9 August 2010

Mr Lincoln Coe
Technical Services Manager
Port Otago Ltd
PO Box 8
Port Chalmers 9023

Dear Lincoln

Review of Technical Report: Port of Otago Dredging Project: Harbour and Offshore Modelling

I confirm I have received the Tonkin & Taylor (T & T) peer review of the NIWA/MetOcean technical report that you sent to me on Wednesday 3 August.

Overall, the review stated that the study of effects on hydrodynamics, sediment transport and wave climate was comprehensive. The peer review acknowledged that simulating seabed disturbance, sediment discharges and sediment transport is not a precise science, but noted the authors have chosen to be conservative or bracket model parameters where in doubt.

The modelling was assessed as being robust and fit-for-purpose, with no further or more detailed studies being necessary. Although the T&T peer review suggested that alternative models and methodologies could have been used, they also state that the final conclusions are likely to be similar to those given in the NIWA / MetOcean report. Finally, T & T appraised the modelling results and conclusions drawn from them to be sound.

I have outlined below some responses to the specific comments raised in the T & T review, categorising them into broad topics.

1) Editorial comments

Several suggestions were raised about the structure, style and composition of the Report:

- Decision on not proceeding with an Executive Summary was made by the Project Team, given the range and complexity of the investigations–instead a more comprehensive Summary & Conclusions section was provided at the end.

- Various comments on how the style of the text, cross-referencing and Figures (e.g., Fig. 4.26, Fig. 5.4) could be improved.

- White areas on Fig 5.4 to 5.6 are intertidal areas where the bed is dry for part of the tide cycle. Therefore tide amplitude (half-range) and timing (phasing) of low and high tide can't be extracted from the model results as the tidal processing module can only be done for sites that are continuously inundated by the tide. Note: It doesn't mean these areas are any less accurate than those model cells that don't dry out.

2) Linkages to other reports (that weren't reviewed by T & T)

Several comments related to how results flowed through to other assessments on water clarity and ecological effects for instance. It should be recognised that this report is one of many streams of work supporting a wider Assessment of Environmental Effects (AEE). Ecological matters are picked up,

National Institute of Water & Atmospheric Research Ltd, Gate 10, Silverdale Road, Hillcrest, Hamilton 3216
PO Box 11115, Hillcrest, Hamilton 3251, New Zealand. Phone +64-7-856-7026, Fax +64-7-856-0151

assessed and discussed in detail in the report by James et al., 2009, and wider considerations of physical coastal processes are provided by Single et al., 2009. The integrated effects of the project's various activities are further assessed in the AEE document.

Field data for the present investigations is contained in a separate technical report (with its Executive Summary appended to AEE), while existing field and environmental information was covered in the Shore Processes & Management report (Single, & Benn, 2007). Our approach was to focus on those specific field datasets used to drive the models or used to calibrate or verify the model performance, but in the context of a wider body of field data summarised in Sections 2.2–2.4.

3) Types and resolution of models

The modelling for the project was undertaken in a sequence starting with preliminary scoping modelling inside the Harbour in 2007 (see Exec Summary of January 2008 NIWA report) and ending with the offshore modelling in 2008/09. In 2007, the Flexible Mesh DHI models were just coming into consideration in the market, so a decision was made to continue modelling with the regular-grid MIKE21 model for the Harbour and moving later to the flexible-mesh approach for the offshore modelling. Therefore, in a regular-grid model there are trade-offs in a lower resolution of specific areas of narrow channels (which can readily be resolved in a flexible-mesh model) versus overall run-times for 1-month simulations. In hindsight, persisting with the regular-grid MIKE21 model was warranted as the DHI Particle-Tracking module (used to simulate the sediment plumes) for flexible-mesh model grids struggles to work reliably in intertidal harbours (but alright offshore where it was used for this Project) and it doesn't readily output sediment deposition thicknesses (but the MIKE21 module does).

Swell penetration into the Harbour is minimal, limited to the area around the entrance and northward of Te Rauone Beach and does not extend appreciably past Harington Bend. The wind-wave modelling inside the Harbour was carried out to characterise the wave climate from different wind directions to assess effects on ship handling and for assessment of physical sediment processes in the Harbour. Deepening the main channel would have little effect on wave heights in the Harbour.

Resolution of the model in the area of the offshore disposal ground (A0) was assessed. The velocity field in the area of A0 changes gradually with distance across it. Therefore with the Particle-Tracking module using interpolation of these velocity fields from the hydrodynamic model, the resolution was seen as sufficient to characterise the flows over the disposal ground.

Inclusion of the Harbour Entrance in the offshore model was a compromise between including the tidal flow in and out of the Harbour (but only through a single model cell) and the run-time of the model for the duration of field measurement periods, knowing that the tidal jet doesn't influence flows further offshore e.g., at site A0. It also served its purpose in assessing potential disposal closer to shore off Taiaroa Heads and coming to a decision that disposal would need to occur further offshore. So the implementation of the model was fit-for-purpose in that regard. However, further resolution of the Harbour Entrance would have been undertaken if any inshore disposal sites had looked favourable in terms of effects.

The DHI sand transport module was assessed on previous sand-transport projects that NIWA had used it for, but we didn't have the confidence that it would produce sound results for predicting the longer-term changes in the disposal site mound. Instead, NIWA adopted a more fundamental approach based on sediment-transport physics, based on actual current-meter measurements for the 3 month field

National Institute of Water & Atmospheric Research Ltd, Gate 10, Silverdale Road, Hillcrest, Hamilton 3216
PO Box 11115, Hillcrest, Hamilton 3251, New Zealand. Phone +64-7-856-7026, Fax +64-7-856-0151

period. This fundamental approach was undertaken by sediment-transport experts in NIWA, which bracketed the potential deflation of the seabed mound using two different, but internationally recognized, sediment-transport formulae (viz. Rouse and Nielsen formulations). The results were also assessed within the context of the local geomorphology of the offshore submergent sand spit.

4) Model calibration

- Regarding the comment about the inverse Manning's n (Section 4.2.2), two values were tried 32 (the default value) and 38, but this change made little difference to the results – it is the form drag of the larger channel-bank-island features that predominantly govern flows rather than the bed roughness.

- The Braystoke current velocity used (p. 34) was averaged down the depth profile measurements, so can be compared with the model depth-averaged velocity. Comparing velocities measured at a single point with a model result will never match exactly as the model calculates an average over a model grid cell of 30×30 m or 900 m^2 area, so some discrepancies will be expected.

- Depth adjustments were made to match the mean tide level from the S4 current meters with the mean tide level from the model. The key here was to look at how well the model is performing in predicting the measured tidal range and timing of high and low tides rather than assessing absolute mean-tide levels during the mooring period (which are a function of climate and weather effects).

- The Macandrew Bay current meter site (Fig 4.22) was on the end of the intertidal bank on a sharp turn in the channel. On the flood tide, the current locally accelerates across that site (Beacon 'N') more than is shown by the averaged current velocity over a 30×30 m model cell. A higher resolution of cells in this area would have improved this match, but in terms of the overall result, the suspended sediment concentrations at Macandrew Bay would be slightly less in reality because the modelled flow hasn't cut the corner.

- The Jan-Feb 2007 period chosen for the hydrodynamic modelling runs was based simply on taking a period of recent measurements (at the time the Harbour modelling commenced in 2007 with freshly measured bathymetry data) that also included a higher spring–tide range and two complete neap-spring tide cycles.

- The modelled suspended-sediment concentration (SSC) was an average over the depth. Again a flexible-mesh 3-dimensional model was not available to NIWA (as outlined above), but given sources of sediment from a dredger occur at both the sea-bed and further up in the water column from the overflow, depth averaging is not too much of a constraint in terms of assessing in-water ecological effects. Depth-averaged results will also be more conservative for the visible surface SSC, as sediments start to settle and most of the discharges are below the water surface.

The above comments encapsulate the themes raised in the T&T peer review and I trust that this provides the clarification and context for the review.

Yours sincerely

Robert Bell
Project Leader

National Institute of Water & Atmospheric Research Ltd, Gate 10, Silverdale Road, Hillcrest, Hamilton 3216
PO Box 11115, Hillcrest, Hamilton 3251, New Zealand. Phone +64-7-856-7026, Fax +64-7-856-0151