MEMORANDUM

To:	Luke Twomey	**Date:**	4 August 2010
From:	Murray Burling	**Ref:**	J0057
Re:	Oakajee Desalination Discharge Modelling		

BACKGROUND

A Seawater Reverse Osmosis (SWRO) desalination plant is required to provide water for the operational phase of the project. Most of the water will be required for dust suppression of the iron ore stockpiles, and the total amount is anticipated to be a total of 70.0ML/year of potable water and 1.1GL/year of process water.

The desalination plant will generate up to approximately 18ML per day of hypersaline water (salinity of approximately 64,000mg/L) that will be disposed of by return to the ocean, at the expected recovery rate of freshwater from seawater of 44 per cent (Consulting Environmental Engineers (CEE), 2010). The intake is likely to be located within the harbour, with the discharge proposed to be located on along the southern port breakwater, approximately 800 m from the shoreline (*Figure 1*).

The discharge has been designed by CEE to provide a minimum initial dilution of 1:34 within 30 m of the discharge point. This is presently proposed to be achieved using a 50 m long subsea diffuser array located at a water depth of approximately 8 m CD.

An initial mixing zone will result in elevated salinity primarily in the lower half of the water column, with the diluted plume dispersing thereafter due to the ambient currents. At this location, the ambient currents will in general be directed offshore due to the physical barrier to longshore drift provided by the port breakwater. This provides a consistent cross flow to the diffuser and should result in minimal "double dosing", or comprised mixing.

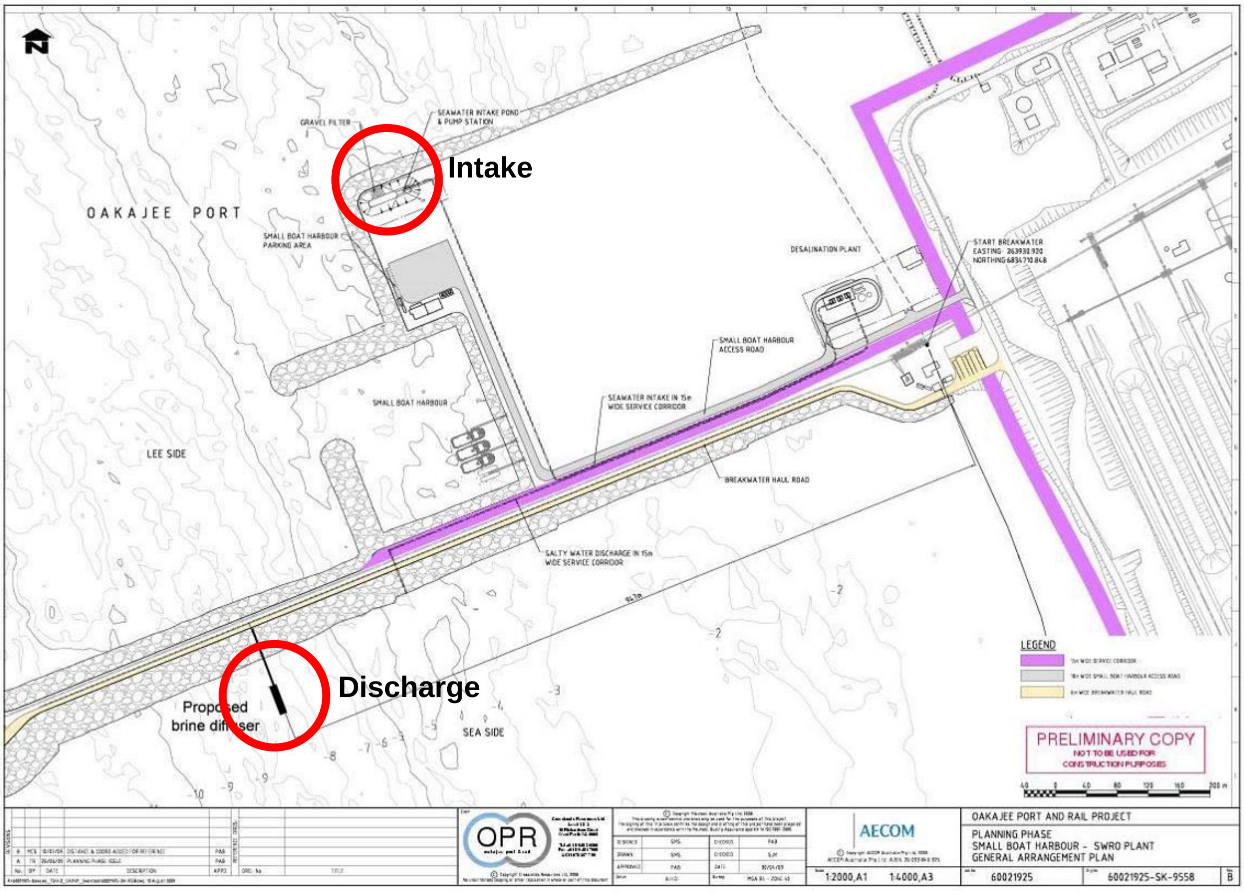

Figure 1 Location of desalination plant intake and discharge sites applied in the model.

DISCHARGE CHARACTERISTICS AND MODEL SCENARIO

The discharge is expected to be approximately 186 litres/second with a salinity of approximately 28 above the intake water. The temperature of the discharged water is also expected to be elevated above the intake, or background, water. The expected temperature increase is 1ºC.

To investigate the potential for adverse elevation of salinity levels in the surrounding waters, modelling of the desalination discharge was completed for a nominal “worst-case” or low mixing scenario. The scenario was selected based on an analysis of the available metocean data, with a focus on the persistence of relatively low wind speeds, as these are the dominant driver circulation efficiency at the site. The Autumn period of 2008 was selected, and the month of May 2008 has been used for the analysis that is discussed below. It is expected that under general conditions, the mixing and dispersion of the discharge plume would be more favourable from an environmental context than for the May 2008 period.

The modelling was undertaken using a modified version of the EFDC model application used for the harbour flushing study. The domain was further extended towards the south and offshore and the model grid shifted slightly to ensure an appropriate representation of the diffuser and nearfield zone in the model. The model was run with 8 vertical layers, with a focus on the resolution near the sea bed, with the bottom two layers being 5% of the total depth and resolution increasing towards the surface.

The model was initialized with a constant temperature and salinity field, and boundary conditions and external forcing defined based on expected conditions in this region. The initial water temperature was set at 20ºC and the salinity at 35. Atmospheric heat exchange and evaporation were included in the model. A one month warmup was included (April, 2008) then the model run for the further month to provide data for analysis. The difference predicted due to the discharge was evaluated by comparing cases with, and without, the discharge, all other forcing being identical.

THRESHOLD ANALYSIS AND RESULTS

The model results were assessed against a trigger value defined by the median salinity difference between the existing and the proposed case. This level is defined at 0.8 ppt at a level of 0.5 m above the seabed, consistent with high ecological protection areas (HEPA) as described in "*Environmental Quality Criteria Reference Document for Cockburn Sound (2003-2004) - A supporting document to the State Environmental (Cockburn Sound) Policy 2005"* (EPA 2005). The results are shown graphically in *Figure 2*.

The results of the analysis predicted that under the representative low energy conditions modeled the maximum median salinity difference of 0.35 ppt would result and therefore the trigger level would not be reached. The orientation of the elevated salinity zone is consistent with the expected current direction parallel to the breakwater. A zone of 0.3 to 0.35 elevation extends approximately 350 m from the discharge. There are no elevations above 0.1 beyond approximately 1,300 m in the cross-shore direction. There are no measureable impacts predicted within the inner harbour precinct under these conditions.

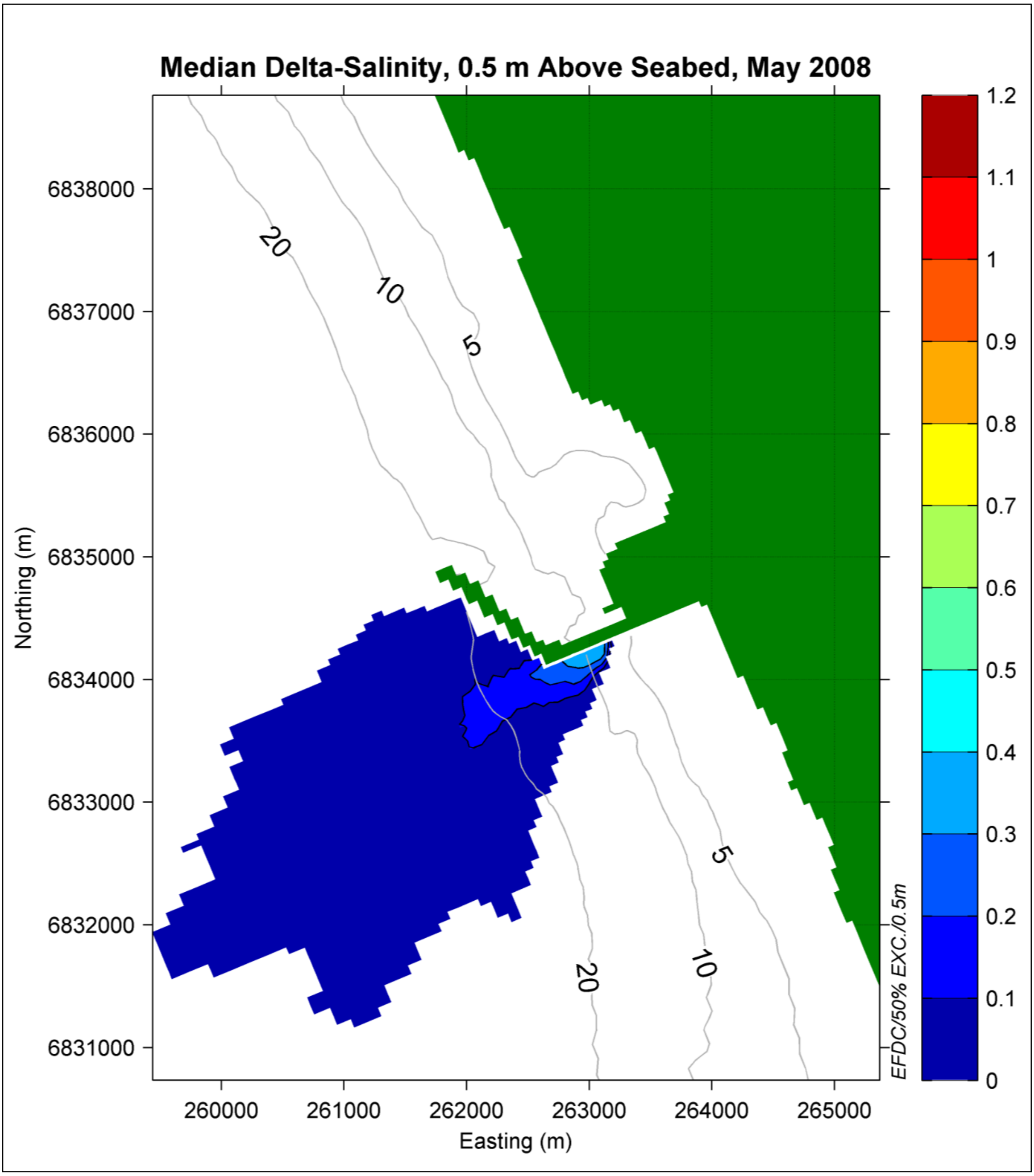

Figure 2 Spatial plot showing the predicted median salinity difference (proposed – existing) for the modelled May 2008 conditions. The coloured zones show the values indicated by the scale. Depth contours (5, 10 and 20 m) are also shown.