BMT Commercial Australia Pty Ltd
Level 5, 348 Edward Street,
Brisbane, Qld, 4000
Australia

ABN: 54 010 830 421

Our ref: L.A11800.002.DraftPeerReviewReport.docx

14 April 2022

Tasmanian Ports Corporation
90-110 Willis Street
Launceston TAS 7250

Attention: TasPorts Technical Advisory Consultative Committee (TACC)

Dear Chair and TACC Members

RE: TASPORTS QUAYLINK EIS - REVIEW OF SEDIMENT PLUME MODELLING

The following provides a review of the dredging-related sediment plume modelling and proposed monitoring program used to support the Devonport East Terminal 3 (T3) Dredging and Reclaim Project Environmental Impact Statement (EIS). The review has focused on the information and assessments presented in:

- EPA Tasmania (2019), Project Specific Guidelines for Preparing and Environmental Impact Statement for Tasmanian Ports Corporation Pty Ltd, Port Devonport – Devonport East Dredging and Reclaim
- Consulting Environmental Engineers (2020), Extent of Sediment Plume during Dredging in Port of Devonport, report prepared for Tasmanian Ports Corporation
- Marine Solutions (2021), Devonport East Reconfiguration Aquatic Impact Assessment, report prepared for Tasmanian Ports Corporation
- TasPorts (2021), Devonport QuayLink Environment and Sustainability Management Plan – Programme Wide, Revision 0

The review has focused on the following key issues:

- The application of the numerical modelling tools and suitability of the data used to inform key modelling assumptions
- The use of model outputs to assess the potential impact to marine habitat, fishing resources and scallop beds
- Adequacy of the proposed monitoring to detect potential impacts to marine habitat, fishing resources and scallop beds.

This document is comprised of the following parts:

- Summary of the technical review
- Recommendations for further work
- Technical review detailed table.

Authors

The authors of this review are:

- Dr Ian Teakle, Senior Principal Coastal Engineer – numerical modelling
- Dr Matthew Barnes, Principal Coastal Engineer – numerical modelling
- Dr Darren Richardson, Senior Principal Scientist – marine ecology impact assessment and monitoring
- Geoff Withycombe – project coordination

If you require any further information or clarification, please do not hesitate to contact the undersigned.

Yours Sincerely,

BMT

Dr Matthew Barnes
Principal, Team Leader Coastal (Eastern Region)

1 Summary of the technical review

1.1 Introduction

The proposed dredging project, as described in the reviewed documents, is summarised as follows:

- Location: Port of Devonport, Berth 3, Mersey River estuary
- Target depth: -8.35 m Chart Datum (over-dredge allowance of 0.3 m)
- Volume: < 50,000 m^3
- Material types: clay (12%), silt (28%), sand (34%), gravel (5%), underlying rock (21%)
- Method: land-based long reach excavator and/or backhoe dredger operating from a barge
- Material management: land-based reclamation within the port area
- Duration: ~4 weeks

Based on these details, it is the reviewer's opinion that the proposed works are unlikely to generate significant sediment plumes in the marine environment offshore from the Mersey River mouth. Dredging-related sediment plumes are more likely to develop and persist within the estuary in areas upstream and downstream of the project location. The sediment plume distribution (throughout the water column and spatial extent) will be strongly influenced by dredging operations and the environmental conditions at the time of dredging, including the river flow rate and salt wedge condition within the lower estuary.

The following section summarises the key comments from the independent technical review.

1.2 Plume modelling and impact assessment

- The EIS plume modelling assessment (Consulting Environmental Engineers, 2020 and Marine Solutions, 2021) addresses the core requirements of the EIS guidelines (EPA, 2019), however additional work is recommended to further address remaining uncertainty in the prediction of dredge plume risk, mitigation options and adaptive management strategies for the QuayLink project.
- Based on the reports reviewed it is assumed that the EIS modelling is two-dimensional (depth-averaged).
- The description of the modelling software is incomplete, and no validation is presented so that it is unclear if the model captures important Mersey River estuary hydrodynamic processes (such as a salt-wedge condition) that will influence plume dispersion.
- The modelled dredge plume source rates are at the lower end of the possible range, which may lead to potentially un-conservative impact assessment conclusions being drawn.
- The dredge plume impact assessment is based on a single model scenario. Sensitivity of the results to different environmental conditions and/or dredge plume source rates (for example) is not presented. Consequently, the risk assessment is not well informed about predictive uncertainty.
- Model outputs and impact assessment focuses on the higher intensity 'acute' (hours) increases to turbidity, for some sensitive receptors the low intensity 'chronic' (days) increases to turbidity are also important.

1.3 Proposed monitoring

- The proposed adaptative management approach, whereby turbidity monitoring data are compared to 'threshold values' to trigger management actions, is consistent with standard industry practice and supported.
- The methodology and design (upstream/downstream sites, continuous telemetered data collection) are consistent with standard industry practice and is supported.
- The proposed development of turbidity 'reference levels'/threshold values to trigger management actions is supported. Refinements to the threshold value derivation method are recommended.
- The proposed approach of conducting vessel-based water quality measurements to characterise dredge plumes in response to any threshold values exceedances is supported. In addition, routine water quality profiling is recommended to better understand plume behaviour.
- In addition to the above monitoring, it is recommended that vessel-based dredge plume measurements are undertaken to validate modelling and test assumptions of source terms.
- The proposed approach of assessing potential giant kelp habitat prior to dredging is supported.
- The proposed monitoring can be enhanced to provide a more complete dataset for mitigating risk, validating model assumptions/outputs and improving stakeholder confidence in the impact assessment conclusions.

2 Recommendations for further work

The following list of recommendations are provided to TasPorts to help improve the management of both environmental and project delay risk associated with the QuayLink project dredging works. The recommendations are targeted at reducing uncertainty in the dredge plume risk assessment and thereby improving the design of the adaptive dredge management plan and associated monitoring program.

2.1 Plume Modelling Assessment

1. Complete a 3D modelling assessment to improve the understanding of potential dredge-related increases to turbidity
2. Complete a model validation exercise using existing Acoustic Doppler Current Profiler (ADCP) data, focus on the simulation of Mersey Estuary salt wedge hydrodynamics
3. Validate the model for simulating ambient sediment dynamics is industry best practice
4. Complete a refined assessment of plume impacts, addressing key uncertainties
   - Improved understanding of contractor methodology
   - Model parameter uncertainty (validation and/or parameter sensitivity tests)
   - Variable environmental conditions (ensemble of historical periods)
   - Sediment source rate uncertainty (expected and worst case)
5. Complete a refined risk assessment of 3D distribution of plume through estuary and adjacent coastal environments to inform adaptive management and monitoring program design

2.2 Proposed Monitoring

6. Fixed stations:
   a. Install both near bed and near surface water quality instruments at monitoring sites
   b. Consider the need for refining/additional sites based on the outcomes of proposed modelling
   c. In addition to turbidity, it is recommended that water level, electrical conductivity, dissolved oxygen and pH are measured
   d. Install duplicate sondes to provide instrument redundancy
7. Threshold values:
   a. In addition to the proposed acute (hours) threshold values, develop and implement threshold values to assess and manage potential chronic effects (days)
   b. Refine threshold values based on ambient conditions (excluding predicted dredging effects) using standard methods. In the absence of other lines of evidence (e.g. biological tolerance data), it is recommended that these values should not exceed the observed ‘upper range’ of seasonal ambient conditions
8. Vessel-based dredge plume validation:
   a. It is standard industry practice to undertake field studies to validate dredge plume modelling predictions and modelled plume source assumptions. Further detailed studies of plume

behaviour are recommended. This should include, for example, vessel-based ADCP transecting, combined with WQ instrument profiling and water sampling and laboratory analysis. Representative spring and neap tides should be measured, undertaken early in the program.

9. Vessel-based dredge plume monitoring:

    a. Undertake water quality instrument profiling on transects located upstream and downstream of the dredge site, and at sensitive receptor sites. Sites depending on plume behaviour and modelling results.

    b. Sampling should be conducted if threshold values are exceeded (as already proposed), and in addition: on multiple occasions (e.g. every 3-4 days, frequency depending on risk, as determined through dredge plume modelling) during flood and ebb tides for the duration of the campaign, and during/following significant flow events.

3 Technical Review Detailed Table

Topic	Element	Document Reference	BMT Assessment
Consulting Environmental Engineers (2020), Numerical Modelling			
Quantity of material to be dredged	Quantity	Section 3.2, page 5	• Quantity of dredging that has been assessed (47,600 m^3) is consistent with (slightly larger) than 45,900 m^3 stated in EIS.
Characteristics of material to be dredged	Sediment Particle Size Distribution Fines content	Section 3.3, page 5	• Characteristics of material to be dredged are based on Marine Solutions (2019) sampling and analysis report. The proportion of clay, silt, sand, gravel and weathered rock material has been verified by the reviewer against Marine Solutions (2019). • It appears that the proportion of fines used in the modelling is based on an average over the entire dredging volume, inclusive of weathered rock material. A higher fines proportion would be obtained if averaged over the predominant loose silty-sand material overlying the weather rock. It would have been more appropriate and conservative to consider this higher fine content for deriving expected plume source rates. • WAMSI/CSIRO (2020) also consider the upper range of potential fines content that may be encountered for a sustained period during the dredging campaign. No attempt has been made to assess this upper range.
Dredging method	Dredging method (modelled)	Section 3.3, page 5	• The modelled dredging method is based on one of two options considered in the Project Dredge Management Plan (DMP), involving a Backhoe Dredger (BHD) operating from a barge. This option would have a higher productivity and therefore intensity of plume production than the alternative land-based excavator option. • No consideration has been made of the potential for multiple sources, should there be a BHD and land-based excavator operating simultaneously. • The adopted dredging productivity for plume source derivation of 1800 m^3/day is based on an average over the entire campaign and is slightly lower than the 2000 m^3/day mentioned in the DMP. For plume source derivation we typically account for BHD experiencing 40% downtime and 60% operational time over the course of a campaign. Using this basis, the appropriate productivity for dredge plume source derivation would be 2000/0.6 = 3330 m^3/day, which is significantly (85%) higher than the value assumed for the modelled plume source derivation.
Disposal of dredged material	Material dewatering and rehandling	Section 3.4, page 6	• Material dewatering will require a discharge of water and associated sediment back into the estuary. This does not appear to have been included as a potential plume source in the modelling simulations. While tailwater discharge is typically only a minor plume source compared with the adjacent dredging activities, it would typically be included in a plume modelling assessment.
Description of existing environment	Tidal water levels Tidal currents River flows Stratification Background turbidity	Section 4 & Section 5	• Tidal current profiles were measured by a bottom-mounted ADCP deployed in the swing basin for a 14-day period from 4/2/2020 to 18/2/2020. Analysis of the ADCP data demonstrated that stratification is significant in driving a salt wedge estuary circulation with near surface flows having a net downstream direction and near bed flows having a net upstream direction (averaged over a tidal cycle). This 3D structure of the water column will be critical for accurately predicting the fate of dredge plumes. • The variability of river flows and significance for driving estuary stratification and ambient turbidity signals is discussed in the report. However, when it comes to plume modelling, only a median river flow and non-stratified estuary configuration is assessed in the simulation/s. • A single set of vertical profiles of salinity and turbidity from 24 June 2016 was described and again highlighted the significance of stratification to the hydrodynamics of the Mersey River estuary. • Turbidity in the estuary was measured at two locations from 28 January 2020 to 18 February 2020. Measurements demonstrated significant variability within a tidal cycle, and also higher turbidity variability during spring tide periods indicating that tidal resuspension of fine sediment is occurring in the estuary. • The relatively short (~3 week) duration of measurements is of limited value in describing the baseline long-term and seasonal turbidity climate of the estuary. This presents some risks for the robust derivation of turbidity thresholds to inform the DMP. • The relationship between turbidity and suspended solids is an important assumption for converting modelled plume intensity (typically mg/L) into turbidity (NTU) units. A previous study (CEE, 2015) was cited but has not been reviewed as to the basis for the assumed relationship (Turbidity = 1.1 x TSS).
Hydrodynamic model development	Modelling software Hydrodynamic model configuration Hydrodynamic model parameterisation Hydrodynamic model calibration and validation	Section 6	• The software attributed in the report is “Coastal Management Model (CMM)” developed by the United States Army Corps of Engineers (USACE). No formal reference is provided for the software and there is very limited description of the numerical model such that the reviewers remain uncertain about what has been applied in this study. The reviewers suspect that the modelling suite used is the “Coastal Modeling System (CMS)” developed the US Army Engineer Research and Development Center (ERDC). • The CMS-flow hydrodynamic model is a 2D depth-averaged solver of the Nonlinear Shallow Water Equations. It will therefore be unable to accurately simulate vertically stratified mixing processes such as those which occur in the Mersey River estuary.

Topic	Element	Document Reference	BMT Assessment
			• There is almost none of the model description that would be typically expected by the reviewers in a numerical modelling study: - Model domain figure showing extents and boundaries - Model discretization (grid size) - Bathymetric data source/s - Boundary conditions - Model coupling configuration, e.g. waves, sediment transport, morphology - Simulation periods - There is no model calibration or validation reported, despite the availability of tide data and 14 days of ADCP data that would allow for verification of model predictive skill. The absence of any model predictions other than the dredge plume results makes it impossible for the reviewer to form an impression of the model's fitness for purpose for this study.
Sediment model development	Sediment model configuration Sediment model parametrization Dredge plume source rate	Section 6	• There is very limited description of the numerical modelling software sediment transport module capabilities and configuration. The reviewers consequently remain uncertain about the basis for the dredge plume simulations. • There is no validation of the sediment transport model predictive skill, either in terms of prediction of ambient suspended sediment dynamics in the estuary or in terms of reproducing dredge plumes. • The model appears to be configured with multiple fine sediment fractions, which is in line with industry standards and the reported settling velocities are consistent with recommended values for cohesive sediment in estuarine environments. • There is no description of sediment resuspension parameters and therefore the reviewer is left to assume that the process of dredge plume material resuspension has not been included in the simulations, which would limit the model's ability to predict the chronic build-up of above-ambient plumes over multiple tidal cycles and days. • A dredge plume source rate of 2% loss of fines material has been applied. While 2% is within the range of values reported in literature it may be on the low side for loosely consolidated silty-sand material. BMT's experience from monitoring BHD operation in similar material is that a fines loss rate of ~5% (i.e. at upper-end of reported literature range) is likely to be more appropriate. • The derived dredge plume source rate (900 kg/hr = 0.25 kg/s) may be based on low-end assumptions about peak productivity, fine sediment content and fine sediment loss rate. • Best practice dredge plume studies will attempt to address uncertainty around plume source rates by assessing a range of assumptions from the (mid-range) expected case to the (upper-range) worst case. This study has only considered an expected case, which seems to be on the low-side due to some unconservative assumptions.
Model scenarios	Plume modeling	Section 6.5	• The plume modelling scenario is based on simulating a 3-week period corresponding to removal of the loose sediments overlying the weathered rock. In-lieu of simulating the entire campaign, this period is probably likely to coincide the highest potential for plume generation. • The plume modelling scenario is based on a single river inflow rate of 7.5 m^3/s. There is no assessment of sensitivity to higher or lower inflow rates. • The plume modelling scenario is based on simulating an un-stratified condition, though this is probably a limitation of the software, assuming that it is a 2D depth-averaged model that has been applied. In reality, the Mersey River is more likely to be stratified at the time of dredging and the fate of dredge plumes will be driven by 3D salt wedge dynamics. • A stratified condition is likely to result in higher upstream impacts and also in higher retention of dredge plumes within the estuary (i.e. greater chronic build-up of turbidity). The un-stratified assumption is probably conservative for flushing of plumes into the marine environment and therefore for prediction of impacts to marine sensitive receptors. • The plume modelling scenario has only considered an expected case plume source rate and has not assessed sensitivity to worst case assumptions. • The study has not addressed uncertainty in line with best practice dredge plume modelling practice. Typically, this would require: - Calibration and validation of model hydrodynamic predictions to address model parameter uncertainty - Assessment of environmental uncertainty, i.e. simulation of an ensemble of different potential conditions that may be encountered during dredging. - Assessment of source rate uncertainty, i.e. simulation of expected and worst case source rate assumptions.
Plume modelling results	Plume extent Turbidity	Section 7	• The model results are presented as snapshot plume intensity contours at four different tidal stages: - Peak spring tide downstream extent (Figure 7-1) - Peak spring tide upstream extent (Figure 7-2) - Peak neap tide downstream extent (Figure 7-3)

Topic	Element	Document Reference	BMT Assessment
			- Peak neap tide upstream extent (Figure 7-4) • Plume intensity contours correspond to above ambient surface turbidity. It is not clear how surface turbidity is derived if the model is 2D depth-averaged but in any case, near bed turbidity would be expected to be significantly higher than surface turbidity. Use of surface turbidity for the prediction of impact to sensitive receptors may be unconservative. • The following presentation of model results would be expected in best practice dredge plume studies: - Turbidity timeseries at reference and sensitive receptor locations - Surface, depth-averaged and near-bed turbidity predictions - Percentile maps of plume intensity - Sediment deposition predictions - Zones of impact level based on turbidity thresholds derived from baseline data and/or receptor threshold levels
Reclamation modelling results	Impact to waves Impact to currents Impact to sediment transport	Section 9	• The assessment of impacts to waves, currents and sediment transport does not appear to have been based on any modelling simulations, or if it has this has not been clearly articulated in the reporting. • The reviewer/s agree that impact to waves in the riverine environment is unlikely to be significant and should not require a modelling assessment • The impact to currents of the reclamation and dredging should be assessed using a 2D or 3D hydrodynamic model and the spatial distribution of impacts to ebb tide, flood tide and flood event currents reported using map figures. • The impact to sediment transport should be assessed using model predictions that could include some of the following (sufficient to the particular assessment): - bed shear stress; - sediment transport potential; - sedimentation/erosion rates. • The potential for increased sedimentation requiring future maintenance dredging due to the reclamation and expanded dredge footprint has not been assessed.
Marine Solutions (2021), Aquatic Impact Assessment			
Impacts of suspended sediments	Impact to marine plants Impact to marine fauna	Section 6.1.1 & 6.1.2	• The existing status of the giant kelp community (extent, condition, resilience) is undefined. There is no discussion on the light requirements of giant kelp and therefore sensitivity to increased turbidity. In lieu of this information, MS (2021) conservatively assumes this community is present, and has developed an adaptative management strategy to manage potential water quality impacts at the river mouth. See comments below regarding monitoring program and adopted turbidity threshold values. • The sensitivity of Australian grayling to turbidity is undefined. MS (2021) conservatively assumes that Australian grayling may avoid moving through turbid plumes, but could potentially move through the port via a predicted corridor of clearer water on the eastern shore of the port. It is recommended that turbidity monitoring be undertaken to validate modelling predictions to inform future impact assessment assessments. Pg 18 notes that impacts can be avoided by not dredging during the migratory period of this species, however it is unclear whether this is a commitment. Refer to comments below regarding validation modelling. • Modelling predicts that turbid plumes will not extend to historical commercial scallop beds located ~10 km northeast of the river mouth. The current day status (abundance, condition, resilience) of commercial scallops in this area (and elsewhere in the wider coastal area), and the sediment (suspended sediments and deposition) tolerances of scallops, are undefined. Refer to comments regarding modelling limitations.
Turbidity monitoring	Pre-dredging Turbidity reference levels During dredging	Section 7	• Adequacy of turbidity baseline data (2020). Data were collected from two sites in the port area over a three-week period in February-March 2020. These data do not encompass the range of natural temporal variability in turbidity a different timescales (e.g. storm events, floods, seasonal changes in winds etc.). The sites do not coincide with potential habitat for giant kelp, so the ambient turbidity and light climate at this sensitive receptor site is undefined. Long-term data are available for a site located further upstream. • MS (2021) proposes to use 'turbidity reference levels' to identify potential dredge impacts at the river mouth. These reference levels are understood to incorporate: - background turbidity at the port, which is stated as being 6 NTU. This value is the same as the highest turbidity values recorded in the 2020 monitoring program (during spring tides), but would be applied irrespective of actual tidal state (i.e. not conservative for periods with low ambient turbidity). The adopted background is around three times higher than the average turbidity value at the monitoring site (2.2 NTU) - it is not stated whether this value is from the upstream or downstream site. As mentioned above, it is uncertain whether the ambient turbidity value is representative of potential giant kelp habitat at the river entrance. - dredge-generated turbidity (5 NTU), based on the average value during outgoing tide. This would be applied irrespective of tidal state. - a 'buffer for larger tidal ranges (3 NTU). This would be applied irrespective of actual tidal state. It is uncertain how this was derived.

Topic	Element	Document Reference	BMT Assessment
			- a 'month-specific buffer to accommodate seasonal variation in river turbidity'. These values are based on long term measurements from a site upstream of the port, which may not be representative of patterns in turbidity at the more oceanic-influenced river mouth. • An exceedance of 'reference levels' for 1.5 hours will trigger management actions. This implies that there would be no effects to environmental receptors at turbidity levels less than the reference values, however this has not been demonstrated (notwithstanding approval of the activity). Based on ambient turbidity values in Table 5 (upstream site that is not representative of ocean influenced river mouth site), the reference level is far greater than the 95th percentile ambient value during summer and autumn. This means that environmental receptors could be exposed to high turbidity during periods when it is (typically) naturally low. The report notes that river mouth communities would experience low turbidity during flooding (incoming) tides, but it is not apparent whether such periods would be sufficient to maintain ecological receptors. In the absence of long term baseline data it is recommended that a more conservative approach be adopted for deriving 'guideline values' to trigger management actions. This should include: - acute effects over 1.5 hours – e.g. 95th percentile of ambient or other appropriate value - chronic effects over 3 days - e.g. 80th percentile of ambient + appropriate buffers for seasonal variability etc. • The turbidity monitoring program does not characterize the behaviour of dredge plumes and therefore only allows indirect validation of modelling. A vessel-based dredge plume monitoring study (flood/ebb) would provide a basis for assessing plume behaviour. This could involve the collection of turbidity profiles through the water column to assess plume degradation and spatial extent. The data would provide a basis for: (i) validating modelling predictions; (ii) providing data for future modelling studies; (iii) improving stakeholder confidence of impact assessment conclusions.
TasPorts (2021), Devonport QuayLink Environment and Sustainability Management Plan			
Targets	Target of no more than two exceedances of turbidity limits	Table 6-11	This plan specifies a management target of no more than two exceedances of turbidity limits ('reference values') established in the EIS. As noted above, the turbidity 'reference values' in the EIS consider both ambient turbidity and modelled dredge related turbidity. The management target would therefore be based on maintaining turbidity within the range reported in the EIS, which is appropriate. This goal may need to be refined based on: (i) results of the recommended additional modelling, and (ii) any refinements to reference levels/guideline values.
Monitoring	Daily visual monitoring	Table 6-11	Daily visual monitoring is appropriate and provides supporting information for measurement data.
Monitoring	Monitoring in accordance with the EIS.	Table 6-11	This management action may need to be refined should the monitoring program be refined based on the recommendations provided above.