TOWNSVILLE PORT EXPANSION PROJECT

Additional Information to the Environmental Impact Statement

SECTION 5

Coastal Processes and Hydrodynamics

TOWNSVILLE PORT EXPANSION PROJECT

AECOM BMT WBM

5.0 Coastal Processes and Hydrodynamics

5.1 Introduction

The physical processes occurring within the Cleveland Bay study area that are relevant to the Port Expansion Project (PEP) impact assessment include:

- hydrodynamics
  - water levels relating to tides and storm surges
  - wave climate, which comprises:
    - ocean swell
    - Great Barrier Reef lagoon wind waves
    - Cleveland Bay wind waves
  - currents within Cleveland Bay, generated predominantly by tidal and wind forcing
  - freshwater inflows from the Burdekin River, Ross River and Ross Creek
  - tidal exchanges with Ross River and Ross Creek
  - key influencing factors of cyclones and other severe weather events
- marine sedimentation processes
  - fluvial sediment supply to Cleveland Bay, including from the Burdekin River
  - seabed sediment re-suspension, transport and deposition
  - sedimentation of Port areas requiring maintenance dredging
- shoreline sedimentation processes
  - alongshore sand transport at the beach shorelines, driven by wave breaking
  - erosion and accretion along the adjacent beach system.

Through the Environmental Impact Statement (EIS) and Additional Information to the Environmental Impact Statement (AEIS) process, measurement campaigns and numerical modelling have been undertaken to define baseline hydrodynamic and geomorphological conditions within the study area and to assess the PEP impacts on these processes.

This section considers the coastal process and hydrodynamic impact assessment findings in the context of the following:

- comments raised by stakeholders on the EIS submissions
- findings of additional numerical modelling impact assessments carried out subsequent to the release of the EIS
- refinements to the project design.

The key issues raised in the submission process include:

- adequacy of hydrodynamic modelling methodology
- adequacy of dredge plume modelling methodology
- dredge plume loads relative to Burdekin River loads
- resuspension of dredge material from the Dredge Material Placement Area (DMPA)
- dredge plume impacts on Magnetic Island
- safety concerns due to altered hydrodynamics
- assessment of wave refraction and reflection in Cleveland Bay
- assessment of beach erosion due to the reclamation
- impacts of Project on maintenance dredging volumes
- risk of contaminants in maintenance dredging material
- adequacy of storm surge assessment

- assessment of marine placement options
- adequacy of peer review process.

5.2 Response to Submissions

5.2.1 Hydrodynamic modelling

The Great Barrier Reef Marine Park Authority (GBRMPA) raised the matter that the hydrodynamic model did not include forcing terms for oceanic currents which may be significant within the Great Barrier Reef lagoon. The TUFLOW-FV hydrodynamic model has since been upgraded to include these forcing terms, and the revised impact assessment presented in the AEIS does incorporate the effects of these currents.

5.2.2 Dredge plume modelling

234 submissions (includes form letter submissions) queried the validity of the modelling in the EIS since it was not in full accordance with the GBRMPA guidelines "The Use of Hydrodynamic Numerical Modelling for Dredging Projects in the Great Barrier Reef Marine Park" (GBRMPA, 2012). The modelling in the AEIS has been carried out in full accordance with these guidelines, including the use of additional baseline data for model. The numerical modelling in the AEIS goes beyond the requirements of the guidelines by including ambient sediment dynamics, allowing much more accurate simulation of the mixing of dredged and ambient sediment.

5.2.3 Dredge plume loads and DMPA resuspension

25 submissions raised the matter that the modelling of resuspension of dredged material from the DMPA was not undertaken for a long enough following after placement. The AEIS dredging methodology has been changed so that there is no longer any placement of capital dredge material at the DMPA. Therefore this matter has been resolved and is closed out.

Two of these submissions also referred to the high relative impact of disposal of dredging spoil compared to the fluvial sediment loads delivered to the Great Barrier Reef lagoon by the Burdekin River. They noted that the 5.6 million cubic metres of dredged material proposed for sea disposal in the EIS was larger than the 4 million tonnes of sediment delivered to the coastal environment each year by the Burdekin River (Kroon *et al*. 2012). This calculation is discussed in detail in Section 25.0 of the AEIS, and summarised below.

The revised design considered in the AEIS has removed the need for placement of capital dredging material at sea. Therefore this matter is no longer applicable.

5.2.4 Magnetic Island impacts

217 submissions (includes form letter submissions) expressed the view that perceived increases in turbidity along the coast of Magnetic Island is associated with port dredging activities. Three submissions expressed the view that sediment from dredging will settle out onto beaches and cause an increase in muddiness.

Pringle (1989) undertook an extensive review of the history of dredging in Cleveland Bay. In that study, analysis of aerial photography and beach profile measurements showed no clear trend of expansion or contraction of the beaches along the south-east coast of Magnetic Island. It was concluded that it was unlikely that dredge material was being redistributed onto those beaches. Some coral damage was noted in the early 1970s, however this was attributed to the effects of major cyclones Althea and Bronwyn (December 1971 and January 1972). The study did identify likely impacts on seagrass beds in Cleveland Bay from the combined effects of dredging and cyclones (with associated freshwater runoff) in the early 1970s (noting that a different shallow water DMPA south-east of Magnetic Island was in use at that time).

Analysis of aerial photography undertaken as part of the AEIS has revealed that there continues to be no clear trend of expansion or contraction of the beaches on Magnetic Island. The numerical modelling results indicate that accumulation of dredged sediment is unlikely to occur on Magnetic Island beaches due to the tendency for currents and wind waves to generate sufficiently high bed shear stresses to keep fine sediment in suspension.

5.2.5 Hydrodynamic impacts

Three submitters expressed a view that changes in hydrodynamic conditions in Cleveland Bay will cause safety issues for swimmers at patrolled beaches. The AEIS modelling study identified that direct changes to hydrodynamic conditions are restricted to the area immediately adjacent to the proposed reclamation area and therefore there will be no direct effects on swimmer safety due to changes in currents or water levels. Any indirect effects such as increases in turbidity will be minor in the vicinity of patrolled beaches (refer to Section 6.0 of the AEIS).

5.2.6 Wave impacts

Two submitters raised the matter that wave transmission and reflection influenced by the proposed reclamation structure was not analysed for any areas in Cleveland Bay apart from The Strand. The reason for this is that because of the geometry of the reclamation layout and the nature of the wave climate in Cleveland Bay, impacts are only likely in the vicinity of The Strand (though potential impacts to Rowes Bay are also discussed). Long wave swell energy enters Cleveland Bay from the east or north east, so it is only the blockage of short ‘sea’ waves from the north or north-west that could cause impacts to the east of the Port. Because of the relatively infrequent occurrence of these waves and the relatively minor potential for sheltering due to the proposed reclamation geometry, the potential for wave-related impacts to the east of the Port is considered to be minor. Additional discussion of this issue is provided in Section 5.3.4.5.

5.2.7 Beach erosion impacts

215 submissions (includes form letter submissions) expressed a view that the construction of the proposed reclamation area will result in beach erosion. Chapter B.3 (Coastal Processes) of the EIS and this section have considered the potential for changes to hydrodynamics and wave conditions in detail and have concluded that any changes to beaches caused by the reclamation will be very minor. Ongoing monitoring of The Strand is proposed as part of the AEIS. It is worth noting that the slight reduction in wave energy reaching The Strand due to the protection afforded by the reclamation will reduce the likelihood and severity of major storm erosion.

5.2.8 Maintenance dredging impacts

One submission raised the matter that the Project will lead to increased maintenance dredging requirements. The AEIS modelling assessment concludes that maintenance dredging requirements will increase by a relatively small percentage (~14%) upon completion of the full port expansion. Details of this assessment can be found in Section 5.3.4.4 below. It should be noted that due to the expansion in port capacity (an additional six berths); the dredging volume per berth will actually be reduced by approximately 36%.

Five submissions expressed a view that an increased proportion of fine sediment in the material depositing in the outer harbour will result in increased concentrations of contaminants. Although the fine sediment may be a higher proportion of the total, the actual quantity of fine sediment accumulating in the outer harbour after construction of the PEP will be reduced. There is no identified mechanism for any increase in contaminant concentrations as a result.

5.2.9 Storm surge assessment

Two submissions raised the matter that a storm surge level of only 0.4 m was assessed in the EIS. Chapter B.3 (Coastal Processes) of the EIS does in fact discuss the occurrence of much larger storm surge events and the EIS also considers the effects of climate change on the Project. The design of the Project included full consideration of these issues.

5.2.10 DMPA options assessment

243 submissions (includes form letter submissions) suggested that further assessment needs to be undertaken on alternative marine disposal locations, including those further offshore in deeper water. As part of the revised AEIS methodology, no capital dredging material is to be placed at sea. Therefore this matter has been resolved and is closed out.

5.2.11 Independent peer review

Four submissions asserted that the numerical modelling was not peer reviewed, or that the peer review was not completed. The numerical modelling work undertaken as part of the EIS was peer reviewed by an independent third party and the peer review report was included in Appendix H2 of the EIS. These peer reviews concluded that the modelling was carried out to a high standard and was well suited to the task of assessing the environmental impacts of the Project. In addition, as part of its assessment process, GBRMPA commissioned Australian Institute of Marine Science (AIMS) to undertake a peer review of the EIS modelling methodology, which “*did not raise significant concerns around the suitability of the predictive model, its forcing and its ability to predict longshore transportation and sediment movement within Cleveland Bay*”.

5.3 Revised Environmental Impact Assessment

5.3.1 Legislation and policy

Since the initial release of the EIS, there have been important legislative changes at both the State and Commonwealth level. A new regulation under the Great Barrier Reef Marine Park Regulations 1983 (Cth) was introduced on 2 June 2015, which prevents the placement of capital dredge material in the Marine Park. Specifically, the regulation prevents GBRMPA from granting permission for placement of capital dredge material in the Marine Park.

The Sustainable Ports Development Act also prevents approval being granted for capital dredging areas that are in the Great Barrier Reef World Heritage Area but outside the Great Barrier Reef Marine Park unless it is for a priority port and in accordance with that port’s Master Plan, or if the development is the subject of an EIS process started before the act came into effect. The Port of Townsville is a priority port under the Act and the PEP is the subject of an eligible EIS process.

5.3.2 Design refinement

The project design has been refined as described in Section 2.0 of the AEIS. The design of the Port Expansion Project has been revised in response to submissions and in order to reduce the overall environmental impact and to eliminate the disposal of capital material at sea.

The proposed reclamation is now larger, extending further to the east in the vicinity of the Ross River channel. The hydrodynamic impact assessment has been revised to include consideration of the effects of this refinement (refer to Section 5.3.4.1).

The expanded reclamation area will allow all capital dredging material to be taken onshore rather than placed at sea. Only maintenance dredging material will continue to be placed at sea as part of the current proposal. As a result, the total amount of dredged sediment available for long term resuspension has been substantially reduced.

The revised design includes widening the Platypus Channel on its western side and widening the Sea Channel on its eastern side. It also includes a reduction in the proposed deepening of the channels (to -12.8 m LAT rather than -13.7 m LAT in the EIS). By reducing the depth of the channel in the Ultimate Case design, the need to extend the channel into the Great Barrier Reef Marine Park General Use Zone has been avoided. The impacts associated with widening the channels have been fully assessed as part of the AEIS.

The proposed development will take place gradually in stages, reducing the intensity of the development and its associated environmental impacts. A smaller dredging plant is now proposed, which further reduces the potential impact due to suspended sediment plumes and dredged sediment deposition.

As a result of the design refinements detailed above, the following coastal process impacting processes have been reassessed as part of the AEIS:

- hydrodynamic impacts
- wave impacts due to channel widening
- shoreline impacts due to reclamation expansion
- sediment transport and siltation impacts
- dredge plume impacts.

5.3.3 Supporting studies

The AEIS includes the Hydrodynamic and Advection-Dispersion Modelling Technical Report which is attached as Appendix A2. This report provides details of the upgraded model boundary conditions, model calibration and modelling methodology for the revised design.

5.3.4 Revised impact assessment

5.3.4.1 Hydrodynamic Impacts

Various bathymetric configurations and reclamation phases were considered in the hydrodynamic modelling scenarios based on the proposed staging of the development. The three scenarios assessed included a Base Case (representative of conditions at the time of development of the port expansion), an Interim Case (at the conclusion of Stage 1 development), and an Ultimate Case, as described below.

1. Base Case. This included existing Port geometry plus widening of the Platypus Channel near the harbour entrance.
2. Interim Case. This included the widened channel following Stage 1 dredging, the dredging of Berth 12, and the interim reclamation area proposed as part of Stage 1.
3. Ultimate Case. This included full dredging of the constructed harbour, the final reclamation configuration and deepening of the approach channel to -12.8 m LAT.

Model layouts for these scenarios are shown in Figure 5.1 to Figure 5.3.

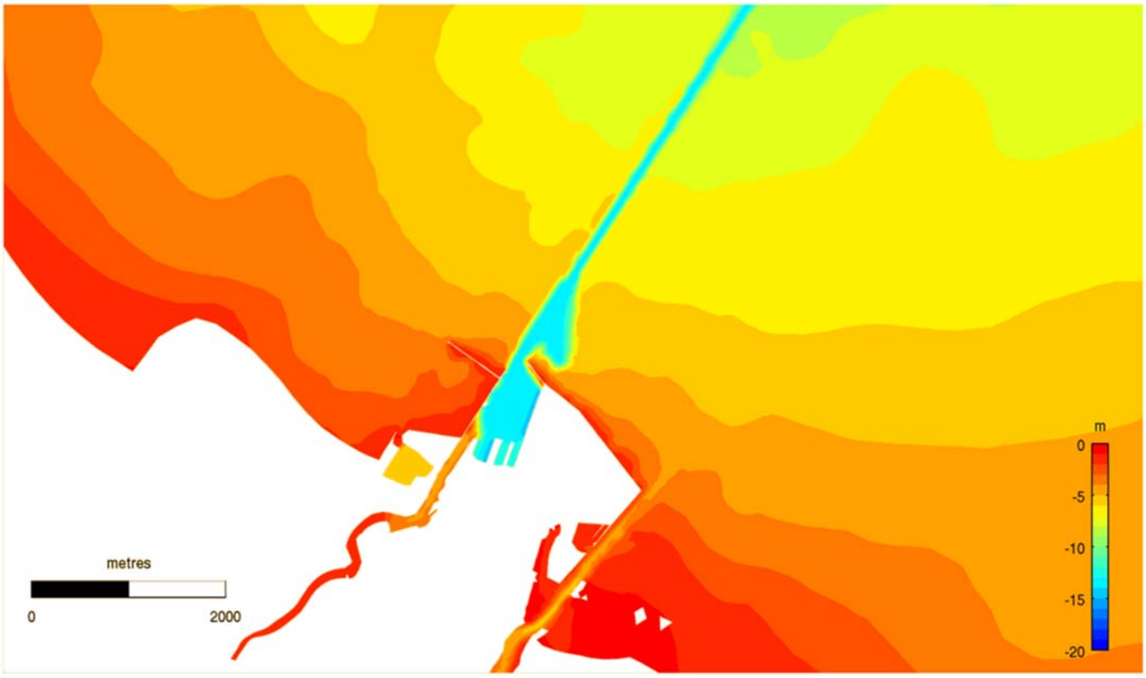

Figure 5.1 Base Case Model Bathymetry

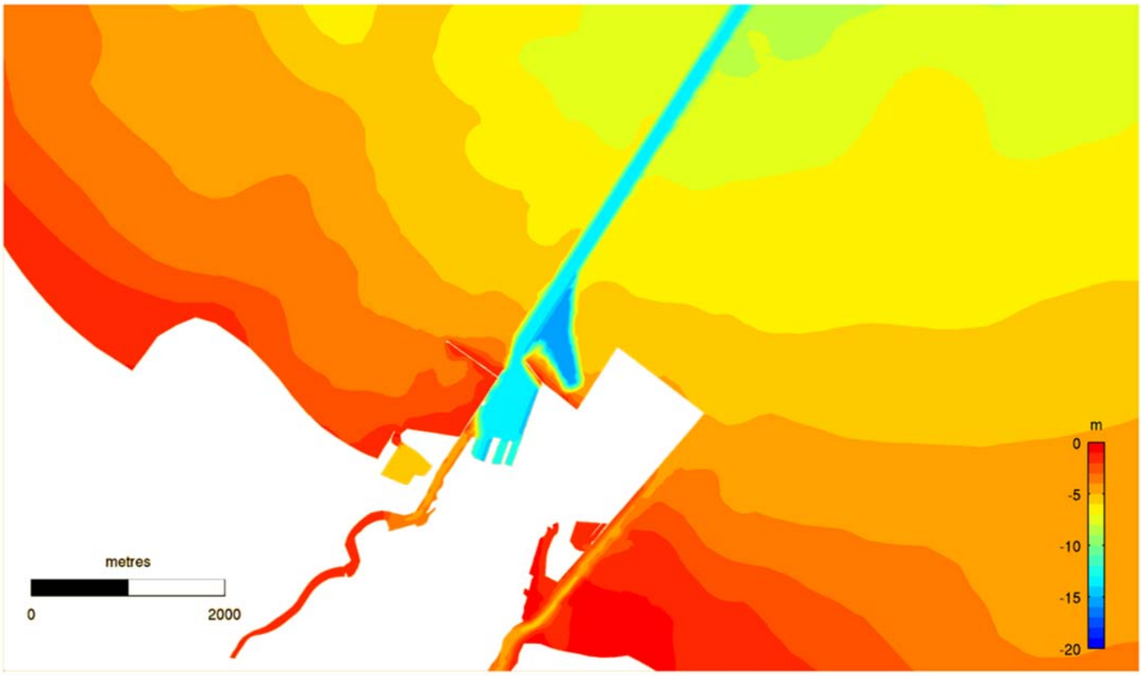

Figure 5.2 Interim Case Model Bathymetry

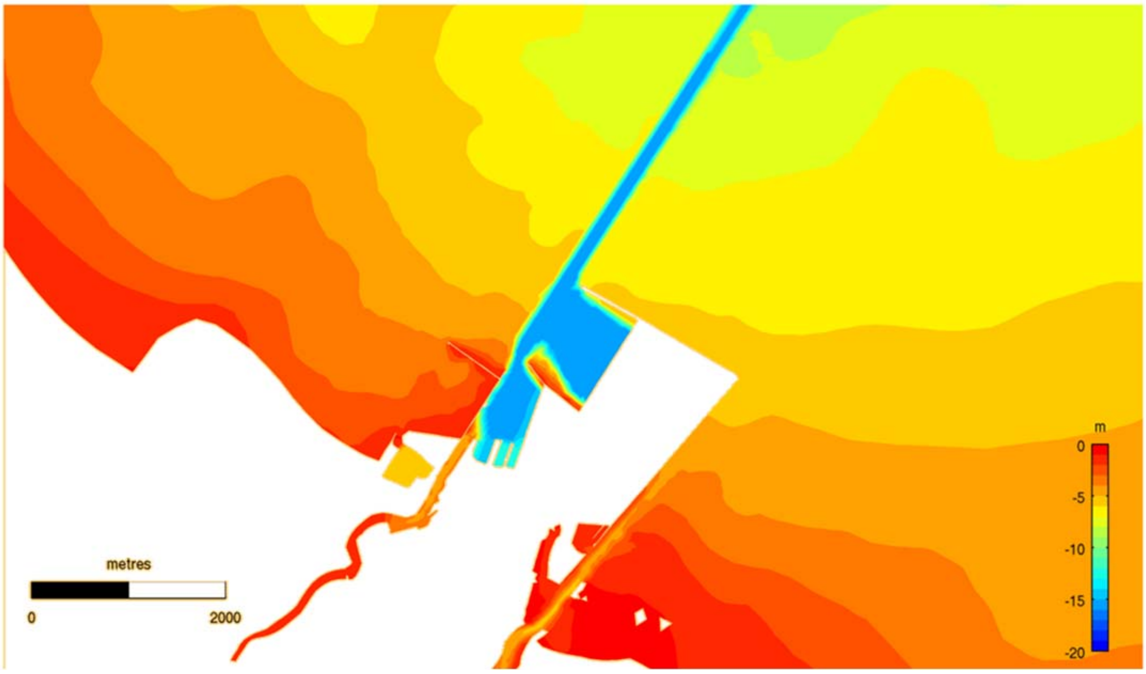

Figure 5.3 Ultimate Case Model Bathymetry

For hydrodynamic impact assessment purposes the model was run from 1/01/2013 to 1/02/2013, a period which included predominantly easterly winds and a period of significantly large spring tides. Hydrodynamic impacts were assessed by comparing the Interim Case and Ultimate Case with the Base Case.

Results are presented below in terms of hydrodynamic impact at specific times between the Base Case and Interim configuration, and the Base Case and Ultimate configuration. Figure 5.4 illustrates the tide level near the port for the simulation and the times at which the typical current patterns and impacts have been extracted. These tidal conditions correspond to peak ebb and flood flows during a period with a large spring tidal range.

Spatial plots of the changes in depth-averaged velocity magnitudes between the Base Case and Interim Case are shown in Figure 5.5 and Figure 5.6, and between the Base Case and Ultimate Case in Figure 5.7 and Figure 5.8. Further context is provided by the base case and developed case current figures in Appendix A2.

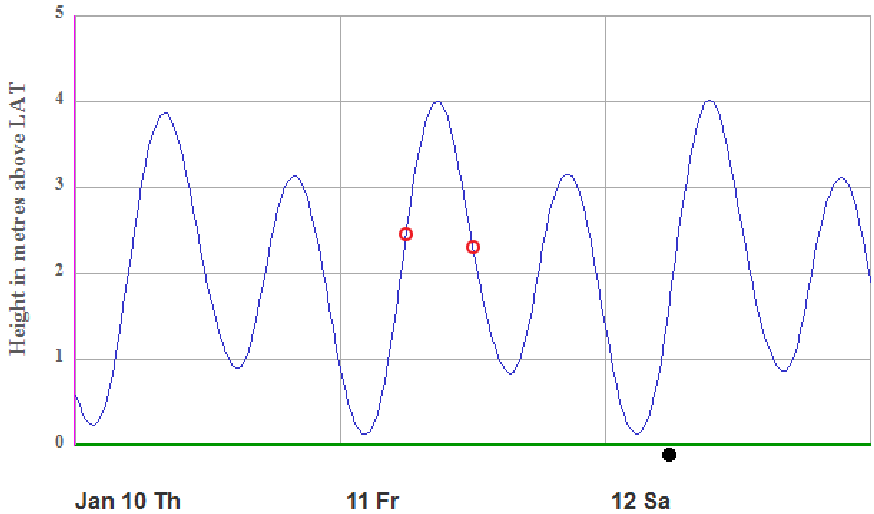

Figure 5.4 Hydrodynamic Impact Assessment Tide Levels Flood: 06:00 11/01/2013 Ebb: 12:00 11/01/2013

Figure 5.5 illustrates the difference in velocity in the Interim Case compared to the Base Case during a flooding spring tide. Reductions in velocity magnitude are in blue, and increases in yellow / red. The velocities to the north, west and south of the interim reclamation area are reduced by up to 0.15 m/s. There are increases in velocity of up to 0.2 m/s relative to the Base Case to the east of the interim reclamation area due to the diversion of tidal flows around the reclamation area. Negligible velocity changes are predicted to occur in the Ross River entrance channel adjacent to the Townsville Marine Precinct.

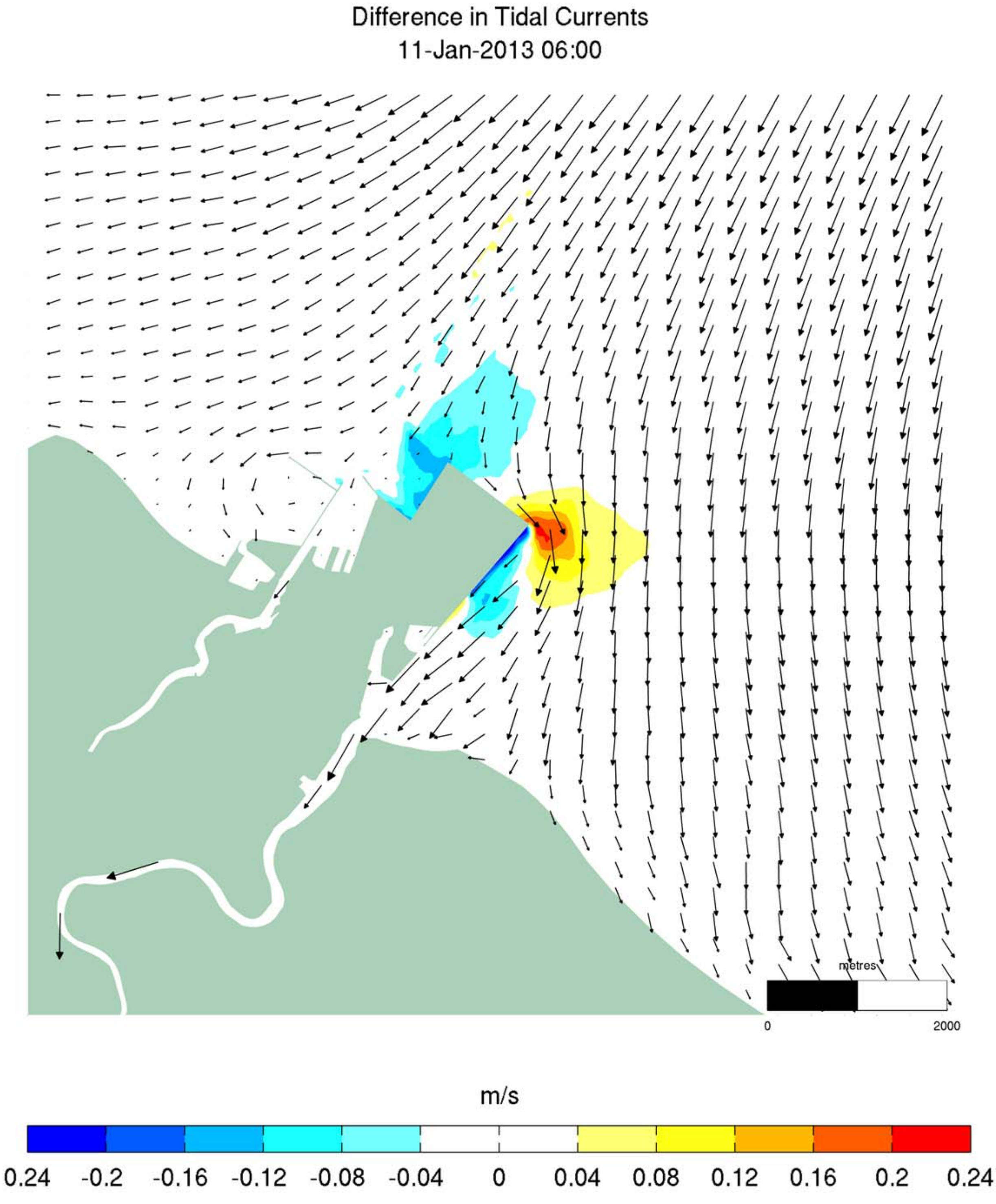

Figure 5.5 Difference Between Interim Case and Base Case during Flooding Tide

Figure 5.6 illustrates the difference in velocity in the Interim Case compared to the Base Case during an ebb tide. Reductions in velocity magnitude are in blue, and increases in yellow / red. The velocities to the west of the interim reclamation are up to 0.07 m/s lower in the Interim Case than in the Base Case. There are increases in velocity of up to 0.03 m/s relative to the Base Case to the east of the proposed interim reclamation due to the diversion of tidal flows around the reclamation area.

Figure 5.7 illustrates the difference in velocity in the Ultimate Case compared to the Base Case during a flooding spring tide. Reductions in velocity magnitude are in blue, and increases in yellow / red. The velocities to the north of the new north-eastern revetment are reduced by up to 0.15 m/s. Velocities within the new port expansion harbour area are up to 0.2 m/s lower than the Base Case due to the increases in depth and sheltering by breakwaters. There are increases in velocity of up to 0.25 m/s relative to the Base Case to the east of the proposed port expansion due to the diversion of tidal flows around the reclamation area. The Ross River approach channel will continue to experience flood tide cross-currents at the tip of the reclamation, which will be shifted further offshore under the Ultimate Case but will remain of a similar magnitude to the Base Case. Negligible velocity changes are predicted to occur in the Ross River entrance channel adjacent to the Marine Precinct.

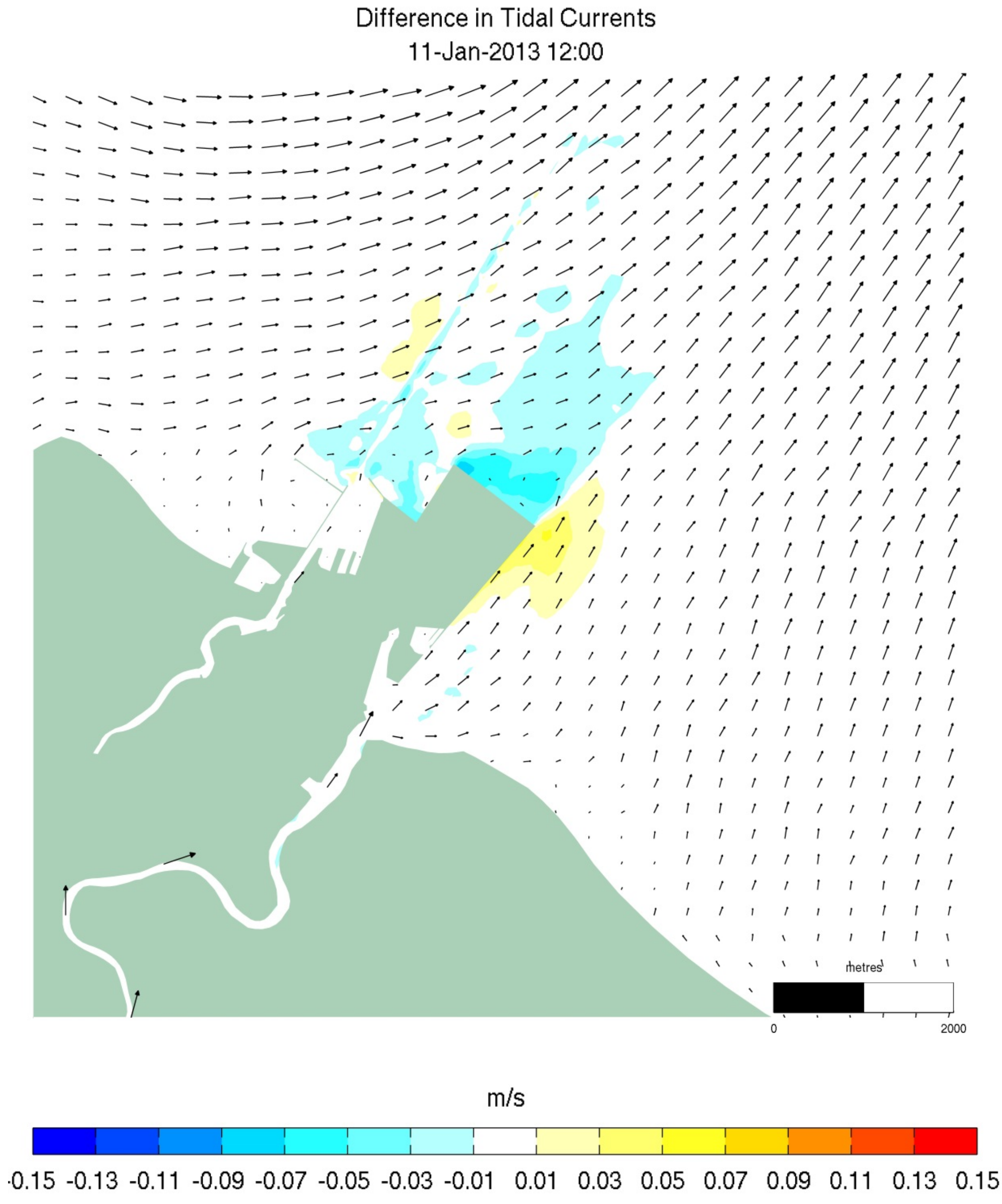

Figure 5.6 Difference Between Interim Case and Base Case during Ebb Tide

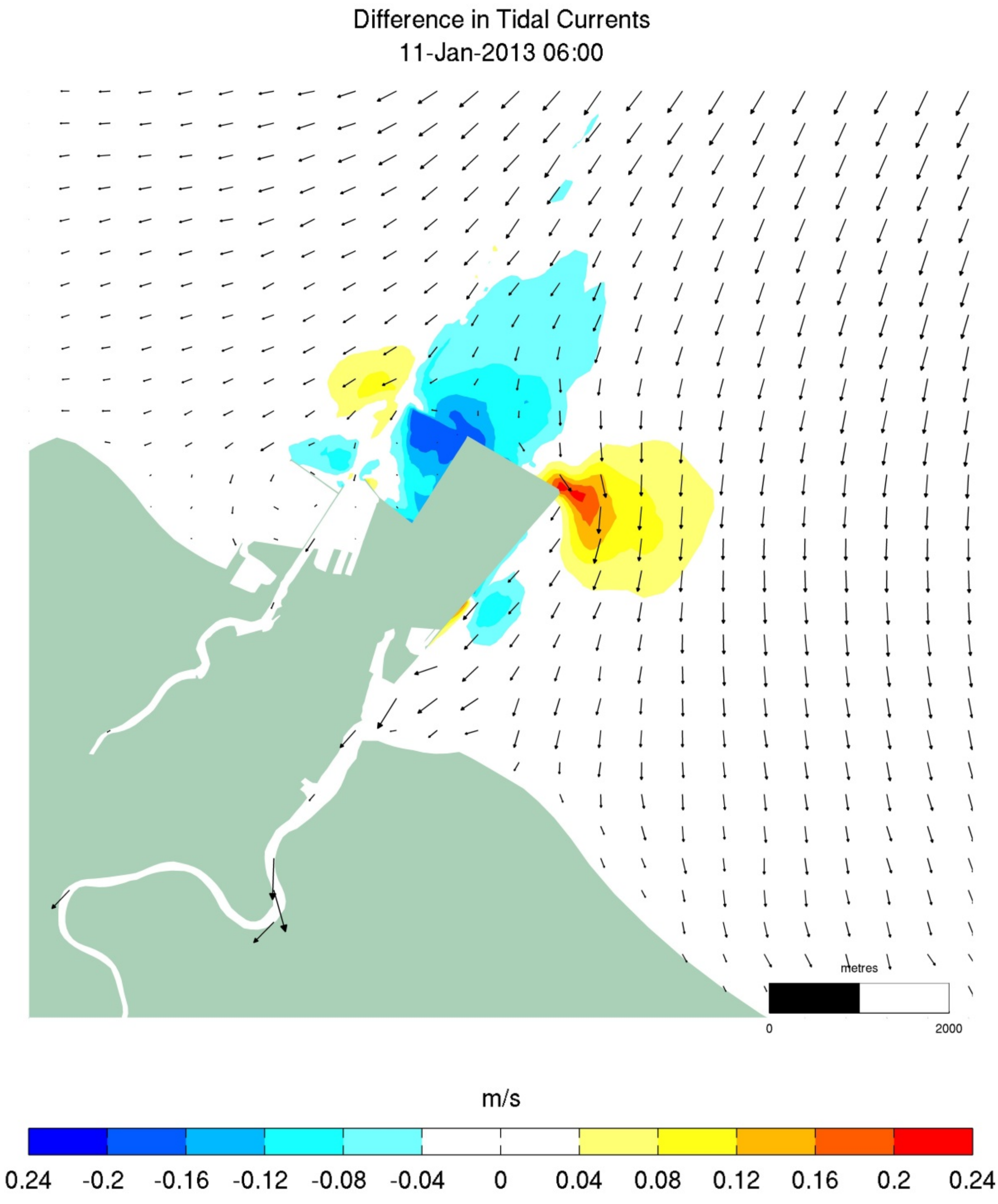

Figure 5.7 Difference Between Ultimate Case and Base Case during Flooding Tide

Figure 5.8 illustrates the difference in velocity in the Ultimate Case compared to the Base Case during an ebb tide. Reductions in velocity magnitude are in blue, and increases in yellow / red. The velocities to the north of the new north-east breakwater are up to 0.07 m/s lower in the Ultimate Case than in the Base Case. Velocities within the new port expansion harbour area are up to 0.1 m/s lower than the Base Case due to the increases in depth and sheltering by breakwaters. There are increases in velocity of up to 0.05 m/s relative to the Base Case to the east of the proposed port expansion due to the diversion of tidal flows around the reclamation area.

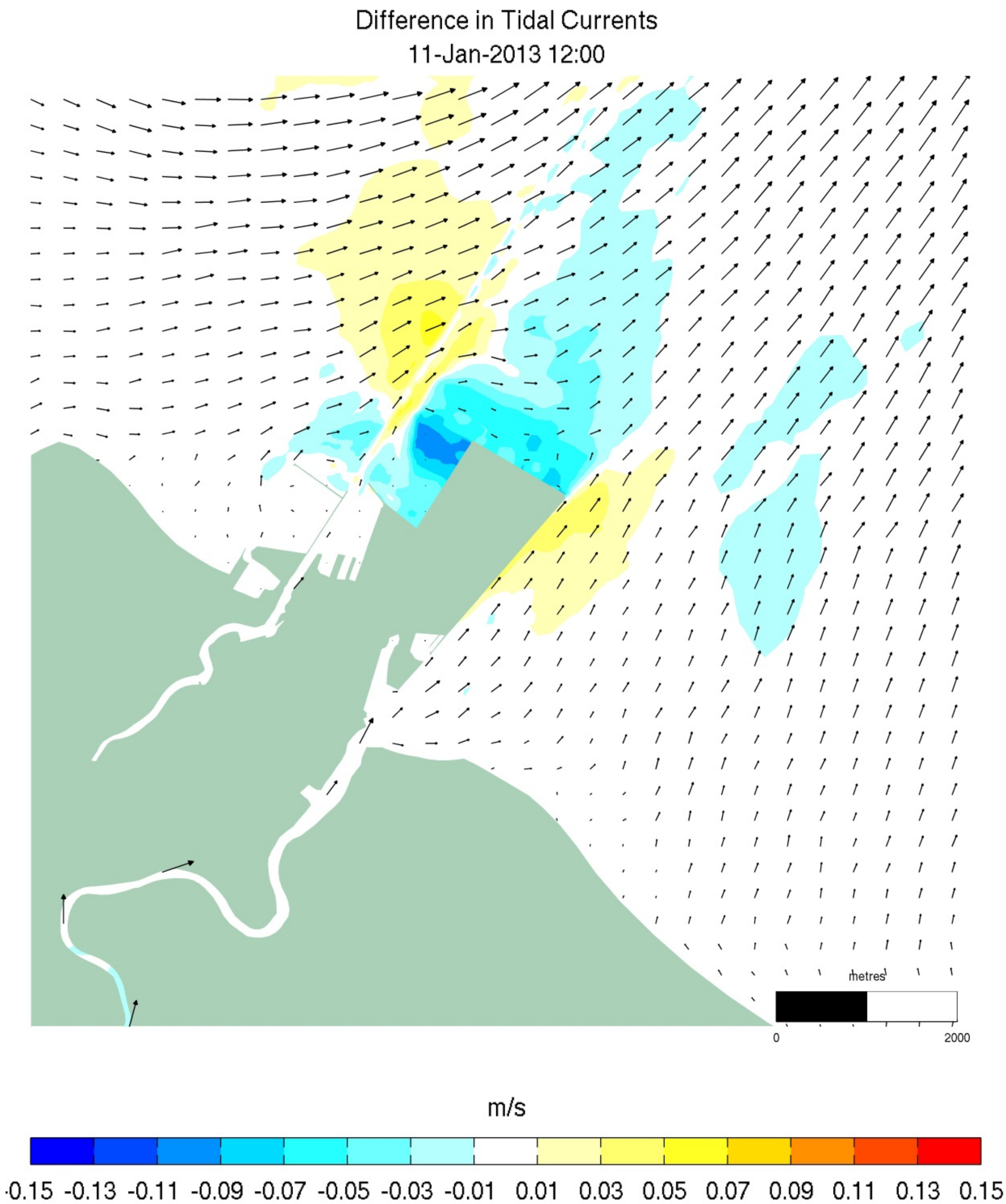

Figure 5.8 Difference Between Ultimate Case and Base Case during Ebb Tide

Water level percentiles derived from the model at the Townsville Storm Tide Gauge for the Base Case and Ultimate Case are shown in Figure 5.9, which shows that no significant change in water levels is predicted for the ultimate port expansion development case relative to the Base Case. The model results indicate that no water level impacts will occur at any location due to the port expansion development.

The velocity magnitude time series near the reclamation footprint for the Ultimate Case is compared to the Base Case in Figure 5.10. The two locations that are compared are shown as Point 1 and Point 2 in the top panel of Figure 5.10. This provides a direct comparison between the expected currents adjacent to the existing and future breakwaters. It is noted that a significant increase in spring tide velocities is expected in the Ultimate Case compared to velocities adjacent to the existing breakwater. In general the current velocity changes are unlikely to create any additional problems for ship navigation.

The hydrodynamic impacts of the proposed port expansion are not large in magnitude or extent, being confined to changes in velocity magnitude in the immediate vicinity of the proposed breakwaters and reclamation area. Water levels at all locations in the vicinity of the proposed works will not change as a result of the Project.

Velocity magnitudes decrease by up to 0.2 m/s adjacent to the new breakwater structures and within the port expansion harbour area on both the flood and ebb tides in the Ultimate Case. There are increases in velocities of up to 0.25 m/s in the Ultimate Case in some areas as shown in Figure 5.7. No significant change in tidal current velocities is predicted in the existing Inner Harbour in the Ultimate Case port expansion scenarios considered in these assessments.

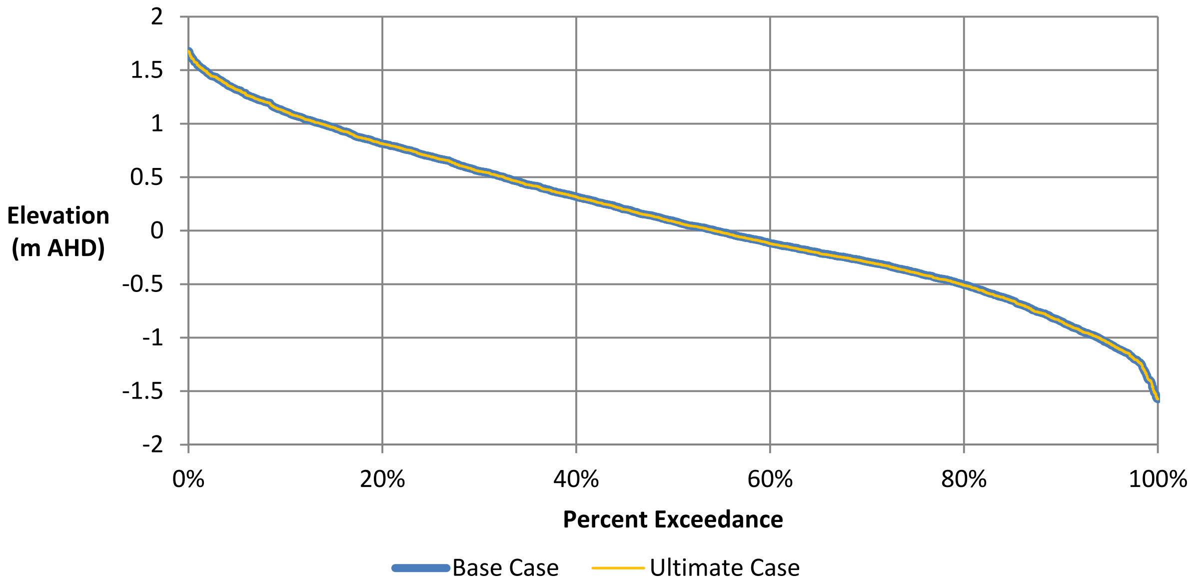

Figure 5.9 Water Level Exceedance Plot at the Townsville Storm Tide Gauge for the Base Case and Ultimate Case

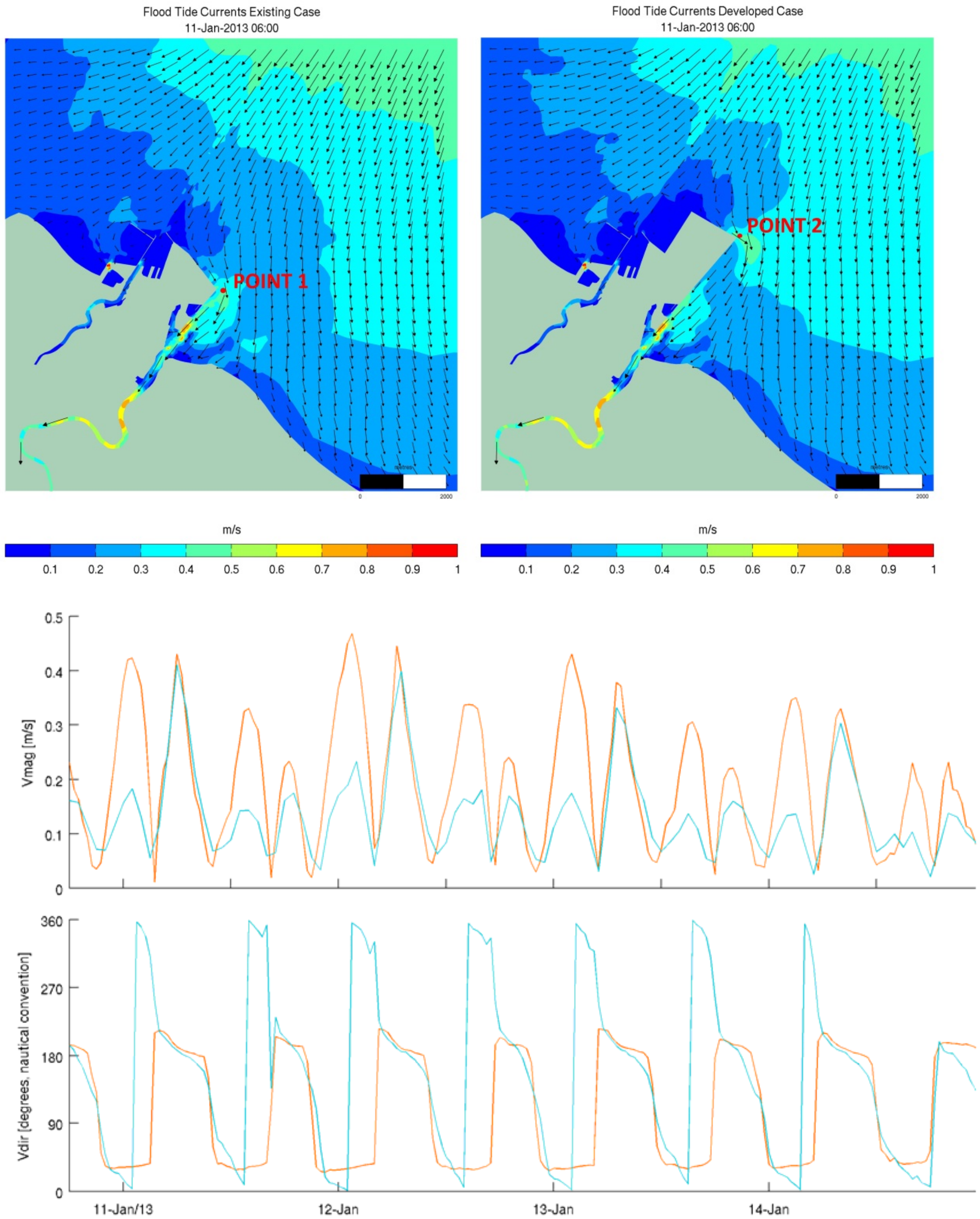

Figure 5.10 Velocity Magnitude Time Series at Point 1 in the Base Case and Point 2 in the Ultimate Case (Base Case in Red, Ultimate Case in Blue)

5.3.4.2 Wave Impacts

The effects of the PEP on the wave climate in Cleveland Bay were investigated in detail in the EIS. The design refinement introduced as part of the AEIS includes widening of the channel, so a new assessment was undertaken to determine if additional changes to the wave climate could be expected as a result of the widened channel. It was determined that the widening of the Platypus and Sea Channels will not affect the transmission or reflection of waves in Cleveland Bay (AECOM 2014), and therefore the conclusions of the EIS remain valid and appropriate for the AEIS. Refer to Appendix A2 Hydrodynamic and Advection-Dispersion Modelling Technical Report for the detailed wave impact assessment.

5.3.4.3 Sediment Transport Impacts

The proposed PEP will alter the bathymetry and hydrodynamics in the vicinity of the Port such that the local sedimentation processes will be altered to a significant extent. Impacts on sedimentation processes and the marine seabed morphology relate predominantly to the following:

- effects that the reclamation and breakwater structures will have on both waves and currents and associated sediment re-suspension, transport and deposition
- effects that deepening and widening the channels will have on sediment deposition in those dredged areas of the marine seabed
- effects that alterations of the harbour basin configuration and depths have on hydrodynamics and deposition there.

This section considers impacts of the revised PEP on siltation processes associated with the harbour and channels and at adjoining nearshore seabed areas (e.g. adjacent to The Strand).

In the context of determining impacts on sedimentation processes, including siltation rates in the harbour and shipping channels, the TUFLOW FV model was used to simulate the re-suspension of fine material due to the action of waves and currents for the Base Case and Ultimate Case to determine the potential impact of the Project on bed morphology and siltation rates. The model was run for the period 01/01/2013 to 01/06/2013 for the purposes of the impact assessment.

Residual sediment transport rates were calculated by averaging results over the simulation period, ensuring that the start and end points both coincided with similar high tide levels. It is acknowledged that the long-term residual may differ from the values derived over this limited time period, however the selected period was adopted based on being reasonably representative of prevailing climatic conditions and should not therefore be grossly different from the longer term residual.

The Base Case residual suspended sediment transport patterns are shown in Figure 5.11, which indicates a net transport in the north-west direction with highest transport rates in the shallower inshore parts of Cleveland Bay. A concentrated region of higher transport is shown immediately offshore of the existing port and the partial interception of the suspended sediment flux by the dredged approach channel can be inferred by the evident reduction in transport from updrift to downdrift of this feature.

The Ultimate Case residual sediment transport and corresponding impact (difference from Base Case) are shown in Figure 5.12 and Figure 5.13 respectively. It can be seen that outer harbour extension will redirect the residual suspended sediment drift around the reclamation. A small net reduction in fine sediment drift from east to west of the port may occur due to the combined interception effect of the outer harbour extension and the wider and deeper Platypus channel.

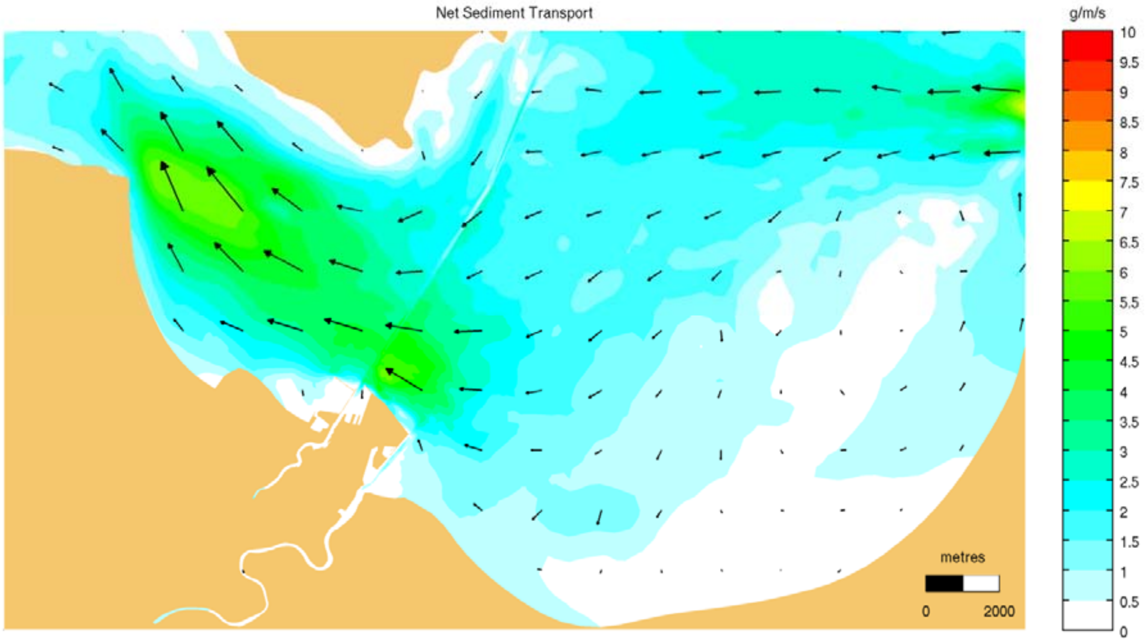

Figure 5.11 Modelled Base Case Residual Suspended Sediment Transport

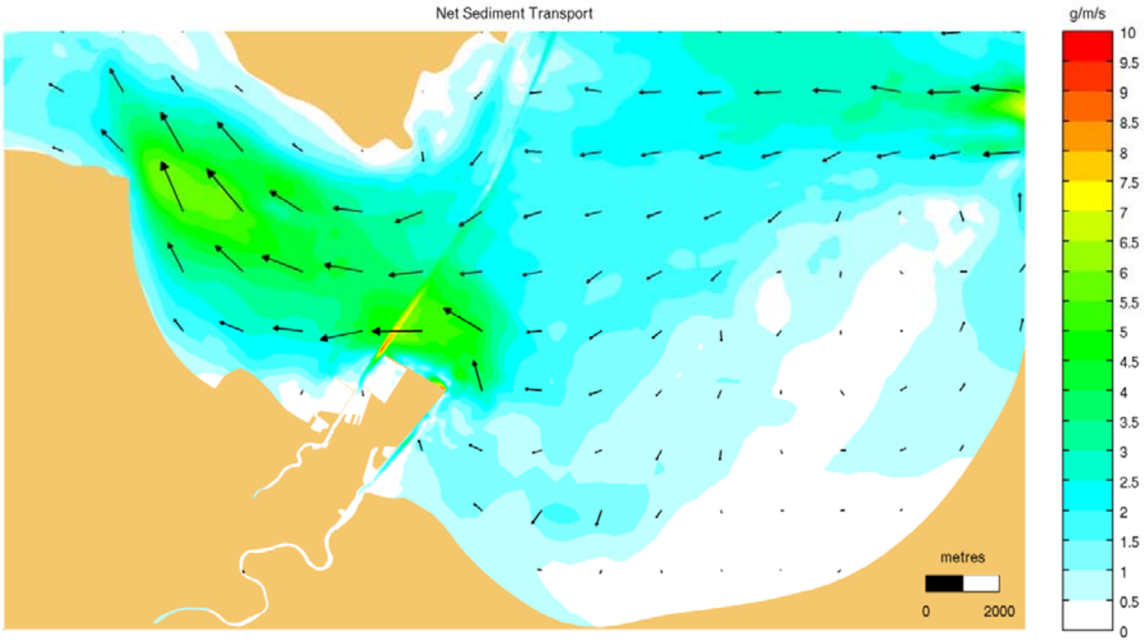

Figure 5.12 Modelled Ultimate Case Residual Suspended Sediment Transport

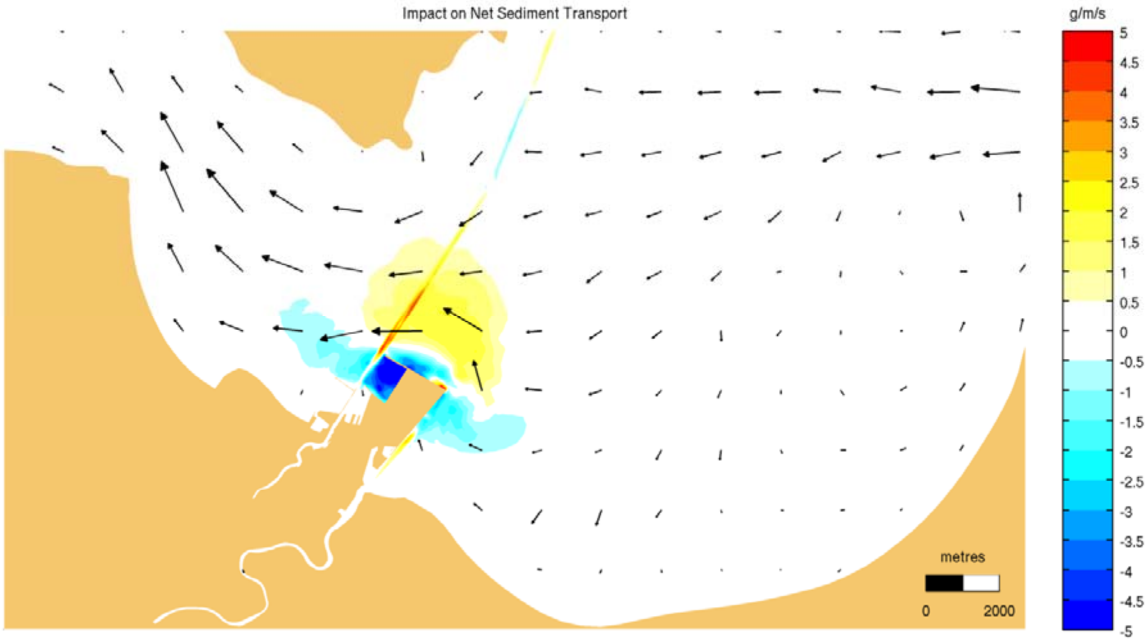

Figure 5.13 Modelled Ultimate Case Residual Suspended Sediment Transport Impacts

5.3.4.4 Siltation Impacts

The modelled Base Case siltation rate in terms of bed level change in metres per year is shown in Figure 5.14 and the modelled annual siltation volumes are summarised in Table 5.1. The modelled base case sedimentation rates were found to be in reasonable agreement with annual average historic dredging volumes for the existing dredged areas (POTL, 2013).

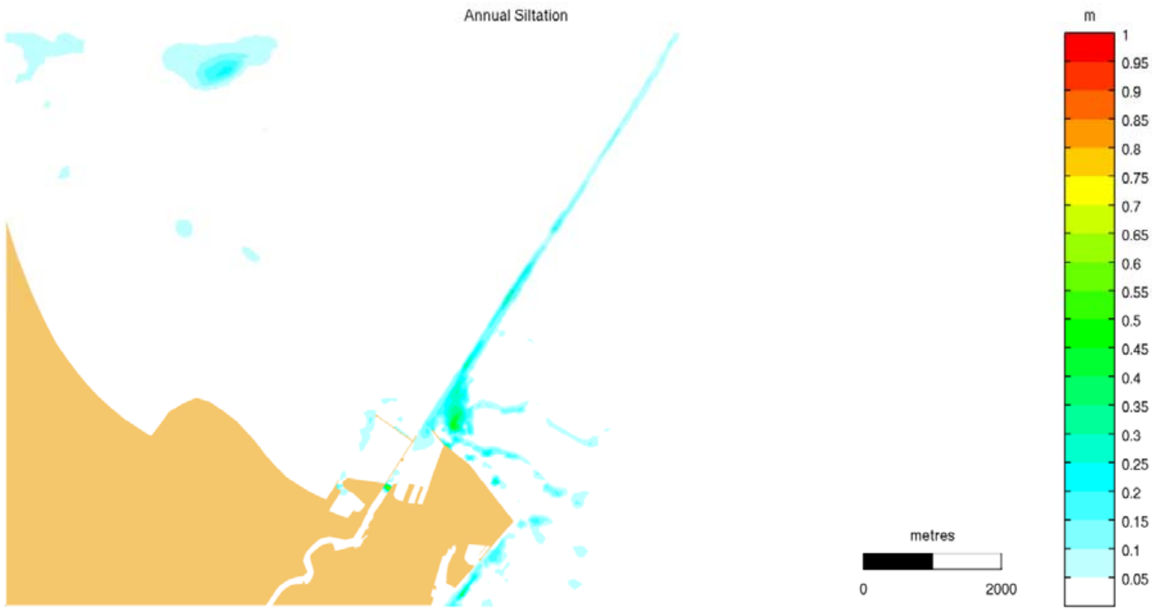

Figure 5.14 Modelled Base Case Siltation Rate (m/year)

5.3.4.4.1 Interim Case (Post Stage 1)

The distribution of modelled Interim Case siltation rate is shown in Figure 5.15 and the modelled annual siltation volumes for the Interim Case are summarised in Table 5.1. The changes to siltation rates due to the interim port expansion are shown in Figure 5.16. The model indicates a reduction in siltation rates within the inner harbour, and an increase in newly dredged areas. The model indicates an increase in siltation in most of the Platypus and Sea Channels.

Sedimentation volumes within the existing inner harbour are predicted to be reduced by around 36%. The Interim Case reclamation acts to partly reduce the magnitude of suspended sediment transport into the inner harbour dredged areas.

The annual volume of sedimentation occurring within the Platypus Channel is predicted to increase by around 20%, and by 13% in the Sea Channel. This is mainly due to the increased channel width. Sedimentation volumes within the outer harbour are predicted to increase by around 20% relative to the Base Case, primarily due to the Berth 12 dredging.

Overall, this modelling indicates that the total quantity of siltation within all of the dredged areas in the port combined may be increased by around 70,000 m^3 per year (about 17% relative to the present situation). This is primarily due to the widening of the Platypus and Sea Channels.

Table 5.1 Modelled Annual Sedimentation Volumes – Interim Case (m^3)

Dredge Area	Base Case	Interim Case	Percentage Change
Ross Creek	4,000	4,000	0%
Inner Harbour	28,000	18,000	- 36%
Platypus Channel	163,000	195,000	+ 20%
Sea Channel	40,000	45,000	+ 13%
Outer Harbour	128,000	153,000	+ 20%
Ross River	33,000	50,000	+ 52%
Total (modelled)	396,000	465,000	+ 17%

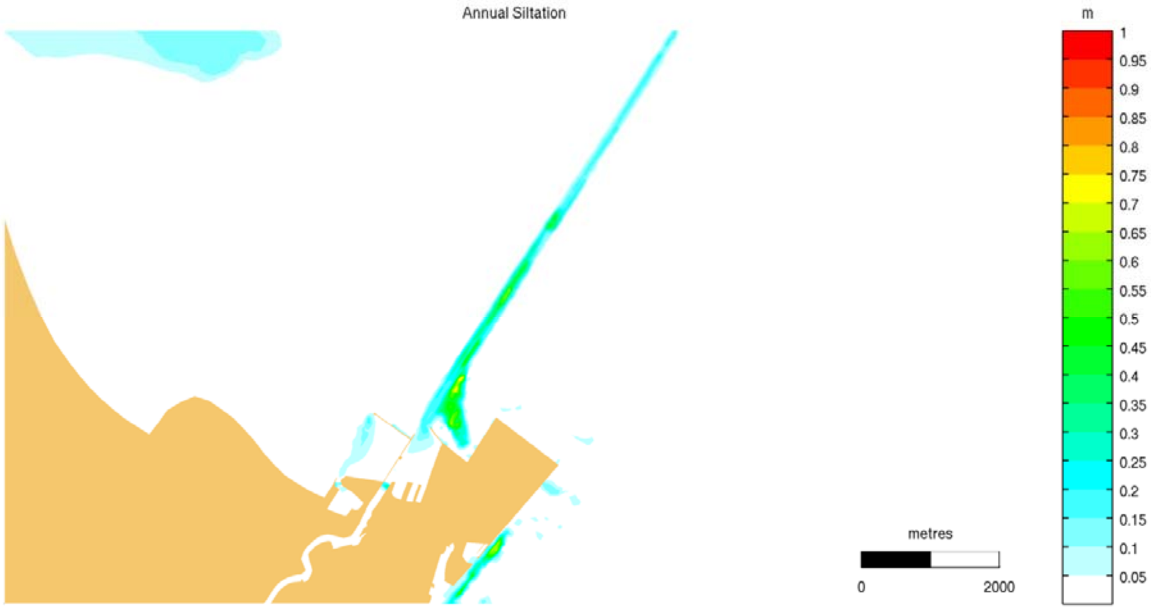

Figure 5.15 Modelled Interim Case Siltation Rate (m/year)

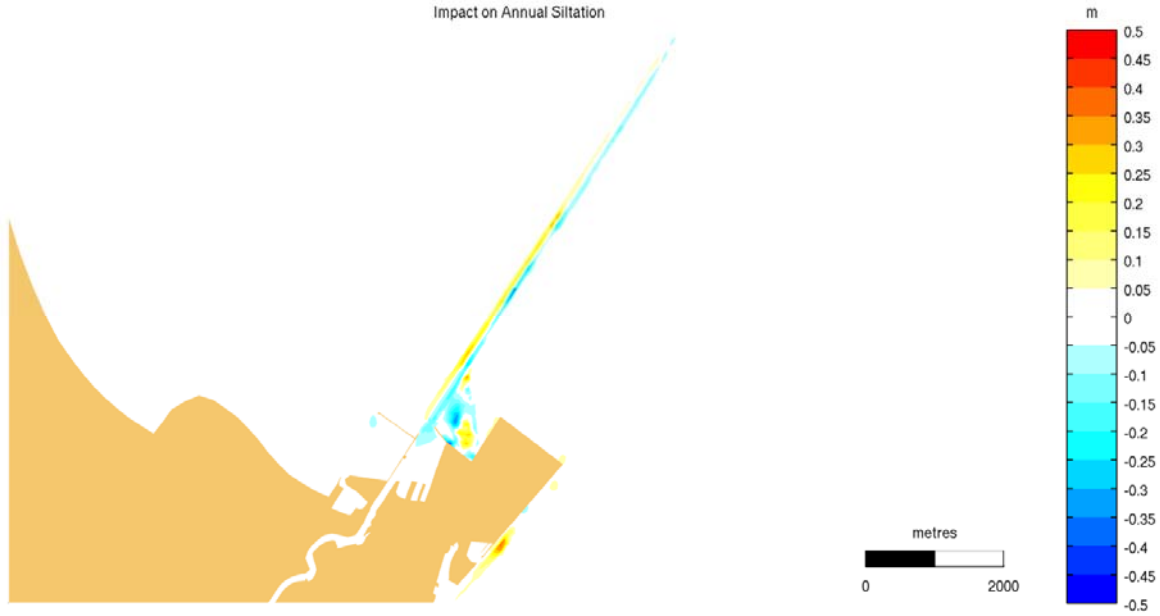

Figure 5.16 Difference in Siltation Rate between the Interim Case and Base Case (m/year)

5.3.4.4.2 Ultimate Case (Post Stage 3)

The distribution of modelled Ultimate Case siltation depths is shown in Figure 5.17 and the modelled annual siltation volumes for the Ultimate Case are summarised in Table 5.2. The change in siltation rates due to the port expansion are shown in Figure 5.18. The model results indicate a reduction in siltation rates within the new enclosed outer harbour area, and an increase in siltation in the Platypus Channel and Sea Channel.

Sedimentation volumes within the existing inner harbour are predicted to be reduced by around 21% and sedimentation volumes within the outer harbour are predicted to decrease by around 15% relative to the Base Case. The Ultimate Case reclamation and breakwaters act to significantly reduce the efficiency of suspended sediment transport into the outer and inner harbour dredged areas. It should be noted that the Ultimate Case assessments have been undertaken without a western breakwater in place. A modest decrease in predicted sedimentation will most likely occur with the addition of a western breakwater.

The annual volume of sedimentation occurring within the Platypus Channel is predicted to increase by around 26%, and within the Sea Channel it is predicted to increase by around 65%.This is due to the increased channel width and depth as part of the ultimate development.

Overall, this modelling indicates that the total quantity of siltation within all of the dredged areas in the port combined will increase by around 14% relative to the present situation. Although there will be a reduced suspended sediment net transport flux around the expanded port, this is more than offset by increased siltation in the widened and deepened channel. The material depositing in the new enclosed outer harbour area will be entirely very fine silts without the minor component of coarser silt/sand that deposits in the existing dredged basin and berth areas exposed at the present time.

Table 5.2 Modelled Annual Sedimentation Volumes – Ultimate Case (m3)

Dredge Area	Base Case	Ultimate Case	Percentage Change
Ross Creek	4,000	4,000	0%
Inner Harbour	28,000	22,000	- 21%
Platypus Channel	163,000	205,000	+ 26%
Sea Channel	40,000	66,000	+ 65%
Outer Harbour	128,000	109,000	- 15%
Ross River	33,000	46,000	+ 39%
Total (modelled)	396,000	452,000	+ 14%

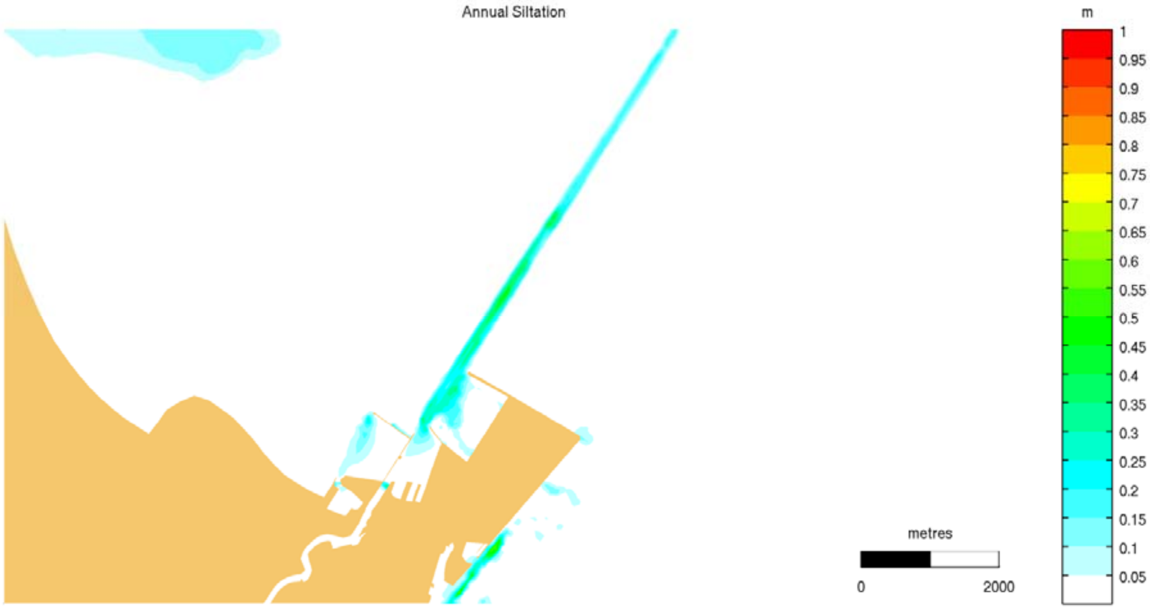

Figure 5.17 Modelled Ultimate Case Siltation Rate (m/year)

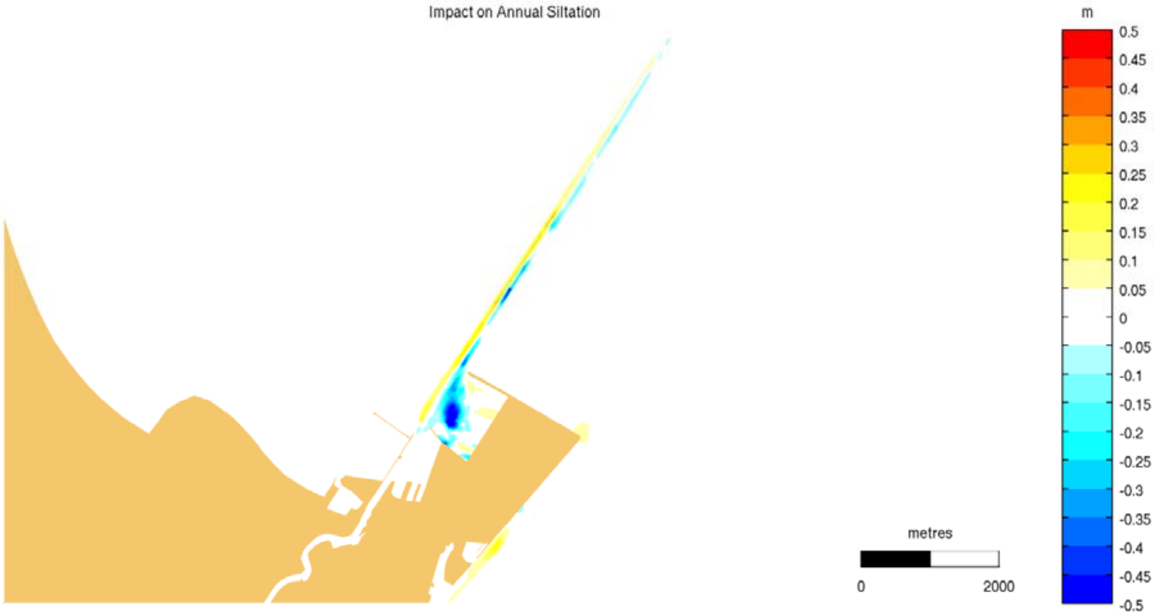

Figure 5.18 Difference in Siltation Rate between the Ultimate Case and Base Case (m/year)

5.3.4.5 Shoreline Impacts

The revised design shoreline impacts to the west of the Port are unchanged from those described in the EIS. Chapter B.3 (Coastal Processes) of the EIS provides a detailed shoreline impact assessment for the Strand and Rowes Bay.

The revised reclamation area extends further to the east than the design proposed in the original PEP EIS. Therefore, there is potential for additional modification to the wave climate to the east of the Port and potential changes to the shoreline coastal processes and morphology of that part of Cleveland Bay.

The shoreline to the east is considerably sheltered from wave action by Cape Cleveland, being exposed only to relatively small locally generated wind waves from the north and highly attenuated waves entering Cleveland Bay from offshore. The minor sand ridges have developed by shoreward movement of coarser sediments during infrequent larger wave events, with only minor longshore distribution of these sediments. The Ross River mouth area is exposed to somewhat higher energy wave action which, together with sand supply from the river, has led to development of more prominent sand ridges (Figure 5.19).

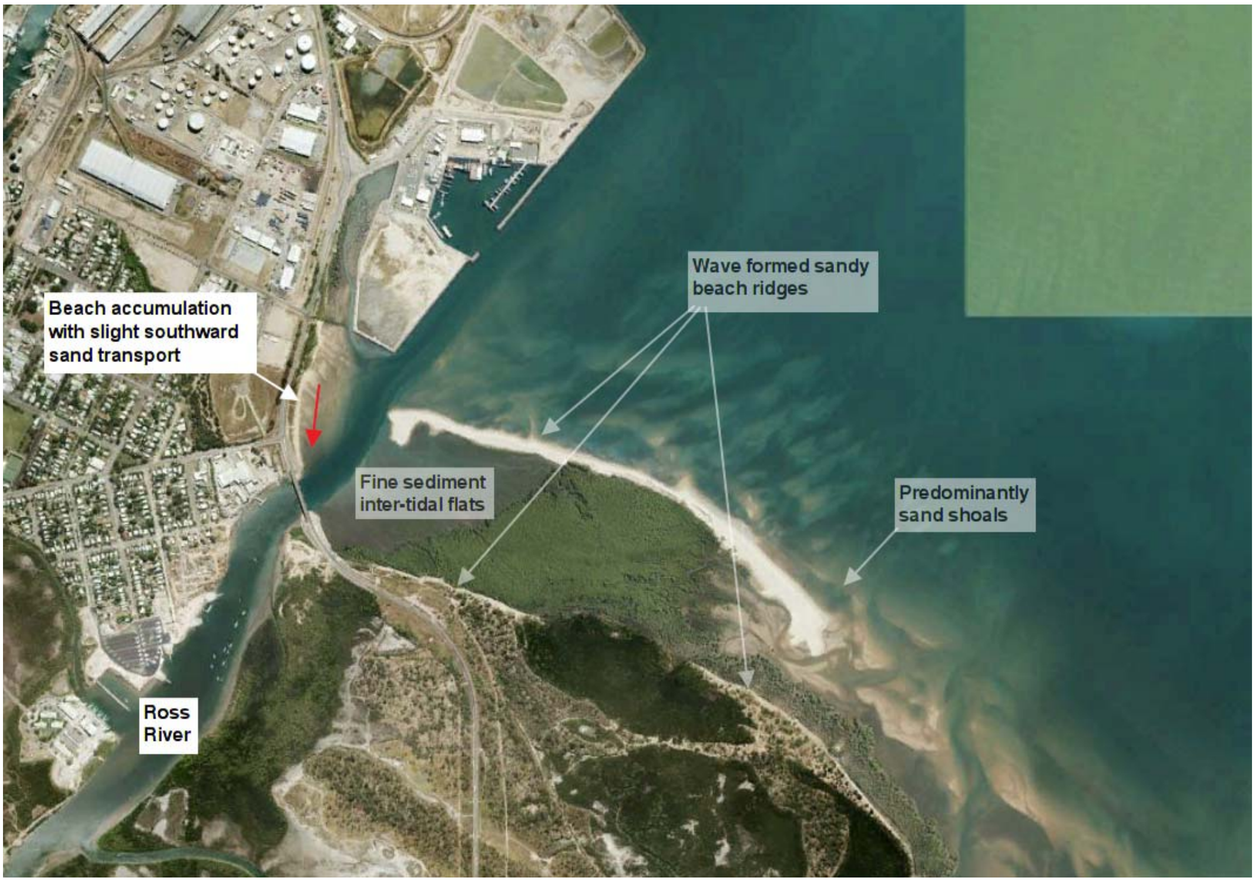

Figure 5.19 Morphology of Ross River Mouth Area

The wave modelling results show that, apart from the local area at the mouth of Ross River, wave propagation to the shoreline east of the Ross River is not affected significantly by the existing Port works. At the Ross River mouth, the eastward extension of the reclamation blocks and modifies waves from the north to north-northeast, particularly along the western side of the river channel. There, fine sediments appear to be accumulating gradually and a small beach has developed (Figure 5.19). Waves propagating to the Ross River mouth from the modal north-easterly direction are not significantly affected by the existing reclamation.

An illustration of the potential modification of wave propagation from the north-west to the Ross River mouth as a result of the PEP development is shown in Figure 5.21. It is apparent that the ‘shielding’ effect of the Port reclamation from north-westerly waves will be increased as a result of the proposed PEP development. The likely morphological response in the vicinity of the Ross River entrance and the coastline to the east will involve a slight increase in the rate of net sediment accumulation in the area. The propagation of waves from the dominant easterly direction will continue to be unaffected after construction of the new reclamation (as shown in Figure 5.21). Since fine sediments were accumulating in that area already due to the existing Port reclamation and given that the prevailing easterly wave direction is not significantly modified, construction of the new reclamation is not likely to result in any substantive change in the long term morphological condition.

The existing state of shoreline progradation at the Ross River mouth will be maintained under the developed case. The increased extent and shielding of the new reclamation may have the effect of slightly accelerating the rate of progradation. Sediment transport modelling results (refer 5.3.4.3-5.3.4.4) indicate that the scale of morphological impacts to the east of the port will be imperceptible within the context of underlying trends and natural variability.

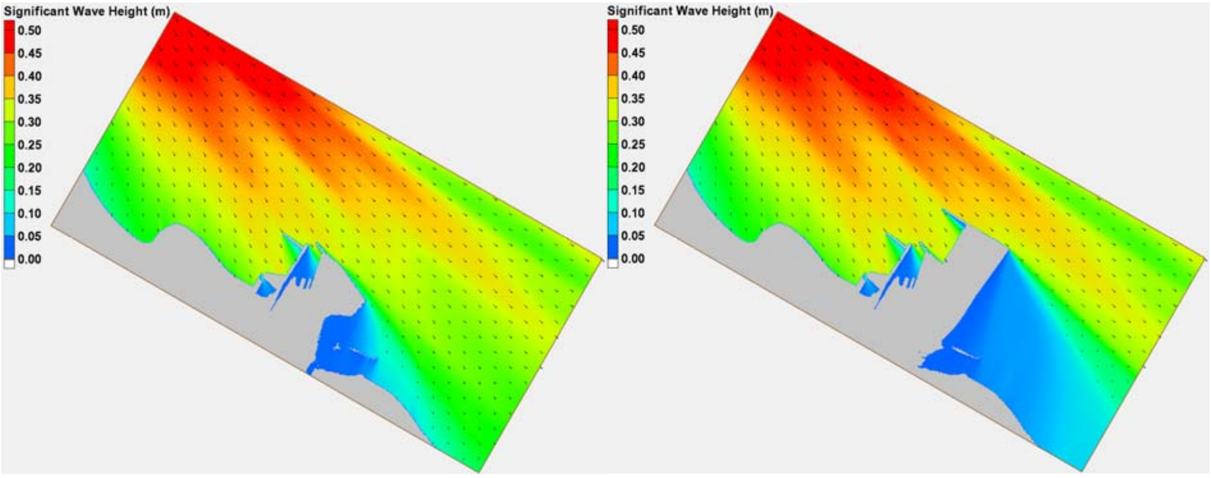

Figure 5.20 Wave Propagation from the North West in the Base Case (Left) and Ultimate Case (Right)

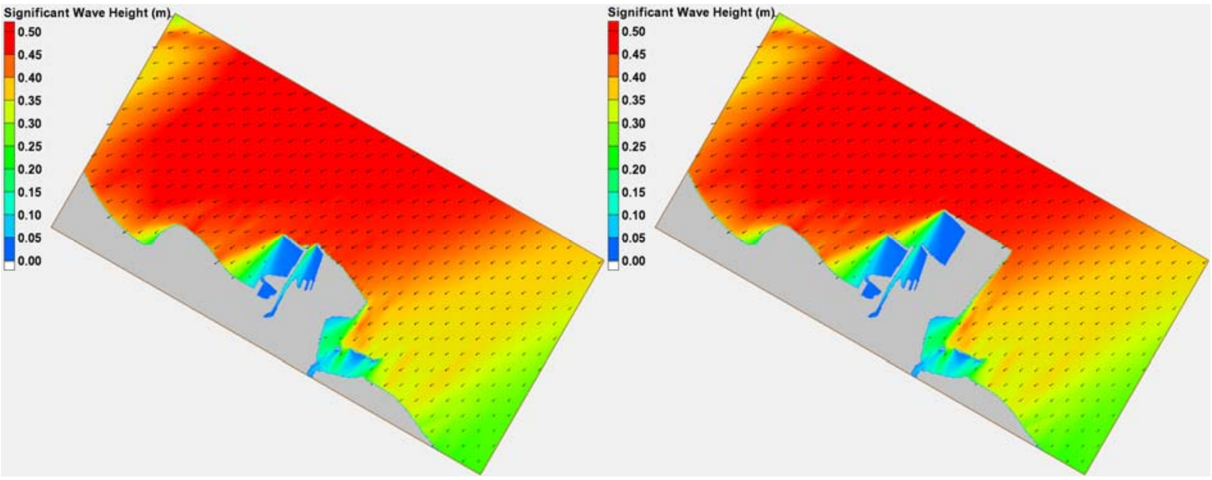

Figure 5.21 Wave Propagation from the North East in the Base Case (Left) and Ultimate Case (Right)

5.3.4.6 Dredge Plume Impact Assessment Methodology

A number of changes have been made to the numerical modelling methodology in the AEIS. Some of the changes are in order to satisfy requirements of the GBRMPA Guidelines (GBRMPA, 2012), while others have been implemented in response to feedback from EIS submissions. The most significant changes include the following.

- Ocean current forcing is now included on the open boundaries.
- All dredge plume modelling was undertaken with both dredged and ambient sediment explicitly included. This allows for mixing of ambient and dredged sediment in the model and improves the accuracy of resuspension dynamics.
- The assessment methodology for predicting dredging plume impacts is substantially different, and includes analysis of turbidity and deposition rate percentiles over a number of 30-day simulation periods. The ensemble approach has allowed for both ‘expected’ and ‘Worst Case’ impacts to be derived.
- The collection of 12 months of ambient turbidity data has allowed impact thresholds to be derived (refer to Sections 6.0 and 8.0).
- The model has been recalibrated for ambient sediment resuspension using the full 12 month set of water quality measurements.
- Maintenance dredging is now explicitly included in the modelling assessment and the cumulative impacts of capital and maintenance dredging are assessed.

The effects of dredging were assessed based on modelled increases in suspended sediment concentration and sedimentation above natural or ambient levels. Both ambient and dredge related signals have been resolved in the predictive model, which allows for an understanding of how significant the dredge contribution is in relation to ambient conditions.

Each dredging activity was simulated over a 30 day period. Spatial representations of the dredging impacts were based on percentile exceedance analysis of the model results. The 30 day window period is somewhat arbitrary but in a physical hydrodynamic context represents the approximate duration of two (2) consecutive spring-neap tidal cycles, while in an ecological context it is a meaningful timescale for assessing impacts to some key sensitive receptors in the area (e.g. dominant seagrass *Halolphila ovalis*).

The percentile impact plots correspond to the predicted increase in turbidity/sedimentation statistics over ambient conditions that are attributable to the dredging. It is important to note that the presented turbidity percentile plots do not represent the plume extent at any one particular instant in time. Percentile values considered in this report are 95th and 50th, which correspond to exceedance durations of 36hrs (5%) and 15 days (50%) respectively for the 30 day window. The highest percentiles correspond to relatively acute and short-lived increases in turbidity/sedimentation while the lower percentiles correspond to more chronic longer-term increases.

The spatial percentile exceedance dredging impact plots are presented in tandem with the equivalent modelled ambient percentile statistics, calculated as the average over all 30 day modelling periods. This allows the increases in turbidity/sedimentation due to dredging to be seen relative to the modelled ambient conditions.

For the most significant dredging activities, the simulation was carried out for an ensemble of five different 30 day periods during different seasons and the results were aggregated to determine the likely range of potential impacts. The 'Expected Case' impacts were determined on the basis of the ensemble average turbidity and deposition percentiles. The 'Worst Case' impacts were determined on the basis of the ensemble maximum turbidity and deposition percentiles.

Key features of the dredging impact analysis include the following:

- Consideration of a range of impact durations from acute to chronic
- Can account for the influence of a variety of meteorological conditions
- A similar analysis applied to the baseline data can quantify the ambient conditions including natural variability across different periods. This can be used to derive meaningful thresholds for the impacts.

Twelve months of baseline turbidity monitoring was undertaken as part of the Project which has allowed for the derivation of contour limits for the presentation of the percentile impact plots that are meaningful at specific sites. It should be noted that different thresholds (and therefore different contour limits) are appropriate for the different percentiles.

For a full discussion of all assumptions and inputs used in this dredging impact assessment please refer to the Hydrodynamic and Advection-Dispersion Modelling Technical Report (Appendix A2). The modelling results provide a detailed and site specific assessment of possible dredge plume dispersion which was used as the basis for water quality and ecological impact assessments. The implications of the modelled turbidity and deposition rate impacts are discussed in Section 6.3.4 and 8.3.4 of the AEIS.

5.3.5 Summary

Table 5.3 Impact Assessment Summary – Coastal Processes

Element	Primary Impacting Process	Updated Risk Rating			Mitigation Measures	Mitigated Risk Rating
		Magnitude	Likelihood of impact	Risk Rating		
Changes in longshore sand transport regime at The Strand	Construction of breakwaters and reclamation	Minor	Almost Certain	Medium	Monitoring of the beach in potentially vulnerable locations. Minor local dune strengthening as needed.	Low
Reduced storm erosion exposure at southern end of The Strand beach	Construction of breakwaters and reclamation	Beneficial	Almost Certain	Positive Benefit	Nil	Positive Benefit
Changes in longshore sand transport regime at Rowes Bay	Construction of breakwaters and reclamation	Negligible	Possible	Low	Nil	Low
Increased rate of sediment accumulation at the Ross River Mouth	Construction of breakwaters and reclamation	Minor	Almost Certain	Medium	Nil	Medium
Changes in velocity magnitudes in the immediate vicinity of the Port	Construction of breakwaters and reclamation	Negligible	Almost Certain	Medium	Nil	Medium
Changes in Cleveland Bay morphology in the immediate vicinity of the Port	Construction of breakwaters and reclamation	Negligible	Almost Certain	Medium	Nil	Medium
Siltation in the harbour and channel	Capital dredging, placement and reclamation	Negligible	Almost Certain	Medium	The ultimate design enclosure of the outer harbour reduces siltation to the extent that Project siltation volumes are increased by 14% over the base case (despite widened channel infrastructure).	Medium
Siltation at The Strand due to Ross River sediment discharge	Construction of breakwaters and reclamation	Beneficial	Possible	Positive Benefit	Nil	Positive Benefit
Sediment resuspension from the DMPA	Capital dredging, placement and reclamation	None	None	None	There is no offshore placement of capital material under the revised AEIS design.	None
Widening and deepening of channel affecting wave propagation	Channel widening and deepening	Negligible	Unlikely	Negligible	Nil	Negligible

5.4 Conclusion

The revised design has accommodated the legislative requirement preventing offshore placement of capital dredge material through development of an expanded reclamation footprint. The revised assessment presented in this AEIS addresses the issues raised in EIS submissions as well as assessing any changes associated with the design refinement.

The expanded footprint of the reclamation area will not cause significant additional impacts beyond those identified in the EIS. The changes to hydrodynamics and sediment transport caused by the construction of the reclamation and breakwaters are minor and there may be slight benefits at The Strand due to a potential reduction in siltation.

The proposed widening of the channel is not expected to cause additional coastal processes impacts because it will not have a significant impact on wave transmission or reflection. The reduction in the proposed depth of the final channel design has reduced the length of the required channel and therefore reduced impacts at the northern end of the Sea Channel. Due to the widened channel, maintenance dredging volumes are predicted to increase by 17% over the existing case for the Interim development stage and by 14% over the existing case for the Ultimate development.

The likely changes in the longshore sand transport regime at The Strand are not changed in the revised PEP. There will be increased sheltering of the Ross River mouth from northerly waves due to the expanded reclamation, however exposure to prevailing north easterly waves will not be significantly changed. The existing state of shoreline progradation at the Ross River mouth will be maintained under the developed case.

The revised assessment presented in this AEIS addresses the matters raised in EIS submissions and finds that the design refinement does not represent a significant increase in impacts to coastal processes and hydrodynamics compared with the EIS.

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