USE OF DREDGING DESIGN AND NUMERICAL MODELLING TO INCREASE SLACK WATER ACCESS TO THE PORT OF MACKAY

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BACKGROUND

The Port of Mackay is a key strategic port within the portfolio of North Queensland Bulk Ports Corporation Ltd (NQBP), accommodating the import and export of goods that support the economy of central Queensland. The Port caters for a wide variety of vessels. Vessel arrival navigation and maneuvering is currently constrained due to existing physical, environmental, and operational conditions at the harbour entrance particularly due to coastal tidally driven cross currents.

Figure 1 - Port of Mackay Satellite image showing current action at the Port entrance.

NQBP engaged Royal HaskoningDHV (RHDHV) to review and assess options to alleviate vessel access constraints primarily through modifications to the physical harbour entrance infrastructure. This paper summarizes the success of an alternative approach devised to increase the slack water arrival windows at the Port.

The Port currently is restricted on arrival on when and how large a vessel can safely pass through the entrance and come to a stop. The restriction is caused mostly by cross-currents which make it unsafe to manoeuvre a vessel through the entrance at a speed slow enough to enable a vessel to stop inside the harbour. Port departures have very little restriction in terms of currents as the vessel can exit at speed.

MODELLED SOLUTION

The new concept is to utilize capital dredging near the critical point of the entrance to dramatically reduce current velocities and increase UKC. Deeper channels can transmit.

- larger volume of water at similar velocities
- similar volume of water but at reduced velocities
- larger volume of water at higher velocities

These modes can be utilized depending upon the specific location and tidal ranges and form a very complex hydrodynamic system. The design is paramount in tuning the velocities to suit the needs of the vessel arrival windows.

The entrance to Mackay Harbour is a choke point between the breakwaters and the nearby island for the tidal exchange of water leading to higher velocities at this critical point. By deepening the entrance channel, the tidal current velocities can be reduced, thereby increasing vessel accessibility (by increasing windows of availability when the currents are below critical levels).

RESULTS

Application of hydrodynamic models for comparison of different dredging scenarios suggest that cross-current conditions can be successfully reduced, increasing access to the harbour under longer tidal window. The models have also been deployed to minimize the anticipated dredging intervention to achieve the required result.

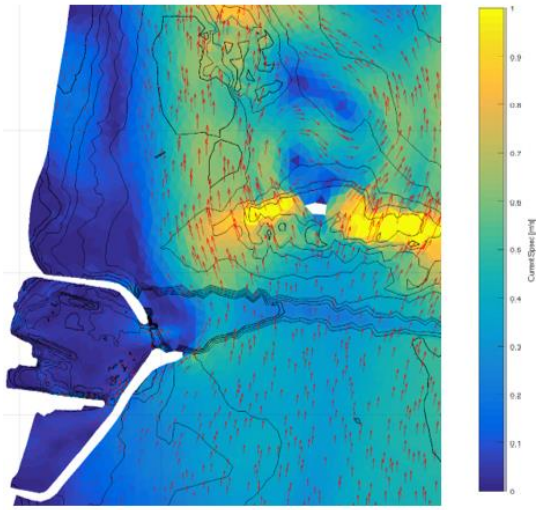

Figure 2 – Dredged solution showing reduced velocity of cross currents at entrance.

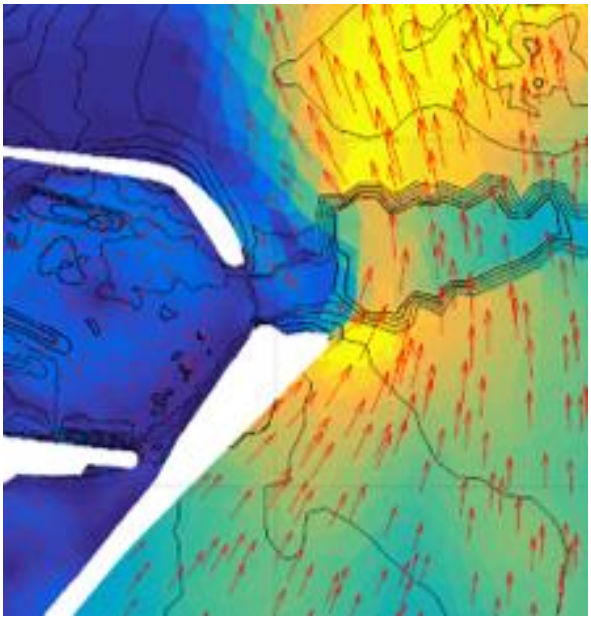

Figure 3 – Further options testing of alternative breakwater shape.

The numerical modelling of this option proved to be a resounding success and above expectations. This has been achieved through the optimization of different scenarios via numerical models to optimize the impact vs amount of dredging intervention. The Strategic design has tuned the tidal currents to the needs of arriving vessels. The physical phenomena that this strategy produces is as follows:

- Increasing the velocities and volume of water moved during non-crossing windows
- Calming the velocities during crossing windows and making these windows larger
- Relocating the higher velocities away from the critical entrance area
- Making current flows more predictable and slower to change

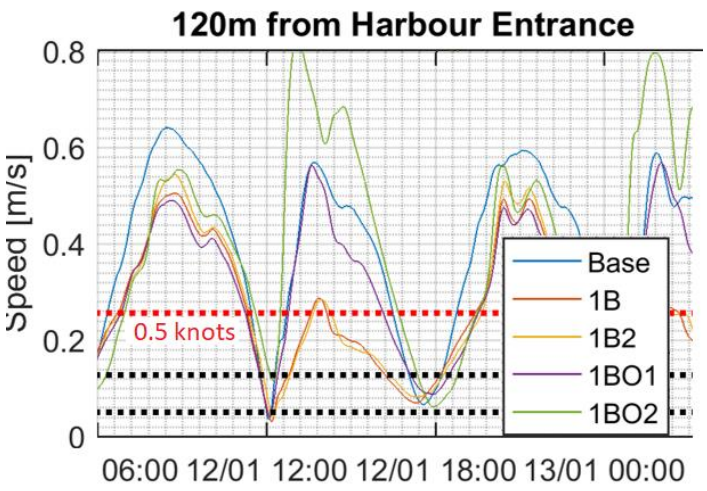

Figure 4. Results of entrance velocities of Various tested scenarios.

Figure 4 shows the dramatic improvement of the 1B solution vs the current Blue line. There is an improvement in the duration of time in the daily cycle where the peak current is below the operational threshold of 0.5knots. This improves the predictability and duration of a window below the required operational threshold.

CONCLUSION

A fresh approach for improved vessel navigational infrastructure has been tested and proven with Numerical modeling of coastal processes.

Further consideration will be required to the effects of channel deepening on wave refraction patterns around the harbour entrance. The quantitative reliability of the analysis can be further improved by validation of the numerical model system at against observed currents at the harbour entrance.

REFERENCES

Port of Mackay - Slack Water Navigation & Entrance Realignment Study 2019. (Private Report)