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THE UNIVERSITY OF
NEW SOUTH WALES



WATER RESEARCH
LABORATORY

School of Civil and
Environmental Engineering

Water Corporation
PO Box 100,
LEEDERVILLE WA 6902

Attention: Michelle Rhodes

Dear Michelle

**PERTH SEAWATER DESALINATION PLANT
COMMENTS ON PEER REVIEW STUDIES BY CSIRO AND NIWA**

1. NIWA - Summary

The NIWA Review is detailed and comprehensive. It should be noted that the NIWA Review is based upon a draft version of the WRL Report and many of the issues raised by NIWA are already addressed in the final WRL Report,

NIWA concluded that:

"in general van Senden and Miller (WRL, 2005) have done a good job, and have fairly and clearly identified the main issues involved. They have made good use of available data and results from previous 3-D modelling to derive parameter estimates and inputs for their own simplified box model, and in this respect have generally been conservative".

They concluded that the WRL report was thorough and that the modelling was clearly documented, and with the provided source code it was possible to clearly determine how each of the various processes had been modelled.

WRL essentially agrees with the NIWA observation that *"only a coupled 3-D hydrodynamic-ecosystem model would yield a significant improvement in predictions and would require a major field data collection program for proper validation"*. The data collection program (encompassing physical, chemical, biological and ecological parameters) to enable such a complex model to provide more meaningful indications (than those already available from the box model) is likely to require several years (more time than is available for any decision on desalination for Perth). In recognition of the lack of suitable data, NIWA agreed that the modelling approach used by WRL was appropriate in the circumstances. Further, even with sufficient data, such a 3-D model may be plagued by



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KING STREET, MANLY VALE
NSW 2093 AUSTRALIA
Telephone: +61 (2) 9949 4488
Facsimile: +61 (2) 9949 4188
Internet: www.wrl.unsw.edu.au
Email: office@wrl.unsw.edu.au
A B N 5 7 1 9 5 8 7 3 1 7 9

unreasonably long simulation times, instability problems and artificial mixing. It is for these reasons that a coupled 3-D hydrodynamic-ecosystem model was not used.

NIWA believe that the modelling adequately represents the relative dissolved oxygen response within Cockburn Sound to the desalination brine disposal. However, NIWA question the validity of dissolved oxygen prediction levels in absolute terms because they consider that the box model is not adequately validated (due to lack of data). In spite of this issue, the reviewer concluded that:

“my own interpretation would be that while the discharge will certainly not improve conditions in the Sound, it will not have a major effect... I would expect the overall shift in median or mean measures of mixing and oxygen to be within the range of natural variation now observed. I think this conclusion is reasonably well supported by the box model and the results presented from the 3-D EFDC model”

NIWA have expressed some concerns beyond the modelling in regard to oxygen demand at the sea bed and the interpretation of critical dissolved oxygen levels for ecological health. WRL understands that these concerns have been addressed independently by Dr Des Lord and Dr Carolyn Oldham.

NIWA concur however with the overall WRL conclusion that the desalination plant can proceed subject to the ongoing commitment of the Water Corporation to in-situ monitoring and an adaptive management plan which includes the possibility of periods of desalination plant shutdown and-or increased dilution if trigger levels of dissolved oxygen are reached.

2. CSIRO - Summary

CSIRO Review of the modelling is not as detailed nor comprehensive as that of NIWA. It should be noted that the CSIRO Review is based upon a draft version of the WRL Report and many of the issues raised by CSIRO are already addressed in the final WRL Report,

Most of the uncertainty in modelling and interpretation by WRL raised by CSIRO, relates to repeated references to the lowest recorded dissolved oxygen levels from Mangles Bay in April 1994 as reported by Masini. The lowest value of 1.8 mg/l reported by Masini persisted for only a few hours during a nineteen day instrument deployment near the sea bed. Subsequent and more extensive data reported by Kwinana Industries Council (KIC) since 2000 indicates the lowest near bottom deep water dissolved oxygen level of 4.3 mg/l. Anecdotal reports are that both the water quality and sediment health have improved significantly since the substantial reduction of nutrient loads to the Sound during the early 1980s. Sediment oxygen demand (SOD) reported by Masini for bed samples, taken in April 1994, were 0.33 to 0.48 gm/m²/day. Recent 2005 bed sediment samples analysed by Read and Oldham (2005) noted maximum SOD rates of 0.19 gm/m²/day – it was noted that these low SOD values appear to be related to low dissolved organic carbon levels in the sample sediments which in turn are consistent with reduced nutrient loads.

CSIRO considered that predicting relative changes due to desalination plant brine disposal were reasonable but had similar concerns to NIWA as to the reliability of WRL predicted dissolved oxygen levels in absolute terms. The concern over absolute dissolved oxygen level predictions related to them being used to predict ecological impacts. CSIRO highlighted the need for ongoing research and clearer delineation of critical ecological trigger levels for dissolved oxygen (level and duration). WRL concurs with the need for such research and understands that the Water Corporation is implementing the required research programme. With regard to the model, WRL is of the firm view that because the model is based upon conservative assumptions and matches well enough with the behavioural trends indicated in the available data, it is more than adequate to allow relative changes and ecological impacts to be judged at this point in time.

It is noted that CSIRO endorsed the WRL recommendation that the desalination plant could proceed subject to the ongoing commitment of the Water Corporation to in-situ monitoring and an adaptive management plan which includes the possibility of periods of desalination plant shutdown and-or increased dilution if trigger levels of dissolved oxygen are reached – this agreement recognising the present uncertainties in data and future refinement of the modelling with this additional data.

3. CSIRO - Detailed issues and WRL response

CSIRO: Initially claim the models are simple and not adequately justified or tested against data.

WRL: As recognised in the more comprehensive and detailed review by NIWA, model complexity varied from full 3-D to the simple vertical box model. The modelling approach developed by WRL was 'fit for purpose' – ie assessing possible changes in salinity and dissolved oxygen and subsequent ecological impact within constraints of available data (as agreed by NIWA). WRL is confident that the approach used is appropriate to the circumstances and provides sufficient confidence to decisions as to whether desalination should proceed. The modelling approach included:

- Conservative assumptions;
- Sensitivity analysis; and
- A recommended management approach that reflected any remaining uncertainty (see the final WRL report).

This approach more than compensated for the validation/data issues raised by CSIRO.

CSIRO: Much criticism of the modelling relates to validation being unproven especially in regard to predicted dissolved oxygen levels being considered by CSIRO as too high – no model predictions indicating levels as low as 2 mg/l as reported by Masini in Mangles Bay during April 1994.

WRL: The lowest recorded dissolved oxygen levels were from Mangles Bay in April 1994. The lowest value of 1.8 mg/l reported by Masini persisted for only a few hours during a nineteen day instrument deployment near the sea bed. Subsequent and more extensive data reported by KIC since 2000 indicates the lowest near bottom deep water dissolved oxygen level of 4.3 mg/l. Anecdotal reports are that both the water quality and sediment health

have improved since the significant reduction of nutrient loads to the Sound during the early 1980s. Sediment oxygen demand (SOD) reported by Masini for bed samples, taken in April 1994, were 0.33 to 0.48 gm/m²/day. Recent 2005 bed sediment samples analysed by Read and Oldham (2005) noted maximum SOD rates of 0.19 gm/m²/day – it was noted that these low SOD values appear to be related to low dissolved organic carbon levels in the sample sediments. WRL model prediction within a broad range of parameters result in DO levels consistent with the more recent KIC data. Notwithstanding this, WRL agrees with CSIRO that further validation against data from ongoing monitoring will result in improved predictions and that further benthic chamber research should be undertaken (WRL understand that the Water Corporation has committed to undertake this).

CSIRO: CSIRO had similar concerns to NIWA in the reliability of WRL predicted dissolved oxygen levels in absolute terms – relative changes due to desalination plant brine disposal being considered reasonable.

WRL: CSIRO concerns over absolute DO level prediction are related to the dissolved oxygen level values being interpreted as to ecological impact. CSIRO highlighted the need for ongoing research and clearer delineation of critical ecological trigger levels for dissolved oxygen (level and duration), research that WRL agrees with and which Water Corporation is undertaking.

CSIRO: *"Salinity assumed for the lower layer is best described as an educated guess..."*

WRL: Clearly WRL and NIWA disagree. WRL presented in detail the calculation of dilution and salinity for the lower layer of the box model – the dilution was separately calculated for the diffuser, the Calista Channel and the drop off slope. Each of the three components was described in detail calculated upon state-of-the-art methods and conservative values adopted.

CSIRO: *"EFDC... state of the art hydrodynamic model... not used to address detailed dynamics of the deep brine layer"*

WRL: Full application of the EFDC 3-D model to dense plume dispersion and subtle effects on stratification and dissolved oxygen would require (as recognised by CSIRO, NIWA, WRL, Water Corporation) a substantial long term field data collection program (physical, chemical, biological and ecological) with particular focus on the deep basin areas. Detailed dissolved oxygen modelling would also require significant increase in vertical layer refinement with substantial increases in model run times along with potential instability and/or artificial mixing problems. Due to these issues and the lack of data, the simpler box modelling approach was developed to represent salinity/ dissolved oxygen dynamics and test response sensitivity to fundamental parameters. As stated by CSIRO, application of a complex operational 3-D biogeochemical hydrodynamic model would be conditional upon availability of complex long term data. In any case, WRL do not believe such a complex model would alter the final conclusions of its study.

CSIRO: *"The simple models may not be wrong but can have no credence until they are properly tested against data..."*

WRL: Disagree as does NIWA. The models are not perfect but agree well enough with the behavioural trends indicated in the available data and are adequate to allow relative changes and ecological impacts to be judged – particularly in light of the conservative assumptions used, sensitivity analysis and the conservative management recommendations.

CSIRO: CSIRO did however endorse the WRL recommendation that the desalination plant could proceed subject to the ongoing commitment of the Water Corporation to in-situ monitoring and an adaptive management plan which includes the possibility of periods of desalination plant shutdown and-or increased dilution if trigger levels of dissolved oxygen are reached – this agreement recognising the present uncertainties in data and future refinement of the modelling with this additional data.

Yours sincerely,



R J COX

Associate Professor in Civil and Environmental Engineering
Director

cc. Dr David Luketina