bounds and suitable for long term planning purposes.

Given the long-term view on water planning in general, these models are usually calibrated with the longest amount of data available to represent as much a variance of climatic conditions as possible. An industry standard for this type of model is around a minimum of 15 years.

Accuracy of planning models.

The required accuracy of a planning model is generally dependent on intended use of the estimates it provides. This means that for a long-term planning model that takes into account extremes of wet and dry periods, estimates of individual flow events or even inter-annual estimates may vary from recorded data. But these models are often accepted for use in long term planning due to their tendency to be accurate in the case of long term averages or percentiles (over periods of 30-100 years).

As correctly stated in the SA Water MLRs Reservoir Inflow Submission, the models employed by DEWNR were found in a recent review to overestimate flows in the recent 10 years. This overestimation of flows over a short-term (10 years) may be another reason for the differences in the initial estimates of reservoir inflows by DEWNR and SA Water.

Limitations of data available to DEWNR at the time of the request

As DEWNR was requested to treat the request for information from ESCOSA on Mount Lofty Ranges Reservoir Inflows as confidential, as stated in its original advice to ESCOSA (8/12/2012), DEWNR was not able to seek further information or clarification on operations or bulk transfers to enable the most up-to-date information to be fed into the estimate provided. As such, DEWNR relied upon only the most recently peer reviewed models that were available to it at the time of the request. Additional climate data was used to extend the time period of the selected models. DEWNR does not keep updated operational models of the Mount Lofty Ranges catchments. Rather, models produced at a point in time for the purpose of, say, Water Allocation Planning are archived.

The process of updating, recalibration and general maintenance of an operational model was not possible in the timeframes and with the confidentiality constraints that were followed in reply to ESCOSA's request for information. Were this to have occurred, it is possible that the two differing methods employed by SA Water and DEWNR may have aligned more closely. However, given the uncertainties in both approaches, it is likely that the differences in the types of models and data used would have still yielded varying results requiring explanation.

3 SUMMARY

3.1 APPROPRIATENESS OF THE HYDROLOGICAL METHODOLOGY ADOPTED BY SA WATER IN ESTIMATING MLR INFLOWS FOR THE RBP

Given the arguments in Sections 1 & 2 relating to the purpose and use of various types of models, it is considered that the use of a water balance is appropriate in this case (for short-term operational/planning purposes), when the unmeasured reservoir inflow term can be back-calculated based on the data available in catchments and at the reservoirs.

Short-to-medium term predictions in climate and hydrological sciences can be fraught with uncertainty, however it appears that SA Water have used the information available to them to make an appropriate estimate that plans for a period of lower inflows, which have been observed over the recent 10 year period.

3.2 SUGGESTIONS FOR POTENTIAL IMPROVEMENTS TO THIS METHODOLOGY IN THE FUTURE

The largest uncertainties in the water balance estimates (and thus the estimation of reservoir inflows) are expected to be involved in the calculation of:

- evaporation volumes
- estimating large changes in storage from small changes in water level
- inter-basin bulk transfer volumes

For the purpose of estimating reservoir inflows, the uncertainty associated with the three variables above could be circumvented by gauging bulk transfers and the stream flows into the reservoir storages. In the absence of this information, a thorough documentation of the data sources (including methods of collection and an uncertainty analysis) would improve the ability to assess the accuracy and uncertainty of input information submitted by SA Water for future RBPs.

ATTACHMENTS:

1. ESCOSA Terms of Reference for this DEWNR Review
2. SA Water's submission for DEWNR Review