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Re: Independent Reviewer for the Port of Gladstone Sustainable Sediment Management Project

The Australian Institute of Marine Science (AIMS) has been commissioned by Gladstone Ports Corporation (GPC) to provide an independent review to assist in the delivery of the Port of Gladstone (PoG) Sustainable Sediment Management Project (SSM Project).

This letter represents AIMS review of the following components of the SSM Project:

- Review the Quantitative Sediment Budget of the PoG (WBS: 2.6.4); and
- Review the PoG Hydrodynamic model (WBS: 2.6.5).

The above tasks are defined in GPC Doc No.: #1410482 (as Tasks 3 and 4).

The Draft Quantitative Sediment Budget of the PoG and Draft PoG Hydrodynamic Model Refinement and Validation Report were provided in the following documents:

- P009R08D02_SedimentBudget_PCS.docx
 - PCS (Symonds, A., Erftemeijer, P.), 2019. Sustainable Sediment Management Project, Port of Gladstone: Quantitative Sediment Budget. August 2019
- R.B22927.002.01.Model_Refinement_and_Validation_1.docx
 - BMT (Guard, P.). 2019. Gladstone Sediment Budget: Model Refinement and Validation. August 2019

In addition to the above documents, a report on data interpretation was provided as context to interpret the improvements to the hydrodynamic model, and the rationale for conclusions in the quantitative sediment budget. This report was provided in as the following document:

- P009R07D02_DataInterpretation.doc
 - PCS (Symonds, a., Loehr, H., Marsh, J.), 2019. Sustainable Sediment Management Project, Port of Gladstone: Quantitative Sediment Budget. July 2019

Summary:

It is important to appreciate that observation and modelling of coastal sediment transport processes is not a precise science. Observations and modelling and inferences derived from such activities will

have elements of uncertainty, due to manifold complexities of spatially and temporally varying natural processes and associated assumptions related to process parameterisation, process interactions and the mathematical act of simulating these processes. At a minimum, deterministic models should demonstrate skill (through comparison with observations) to reproduce dominant processes, such that the model(s) can provide qualitative data on overall regional dynamics, and support the investigation of broader process integration (e.g. budgets), relative importance of processes, and sensitivities.

The underpinning observations, analysis and modelling presented, represent a significant body of work to improve the understanding of sediment budgets in the PoG. The modelling is comprehensive and fit for purpose to support expanding the conceptual sediment budget into a quantitative analysis of sediment dynamics within the PoG, although some clarification of the modelling approach would add confidence to the modelling results in the context of determining quantitative values.

Noting the uncertainties related to observational studies and modelling results, the key findings from the quantitative sediment budget are justifiable, and represent a valuable integration of existing knowledge, historical observational programs and modelling activities. The notable omission is the identification of contributions from suspended transport and bedload transport. The language of the budget seems to indicate that either bedload transport is not considered, or bedload and suspended transport are combined. This needs clarification, particularly as the data interpretation report makes suggestion that bedload is important.

Specific comment on the individual reports are as follows:

Task 3 – Review the Quantitative Sediment Budget of the PoG (WBS: 2.6.4); and

Document Title: Sustainable Sediment Management Project. Port of Gladstone: Quantitative Sediment Budget (PCS). GPC Contract No. 18000078

- The discussion in the *Avoid Assessment* (Page 11) needs to consider or acknowledge the likelihood of extreme events (cyclones, tropical lows, floods). As justification for the need to include a statement on extremes, see results of model estimates of sediment fluxes: for 12/13 (7 months) during extreme weather nett sediment fluxes were larger than 14/15 fluxes over 12 months, during more benign conditions.
- In the section on discussion of nett sediment transport movement in offshore areas (page 28) to account for different length of transects, the transects could be normalised based on % of transects at different depths (e.g. x% of transect is 0-10m depth, x% of transect is 10-20m, and so on), or transects re calculated, such that they are more uniform lengths. Given that the analysis is looking for quantitative numbers, suggest having (at least offshore) transects of similar lengths.
- Page 29: “*The results show that there is a net import of sediment through the South Channel (predicted to be between 90,000 and 410,000 tonnes, but based on the model underprediction this is likely to range from 450,000 to 2 million tonnes) and through the Narrows (predicted to be 30,000 tonnes, based on the model underprediction this is likely to be around 60,000 tonnes)*”. Need to more clearly justify the scaling up of the estimated ranges of fluxes, based on the data interpretation report (but the numbers in the data interpretation report are also different – see page 24 of that report for example).

- Section 4.4. Sediment Sink - Dredged area (page 37) – Areas of Jacobs channel, LNG berths and Targinnie Channel region are not listed, but have required recent maintenance dredging. These are clearly sediment sinks, and are referred to as such in subsequent sections of the report.
- Trawling – Can the assumption that “*half of the trawling is undertaken in the Inner Harbour region and half in the Outer Harbour*” be validated by seeking more detailed data from Qld Govt?. Is the total budget sensitive to this assumption?
- Ecological implications: “*Monitoring studies by Jones et al. (2015) of the present-day condition/health of coral communities within the Inner Harbour provide evidence of major declines since baseline surveys in 2009*” - The reference listed is not the correct reference for monitoring studies. There must be a reference missing.
- Tolerance limits: Light availability, more so than simply exposure to increased suspended sediment concentration (SSC), or sedimentation, is a major driver of corals and seagrasses health. The section on impacts for coral would be strengthened if the exposure to turbidity units could be translated in to impacts on light availability (as is done more clearly in the seagrass section). The work of Jones (through the WAMSI dredging node, and the NESP Project on dredging Impacts in Cleveland Bay <https://nesptropical.edu.au/index.php/round-2-projects/project-2-1-9/>) deals more with cumulative light exposure reductions and implications for corals, more so than simply exposure to increased SSC. There may be some work therein to support the assumption of limited adverse environmental impacts from dredging operations in the PoG on the sensitive receptors (corals and seagrasses).

Task 4: Review the PoG Hydrodynamic model (WBS: 2.6.5).

Document Title : Gladstone Sediment Budget: Model Refinement and Validation (BMT)

- Main points
 - There is limited information on calibrated parameters
 - There is limited information on calibration of different processes – suspended transport versus bedload
 - Model qualitatively reproduces synoptic descriptions of turbidity as observed from sat imagery, which is strong indication that the model is performing well for resuspension-driven transport, and is capturing the subsequent advection/dispersion of suspended material to reproduce synoptic patterns.
 - Limited discussion/evidence on suspended (seems to perform well) versus bedload processes.
- Hydrodynamic model - grid and underlying bathymetry are fit for purpose and include most recent bathymetry for the region
- Wave model – assume same underlying bathymetry. Nesting scheme is appropriate to enable a mechanism for capturing the contribution of remotely generated seas, and local generated waves.
- Model boundary conditions –
 - Appropriate for the hydrodynamics to capture oceanic forcing.
 - For the wave model it is not clear if offshore swell is applied at the open boundary of the coarse regional grid (1000 km spatial resolution), or if swell is neglected. If it is

the latter, then there should be some justification, as there is likely to be a swell influence in the region.

- Wind fields are generated from the National Centers for Environmental Prediction (NCEP) atmospheric reanalysis (a modelled product). This a valid approach to capture spatial variability in the wind fields, however the performance of the NCEP Climate Forecast System Reanalysis (CFSR) model reanalyses against local observations should be presented. The data and interpretation of the suite of reports makes it clear that sediment transport is primarily driven by wind events – at event durations of days-weeks and sub-daily events. It would add confidence to the model validation if a comparison of NCEP CFSR model reanalyses winds fields and local observations (from Bureau of Meteorology, Gladstone Automatic Weather Station and others if available) were presented, to demonstrate the modelled winds capture the variability that drives the variability in sediment transport.
- The report lists the three major changes adopted for the final model simulations but it would be useful to see what parameters related to sediment dynamics were ‘tuned’ for the final simulations. The Data Interpretation Report suggests changing critical thresholds for erosion of different sediment types, and for resuspension and bedload transport. It is unclear from the report if these parameters were tuned, based on the observed resuspension regimes from the data collection exercise.
- At present there is not discussion on how different elements of the sediment transport model were calibrated (apart from the “*The three major changes adopted for the final model simulations*”) so it is not clear if bedload transport is included in the calculations of budget. [even if this is mentioned in the previous modelling reports, it should be summarised in the calibration report].
- A discussion on if/how this is done may help interpret the reason for the general overestimation of the gross sediment flux both into the Port on flood tides and out of the Port on ebb tides, compared to that suggested by the observational data.
- The report states “*After adjustment of the model parameters, the model achieved an acceptable level of predictive skill for turbidity across all locations and conditions.*” How is an acceptable level of predictive skill defined?
- Page 56 – ‘event’ should also include spring tides...“*It is apparent that the modelled net flux through the biggest entrance (the South Entrance) is primarily **wind and tidal** driven by events,*”
- Page 50 “*The results of the analysis are presented in **Error! Reference source not found.** to **Error! Reference source not found.***”
- There is general qualitative agreement between the sat derived turbidity and the selected snapshots of model output, which is a strong indication that the model is performing well for resuspension-driven transport, and is capturing the subsequent advection/dispersion of suspended material to reproduce synoptic patterns.
- Page 56: “*The results of the analysis are presented in **Error! Reference source not found.** to **Error! Reference source not found.***”
- Figures 7-1 to 7-3 . There is an error with the legend in the bottom panel (sediment flux). Is The Narrows the red line and the North Entrance the blue line?

Please do not hesitate to contact me if you require clarification or wish to discuss further

Regards,



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