PORT OF **WEIPA**

PLAN

Long-term Maintenance Dredging Management Plan

North Queensland Bulk Ports Corporation

Port of Weipa

Long-term Maintenance Dredging Management Plan

2020 – 2030

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ADAPTIVE STRATEGIES

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Contents

1. Introduction

The Port of Weipa (the Port) was established on 1 June 1965, together with the Rio Tinto Alcan (RTA) mine and the township of Weipa. The port handles more than 36 million tonnes of product per annum, most of which is bauxite. It serviced 619 ships in 2017-18, carrying 36.1 million tonnes of bauxite. In addition, 94,872 tonnes of fuel and 59,422 tonnes of other cargo were also handled.

The main activity of the port is the export of bauxite from the RTA mine. RTA currently operates the majority of port facilities and maintains on-shore bauxite handling, processing and stockpiling infrastructure, including conveyors for ship loading servicing Lorim Point Wharf. The Port also handles fuel oil, cattle, breakbulk and general cargo.

The port is located 640 km north west of Cairns and 1,180 km east of Darwin in Albatross Bay on the eastern shore of the Gulf of Carpentaria, on the north west coast of Cape York Peninsula (Figure 1). Weipa is a coastal town of approximately 3,500 people, making it the largest community on the Cape York Peninsula.

The port's navigational areas include a main shipping channel in Albatross Bay, four shipping berths across three wharves, and tug berth area. There is an inner approach channel and an inner departure channel.

1.1. Purpose and Objectives

The purpose of this Long-term Maintenance Dredging Management Plan (LMDMP) is to document the strategy for managing natural sediment accumulation at the Port of Weipa, in a way that ensures the safe and efficient operation of the Port and the ongoing protection of local environmental, social and cultural values.

Left unmanaged, natural sediment fills up navigational infrastructure, impacting the depth necessary for safe loading, manoeuvring and transit of ships. A reduced ability to effectively load ships can have a substantial economic impact on the region that the port supports.

The objectives of the LMDMP are to:

1. Provide a framework for maintenance dredging of the Port over the next 10 years.
2. Establish a robust, transparent long-term planning approach to managing port sediment.
3. Outline operational, planning, consultation and monitoring arrangements.
4. Maintain local environmental, social and cultural values,.
5. Apply continual improvement practices in the management of sediment and dredging actions.

1.2. Changes to the LMDMP

This plan is intended to demonstrate commitment to the long-term management of maintenance dredging and placement activities for the Port of Weipa, from 2018 to 2043. The plan is supported by a detailed technical analysis, titled: *The Port of Weipa Sustainable Sediment Management Assessment* (refer www.nqbp.com.au).

This LMDMP will be reviewed and updated when or if one of the following occurs:

1. When permit conditions have been changed or amended or new permits issued.
2. When monitoring results report substantially different impacts than were predicted.
3. If new navigational infrastructure is planned and developed at the Port.
4. If an incident occurs that poses a significant risk to effective future management.

The current approved LMDMP will be maintained on the North Queensland Bulk Ports (NQBP) website – www.nqbp.com.au.

Figure 1: Port of Weipa

1.3. Policy Content

The plan will also ensure that dredging activities align with the principles, elements and objectives described in:

- Environmental Code of Practice for Dredging and Dredged Material Management (Ports Australia 2016)
- National Assessment Guidelines for Dredging (NAGD) (CoA 2009).

In addition, while Weipa is not located within the Great Barrier Reef World Heritage Area (GBRWHA) this Plan has followed the approach recommended in the:

- GBRWHA Maintenance Dredging Strategy (SOQ 2016)

Ports Australia Dredging Code of Practice

The Ports Australia *Dredging Code of Practice for Dredging and Dredged Material Management* sets out a number of environmental principles that Australian ports meet when undertaking dredging and placement of dredged material. The principles have been defined on the basis of ecologically sustainable development principles.

National Assessment Guidelines for Dredging (NAGD)

The NAGD established a scientific assessment framework to determine if dredge material is suitable for ocean placement in line with the *Environment Protection (Sea Dumping) Act 1981* and the *1996 Protocol to the Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter, 1972* (the London Protocol). The Guidelines include an assessment framework (Figure 2) that is applied to ensure the impacts of dredged material loading and placement are adequately assessed.

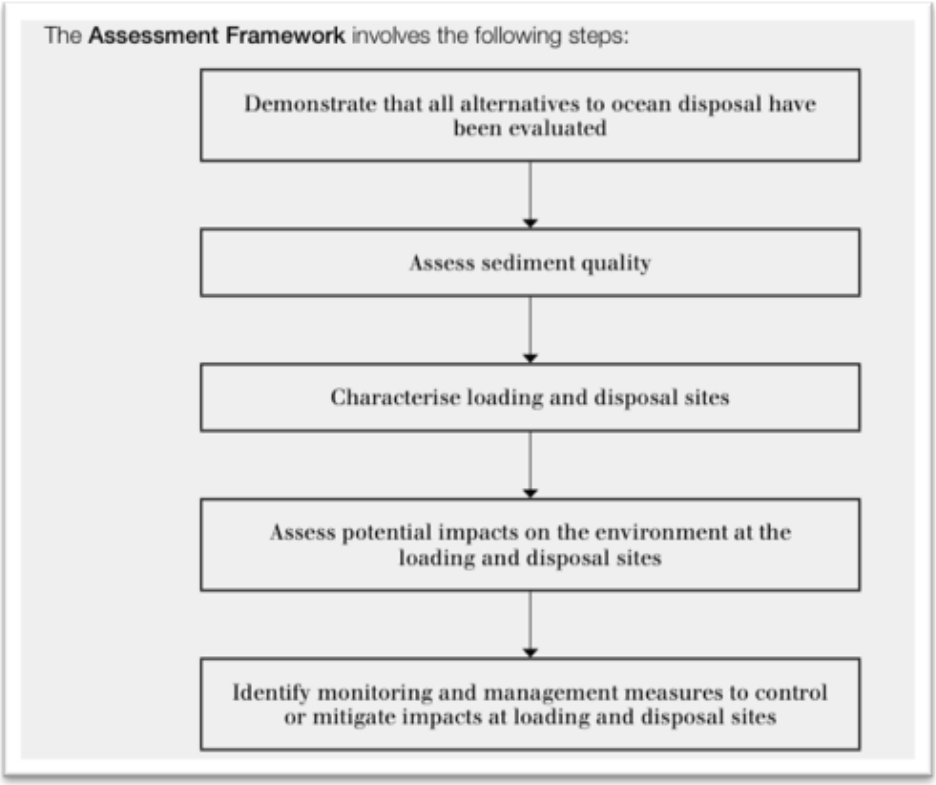


Figure 2: National assessment framework for dredge material placement (CoA 2009)

GBRWHA Maintenance Dredging Strategy

Queensland's *Maintenance Dredging Strategy for Great Barrier Reef World Heritage Area Ports* (SOQ 2016) provides a framework for sustainable, leading practice management of maintenance dredging at ports in the Great Barrier Reef World Heritage *(*GBRWHA). The framework builds on the current regulatory requirements to ensure the ongoing protection of the Reef's values and the continued operating efficiency of ports within the GBRWHA.

While not directly related to the Port of Weipa, the Strategy sets up a best practice framework for maintenance dredging management and recommends ports develop and implement long-term maintenance dredging management plans.

Figure 3: Framework for Long-term maintenance dredging management (SOQ 2016)

The development and implementation of this Plan is in line with applicable principles contained in the Maintenance Dredging Strategy (Figure 3), specifically:

- Developing the knowledge base, using the best science available
- Avoiding or minimising the need for maintenance dredging where possible
- Application of the principles of ecologically sustainable development
- Maintaining and enhancing environmental values
- Going further than avoiding and mitigating impacts, to look for opportunities to deliver environmental protection, restoration or enhancement outcomes (working with nature principles)
- Application of comparative analysis to determine the most suitable solutions
- Application of adaptive management and continuous improvement processes
- Reporting evaluated performance and providing access to data and information from monitoring
- Favouring transparency, consultation with key stakeholders and values-based assessment.

This LMDMP comprises the main planning and management tool for maintenance dredging at the Port. Supporting this Plan will be a Maintenance Dredging Environmental Management Plan (EMP) and a Monitoring Program.

- The Maintenance Dredging EMP is developed in conjunction with the dredge operator, it is specific to an individual dredging program and contains the operational controls for dredging.
- The Monitoring Program is developed by NQBP and outlines the ambient, impact and adaptive monitoring overseen by the Port Authority.

1.4. GOVERNANCE

LEGISLATION AND APPROVALS

Maintenance and capital dredging programs are subject to a number of Commonwealth and Queensland government laws and policies. This section describes the key environmental, cultural and planning legislation and policies that apply to dredging and dredge material placement projects undertaken at the Port of Weipa. Specifics on which of these particular legislation and approvals processes apply to a proposed dredging project will need to be undertaken in the initial planning stage of any proposed dredging program, taking into account the specifics of each proposed dredging program.

COMMONWEALTH LEGISLATION AND POLICY

Two key pieces of Commonwealth environmental protection legislation apply to dredging projects undertaken within Australia:

- *Environment Protection (Sea Dumping) Act 1981*
- *Environment Protection and Biodiversity Conservation Act 1999*

Environment Protection (Sea Dumping) Act 1981

Dumping of waste and other material from any vessel, aircraft or platform in Australian waters is prohibited under the *Environment Protection (Sea Dumping) Act 1981*, unless a permit has been issued. Permits are most commonly issued for dredging operations and the creation of artificial reefs. The Act fulfils Australia's international obligations under the London Protocol (to prevent marine pollution by controlling dumping of wastes and other matter). The Act is administered by the Department of Agriculture, Water and Environment (DAWE).

Environment Protection and Biodiversity Conservation Act 1999

The *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) is the Australian Government's central environmental legislation. The EPBC Act provides a legal framework to protect and manage nationally and internationally important flora, fauna, ecological communities, wetlands and heritage places which are defined in the EPBC Act as matters of national environmental significance (MNES).

The EPBC Act is triggered when a development proposal has the potential to have a significant impact on MNES. Approval under this Act is not required if significant impact to MNES will not result.

STATE LEGISLATION AND POLICY

The Queensland Government also regulates maintenance dredging under a series of State laws. The legislation that applies is determined by the location of the dredging activity and the type and scale of dredging being undertaken.

APPROVALS

There are a number of State and Federal approvals necessary for ongoing maintenance dredging and placement at the Port of Weipa.

Table 1: Dredging related permits

Permit	Activity
Environmental Authority (EA)	Undertake maintenance dredging of navigational infrastructure
Operational Works (Tidal Works)	Placement of dredged material below high-water mark
Sea Dumping Permit (Clth)	Loading and placement of dredged material at sea

NOTIFICATION AND OBLIGATIONS SCHEDULE

Prior to maintenance dredging commencing NQBP will develop a 'notifications and obligations schedule' that clearly outlines relevant reporting requirements and obligations arising from all current permits. The schedule will separately show notification requirements and condition obligations for the periods:

1. Pre-maintenance dredging commencing.
2. During active maintenance dredging and placement.
3. Post-maintenance dredging reporting and closeout.

The most current notifications and obligations schedule will be provided to the Technical Advisory Consultative Committee (TACC).

1.5. Responsibilities

NQBP is a government owned corporation that reports to two Government Shareholding Minsters (Minister for Main Roads, Road Safety and Ports; and the Treasurer). The shareholding ministers are represented by a Board of Directors who oversee the governance and direction of the organisation.

A *Maintenance Dredging Steering Committee* oversees the day to day planning and operations of maintenance dredging at the Port of Weipa. The committee is responsible for:

- financial review and approval
- dredging contract review and approval
- approval of the LMDMP, Monitoring Program and environmental management plans
- review and approval of external affairs and media correspondence.

The committee is chaired and attended by key executives of NQBP and includes senior representatives from RTA.

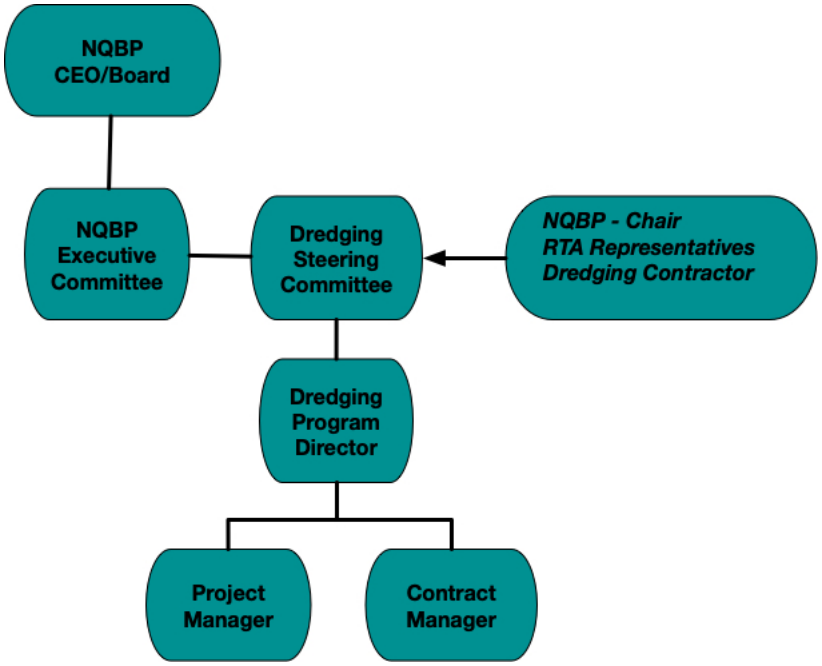


Figure 4: Structure of Maintenance Dredging Steering Committee

2. Port Locality, Setting and Shipping

The Port of Weipa is located within Albatross Bay in the Gulf of Carpentaria, on the north west coast of Cape York Peninsula (Figure 1).

The Port of Weipa consists of a main shipping channel in Albatross Bay (South Channel) and an Inner Harbour. The Inner Harbour consists of three wharves: Lorim Point, Humbug Wharf and Evans Landing; plus an inner Approach Channel and an inner Departure Channel (see Figures 5 and 6). The three wharves provide four shipping berths.

- Lorim Point Wharf has two berths, which are dredged to 12.5 m below LAT
- Humbug Wharf has one berth and is dredged to a depth of 8.1 m below LAT
- Evan's Landing has one berth that is dredged to 9.6 m below LAT.

In addition to the shipping berths, there is a tug berth behind the Lorim Point Wharf.

The South Channel is located in the centre of Albatross Bay and is the access channel for ships using the Port of Weipa. The channel was first dredged in the early 1960s, with additional capital dredging in the 1970s and in 2006 and 2012. The South Channel is currently maintained to a length of approximately 17 km, a width of 105.5 m and a declared depth of a maximum of 12.0 m LAT (design depth for departure channel is 11.1 m LAT and that of the 2012 channel extension is 12 m LAT.

The South Channel terminates at the junction with Jackson Channel, which is located within the natural harbour formed by the Embley-Hey River estuary (Inner Harbour). Within the Inner Harbour there is a natural swing basin surrounding Cora Bank. Depths in the Inner Harbour range from 0 – 2 m at the centre of Cora Bank to 8 – 20 m in the surrounding swing basin.

Table 2: Dimensions of navigational areas at the Port of Weipa

Location	Design Depth (m below LAT)	Length (m)	Width (m)
South channel	-12.2 to 14.1	17,400	105.5
Inner departure channel	11.4 to 11.8		
Lorim Point East Wharf	12.3	365	60
Lorim Point West Wharf	12.3	325	60
Humbug Point Wharf	9.5	195	35
Evans Landing Wharf	9.4	165	30

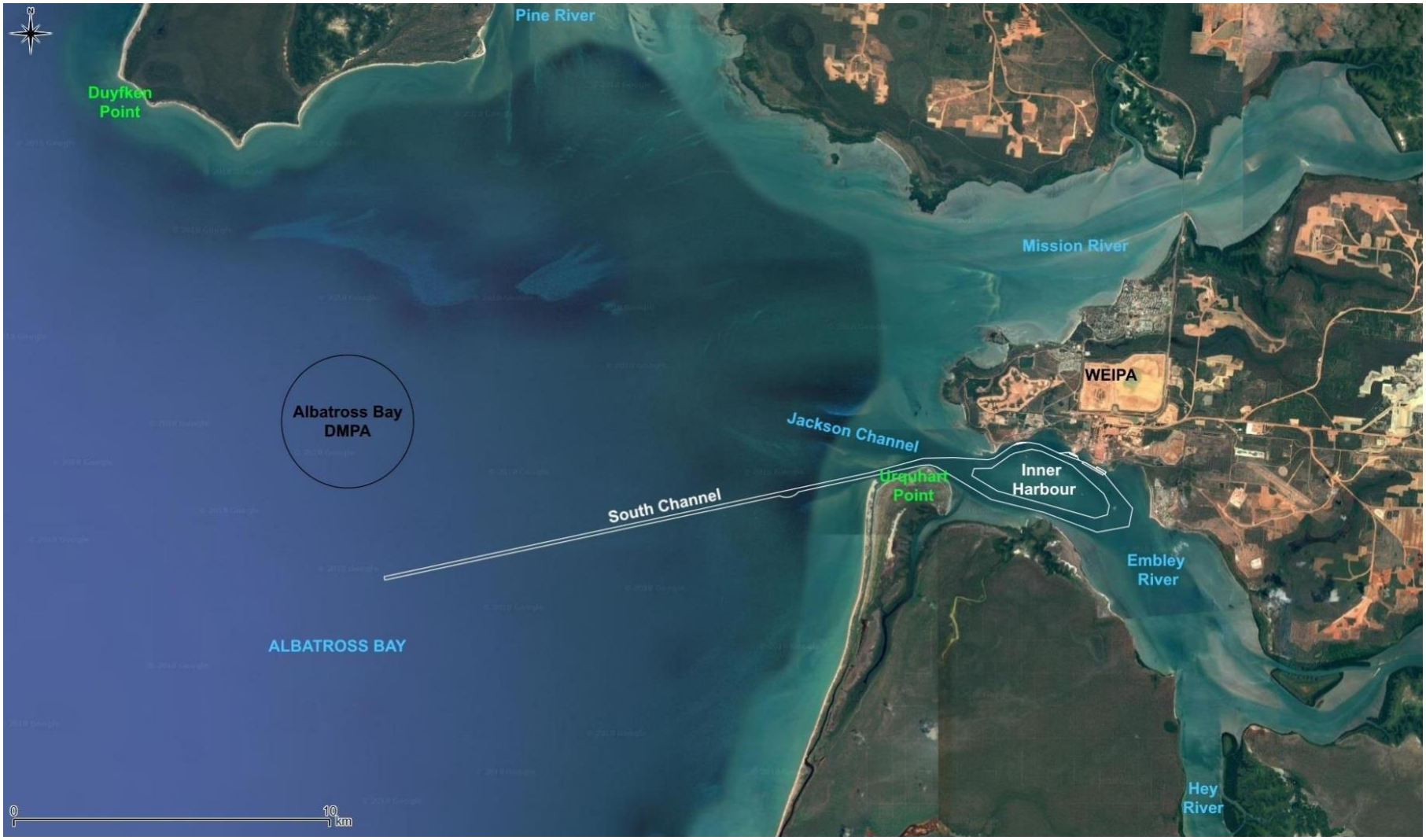


Figure 5: Port of Weipa navigational infrastructure

Figure 6: Port of Weipa inner harbour navigational infrastructure

2.1. FIGURE VESSELS

The Port of Weipa primarily ships bauxite (aluminium ore) from the RTA mine with tonnage of approx. 28 million tonnes in 2018-19.

Vessels currently transporting bauxite from the Port of Weipa include a mix of vessels owned and operated by Rio Tinto Marine (the Rio Tinto fleet) and chartered vessels. The Rio Tinto fleet consists of seven vessels (five existing vessels of approximately 90,000dwt and two new vessels of approximately 88,000dwt). The vessels are all Japanese built bulk carriers with minor modifications to the cargo spaces, rudder and hull form to suit the specific requirements of the bauxite trade.

Bulk carriers from the Port of Weipa currently travel to and from the Port of Gladstone via the Torres Strait and follow the inner Great Barrier Reef Designated Shipping Area.

In addition to the Rio Tinto fleet, Rio Tinto charters Panamax vessels (typically 75,000 to 88,000dwt) as required. In future Rio Tinto may also charter Cape size vessels if required for the transport of bauxite internationally.

To accommodate bulk carriers of this size the navigational areas within the Port have been deepened to enable the safe departure of loaded vessels.

Figure 7 provides a cross-sectional representation of the various depths related to dredging and safe vessel movements.

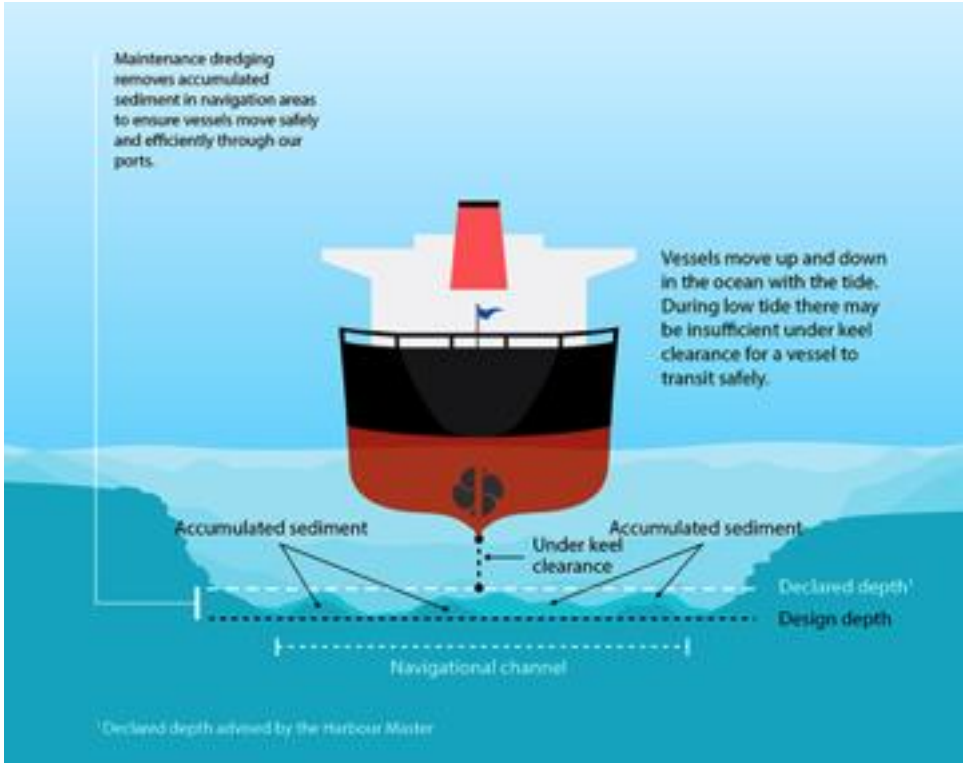


Figure 7: Shipping channel terms and depths

3. Port Environmental Values

In managing sediment and dredging activities at the Port of Weipa it is essential to understand the environmental, social and cultural values of the Port and the surrounding area.

The focus is on values that are considered important or notable at a national, regional or local level. The aim is to provide a useful level of detail and relevance to management planning. Values are described for the broader area incorporating the port limits and adjacent environs. More detailed information regarding these values can be found in the *Port of Weipa Environmental Values Report* (GHD 2019).

This EVA has identified, assessed and evaluated those values considered to be important for the Port of Weipa across the headline categories of social, aquatic ecosystems, landform and biota and air quality. This has been completed using robust methodologies that considered how values considered important at a national, regional and local level were expressed within the region to determine those values that are considered significant for the Port of Weipa. Assessment used desktop review of data collated and reported from field investigations in conjunction with data available through online portals, including government databases.

Assessment determined the significant values for the Project area to be:

- Traffic management
- Fisheries
- Waste management
- Indigenous cultural heritage
- Seagrass
- Mangroves
- Catchments and streams (estuarine)

These values have been assessed as significant as they represent something that is regionally or locally unique. Some values, like corals and shorebirds, were recognised to be important for the region however were not found to be unique to the Project area when compared with other surrounding areas/regions.

A summary of the significant values is provided at Figure 8.

WHAT IS AN 'IMPORTANT VALUE'?

- For the purposes of this review, *important environmental* values are those that are:
- Matters of national environmental significance protected under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act).
- Matters of state environmental significance protected under Queensland environmental protection and management laws.
- Habitats or ecosystems that are considered 'important' or 'critical to the survival' of listed species or communities.
- Values that contribute significantly to the regional and local landscape.

Important *social and cultural* values are those that are:

- Included in national or state registers.
- Identified by traditional owners or community members.
- Values that contribute to the appreciation culture and heritage in the region.
- Features that provide a connection to the landscape, history or previous or current use of the area.

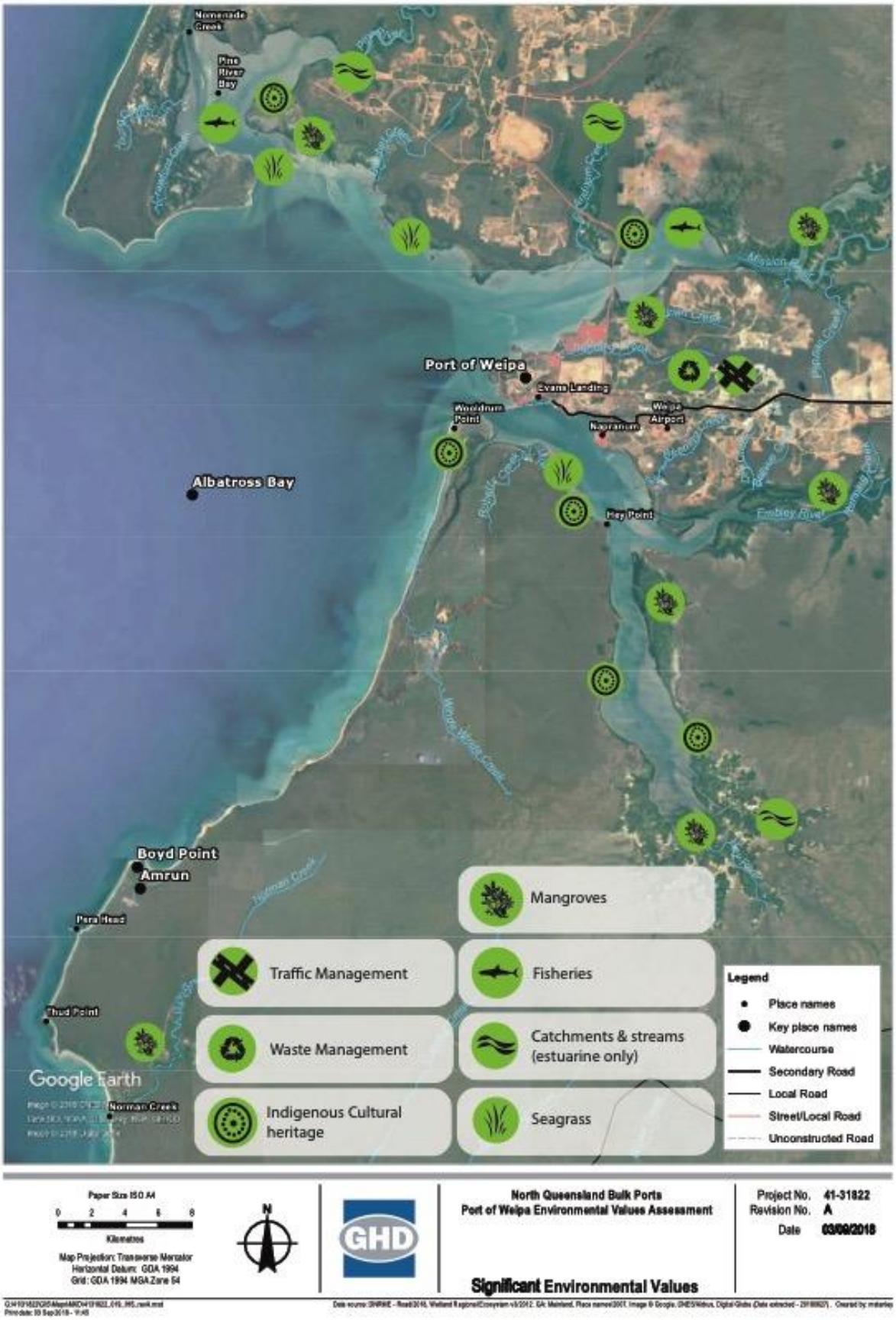


Figure 8: Environmental values surrounding the Port of Weipa (GHD 2019)

3.1. Regional Environmental Features

Measures of importance were used as criteria to identify important environmental, cultural and social values on a national, regional and local level. Assessment was undertaken on important values to determine those that contribute significantly to the project area. These identified environmental, cultural and social values were then classified according to criteria defining 'significant values' and were supported by confidence of robustness to maintain integrity with this values assessment.

The findings can assist in identifying potential environmental constraints and opportunities when considering and ultimately deciding sediment management options for the port, as well as provide an important input into broader port planning and decision-making.

The environmental values were defined as important at a National, State/Regional or Local level by using set criteria, including:

- matters of National and State Environmental Significance
- critical habitats and ecosystems
- regional significance
- national/state heritage registers
- traditional owner considerations.

Those values that were found to be important for the region were further assessed to determine if they contributed significantly to the expression of social, cultural, environmental or economic values of the project area.

It is important to note that some values that were considered locally and regionally significant, such as terrestrial flora and fauna, were included as subsets of broader categories that were assessed overall as not being significant and therefore not included as significantly important values for the project area.

Those values determined to be significant for the Project area are summarised below:

Traffic management

Transport infrastructure in the area is highly valued and is regionally significant as it provides broader connections in the region and increases access to employment and essential social services. Transport was determined to be of high social significance in the area as there are limited traffic options given the remoteness of the area and the road and air network is vital to the economic survival of the region

Fisheries

Commercial fishing in the area is highly valued as it is an important component of the economic landscape that is largely reliant on mining. Commercial fishing is recognised in the Cape York Regional Plan as being an important economic value of the region as providing for a more diverse economy. Commercial fishing is of high social significance and the species (barramundi, mackerel, grunter) that attract fishers needs to be considered in future port decision making.

Waste management

Waste management is considered to be of high regional significance to the area as there are limited waste management facilities in the region and there is also limited capacity to manage waste resources in the region.

Indigenous cultural heritage

Indigenous cultural heritage has been determined to be a significant value. The area is home to shell middens, stone axes and a number of the woomera scarred trees with high archaeological significance.

Seagrass

Seagrass communities are considered to be of high local and regional importance in the area. Seagrass has been determined be a significant value as it provides critical ecosystem functioning, important nursery ground for fisheries, and ultimately supports the commercial and recreational fisheries in the Gulf.

Mangroves

Mangroves have been determined to be a significant value for the area as they provide for nursery and feeding grounds for important species and provide for critical ecosystem functioning.

Catchments & streams (estuarine)

Catchment and streams are considered to be of high local and regional importance as they provide for permanent aquatic refuge in a highly seasonal environment and provide for critical habitat for conservation significant species. Catchment and streams that are located downstream (estuarine environment) are specifically rated as being a significant value as they play a vital part of the economic and environmental productivity in the Gulf.

3.2. Albatross Bay

Albatross Bay is a large, shallow embayment, varying in depth from 0 to -20m (LAT) (GHD 2005). Tides are predominantly semi-diurnal, with a strong daily inequality that occasionally results in a fully diurnal tidal cycle. The mean spring and neap tidal ranges are 2.2 m and 0.7 m, respectively and mean tidal current velocity is 0.7 m/s (URS 2002).

There are two main seasons at Weipa, with the wet season usually commencing in October-November and finishing in late April. However, the monsoonal climate is variable, with the start, duration and intensity of rainfall varying for each wet season.

Tropical cyclones regularly form in the Gulf of Carpentaria and cyclones in the area result in strong to gale force winds and high wave action, which causes substantial resuspension and transport of seabed material within Albatross Bay (GHD 2005). Average annual rainfall in Weipa is 1,884 mm, 95% of which is received during the wet season (GHD 2005). Air temperatures range between 13 – 35 °C in winter (mean 26 °C) and 18 – 38 °C in summer (mean 28 °C) (BoM 2009). South-easterly land breezes are predominant during the dry winter season and winds are generally lighter, more variable and with more northerly and westerly components during the summer.

The catchment area for Albatross Bay consists of four relatively small river systems, the Pine River to the north, the Mission and Embley Rivers to the south, and the Hey River, which flows from the south into the Embley River before it discharges into the bay. The rivers and bay form an extensive estuarine system that supports a diversity of habitats, including seagrass beds, mangrove communities, soft bottom habitats and rocky reefs (GHD 2019). Bordering catchments include the large Wenlock River system to the east, the Pennefarther River system to the north, and the Watson River system to the south.

3.3. Indigenous Cultural Heritage

A large number of groups have historically occupied land in the vicinity of Albatross Bay, many of which now live within a number of Indigenous communities along the western coast of Cape York. The cultural heritage value of the areas around Albatross Bay and the Port is defined by both significant sites and places and by the presence of natural resources that are culturally significant.

Traditional Owners carry out commercial fishing for prawns in Albatross Bay, which contributes to the economy of a number of local communities. They also hunt for turtle and dugong within Albatross Bay.

The area around Chwahn sandbank has been identified by Traditional Owners as an area of significance due to the location of two story sites:

- Thungganh story is located in the area around the Chwahn (Jackson) sandbank
- A’Ang story is located at the base of the existing Channel.

Previous capital and maintenance dredging has not impacted these cultural story sites.

Each option for a new offshore dredge management placement area within Albatross Bay has been considered in consultations with traditional Owners. Consultation undertaken with Traditional Owners and other Aboriginal Parties concluded that no matters of cultural heritage significance were present in the proposed areas.

It is recommended that ongoing efforts be made to consult with the Traditional Owner parties prior to commencement of works and thereon each year in which dredging is to occur.

4. Consultation

4.1. Technical Advisory and Consultative Committee

Under the NAGD (CoA 2009), development of a Technical Advisory and Consultative Committee (TACC) is necessary to assist in the consultation process required for a Sea Dumping Permit application. The NAGD states that:

"The TACC is intended to assist ports and other proponents and Determining Authority to access local knowledge and reconcile various stakeholder interests."

The TACC is intended to:

- provide continuity of direction and effort in protecting the local environment
- support communication between stakeholders
- assist in the establishment of longer term management arrangements, including reviewing the development and implementation of management plans and monitoring programs
- review dredging and dumping activities in accordance forecast plans and programs
- make recommendations to the port authority and regulators as necessary or appropriate.

A TACC has been in place for the Port of Weipa for more than 10 years. Communication with the TACC is primarily through pre- and post-dredge meetings, emails and telephone discussions.

The TACC for the Port of Weipa includes representatives from Commonwealth, Queensland and local governments, port users and community interest groups as detailed below.

Table 3: TACC Membership

- Commonwealth Science and Industrial Research Organisation (CSIRO)
- Department of Agriculture, Fisheries and Forestry (Qld)
- Department of Agriculture, Water and the Environment (Clth)
- Department of Environment and Science (Qld)
- Department of Transport and Main Roads (Qld)
- James Cook University – TropWATER
- Maritime Safety Queensland
- North Queensland Bulk Ports Corporation
- Port of Brisbane (dredge operator)
- Weipa Town Authority
- Rio Tinto Alcan (RTA)
- Traditional owners
    - Mokwiri Corporation
    - Wik-waya people
    - Alngith people
    - Thanikwithi people
    - Peppan people
    - Wathayan people

5. Sediment Assessment

5.1. PORT SEDIMENT CHARACTERISTICS

Port navigational areas, including shipping channels, aprons and berth pockets, are areas that have been deepened to allow the safe navigation, movement, loading and transit of ships trading at the Port. In these deeper areas of the Port, currents, wave energy and tidal regimes are responsible for mobilising and transporting sediments. This can be different to what is occurring in the adjacent natural seabed areas. The different depths and water movement can cause significant changes in the patterns of sediment scouring and accumulation.

Currents, wave energy and tidal regimes are responsible for mobilising and transporting sediments into these deeper areas of the Port. The different depths and water movement can cause significant changes in the patterns of sediment scouring (erosion) and accumulation (accretion).

Accretion of seabed sediments results in ‘high spots’ or ‘high areas’ within the navigational areas, above which safe navigational depths are enforced by the Regional Harbour Master. The result is often reduced ‘declared’ depths, the effects of which may significantly affect the efficiency of the Port.

Currently the Port of Weipa consists of:

- a main shipping channel in Albatross Bay called the South Channel
- an Inner Harbour which is within the Embley River and consists of four shipping berths (Lorim Point East and West, Humbug Wharf and Evans Landing) and the Approach and Departure Channels.

In total the Port has approximately 622 hectares of channels, swing basins and berths where depths are maintained by maintenance dredging.

A number of technical studies (PCS 2019a, PCS 2019b) were commissioned as part of the SSM Project to understand the sediment management needs of the Port. These studies answered key questions around:

- The nature and sources of marine sediments that accumulate in the navigational areas at the Port
- What drives sediment dynamics at the local and regional scales
- Current and predicted rates of sediment accumulation
- Risks to operations from increased sedimentation at the Port.

NATURE OF THE SEDIMENT

Exploration for commercial deposits of bauxite in the Gulf of Carpentaria in the early 1970’s involved a number of marine surveys that included seismic and borehole data from the inner shelf environments offshore of Weipa (e.g. Bates et al., 1971). Results from the drilling showed that the surface sediment typically comprised of Holocene marine muds with thicknesses of less than 1 m north of Duyfken Point (Figure 2) to more than 6 m in parts of Albatross Bay (Hudson, 1995). Based on information from available literature, the deposits which typically occur along the eastern shoreline of the Gulf of Carpentaria can be categorised by water depths as follows:

- Depths of less than 20 m: sands and sandy muds are present on top of older sediment (pre-Holocene). Typically, sands are present along the open coast down to 10 m water depth, while in sheltered embayments such as Albatross Bay silts and clays are present (Michaelsen, 1994)
- Depths of 20 to 60 m: relict alluvial (river) sands and gravels are common on the seafloor (Hudson, 1995).

In the Gulf of Carpentaria from Weipa north, there is little evidence for the accumulation of significant volumes of terrigenous sediment on the present day inner shelf, suggesting limited sources of new sediment to the system (Hudson, 1995).

The sediment composition information from the literature agrees well with the findings from recent sediment sampling undertaken in the region as part of the impact assessment for Amrun Port and the ongoing maintenance dredging requirements at the Port of Weipa. Based on the available information as well as findings from the bathymetric analysis and observations (PCS, 2018a) a sediment composition map has been developed for the region (Figure 9). The map shows the following:

- the majority of Albatross Bay is made up of sandy/clayey silt

- the ebb tidal deltas and some upstream areas of the main channels in the Pine, Mission and Embley Rivers are made up of predominantly silty sand
- the main channels of the Pine, Mission and Embley Rivers close to the river mouths are made up of predominantly sand, with some sandy gravel present in the Embley River where the current speeds are highest
- the nearshore areas along the open coast and the southern side of Albatross Bay is predominantly sandy sediment
- the offshore region (deeper than 15 to 20 m) is predominantly made up of silty sand.

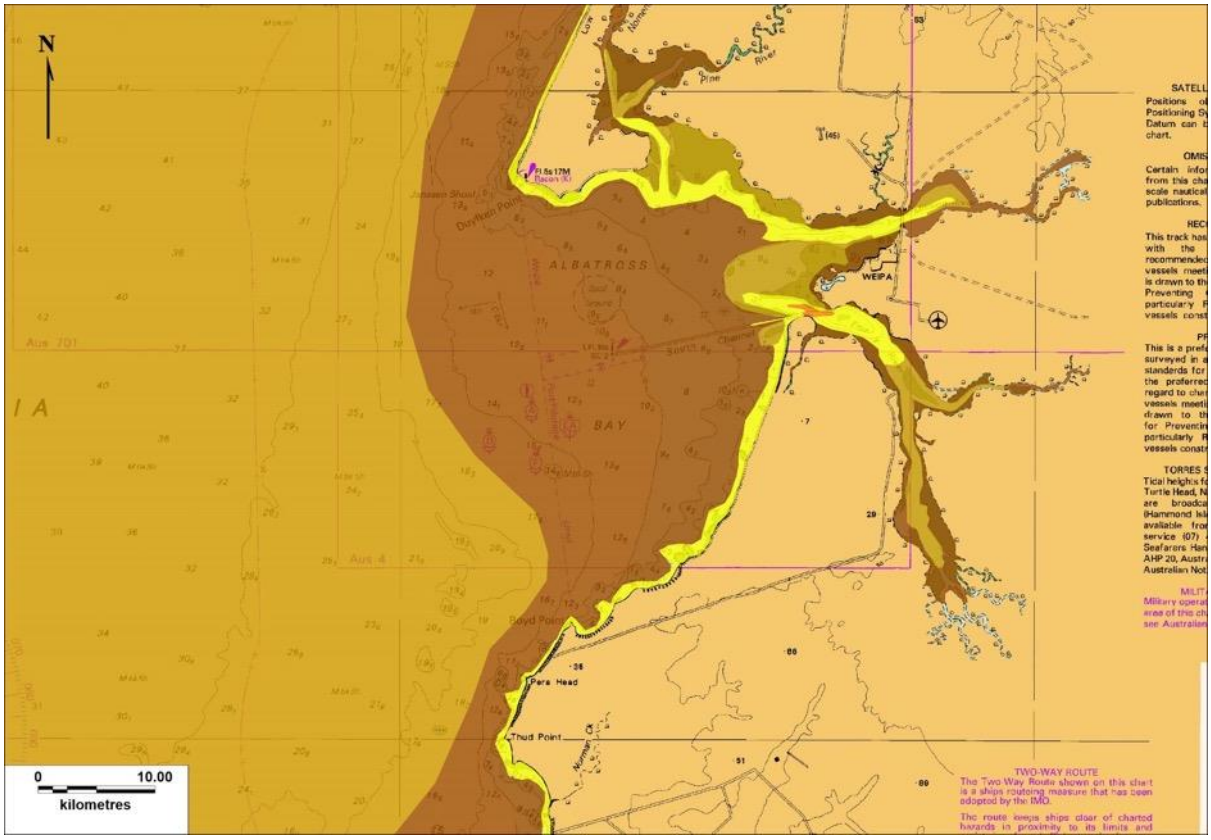


Figure 9: Inferred sediment composition for the Weipa and Amrun regions (PCS 2019b)

It is also important to understand the sources of sediment which contribute to sediment transport in the region. There are two types of sediment sources:

1. **Sources of new sediment**: for the Weipa region the main sources of new sediment to the marine system are from cliff erosion and river discharge/overland flow, although there will also be small inputs from the erosion and reworking of carbonate reefs.
2. **Sources of existing sediment**: for the Weipa region the main source of existing sediment which contributes to the sediment transport is from the surface sediment on the seabed, although the sediment in the estuaries, particularly in shallow intertidal areas, will also contribute.

SEDIMENT CONTAMINATION

As reported in Advisian (2019), a succession of sediment contamination surveys for dredging operations in the Port of Weipa has been conducted over the last nineteen years. NQBP has commissioned multiple Sampling and Analysis Plans (SAPs) in preparation for the 2000, 2002, 2003, 2004, 2005, 2009, 2013 and 2018 maintenance dredging programs, as well as the 2006/2007 capital dredging program and the extension of the Southern Channel during 2012.

Historical sampling indicates that the dredging footprints of the Southern Channel and Inner Harbour (arrival and departure areas) are in areas of low contamination risk (classified as probably clean). The berth pockets of Lorim

Point (east and west), the Tug berths; Humbug Wharf and Evans Landing may be considered of higher contamination risk (potentially contaminated).

All areas have however always recorded contamination levels acceptable for ocean placement.

SEDIMENT BUDGET

In managing sedimentation within the Port it is important to understand the natural sediment transport processes which occur in the Weipa region. This includes understanding the source of the sediment, sediment transport pathways, processes controlling the sediment transport and the development of a quantitative sediment budget. Ports and Coastal Solutions (2019a, 2019b) has undertaken a series of studies to understand how best sedimentation should be managed at the Port of Weipa. The following summarises these studies.

Local Conditions: The dominant process which is resulting in sedimentation in the dredged areas at the Port of Weipa is wave action. The wave conditions control the mass of sediment resuspended along the open coastline and within Albatross Bay and the tidal currents subsequently transport the suspended sediment. The sediment will be transported until the bed shear stresses are sufficiently low for the sediment to be deposited (i.e. either the wave energy and tidal current speed have reduced or the sediment has been transported to a sheltered location). The tidal currents also appear to be an important driver within the Inner Harbour area of the Port of Weipa, driving transport by bed load or localised resuspension which can in turn result in localised accretion within the channel.

Wave Resuspension Relationships: To better understand the relationship between wave activity and turbidity, numerical modelling simulations were undertaken for a range of wave conditions. The results show an approximate exponential relationship at all locations, with the suspended sediment concentration (SSC) highest in Albatross Bay and lowest in the Inner Harbour. The increase in SSC is relatively gradual up to a significant wave height (Hs) of 2 m, and much more rapid when the Hs increases beyond this.

Resuspension Calculations: Two approaches were adopted to estimate the natural resuspension of fine-grained sediment from the Albatross Bay region and assess the differences between the two approaches. The first approach estimated the annual resuspension through statistical analysis of measured turbidity data, while the second approach estimated annual resuspension using a calibrated sediment transport model. The two approaches provided similar (less than 10% difference) natural annual resuspension estimates for the Albatross Bay region, with the first estimating 38 Mt/yr and the second 35 Mt/yr. The similarity between the two approaches provides confidence that the sediment transport model is able to provide a reliable estimate of the quantitative sediment budget for the region.

Sediment Budget: The quantitative sediment budget has been run at both a regional and a local Port of Weipa scale. The budget shows the following:

- approximately 45 Mt/yr of sediment is resuspended at the Weipa and Amrun regional scale (covering 10,000 km^2, approximately 130 km along the coast and 80 km offshore) during a typical year and 70 Mt/yr during a cyclonic year.
- the majority of sediment which is suspended at the Weipa and Amrun regional scale is from the local resuspension of existing fine-grained sediment. Wave action drives the resuspension of existing fine-grained sediment within Albatross Bay and along the open coast to the north and south, while tidal currents and locally generated wind waves drive resuspension within the estuaries.
- there is limited input of new sediment to the sediment budget in the Weipa and Amrun regions (less than 1% of the total annual resuspension mass), with the main sources of new fine-grained sediment being from cliff erosion and river discharges/overland flow.
- there is limited net residual transport of sediment (less than 10% of the gross sediment transport in the Port of Weipa local region) and as such the sediment budget is generally balanced. The suspended sediment is typically either transported north and south along the open coastline, or offshore (west) and onshore (east) in Albatross Bay and the adjoining estuaries.
- significant sedimentation occurs in the South Channel of the Port of Weipa, which is mainly due to the resuspension of existing fine-grained sediment within Albatross Bay due to wave action. The suspended sediment is then repeatedly transported backwards and forwards past the channel with 2 – 3% of the total (gross) suspended sediment becoming trapped. Sedimentation occurs predominantly during the

wet season due to the increased SSC resulting from larger waves, with limited sedimentation during the dry season when wave conditions are calm and there is little resuspension of sediment from the seabed.

- limited sedimentation occurs within the dredge areas of the Inner Harbour at Weipa. The results suggest that during cyclonic years some sedimentation can occur at the eastern end of the approach channel and the northern area of the departure channel.

Figures 10 to 12 show the sedimentation changes over a typical dry, typical wet and cyclonic wet season.

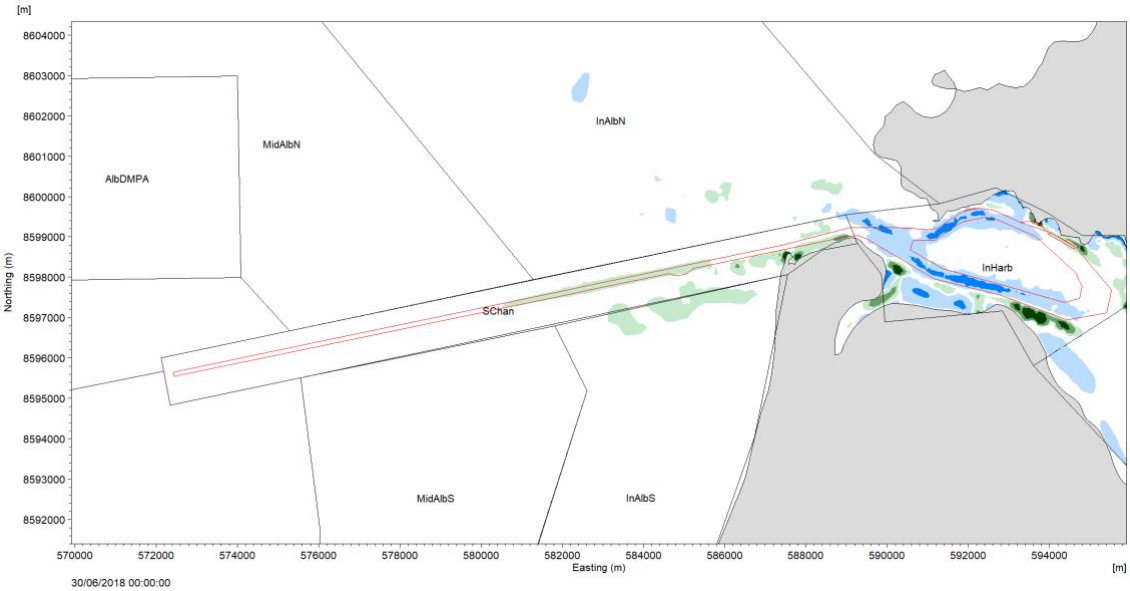


Figure 10: Modelled bed level change around the Port of Weipa over a 3 month dry season period.

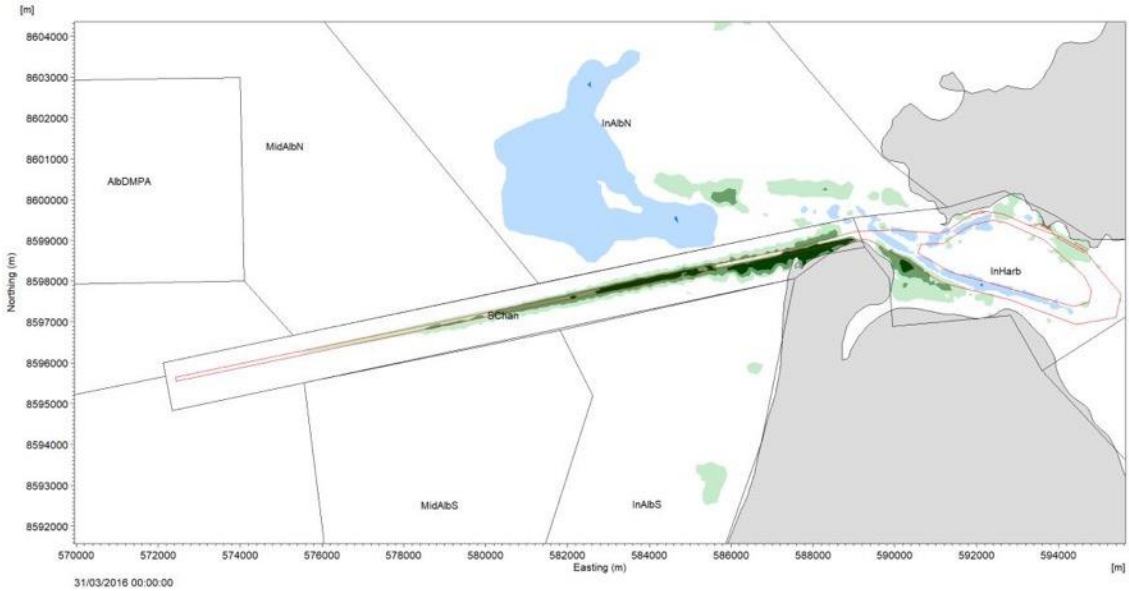


Figure 11: Modelled bed level change around the Port of Weipa over a 3 month typical wet season period.

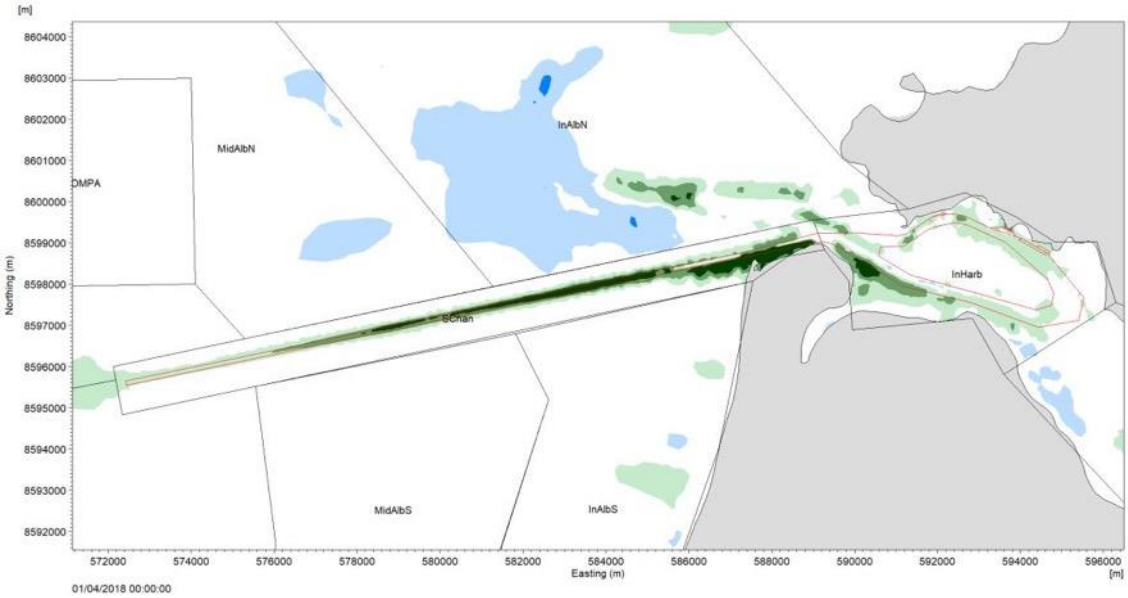


Figure 12: Modelled bed level change around the Port of Weipa over a 3 month cyclonic wet season period.

Transport from Dredge Material Placement Area: Numerical modelling was also undertaken to better understand the potential for resuspension from the Albatross Bay Dredge Material Placement Area (DMPA) and the fate of any sediment which was resuspended at the DMPA. The modelling showed that sediment placed at the Albatross Bay DMPA only has the potential for significant resuspension during large wave events. It is expected that if the DMPA was not there then the natural seabed sediment would be resuspended, resulting in a similar mass of sediment being suspended (i.e. the DMPA is not significantly increasing the natural resuspension that would occur in the area). Less than 5% of the sediment eroded from the Albatross Bay DMPA was subsequently deposited within the South Channel, with the remaining sediment being thinly distributed within Albatross Bay. This shows how the sediment lost from the Albatross Bay DMPA becomes redistributed across Albatross Bay and is subsequently re-assimilated back into the ambient seabed sediment.

Implications: The sediment budget shows that due to the regular reworking of existing fine- grained sediment within Albatross Bay due to wave conditions in the wet season, there is expected to be regular annual sedimentation in the South Channel. As long as the South Channel remains deeper than the adjacent natural seabed, (i.e. remains as a navigable channel) it will act as a sediment sink with sedimentation likely to continue. As such, if no maintenance dredging is undertaken, then ongoing sedimentation in the South Channel will pose a significant risk to Port operations and safety as the sedimentation will result in the South Channel becoming shallower than the declared depth.

From this work it was concluded that it is necessary to manage marine sediments in both the short and long term. This is due to the accumulation of marine sediments within the Port navigational areas, which will substantially impact port operations (ACIL Allen Consulting 2019) in the absence of measures to manage sediment. Current levels of marine sediment accumulation and predicted future rates necessitate a management approach that provides both short and long term solutions.

5.2. MAINTENANCE DREDGING AND PLACEMENT REQUIREMENTS

To better understand exactly where sediment accumulates and in what quantities with the Port's navigational areas, an examination was undertaken of the historic siltation in the channel, apron and berths at the Port of Weipa (PCS 2019a). The work was designed to:

1. Provide quantitative changes in bathymetry based on historical data.
2. Analyse the cause and reasons behind any changes.
3. Develop a predictive tool for use in future sediment management decision making.

Coastal processes were defined using a wide range of hydrodynamic, meteorological, water quality and sedimentation data. Some of the key findings around coastal processes are shown in Table 3.

Table 3: Summary of key issues and findings of studies commissioned to understand the sediment management needs of the Port (source Advisian 2018, PCS 2019a, PCS 2019b)

Issues considered	Key findings
Nature of marine sediments in the navigational areas	The Southern Channel sediments are characterised by silt (49%), sand (32%), clay (5%) and gravel (5%). The sampling locations closest to the mainland are characterised by high proportions of gravel, shell and coarse sand.
	The Approach Channel sediments are similar across all sites and contain very high proportions of sand (83%) compared to clay (8%), silt (6%) and gravel (5%).
	The Departure Channel sediments are characterised by high proportions of sand (64%), gravel (18%), clay (11%) and silt (8%).
	Lorim Point Berth sediments predominately contain sand (49%) and gravel (22%) with lesser amounts of clay (18%) and silt (11%). Humbug Berth sediments predominately contain sand (48%), silt (31%) and lesser amounts of clay (16%) and gravel (5%) Evans Landing sediments are consistent across the area and are dominated by gravel (43%) and sand (40%) with lesser amounts of clay (9%) and silt (7%). Tug Harbour Berth sediments are dominated by silt (42%) and clay (35%) with lesser amounts of gravel (14%) and sand (9%)
	Sediments have consistently been found to suitable for ocean placement with contamination levels below screening levels.
Source and movement of marine sediments in the region	The dominant process which is resulting in sedimentation in the dredged areas at the Port of Weipa is wave action. The wave conditions control the mass of sediment resuspended along the open coastline and within Albatross Bay and the tidal currents subsequently transport the suspended sediment.
	Sediment is transported until the bed shear stresses are sufficiently low for the sediment to be deposited (i.e. either the wave energy and tidal current speed have reduced or the sediment has been transported to a sheltered location). The tidal currents also appear to be an important driver within the Inner Harbour area of the Port of Weipa, driving transport by bed load or localised resuspension which can in turn result in localised accretion within the channel.
	Significant sedimentation occurs in the South Channel of the Port of Weipa, which is mainly due to the resuspension of existing fine-grained sediment within Albatross Bay due to wave action. The suspended sediment is then repeatedly transported backwards and forwards past the channel with 2 – 3% of the total (gross) suspended sediment becoming trapped.
	Fluvial sources of sediment contribute to sediment deposition in the Port in a minimal manner.
	Cyclones have the potential to resuspend and move large quantities of sediment in the region. These events can have significant impacts on navigation access to the Port.

Issues considered	Key findings
Sediment accumulation within the Port	The sedimentation rates within the South Channel were determined based on the available bathymetric survey data. Sedimentation was found to be linearly correlated to the duration of time that wave height was above 2 m (i.e. the duration of large wave events). Sedimentation in the South Channel was found to predominantly occur over the wet season, with sedimentation rates ranging from 1,100 m^3/day to 3,300 m3/day over this period, depending on the wave energy (low to high). Based on this it is expected that maintenance dredging will be required annually to ensure that the entire South Channel remains below the declared depths. In the Inner Harbour tidal currents are considered to be the dominant driver responsible for the mobilisation and transport of sediment in the Inner Harbour. Sediment sampling has shown that the sediment in the channels is predominantly sand and gravel, indicating that the current speeds are strong enough to prevent the build-up of fine-grained sediment in these areas. Maintenance dredging within the Inner Harbour is also expected to be required, with an estimated frequency of once every 2 to 5 years.
	The future predicted rates of sedimentation for the Port are: South Channel: annual sedimentation typically ranges from 200,000 to 600,000 m3, with the majority of this being above the design depths. The majority of the sediment is deposited in the middle 8 km of the 17 km long channel. Inner Harbour: the annual average volume of sediment above the design depths in the Inner Harbour is just under 25,000 m3 with an annual minimum of 3,500 m3 and an annual maximum of 105,000 m3. Of the average sedimentation of just under 25,000 m3, approximately 15,000 m3 is in the Departure Channel, 7,000 m3 in the Approach Channel and 2,000 m3 in the berths.
Maintenance dredging	The following two sediment management approaches have historically been used and are expected to continue to be adopted at the Port of Weipa: • Maintenance Dredging: this has been the main approach to remove sediment and maintain declared depths in the Port of Weipa. Since 2002, annual maintenance dredging has been undertaken at the Port, with volumes ranging from approximately 300,000 m^3 to over 800,000 m^3 per year. Over this period the TSHD Brisbane has undertaken the majority of the maintenance dredging. • In 2019 following extreme climatic conditions 2.4 million m^3 was removed and placed in the offshore DMPA. It is anticipated that this form of extreme sedimentation could occur once or twice a decade and should be incorporated into worst case management planning. • Bed levelling: bed levelling has routinely been undertaken during and following maintenance dredging to redistribute the sediment on the bed and remove any high spots.

The bathymetric analysis has shown that regular sedimentation has been naturally occurring in the South Channel at the Port of Weipa and in localised areas within the Inner Harbour. In addition, the analysis has found that the Albatross Bay DMPA is partially retentive and that approximately 60% of the sediment placed there has been retained.

Conceptual sediment transport models of the erosion and accretion processes in the South Channel and Inner Harbour regions of the Port of Weipa were developed based on all available information.

In the South Channel, the conceptual model showed that the majority of the sedimentation is a result of a combination of wave and tidal current processes. Wave action resuspends natural fine-grained sediment from the seabed in Albatross Bay and then the spatial distribution of tidal currents around the South Channel, along with the trapping efficiency of the channel (i.e. depth of channel below adjacent seabed), control where the fine-grained sediment is deposited within the South Channel. High tidal current speeds occur in the South Channel

within 4 km of the mouth of the Embley River, limiting the build-up of fine-grained sediment in this region. As the tidal currents reduce with distance away from the mouth of the Embley River the potential for the build-up of fine-grained sediment increases, while the elevation of the adjacent seabed remains between 2 and 6 m below LAT. As the depth of the adjacent seabed increases, sedimentation in the South Channel reduces as resuspension occurs less regularly, as larger waves are required to resuspend the fine-grained sediment from these depths.

In the Inner Harbour the conceptual model shows that there have only been localised areas of sedimentation, with the deposited sediment typically being predominantly sand. The relatively high tidal current speeds limit deposition of fine-grained sediment in most areas. The sedimentation that has occurred has typically been due to the existing shallow sand banks encroaching on the channel due to bedload transport driven by the tidal currents. The propeller wash from vessels operating in the Port results in some localised erosion in the Approach and Departure Channels, as well as at the Lorim Point berths and the adjacent tug berths. Adjacent to the areas of erosion at the berths there is localised deposition in the areas that are sheltered from the vessels' propeller wash, typically directly adjacent to the wharf and at the ends of the berths.

The sedimentation rates within the South Channel were determined based on the available bathymetric survey data. Sedimentation was found to be linearly correlated to the duration of time the Hs was above 2 m (i.e. the duration of large wave events). Sedimentation in the South Channel was found to predominantly occur over the wet season, with sedimentation rates ranging from 1,100 m3/day to 3,300 m3/day over this period, depending on the wave energy (low to high). Based on this it is expected that maintenance dredging will be required annually to ensure that the entire South Channel remains below the declared depths. Maintenance dredging within the Inner Harbour is also expected to be required, with an estimated frequency of once every 2 to 5 years.

Based on the findings of this assessment, a more detailed predictive model will be developed for NQBP. This model will be designed to allow the user to adopt different metocean scenarios to predict sedimentation and associated maintenance dredging requirements at the Port of Weipa, for a range of temporal scales. The interactive model will provide a decision support tool to allow for future strategic planning of maintenance dredging activity at the Port.

Figures 13 to 16 shows the cumulative change in bathymetry since 2002, with volumes outlined in Table 4.

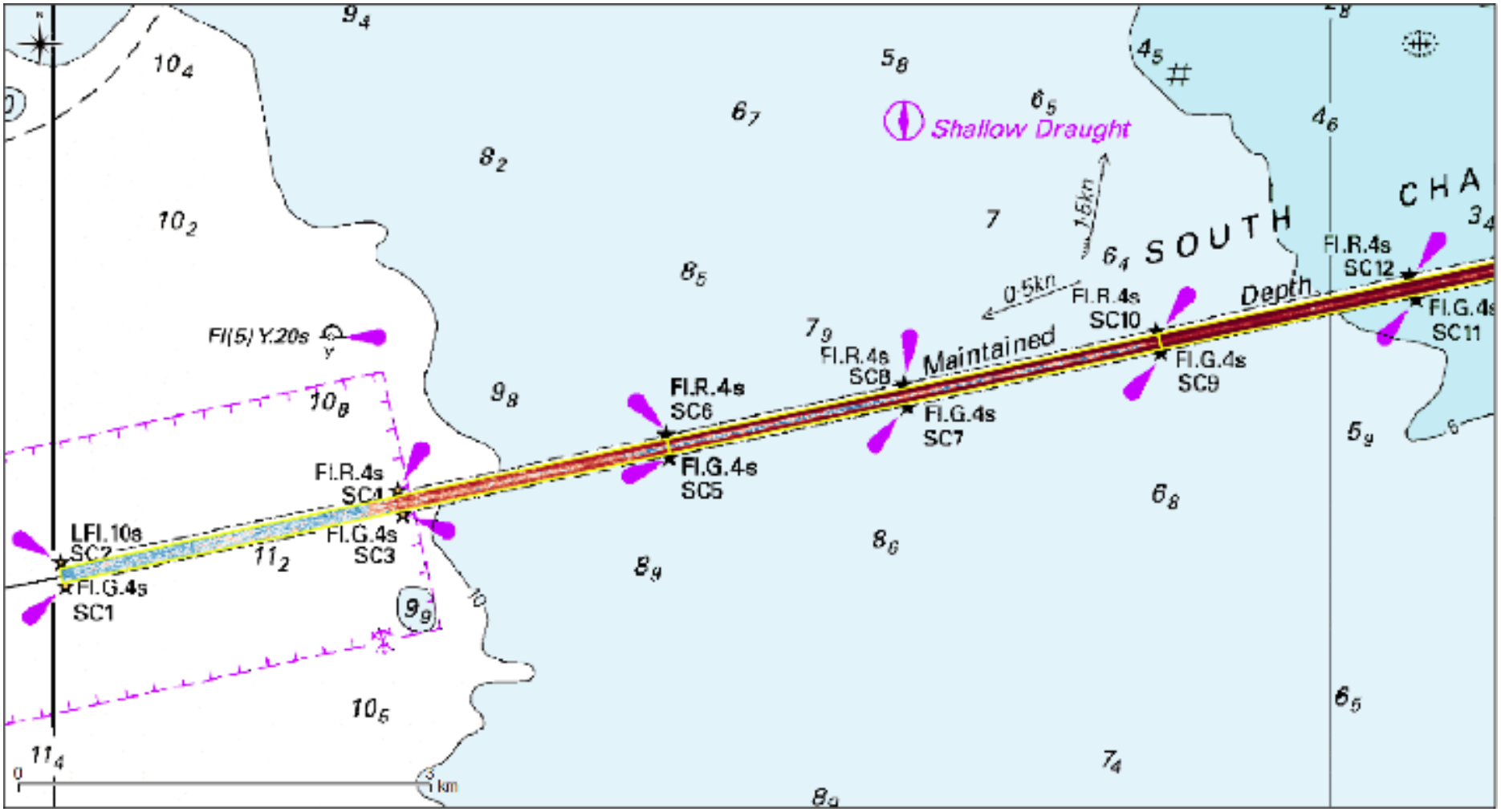


Figure 13: Cumulative sedimentation/erosion from 2002 to 2018 in the Outer to Mid South Channel, showing erosion in blue, accretion in red and volume calculation regions outlined in yellow.

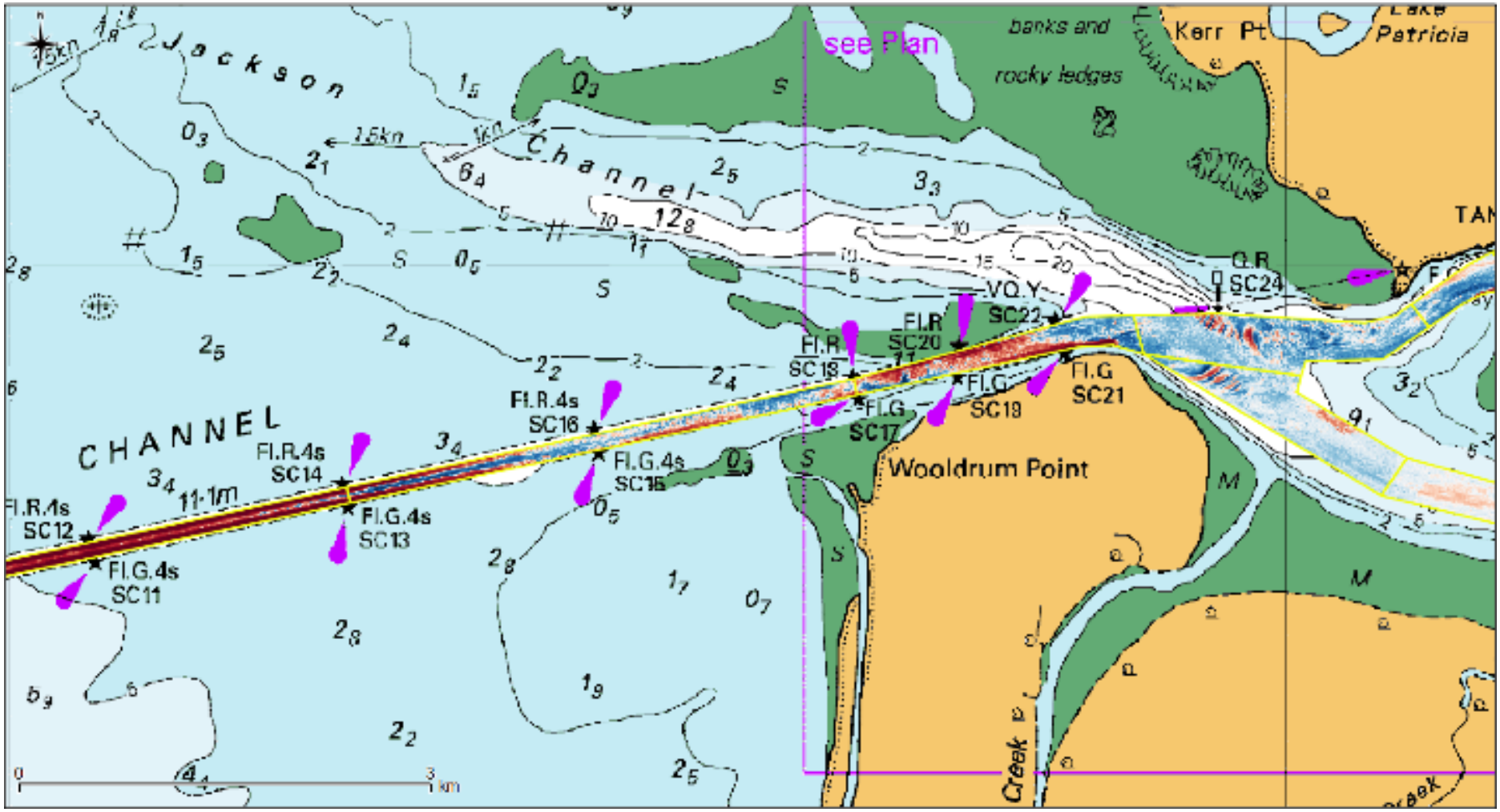


Figure 14: Cumulative sedimentation/erosion from 2002 to 2018 in the Mid to Inner South Channel, showing erosion in blue, accretion in red and volume calculation regions outlined in yellow.

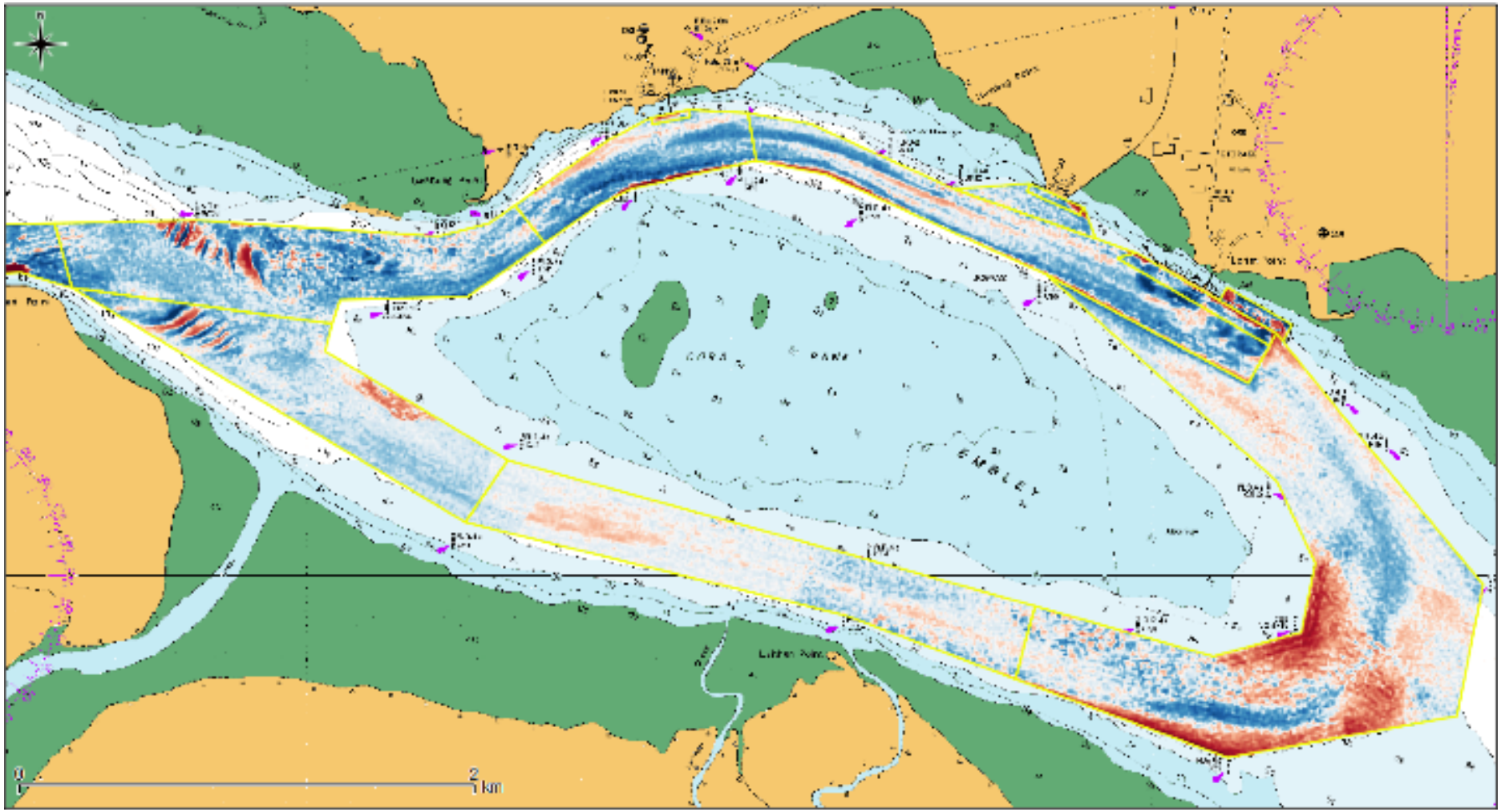


Figure 15: Cumulative sedimentation/erosion from 2002 to 2018 in the Inner Harbour, showing erosion in blue, accretion in red and volume calculation regions outlined in yellow.

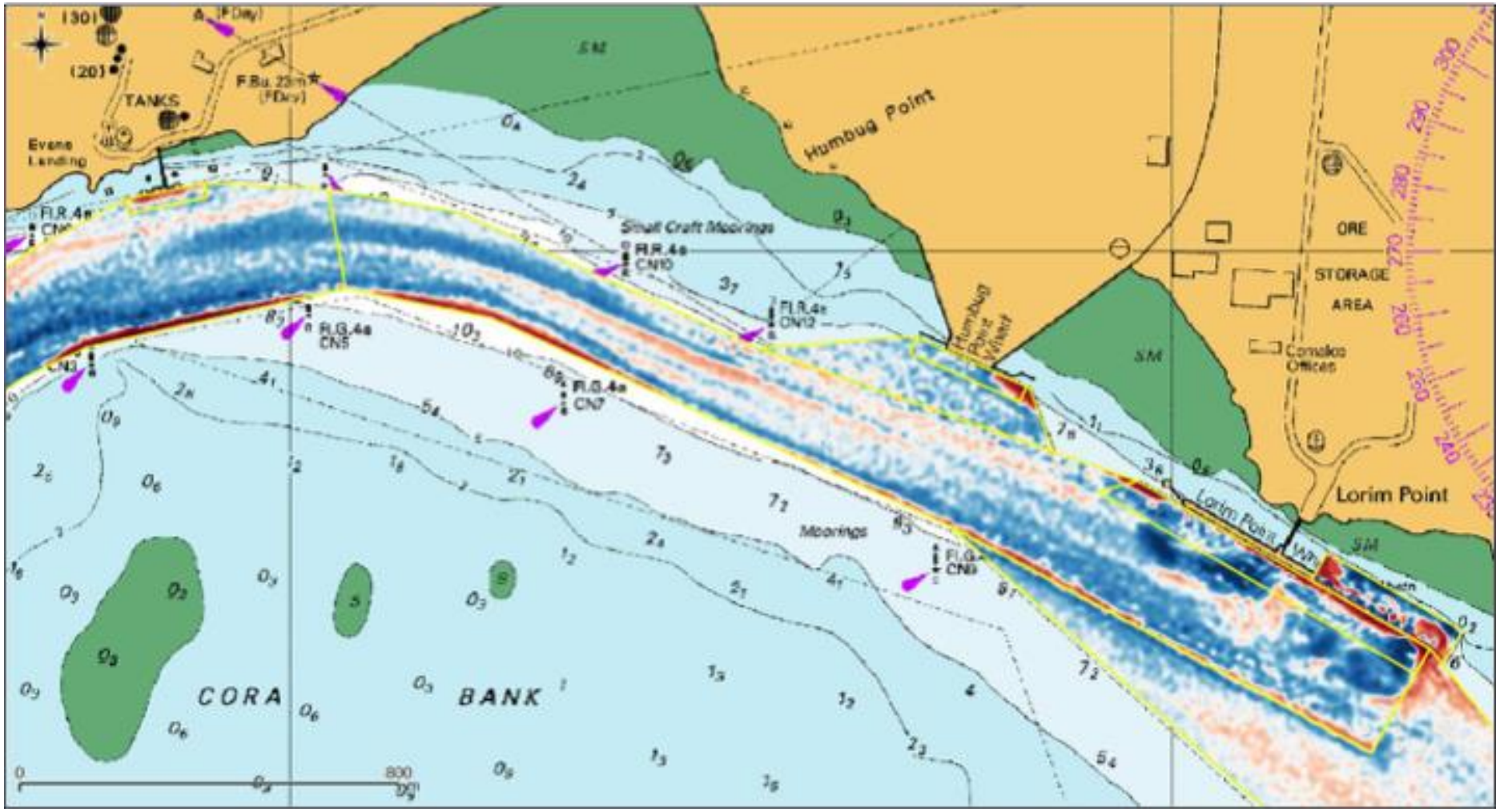


Figure 16: Cumulative sedimentation/erosion from 2002 to 2018 at the Inner Harbour berths, showing erosion in blue, accretion in red and volume calculation regions outlined in yellow.

Table 4: Historical dredging volumes (2007 – 2019)

Year	Type of Dredging	Volume (m^3)
2002	Maintenance	976,585
2003	Maintenance	463,513
2004	Maintenance	621,650
2005	Maintenance	803,098
2006	Capital and Maintenance	2,976,868
2007	Maintenance	711,000
2008	Maintenance	774,100
2009	Maintenance	553,457
2010	Maintenance	832,779
2011	Maintenance	470,820
2012	Capital and Maintenance	927,057
2013	Maintenance	644,525
2014	Maintenance	394,523
2015	Maintenance	368,384
2016	Maintenance	504,071
2017	Maintenance	297,301
2018	Maintenance	591,301
2019	Maintenance	2,413,000

During the 2018 to 2019 wet season a number of cyclonic and tropical low events influenced the Gulf of Carpentaria. This included TC Owen in early December 2018 and TC Penny at the end of December 2018 and early January 2019. Both of these cyclones made landfall twice along the Cape York peninsula. TC Penny made landfall close to Weipa when it crossed in an easterly direction, resulting in the largest waves of the 2018-19 wet season, although a tropical low in January/February 2019 resulted in the longest duration of increased wave heights.

The weather events in the 2018-19 wet season resulted in the significant wave heights (Hs) exceeding 2 m for more than double the duration of any other year since 2009 (when the Albatross Bay waverider buoy (WRB) was installed by the Queensland Government, Department of Environment and Science (DES)). This threshold was identified as a potential indicator of sedimentation volumes in the dredged areas (specifically the South Channel) of the Port of Weipa (PCS, 2018a). As a result of the potential for high sedimentation during the 2018-19 wet season, additional bathymetric analysis was undertaken which showed that in total almost 1.9 Mm^3 of sediment was deposited in the South Channel between May 2018 and February 2019. Due to the sedimentation the volume of sediment above the design depths in the South Channel was just over 2 Mm^3.

FINDINGS

It is expected that at a minimum maintenance dredging in the order to 400,000 m^3 will be required annually; in addition to this historical data indicates that volumes in the order of 800,000 m^3 may need to be removed 2 or 3 times a decade and that following multiple cyclonic events a volume in excess of 2 million m^3 may need to be dredged to maintain safe port operations.

Accordingly, management options have been considered that accommodate the following volumes over a ten year period:

Standard volume – 400,000 m^3 removed 5 years out of every 10 years.

Large volume – 800,000 m^3 removed 3 years out of every 10 years.

Worst case volume – 2.5+ million m^3 removed 2 years out of every 10 years.

Allowing for 15% contingency, the full ten year volume may be in the order of **10.8 million m^3.**

Table 3-1: Dredge volume requirements

Number of years	Anticipated volume	Plus 15% contingency / overdredge
5 years in 10 year period	400,000 m^3 (typical year)	460,000 m^3
3 years in 10 year period	800,000 m^3 (cyclonic year)	920,000 m^3
2 years in 10 year period	2,500,000 m^3 (multiple cyclone year)	2,875,000 m^3
TOTAL: 10 years	**9,400,000 m^3**	**10,810,000 m^3**

6. Sustainable Sediment Management

The following is a summary of the **Port of Weipa Sustainable Sediment Management Assessment for Navigational Maintenance.** For further details and data associated with the comparative analysis please refer to the Port of Weipa Sustainable Sediment Management Comparative Analysis Report (Adaptive Strategies 2019) and supporting technical reports.

All reports are available at www.nqbp.com.au

CONCEPT

During 2018 and 2019, NQBP undertook an extensive research project to investigate the most sustainable way to manage accumulated sediment in and around the Port of Weipa.

The project: the *Port of Weipa Sustainable Sediment Management Assessment for Navigational Maintenance* (SSM), was to understand how the day to day operations at the Port of Weipa are affected by marine sedimentation and to determine, if necessary, the best way to manage operations and sediments.

First applied at the Port of Hay Point in 2018, this innovative sediment management approach has been widely acknowledged and a similar framework is now applied in the Department of Transport and Main Road's Maintenance Dredging Strategy for Great Barrier Reef World Heritage Area Ports.

The SSM project investigated where specifically the sediment at the Port of Weipa comes from, what impact it has on Port operations, whether accumulation can be eliminated or reduced, and what alternatives are available to reuse or dispose of any sediment that might need to be dredged.

The project has determined what is the best short and long-term approach to managing sediments within the Port. This includes investigation and consideration of:

- the source and nature of the particular sediment at the Port
- the requirements for management of the sediment in the short and longer term
- whether sediment can be managed without dredging while maintaining port operations and meeting legal requirements
- the feasible alternatives for use or placement of material if dredging is required
- the best package of measures to provide for long-term (25-year) sustainable management of marine sediments at the Port.
- The project involved consultation with stakeholders including Commonwealth, State and Local Government; port operators; conservation groups; the local community including indigenous people, fishing groups and community bodies; researchers; and tourism operators.

The work has provided valuable context for long-term management at the port, including understanding the economic effects of sedimentation and development a long-term sediment management strategy.

SSM METHOD

A central component of the SSM Project is a structured decision-making process that has focused on what is important to all stakeholders, not just the port authority and port customers. Contained within this structured process is a detailed comparative analysis of the various alternatives that are available to manage sediment to determine the best long-term strategy.

The decision-making process for the SSM project is a complex task dealing with social, economic and environmental factors. The principles of Structured Decision Making (Gregory *et al*, 2012) were used to provide a robust method for the Project. The process involved the following five steps:

AVOIDANCE AND REDUCTION

The SSM project considered a range of possible alternatives to avoid or reduce the volumes or rates of sedimentation occurring within the navigational areas of the port, as this would be the first and potentially ideal way to manage sediments in the Port area.

The SSM investigation:

- Described the sediment and hydrodynamic environment at the Port of Weipa in the context of possible solutions to 'keep sediment out' or 'keep sediment moving' from the offshore infrastructure areas.
- Identified both engineered and technological solutions to avoid or minimise future maintenance dredging and consider their feasibility based on the local environment, port layout and infrastructure design.
- Undertook a constraints analysis of the solutions for any feasible alternatives.
- Estimated the potential impact of any feasible solutions to existing and future maintenance dredging at the Port of Weipa.

A set of technical work was undertaken to fully explore the options available to manage marine sediment at the Port of Weipa. Three broad strategies used to reduce siltation at ports and harbours were considered (PCS 2019c). These were:

- Keep Sediment Out – keeping sediment out of the area of interest that might otherwise enter and deposit.
- Keep Sediment Moving – raising flow velocities in quiescent areas to prevent sediment from settling as it passes through the area of interest.
- Keep Sediment Navigable – applicable to sites characterised by high turbidity near-bottom sediment regimes where navigability of fluid mud zones is permitted, thereby reducing the required dredged depth.

The range of possible approaches is provided in Table 5.

Table 5: Outline of approaches to avoiding or reducing sedimentation

Strategy	Approach	Example
Keep Sediment Out	Control sediment sources	Reduce sediment inputs through better catchment management
	Divert sediment-laden flows	Divert river inputs away from port
	Trap sediments before entering port	Sediment traps and insurance trenches
	Blocking sediment entry	Pneumatic barriers, silt screens, barrier curtains
	Habitat creation	Seagrass, saltmarsh, mangroves to stabilise and promote accretion away from port areas
Keep Sediment Moving	Structural solutions to train natural flows	Training walls to divert flow and prevent local deposition of sediment.
	Devices to increase bed shear stresses	Hydraulic jets, mechanical agitators
	Methods to reduce sediment flocculation	Adopting designs that reduce turbulence and therefore flocculation (e.g. solid wharf walls instead of piling supported wharfs).
Keep sediment navigable	Adopt a 'nautical depth' navigation approach which includes fluid mud	Nautical depth is the distance from the water surface to a given wet density, typically in the range of 1,100 to 1,300 kg/m3.

The potential applicability of approaches to reduce sedimentation must be considered on a case-by-case basis as the suitability is dependent on the port configuration, sediment type, natural environment and processes. The SSM investigation showed that many of the alternatives were simply not achievable at the Port of Weipa.

Within these strategies a set of options were examined to determine potential feasibility. Options that were considered included:

- Stabilise sediment sources
- Diverting sediment-laden flows:
- Trapping/Bypassing sediment
- Blocking sediment entry

- Habitat creation:
- Structural solutions to train natural flows
- Devices to increase bed shear stresses
- Alter nautical depth
- Traditional maintenance dredging

For each of these options a feasibility analysis was developed to get a high level understanding of environment impacts, operational impacts, ongoing maintenance requirements, the degree of confidence in achieving the desired outcomes and consideration of the regulatory pathways or approvals.

Due to the processes which control the sedimentation and the configuration of the dredged areas at the Port of Weipa, the assessment was not able to identify any feasible engineered or technical solutions which could significantly reduce the natural sedimentation at the Port of Weipa.

None of the alternative solutions are clearly preferable over ongoing maintenance dredging, however while the sustainable relocation solution may have potential merit but will require further feasibility testing.

The approach of sustainable relocation involves retaining sediment in the marine environment and within the natural sediment system. The aim of the sustainable relocation approach is to ensure that some sediment which is deposited/trapped within the dredged areas of the Port of Weipa is retained within the sediment system, to feed natural habitats such as mudflats (fine-grained sediment), mangroves (fine-grained sediment) and beaches (sand sized sediment).

It was concluded through the initial consideration of the decisions that:

- It is necessary to manage sediment at the Port
- Maintenance dredging is required as part of the solution for managing sediment
- Sustainable sediment relocation (beach nourishment) is a potential partial option.

EXAMINATION OF REUSE, RECYCLE AND PLACEMENT OPTIONS

As the alternative analysis showed that eliminating the need to conduct maintenance dredging at the Port of Weipa is not a feasible option if port operations and safety are to be maintained at efficient levels, the SSM project then moved to determine the most suitable use or placement location for any dredged material.

The SSM project undertook a comprehensive reuse assessment investigation of the most appropriate solutions for reuse of any maintenance dredging material. Factors considered were: sediment suitability, greenhouse gas emissions, opportunity or demand, conceptual cost, confidence in beneficial reuse process, duration from construction to use, environmental implications, socio-economic implications, environmental approvals, constraints, knowledge gaps and longevity of the beneficial reuse option.

One of the primary considerations for reuse is the physical and chemical properties of the sediment to be dredged. The analysis of the geotechnical properties of the material to be dredged indicated that (Advisian 2018a):

- Naturally accumulating material encountered in the Port of Weipa navigational areas varied considerably between and within areas with typically high fines (clay and silt) content.
- The areas where coarse-grained sediments appear to prevail include most of the Approach and Departure Channel and the eastern portion of the Southern Channel.
- The fine-grained sediments may be suitable for low to medium load applications following adequate drying out and compaction, noting that this material may take many months to many years to consolidate. The coarser sediments may be suitable for medium to high loading applications following adequate compaction.
    - The relatively high water and fines contents would limit the use of sediments in high end concrete products; however, the areas with relatively low fines, and high silica and sand content could be useful (with treatment) as an alternative source of fine sand in some concrete and concrete products.
    - Potential Acid Sulphate Soil (PASS) was detected in all samples; however, analysis of the Acid Neutralising Capacity (ANC) of these samples indicated that if bought ashore, the marine sediments are unlikely to require treatment.
    - All samples are considered highly saline and therefore if sediments are placed on land without treatment, salinity will degrade the quality of terrestrial soils and may impact the quality of receiving waters.

The assessment then identified potential beneficial reuse options and analysed the opportunity, potential feasibility and achievability of the options in the context of the Port of Weipa. The highest ranked beneficial reuse

opportunities include: beach nourishment, land reclamation, shoreline protection, concrete products and deep-water habitat creation.

Two beneficial reuse options were selected for further consideration: ‘beach nourishment and ‘land reclamation’. These options were selected as they ranked highly on the primary consideration of sediment suitability and also were considered to have moderate demand /opportunity.

From these two selected beneficial reuses, two options were developed based on likely suitable locations where the opportunity is may be present, these are:

1. Land reclamation – Evans Landing.
2. Beach nourishment - Gonbung Point.

In addition to reuse analysis, a number of material placement alternatives and locations were identified following studies undertaken to identify potential locations for the placement of dredge material.

In addition to the two beneficial reuse options identified above, it was important to include a full range of placement options for comparison and consideration. Options were selected on the basis that:

- One is the existing placement area that has been used at the Port for a number of years with success, monitoring has shown very low levels of environmental impact
- A western offshore option in deeper water less influenced by tides and currents and well away from sensitive environments
- A third offshore option south of the shipping channel well away from sensitive environments, but also located to reduce potential for placed material to mobilise and return to the shipping channels
- One onshore option within reasonable pumping distances from the dredging vessel.

In all, two reuse, one onshore and three offshore placement options were selected as possible options for consideration in the comparative analysis. These are:

- Land reclamation at Evans Landing
- Beach nourishment at Gonbung Point
- Onshore pond at Weipa
- Existing (modified) Albatross Bay offshore dredge material placement area
- New west Albatross Bay offshore dredge material placement area
- New south Albatross Bay offshore dredge material placement area.

The location of all options is shown in Figure 18.

REALIGNMENT OF ALBATROSS BAY OFFSHORE DREDGE MATERIAL PLACEMENT AREA (DMPA)

The existing Albatross Bay DMPA is located approximately 2.9 km northwest of the seaward end of the South Channel. The DMPA has a depth range of 8.4 – 11.2 m below LAT with depth increasing from east to west. It is proposed to shift the DMPA slightly to the west to increase depth and capacity. Recent dredge material placement with a large dredge vessel was restricted by the depths of the DMPA. A 2 km shift westwards has been applied to the DMPA as per Figure 17.

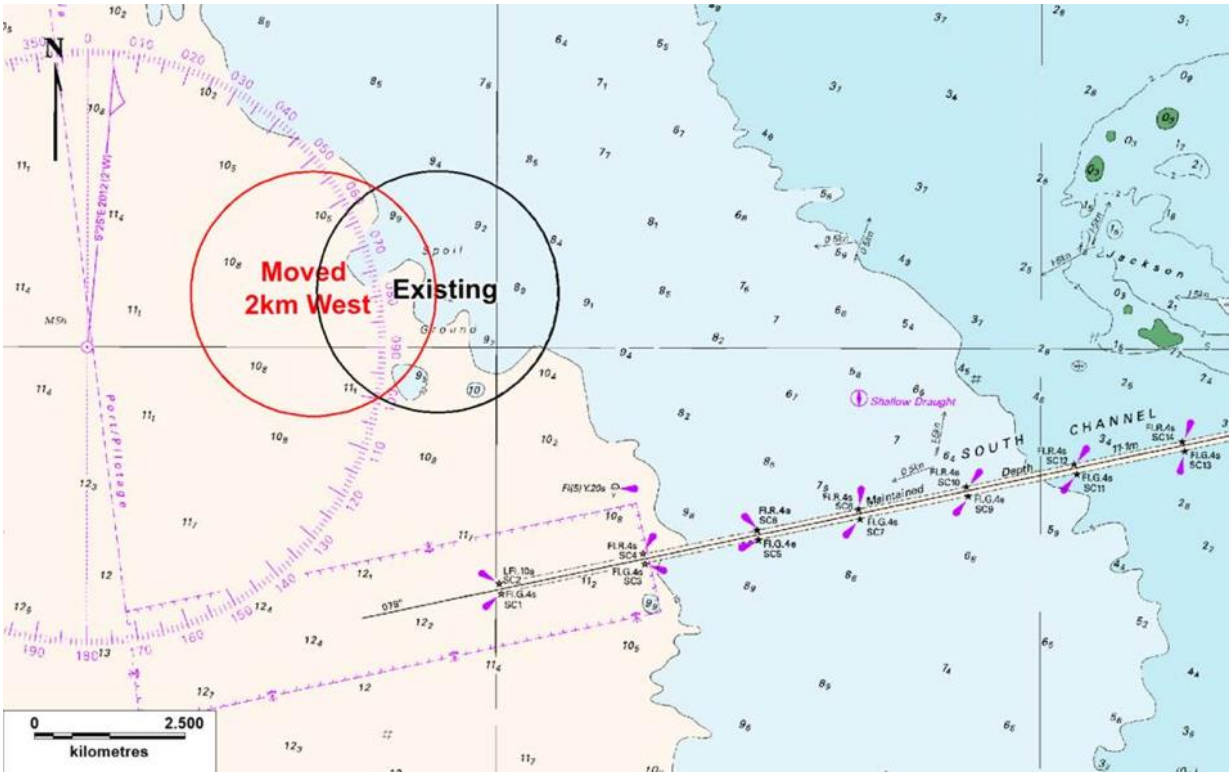


Figure 17: Re-alignment of existing Albatross Bay DMPA

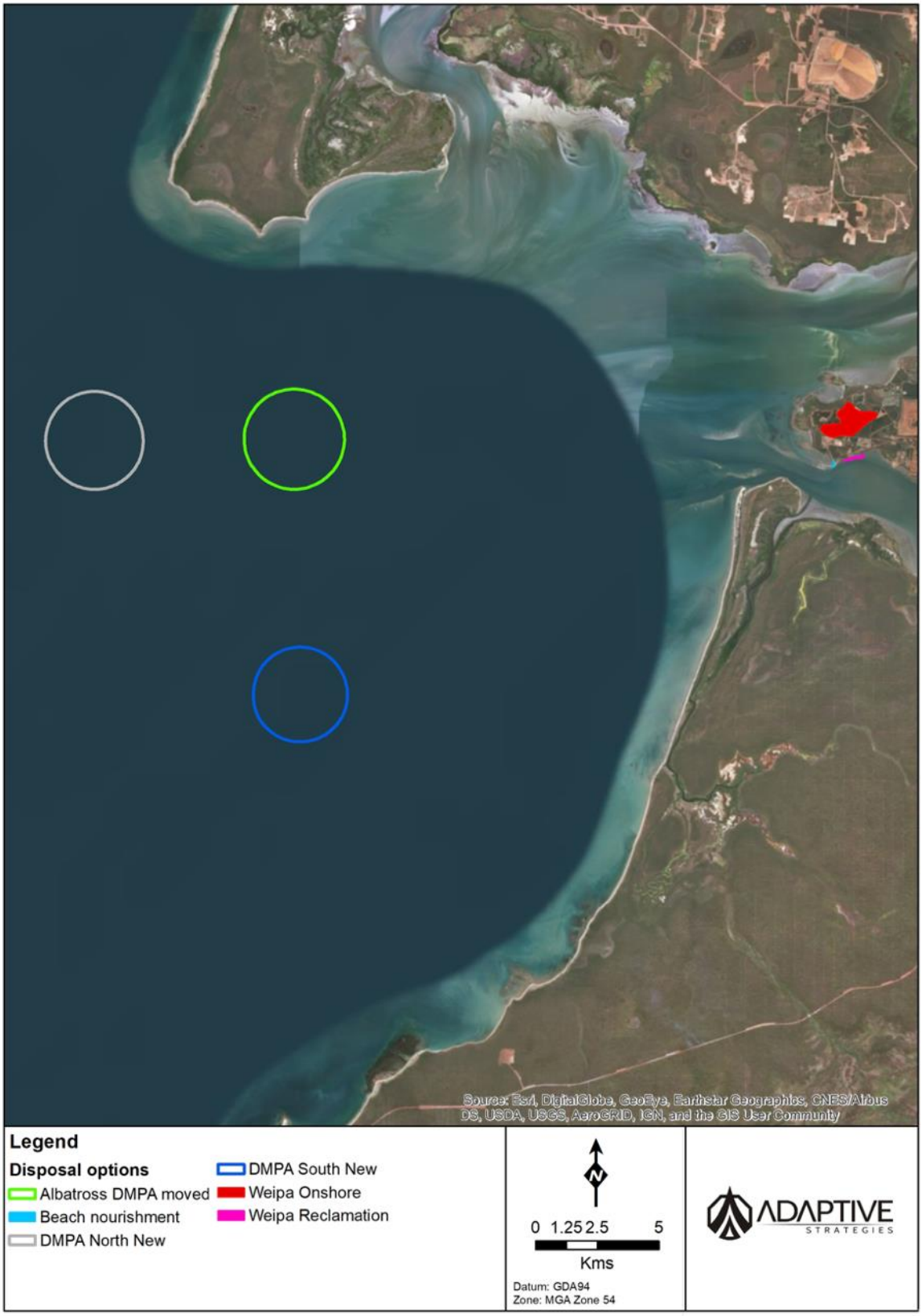


Figure 18: Location of the options for dredge material placement

6.1. Comparative Analysis

To compare the various options a set of objectives and performance measures were developed in close consultation with the TACC. A workshop was held with the stakeholder advisory group in September 2019 to help define objectives and performance measures. Additionally, separate discussions were held with traditional owner and government stakeholders to obtain their views.

This step generated two key components of the comparative analysis process:

1. **Objectives** to consider in the decision making process. In other words, the things that really matter to NQBP and stakeholders when trying to make comparisons between sediment management options.
2. **Performance measures** for each of the objectives that provide a clear and transparent way of measuring how each of the sediment management options perform.

Through this process a range of values were identified as relevant to the Port. These values fall within the following six broad themes:

- Environment
- Port Operations
- Costs
- Cultural heritage
- Social
- Health and safety.

The objectives identified were aimed to be (Gregory *et al,* 2012):

- Complete – objectives were designed to capture all of the things that matter at the Port in the context of the decisions being made.
- Concise – unnecessary or similar objectives were removed to avoid double counting.
- Sensitive – objectives were developed that distinguish between the options, thereby helping to differentiate them to aid decision making.
- Independent – objectives were developed in a way that ensures that performance against an objective could be considered independently of any other objective.

The performance measures provided a mechanism for predicting how well each of the options performed against the objectives. Similar to the objectives, the performance measures were developed with a set of principles in mind to ensure they were useful and appropriate. The key issues considered when defining a performance measure were (Gregory *et al,* 2012):

- Coverage - the measures addressed the range of relevant consequences of each option.
- Practicality – the measures needed to be predictable, which means the data required to assess them could be obtained or generated.
- Direct and specific – the measures reported directly on the relevant consequences and effectively highlight differences in the options to allow informed value comparisons.

The objectives and measures were refined and finalised following the workshop based on a review of the technical information that was available to conduct the analysis.

In total nine objectives and eleven performance measures were defined. These are shown in Table 6.

Further discussion of each of the performance measures, including a rationale for their use and how they have been calculated and analysed is available in Adaptive Strategies 2019.

Table 6: Objectives and performance measures for the SSM Project

Theme	Objective	Measure
ENVIRONMENT	1. Avoid and minimise impacts to coastal ecosystems	A) Predicted performance in relation to avoidance and minimisation of impacts to coastal ecosystems
		B) Predicted risk on dredge material placement plumes and/or tailwater discharge exceeding ambient variation (percentile above median ambient TSS)
	2. Minimise carbon emissions	C) Forecast Greenhouse gas emissions
CULTURAL HERITAGE	3. Minimise impact on cultural heritage	D) Nature and scale of any impact on cultural heritage
PORT OPERATIONS	4. Maintain effective and efficient port operations	F) Predicted lead time to dredge material placement
		F) Capacity to provide a long term solution for the port
	5. Avoid a loss of future port expansion opportunities	G) Predicted performance in terms of facilitating or constraining future port expansion
COSTS	6. Ensure solution is cost effective	H) Assessment of costs
HEALTH & SAFETY	7. Avoid or mitigate health and safety risks	I) Relative risk
SOCIAL[1]	8. Minimise interference to social activities	J) Scale and duration of any impacts on social activities
	9. Provide increased economic and social opportunities	K) Predicted number of FTE jobs created

The final step in the comparative analysis was the application of a process to compare the options against the objectives and performance measures.

The process was extensive and involved:

- Calculating raw scores for all measures and options
- Converting raw scores into normalised results to enable fair comparison

[1] The social theme includes consideration of other industries such as fisheries, aquaculture and tourism. It also takes into account local recreational and commercial activities.

- Comparing options against the objectives and performance measures
- Ranking options using various methods (e.g. different weightings)
- Recommending a preferred solution based on the outcomes of the analysis.

RAW SCORES CONSEQUENCE TABLE

The raw scores from each performance measure were used to generate a consequence table. A consequence table is a matrix that illustrates and compares the performance of each option with respect to the objectives. Key elements of the table (Table 7) include:

- All of the objectives and performance measures identified in Step 2
- The table indicates which direction is better for each performance measure in the “Direction” column.
- The best scores for a performance measure are highlighted in green
- The worst scores for a performance measure are highlighted in red.

NORMALISED SCORES CONSEQUENCE TABLE

In order to compare options using different performance measures it is necessary to apply standard statistical methods to ensure the comparisons are valid and balanced. In particular this involves the process of normalisation whereby different measures and units of score are standardised to a score in a range from 0 to 1.

The formula that was used to normalise raw scores was:

$$\textit{Normalised score} = \frac{\textit{raw score} - \textit{worst score}}{\textit{best score} - \textit{worst score}}$$

Table 8 shows the results for all measures and options converted into normalised scores. The 1 or the highest number closest to 1 indicates the best result.

Table 7: Raw scores for each Port of Weipa placement and reuse option

					Port of Weipa Placement/Reuse Options					
Objective	Unit	Score min	Score max	Direction is better	Albatross DMPA	Albatross West	Albatross South	Weipa Onshore	Weipa Reclamation	Beach Nourishment
Avoid and minimise impacts to coastal ecosystems	Coastal ecosystems	4	16	lower	10	10	10	11	14	6
	Water quality	0	63	lower	4	1	3	0	3	3
Minimise carbon emissions	GHG emissions	-	-	lower	28,000	34,400	28,500	58,400	39,200	28,500
Long term solution	Percentage	0	100	higher	100	100	100	12.3	37.4	8
Ensure solution is cost effective	Cost ($M)	-	-	lower	$61	$76	$62	$195	$109	$87
Lead time	Years	-	-	lower	0.5	0.5	0.5	3	4	2
Avoid a loss of future port expansion opportunities	Performance	2	8	higher	6	6	6	2	8	4
Avoid or mitigate health and safety risks	Relative risk	8	24	lower	10	10	10	15	15	11
Minimise interference to social activities	Performance	0	9	lower	3	3	7	7	8	0
Provide increased economic and social opportunities	Employment (FTE)	-	-	higher	0.65	0.85	0.67	3.15	9	0.81
Minimise impact on cultural heritage	Performance	4	12	higher	11	11	12	5	5	8

Table 8: Normalised scores for each Port of Weipa placement and reuse option

		Port of Weipa Placement/Reuse Options					
Objective	Unit	Albatross DMPA	Albatross West	Albatross South	Weipa Onshore	Weipa Reclamation	Beach Nourishment
Avoid and minimise impacts to coastal ecosystems	Coastal ecosystems	0.50	0.50	0.50	0.42	0.17	0.83
	Water quality	0.94	0.98	0.95	1.00	0.95	0.95
Minimise carbon emissions	GHG emissions	1.00	0.79	0.98	0.00	0.63	0.98
Long term solution	Percentage	1.00	1.00	1.00	0.12	0.37	0.08
Ensure solution is cost effective	Cost ($M)	1.00	0.89	0.99	0.00	0.64	0.81
Lead time	Years	1.00	1.00	1.00	0.29	0.00	0.57
Avoid a loss of future port expansion opportunities	Performance	0.67	0.67	0.67	0.00	1.00	0.33
Avoid or mitigate health and safety risks	Relative risk	0.88	0.88	0.88	0.56	0.56	0.81
Minimise interference to social activities	Performance	0.67	0.67	0.22	0.22	0.11	1.00
Provide increased economic and social opportunities	Employment (FTE)	0.00	0.02	0.01	0.30	1.00	0.02
Minimise impact on cultural heritage	Performance	0.88	0.88	1.00	0.13	0.13	0.50

The next step involved weighting the normalised scores for each performance measure and calculating an overall performance score for each option out of 100. A score of 100 would mean that an option performs perfectly against every performance measure.

Weighting is an important step in the decision making process. It is a process that people often undertake subconsciously by placing more value on some objectives over others when trying to make a decision between options. The structured decision making process provides a transparent way of applying and testing weightings.

It is recognised that stakeholders value objectives differently and will therefore apply different weightings. Given this, no attempt was made to reach a consensus on how to apply weightings. Rather a number of different weighting scenarios were generated to see how each option would perform. The weighting scenarios (seeTable 9) were:

- Equal weights - all performance measures were weighted equally.
- Environment - performance measures relating to the environment theme were attributed with 75% of the weightings.
- Port operations - performance measures related to the efficient ongoing and future operation of the Port were attributed with 75% of the weightings..
- Costs - performance measure relating to the cost of each option was attributed with 75% of the weightings.
- Health and Safety - performance measure was attributed with 75% of the weightings.
- Social - performance measures relating to the social theme were attributed with 75% of the weightings.
- Cultural - the performance measure relating to the cultural heritage theme was attributed with 75% of the weightings.

A summary of the overall performance of each option under the seven weighting scenarios is provided in Table 9. The best performing option under each scenario is highlighted in green and the worst performing is highlighted in red.

Table 9: Summary of weighted scores (max 100) for each option across the six weighting scenarios

	Equal	Environment	Port Operations	Costs	Health & Safety	Social	Cultural
Albatross DMPA	77.00	79.92	84.96	93.80	84.74	46.81	84.74
Albatross West	75.00	75.58	84.17	85.06	84.11	46.95	84.11
Albatross South	75.00	78.89	83.94	92.45	83.92	30.56	92.99
Weipa Onshore	28.00	40.47	18.42	7.59	48.37	26.54	16.65
Weipa Reclamation	51.00	55.69	47.45	60.44	54.69	54.04	22.98
Beach Nourishment	63.00	82.11	43.08	75.66	76.14	54.53	53.48

FINDINGS

The analysis in the Port of Weipa SSM Project has led to three key findings:

1. Sediment at the Port of Weipa needs to be managed.
2. Dredging is required as part of the management solution.
3. There are a discrete number of feasible options that have the potential to provide a long term solution for use or placement of sediment.

The analysis of options for reuse or placement of dredge material looked at six discrete options against the objectives of the project. From that work it was clear that:

- Offshore placement at the existing or potential one of the new DMPAs would be needed to deal with the full volume of dredged material over a 10 year period.
- Onshore placement at the Port of Weipa was the worst performing single option and does not warrant further consideration.

- Reclamation is a viable option for a partial volume, however it has environmental, social and cultural implications that would need to be addressed. Adoption of this option would only be feasible if there was a specific need or demand.
- Beach nourishment has some merit, particularly from an environmental and social aspect. This option would be worth examining in more detail as part of a combined solution with an offshore placement option.

6.2. Selected Dredging and Placement Strategy

Based on the detailed comparative analysis, offshore placement at the existing DMPA consistently performed the best. It was the strongest of the three best performers and achieved the best score across four weighting scenarios (equal, port operations, cost and health and safety). It also performed strongly under the environment weighting, just 4 percentage points behind beach nourishment which is a not a feasible long term solution on its own.

On balance, offshore placement at the existing DMPA is considered to be the preferred solution. It provides both a short and long-term solution, is well understood, and performs strongly in a range of scenarios.

It should be noted that beach nourishment is also considered to have merit. It is an option that can provide a positive environmental benefit and it is recommended that it should be examined in more detail as part of an integrated solution with offshore placement at the existing DMPA.

Based on the extensive work of the SSM project, a clear preferred 10-year maintenance dredging strategy is now established that involves:

1. Use of operational measures (drag bar and propeller wash) to manage sediments within berths and apron areas.
2. Use of traditional dredging and bed levelling to maintain navigational areas at safe design depths – annually in a volume of between 400,000 and 2.5 million cubic metres or higher dependent on cyclonic influences.
3. Placement of dredged material at sea – preferably at a modified dredge material placement area.
4. Commitment to a detailed investigation into beach nourishment with the intention of executing, if feasible, a restoration program in the next 10 years.

7. Risk Assessment Framework

Depending on the scale and frequency, dredging and dredge material placement activities have the potential to adversely impact on sensitive environmental receptors, social or cultural values associated with the Port.

Impacts can occur over a short or long term and can be direct or indirect. Dredging related impacts can result from:

- the direct removal of benthic habitat in the vicinity of the dredged area
- smothering of benthic organisms in offshore dredge placement locations
- changes to marine water quality from increased turbidity and sedimentation
- mobilisation of contaminants released from dredged sediments
- collisions and disturbance from vessel movements
- increased noise and lighting from dredge vessel operations.

Prior to each dredging program a risk assessment of potential impacts to environmental, social or cultural values should be undertaken. The assessment will help to determine the level of potential harm that environmental, social or cultural values are at from the proposed dredging program. The assessment will assist in refining where management measures to avoid, reduce or mitigate impacts are needed. Identified measures can then be incorporated into revisions of the Maintenance Dredging EMP. This process is outlined in Figure 19.

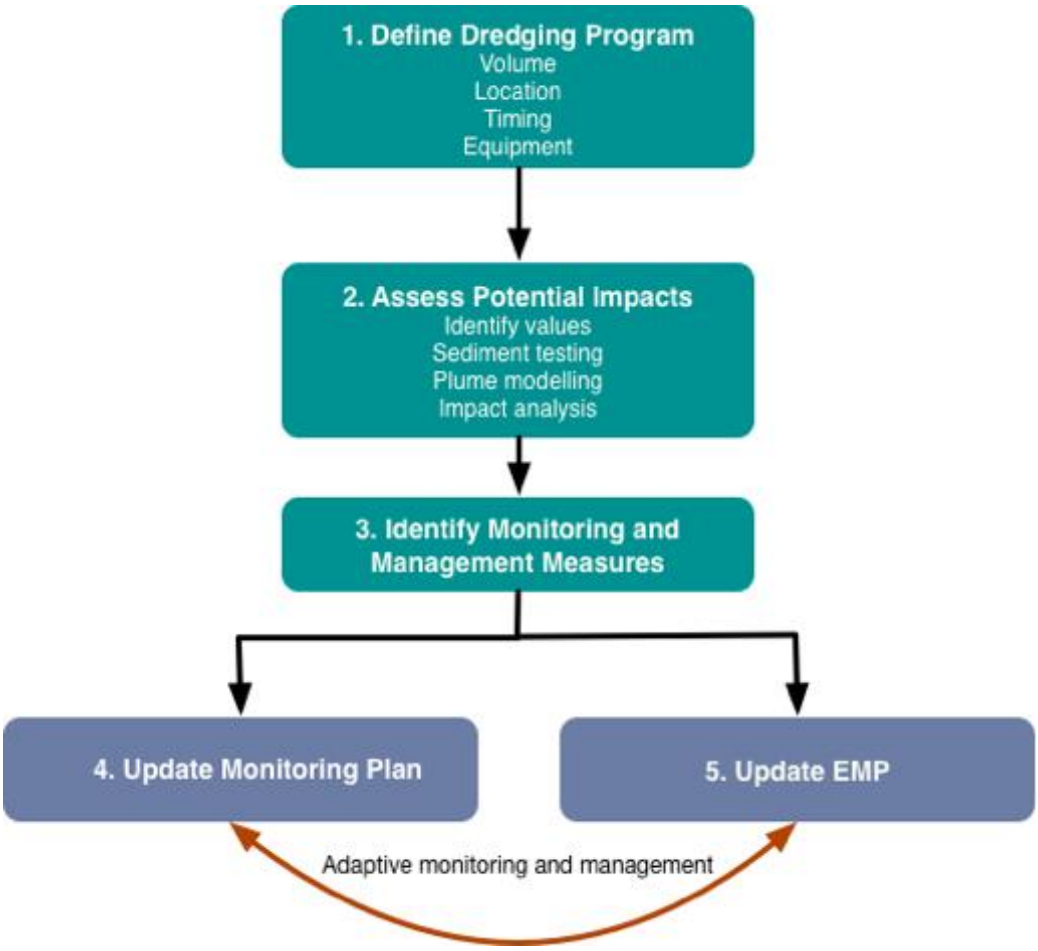


Figure 19: Process for identification of potential impacts and management measures

Information needed to inform the risk assessment should include:

- Up to date environmental values information, including data from baseline surveys of coral, seagrass and water quality.
- Dredging program design including: dredge type, volumes, locations, duration, seasonal timing.
- Sediment characteristics: particle sizes, contamination results
- Sediment plume modelling
- An environmental impact assessment, including an EPBC Act self-assessment against significant impact criteria.

INITIAL ASSESSMENT

To inform the development of this LMDMP an environmental risk assessment has been undertaken of potential dredging scenarios and volumes (ELA 2020). Supporting this risk assessment were:

- a detailed plume modelling study (PCS 2019d) looking at potential water quality changes across various dredging volumes
- an environmental thresholds study (PCS 2019e)
- an environmental values report (GHD 2018).

As outlined in Section 4, there are a number of environmental values that occur in the vicinity of the Port of Weipa. Whilst there is potential for some of the values to be impacted by maintenance dredging, the plume modelling and risk assessment undertaken has indicated that any impacts are highly unlikely to be residual or significant from maintenance dredging.

Generally, the proposed maintenance programs will consist of yearly dredging of volumes in the order of 400,000 to 800,000 cubic metres. Programs will be short-lived in duration (3-6 weeks) and will include a range of impact avoidance and reduction measures that will further reduce impact risks. Depending on cyclone frequency and behaviour larger dredging volumes may be needed to maintain port operations. Volumes up to or even exceeding 2.5 million m^3 are possible once or twice a decade.

All potential impacts were assessed against known environmental values and data to determine the risks posed by maintenance dredging at the Port of Weipa. The key findings of this risk assessment are:

- Resuspension of sediments from maintenance dredging is comparable to natural suspended sediment concentrations (SSC) during normal conditions
- Water quality monitoring results and numerical modelling of sediment transport demonstrates that natural SSC levels are much higher than those generated by maintenance dredging
- Analysis against intensity and duration thresholds indicated that dredging would not result in impacts to sensitive environmental values. Real time monitoring is recommended if two dredgers are operating at the same time.
- Risks to sensitive habitats such as seagrass are likely to be negligible to low. Seagrass communities are naturally ephemeral and have been shown to recover post-dredging.
- Protected species are also unlikely to be significantly impacted by maintenance dredging. The Port of Weipa does not provide critical habitat resources for any marine species and disturbance to habitats will be low. Indirect disturbances can be effectively managed via best practise dredging operations. The short timeframe of each program will also reduce risks

The activities associated with maintenance dredging are well tested and understood. It is considered that there would be limited ongoing management and monitoring requirements once the placement of dredged material has been completed, however NQBP will continue their ongoing seagrass monitoring programs.

A summary of risks is provided in Table 10. This risk assessment is based on the application of standard mitigation measures.

Any dredging program that is substantially different to the parameters modelled and assessed should be subject to a new specific detailed assessment.

Table 10: Summary of environmental risk findings

Risk activity (cause)	Potential environmental receptors	Potential Impact	Consequence	Likelihood	Risk rating
Smothering from dredge material placement	Transient seagrass beds and seagrass habitat Benthic macroinvertebrate communities	Temporary loss of benthic habitat	Minor Temporary, short-term negative impact	Likely	**Medium**
Dredging and placement generated sediment plume	Coral and mangrove habitats Seagrass	Changes to water quality leading to mortality or changes in coral and seagrass cover/diversity	Negligible Within the natural variation and tolerance of the system	Rare	**Low**
Dredging and placement generated sediment plume	Coral, reef, seagrass and mangrove habitats	Sediment deposition resulting in habitat loss	Negligible Within the natural variation and tolerance of the system	Rare	**Low**
Movement of dredge vessel from the Port to the dredge material placement area	Transitory threatened and migratory marine animals	Potential for marine fauna vessel strike	Negligible No impact at the population or sub-population level	Unlikely	**Low**
Release of contaminants and nutrients	Marine biota	Potential for lethal and sub-lethal effects on marine biota	Negligible Material is consistently suitable for at sea placement	Rare	**Low**
Dredging suction	Foraging marine turtles	Potential for marine fauna to be caught	Negligible No impact at the population or sub-population level	Unlikely	**Low**
Noise	Inshore dolphins, dugong and marine turtle	Potential for alienation of habitat	Negligible No impact at the population or sub-population level	Rare	**Low**
Lighting	Inshore dolphins, dugong and marine turtle	Alienation of habitat, animal mortality	Negligible No impact at the population or sub-population level	Rare	**Low**

Overall, the conclusion is that environmental risks from maintenance dredging at the Port of Weipa will be negligible to low. Maintenance dredging is short in duration and impacts to water quality are within the range of natural variability of the region. This in turn limits the likelihood of flow on impacts to species and their habitats, as well as protected areas and other users.

The comprehensive works specific maintenance dredging Environmental Management Plan (as outlined in Section 8) will ensure each maintenance dredging program is undertaken in line with best practice, and that impacts are avoided and reduced as far as possible. A key element of this is the application of ecologically relevant environmental triggers, which will be applied in real time during large dredging events. This is coupled

with a comprehensive impact and ambient monitoring program that has been designed to detect and respond to changes in the marine environment at the Port.

8. Treatment of Key Risks

NQBP is committed to minimising and managing potential impacts from dredging and dredge material relocation as far as practicable.

Based on the results of the initial risk assessment, targeted and ambient monitoring and established best practice; a set of key management strategies and actions to minimise the impact from dredging and dredge material relocation operations will be identified and incorporated into the Maintenance Dredging EMP.

These measures should, when necessary, be supplemented and enhanced with the ongoing real time inputs from the adaptive monitoring program.

8.1. Environmental Management Plan

A works specific Environmental Management Plan (EMP) provides the operational practices required for dredging activities to meet environmental standards. The EMP forms the operational control document to ensure all site specific environmental issues are adequately addressed.

The EMP will be developed or revised prior to the commencement of annual dredging activities. The EMP will be developed in partnership with the relevant dredging vessel operator. The development and implementation of the EMP will be the responsibility of both the dredge operator and NQBP.

The EMP covers all aspects of the dredging operations specific to Weipa and will contain:

1. Location and description of the activities
2. Timing of the dredging operations
3. Measures to meet permit conditions
4. Standard management measures relating to:
    - Waste management
    - Ballast water management
    - Bunkering of fuel
    - Vessel washdown
    - Marine pests
5. Adaptive management measures relating to:
    - Water quality
    - Marine fauna
    - Climate conditions
6. Operation and incident reporting
7. Emergency procedures and contacts

Further specific matters that need to be considered in the development of the EMP are outlined below:

Minimise the Dredge Schedule

NQBP and its contractors will seek to keep dredging schedules as short as practicable. This means that the dredging program will be conducted so that it achieves the required engineering and navigational objectives to ensure ongoing safe shipping in Weipa, in the shortest time possible. Maintenance dredging will occur 24 hours per day, seven- days per week to complete the program as quickly as possible.

Bathymetric surveys – volume and location

A pre-dredge bathymetric survey will be undertaken of the areas to be dredged prior to the dredging program, whereby an accurate volume and location of sediment removal requirements will be determined. This approach allows the dredge contractor to conduct a targeted, and more efficient, program.

Post dredge Bathymetric Surveys are completed on the DMPA and the dredged areas and are submitted to DAWE and the Australian Hydrographic Office (AHO) following each dredge program in accordance with the Sea Dumping Permit.

Dredge Vessel Specifications

Mitigation of potential turbidity and suspended solids impacts from dredging and material placement by the trailing suction hopper dredge operations is also achieved through requirements for modern vessel specifications, including:

- Low wash hull-design
- Below keel discharge
- Central weir discharge system
- Electronic positioning systems.

These elements are considered the minimum standard of specification for trailing suction hopper dredges that will be selected to undertake dredging works at the Port of Weipa.

In addition, a contract deliverable item for maintenance dredging is the development and implementation of a works specific Environmental Management Plan (EMP), which reflects the commitments made within this LMDMP. Environmental staff from the Port of Brisbane have continually improved the EMP for works conducted by the 'TSHD Brisbane' to meet requirements of stakeholders, government departments and port authorities, throughout its operational range.

Marine fauna and turtle management

Turtles are mobile and can generally avoid impacted areas for the duration of dredging activities. However, maintenance dredging has resulted in a small number of turtles being struck by the dredge or captured by the dredge head. Management and operational practices during maintenance dredging to reduce the risk of impacting turtles include the use of turtle excluding devices on the dredge head to reduce the possibility of capture and controlling of the dredge pumps to minimise operation while the dredge head is off the sea floor (pumps need to be operated for a short time to clear sediment from the pump with clean water).

The following management actions are to be applied:

- The Dredging Contractor is to ensure that the dredge is fitted with turtle exclusion devices on the drag heads for the duration of works. Dredging is not permitted unless these devices are installed and operational.
- The Dredging Contractor is to implement procedural controls to minimise off-bed suction time. These controls must ensure that drag head water jets are activated at times when the drag heads are not in contact with the seabed, and pumps are in operation, to minimise the risk of turtle capture.
- The length of the program will be minimised as far as practicable.
- The Dredging Contractor will be required to check for the presence of turtles and other marine fauna, particularly within the path of dredging. Prior to dredging and placement, the Dredging Contractor must check using binoculars from a high observation platform (dredgers bridge) for marine fauna within a 150 metres monitoring zone.
- Dredging and placement activities may only commence if no marine fauna (dugongs, turtles, sawfish or cetaceans) have been observed in the monitoring zone.
- If any marine animals specified above are sighted in the marine zone, dredging and placement activities must not commence in the monitoring zone until 20 minutes after the last marine species is observed to leave the monitoring zone, or until 20 minutes after the last sighting.
- A record of the monitoring must be established and maintained by the Dredging Contractor.
- In the event of an incident involving marine fauna, the Dredging Contractor is to immediately contact NQBPs Environmental Manager.

Management of turbidity and water quality

Generation of turbid plumes and the potential for release of fuels, oils and other chemicals during dredging via spills/accidents has the potential to adversely impact water quality. In particular, increased turbidity may potentially influence the health of seagrasses, by reducing light availability and increasing deposition rates.

The monitoring program for maintenance dredging at Weipa specifies the need to monitor and, where necessary, manage water quality risks. This may include triggers and thresholds that can be applied in real time during the dredging of large volumes (>one million cubic metres and/or when two dredgers are operating at the same time).

Introduced Marine Pests

Under the National System for the Prevention and Management of Marine Pest Incursions the *Australian Marine Pest Monitoring Manual* and accompanying *Australian Marine Pest Monitoring Guidelines* have been developed. These were released in early February 2010.

With regards to dredging the impact of introduced marine pests may stem from:

- an infested dredge vessel being used at the Port of Weipa and leading to the establishment of a marine pest population
- a vessel becoming infected at Weipa and servicing another Port
- in dredging the proposed foot print introduced marine species are translocated from the Port to the DMPA.

The Port of Weipa maintains a program of monitoring for introduced marine pests. This program is ongoing, being managed on a quarterly basis by NQBP.

Clearance of the dredge vessel

Australia has mandatory requirements for international vessels entering Australian waters that wish to discharge ballast water.

Port of Brisbane has been identified as the primary contractor undertaking dredging at the Port of Weipa using the 'Brisbane'. The Brisbane provides evidence under *National Biofouling Guidance for Non-trading Vessels* (Commonwealth of Australia, 2008) to demonstrate a low risk of infestation by introduced marine pests.

- The Dredging Contractor will ensure the dredge complies with AQIS ballast water management requirements.
- The Dredging Contractor is required to ensure that the hull of the dredge is not significantly fouled and does not contain any introduced marine pests.

In addition to these standard protocols, should NQBP be required to utilise the services of an internationally sourced dredge, or an interstate dredge for works at Weipa, a risk based review of the ships work and maintenance history would be performed. Where operations or duration since last maintenance period are extended or the information not provided, certification from the dredging contractor by way of hull inspection clearance would be requested. Clearance of the vessel for fouling prior to its mobilisation to Australia would be considered as an item for contract, including diver or dry dock inspection.

The approach would follow the biofouling risk assessment framework outlined within the *National Biofouling Guidance for Non-trading Vessels* (Commonwealth of Australia, 2008). This document also outlines steps for minimising the risk of marine pest risks aboard dredge vessels, and other non- trading vessels, such as:

- Selecting and applying the correct antifouling coating based on the vessels operating profile
- Ensuring anchors, lines, pipes and cables are checked and cleaned prior to stowage and transit
- Ensuring mud and sediments are cleaned from all equipment before transit
- Undertaking inspections when appropriate, including the hull, pipes, pumps, hoppers, doors hinges, cutters and drag heads, ladders, buckets and pontoons etc
- Applying suitable antifouling methods for internal seawater systems.

DMPA management

The Albatross Bay DMPA has been realigned to move it into slightly deeper water. The DMPA still incorporates half the previous DMPA area (Figure 17). The continued use of a DMPA in the same vicinity mitigates impacts from smothering by preventing the need to dispose of material in an area that has not been disturbed previously or may be closer to key receptors. Modelling completed in 2019 confirmed the retention of sediments is reliant upon the prevailing coastal processes; sediments remain relatively immobile during ambient states, and disperse during wind and wave events, such as the passage of tropical cyclones.

Impacts to the DMPA and adjacent areas will be minimised through placement of the dredge material in such a manner as to uniformly spread it over the DMPA. Uniform distribution of the material also maximises the potential capacity of the DMPA.

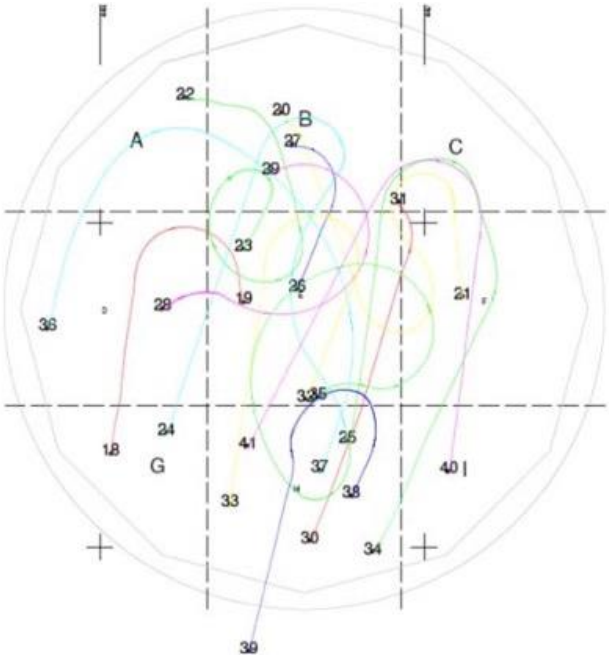


Figure 20: Example of travel plot for placement with DMPA

8.2. Adaptive Management Measures

Adaptive management provides for continuous monitoring, evaluation and adjustment of management response measures based on real-time monitoring and environmental conditions (Figure 21).

Figure 21: Adaptive Management Cycle (CEDA, 2015)

Based on an understanding of acceptable environmental conditions and thresholds for impact a series of response levels (triggers) can be established and then monitored to ensure that conditions that may produce environmental harm are avoided or ceased before impacts occur.

The dredging monitoring framework is outlined in Section 9 with details provided in the supporting *Port of Weipa Marine Environmental Monitoring Program (NQBP 2020)*.

As detailed in the *Port of Weipa Marine Environmental Monitoring Program* and based on a risk assessment conducted in 2020 (ELA 2020), the adaptive monitoring and management program will focus on water quality, weather conditions and marine fauna (mammals and turtles). Responses to monitoring results will be required if trigger events occur. The nature of the response is scaled according to the level of environmental risk.

9. Environmental Management Framework

The following framework is designed to provide a repeatable structure for planning and executing maintenance dredging activities at the Port of Weipa.

The framework provides NQBP and its stakeholders with a clear and structured process for identifying, planning and implementing maintenance dredging. This process provides certainty for NQBP staff, TACC members and regulators around how NQBP will plan and manage dredging activities. The framework will also be key to supporting long-term permit applications.

The framework is illustrated in Figure 22. It is comprised of a staged planning and design process. Three key elements feed into the framework including consultation, monitoring and supporting studies. The framework provides NQBP with:

1. A technically informed process for the identification of Port maintenance dredging and dredge material management needs.
2. A process for identification, risk assessment and management of potential impacts to environmental values from proposed activities.
3. Adaptive management and operational controls to avoid and minimise potential impacts during dredging activities.
4. Ongoing monitoring and management of Port needs and values.

Most importantly, the framework provides a process that will be undertaken in collaboration with key Port stakeholders. Stakeholder consultation will occur throughout the application of the framework including during any dredging program design, execution and ongoing monitoring and management.

The framework draws on and incorporates aspects of processes outlined in relevant key policy documents. These include the:

- The National Assessment Guidelines for Dredging (NAGD) assessment framework for ocean placement (CoA 2009).
- Queensland Maintenance Dredging Strategy for Great Barrier Reef World Heritage Area Ports (SOQ 2016)
- Long Term Monitoring and Management Plan Requirements for 10 year Permits to Dump Dredge Material at Sea (CoA 2012).

Details of each of the steps in the framework are described in the following sections including:

- Identification of Port navigation needs, risks and sediment management approaches
- Dredging program design
- Dredging execution and control
- Monitoring and management

TACC CONSULTATION

Consultation with the TACC should occur during the design phase of larger dredging activities, particularly those involving a larger hopper dredge. The TACC should be consulted on:

- Proposed program specifics such as the location of dredging and placement sites and the timing and duration of dredging and associated activities
- Results of the risk assessment of potential impacts to values and proposed mitigation and management controls
- Scope of program monitoring and reporting requirements.

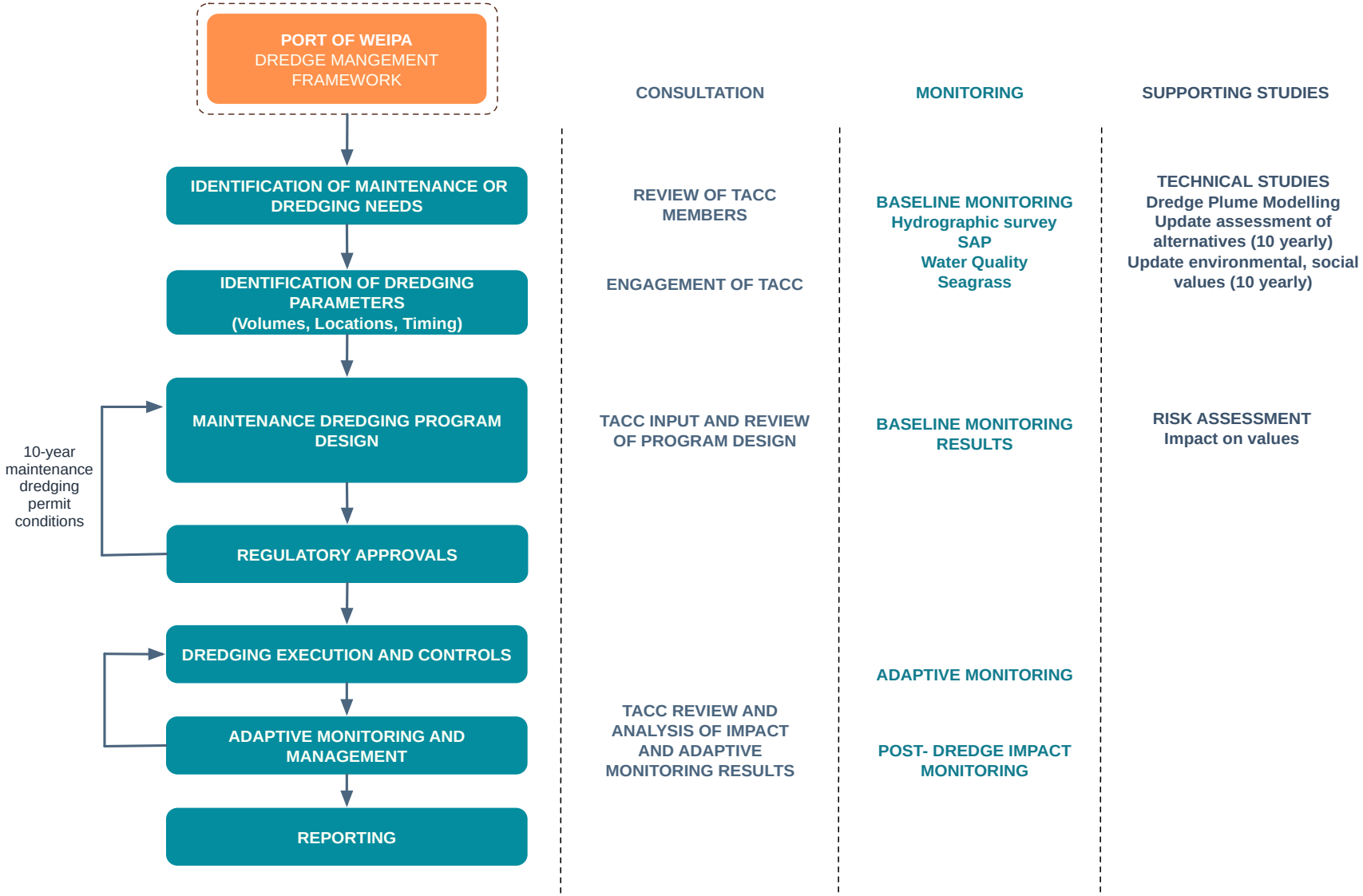


Figure 22: Dredge Management Framework

9.1. Identification of Maintenance Dredging Needs

Identification of navigational risks in the offshore environment of a Port is one of the first steps of the framework process and is key to identifying whether maintenance dredging is likely to be required. Regular baseline monitoring (bathymetric surveys) of the offshore infrastructure of the Port including berths, swing basins and channels, is required. This monitoring will map sediment distribution within key offshore operational areas of each Port. Data from the monitoring will also be able to identify changes in sediment dynamics over time.

Where sediment accumulation may create a potential or future navigational hindrance, a risk assessment should then be undertaken. The aim of the assessment is to determine the level of risk posed to the ongoing safe operation of the Port. The level of risk can then be used to trigger the timing of the further phases of the dredge management framework.

Broad categories of risk are outlined in Table 11. An aim of the framework is to maintain all Port areas in the low or medium risk rating at all times.

Table 11: Navigational risk categories

Risk	Description	Response
Extreme	Port vessel access and safety is compromised. Declared depths are above Port operational requirements. The full loading of vessels is constrained by berth depths. Loaded vessels cannot depart Port or can only depart on high tide.	Sediment management measures are required immediately. Expedite framework planning and actions.
High	Safety and/or access to the Port could be compromised at any time in the near future or access is already significantly tidally constrained. Loaded vessels can only depart on high tide.	Sediment management measures are required immediately. Expedite framework planning and actions.
Medium	Port depths and sedimentation trends indicate that access and/or safety could be compromised within the next 12-18 months	Commence planning for appropriate sediment management action(s).
Low	Sedimentation rates are low, indications are that Port access will not be compromised or affected within the next 2 years (depending on cyclonic influences).	Continue to monitor.

9.2. Identification of Dredging Parameters

Should an immediate or future navigational risk at the Port be identified, it is necessary to determine the appropriate response in terms of the type of sediment management activity required.

Baseline monitoring data will be required to inform this phase. Up to date information regarding sediment volumes, quality and contamination may be needed. The specific data required includes:

1. Sediment Sampling and Analysis Plan (SAP) results. The process for undertaking sampling and analysis of sediments is described in the NAGD (CoA 2009).
2. Bathymetric survey data.

SEDIMENT MANAGEMENT OPTIONS

Depending on the scale of sedimentation and level of navigational risk posed a range of management options could be applied. These need not necessarily be stand-alone actions and could be deployed sequentially to reduce and then remove the risk. Measures include:

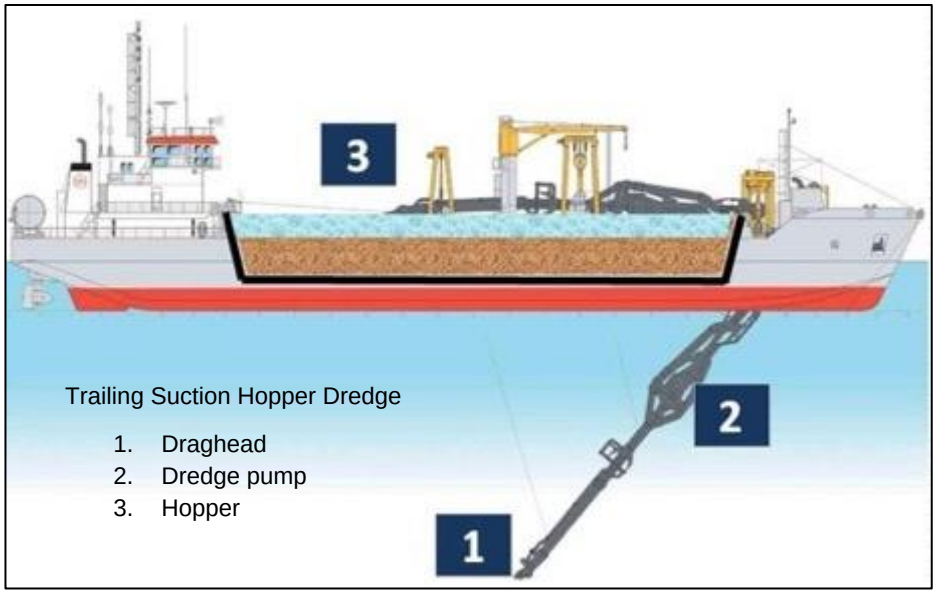
A. **Bed levelling:** using a drag bar, high spots of sediment accumulation can be removed and reduced by shifting them into lower lying depressions in channels and berths. This can help to maintain a suitable

declared depth. Rarely is this a long-term solution but it can be used to alleviate immediate risks or to prolong the period between major dredging activities.

B. **Propeller wash agitation** from operating vessels within the Port area may be of some assistance in reducing the accumulation of sediment in certain areas. This may be partially effective in berth areas and in the shallower channel areas. Minor variation of the vessel path along the channel may assist in widening the area free of accumulated sediment.

C. **Hopper dredging:** often considered the more traditional dredging method, use of a trailing suction hopper dredge (vessel) where sediment is collected in the hopper of the vessel and placed at a designated location. This method is necessary for removing larger volumes and areas. Figure 23 provides a cross section of a typical hopper dredge.

Figure 23: Cross section of a Trailing Suction Hopper Dredge (Source: Ports Australia 2016)



9.3. Dredging Program Design

Should it be determined that hopper dredging is required then the next stages from the sediment management framework is the design of the dredging program and obtaining of relevant approvals.

Where the need for maintenance dredging and dredge material placement has been identified, planning for all aspects of the program needs to be undertaken. This includes:

- Timing and duration of the dredge program
- Location of dredging areas and volumes
- Equipment needs and standard procedures (TSHD Brisbane or other suitable dredge)
- Identification and assessment of potential impacts to values at dredging and placement sites
- Mitigation and management measures (including adaptive management) to address potential impacts to values
- Operational controls.
- Monitoring requirements.

All three input elements of the framework, including consultation, monitoring and supporting studies, will aid in the design of individual dredging programs. Additionally, standard dredging procedures and guidelines will need to be incorporated into the design.

TYPE OF DREDGE

Depending on the ongoing viability and availability the *TSHD Brisbane* will be used for annual dredging over at least the next 10-years.

Additional to this or if the *TSHD Brisbane* is not available an alternative suitable trailer suction hopper dredge would be commissioned and used. This may particular be the case if larger volumes need to be relocated following particularly bad cyclonic conditions.

For the purposes of this management plan, the specifications and operations of the *TSHD Brisbane* will form a baseline for dredge specification and operational environmental management. A brief description of the *TSHD Brisbane* operations is provided below.

Material to be dredged is removed through two suction heads, which are lowered into position on either side of the vessel. As the vessel steams slowly at around 1 – 3 knots, large pumps draw water through the heads, which entrain the sediment and transport the water/sediment mixture aboard into a central collection hopper. The capacity of the hopper is dependent on the sediment type – with volumes (including both sediment and water) approximating 2,800 m3 for fine silts and 1,700 m3 for sands (of a maximum hopper capacity of 2,900m3). Each extraction run takes approximately 1 hour to complete. Whilst the suction heads are fitted with high-pressure water jets, which can be used to agitate consolidated sediment, they are rarely required for maintenance dredging.

The sediment/water ratio of material delivered to the central hopper of the *TSHD Brisbane* is typically quite low. Whilst it varies depending on the type of sediment being dredged, the sediment concentration is generally in the order of 10 – 30 % solids. To maximise dredge material capacity, these large volumes of water are managed using a central column weir, which is incorporated into the hopper. This arrangement allows excess water to decant from the sediment and overflow to discharge. Overflow occurs only toward the very end of the dredging run as the hopper nears capacity (typically the last ten minutes of a one hour dredging run).

Once the dredge has filled its hopper, the vessel will then relocate the material to the designated dredge material relocation ground. Dredged material is discharged below keel level to minimise turbidity generation. Each dredged material placement is manually logged using both satellite navigation and standard bridge equipment, and is electronically fixed using a differentially corrected global positioning system (GPS). The time taken to place material over the dredge material relocation ground is typically about 15 minutes.

- Mitigation of potential turbidity and suspended solids impacts from dredging and dredge material relocation is partly achieved through the use of suitable and specifically designed modern vessels. The following are considered the minimum standard of specification for TSHDs that will be selected to undertake maintenance dredging works in the Port of Weipa:
- The dredger will operate under a Maintenance Dredging EMP. The Dredging contractor EMP will be reviewed by NQBP for approval, and implemented for each maintenance dredging program. The permit conditions, dredge dumping procedures, any associated adaptive monitoring arrangements and corrective actions are incorporated into the EMP. Implementation of the EMP is audited by NQBP environmental staff.
- During the dredging works, electronic logs of each dredge material relocation event will be maintained.
- TSHDs undertaking dredging works at the Port of Weipa will include the following specifications:
    - Central weir discharge system
    - Below keel discharge point
    - Low wash hull design
    - Electronic positioning system (GPS)
    - Turtle exclusion devices on intake heads.

10. Monitoring Framework

Dredging related monitoring is detailed in the *Port of Weipa Marine Environmental Monitoring Program (NQBP 2020)*.

NQBP will oversee the implementation of the monitoring plan, with each component being undertaken by appropriately qualified marine scientists.

Overall, the monitoring plan is made up of a combination of regular ambient monitoring (long-term monitoring) and individual dredging event related monitoring (impact and real time monitoring). The environmental monitoring plan aims to:

- Assess the long-term ambient environmental health of the Port and nearby sensitive receptors.
- Detect any impacts from maintenance dredging, both immediately after dredging programs and over time.
- Respond to real time environmental conditions during maintenance dredging to prevent serious environmental harm
- Collect data that will be used to drive continual improvement

These aims will be met through the implementation of a three-tiered approach to monitoring (Figure 24)**.** The three-tiers will include ambient, impact and adaptive monitoring. Results from each tier of the monitoring program will be used to inform the relevant stages of the dredging management framework.

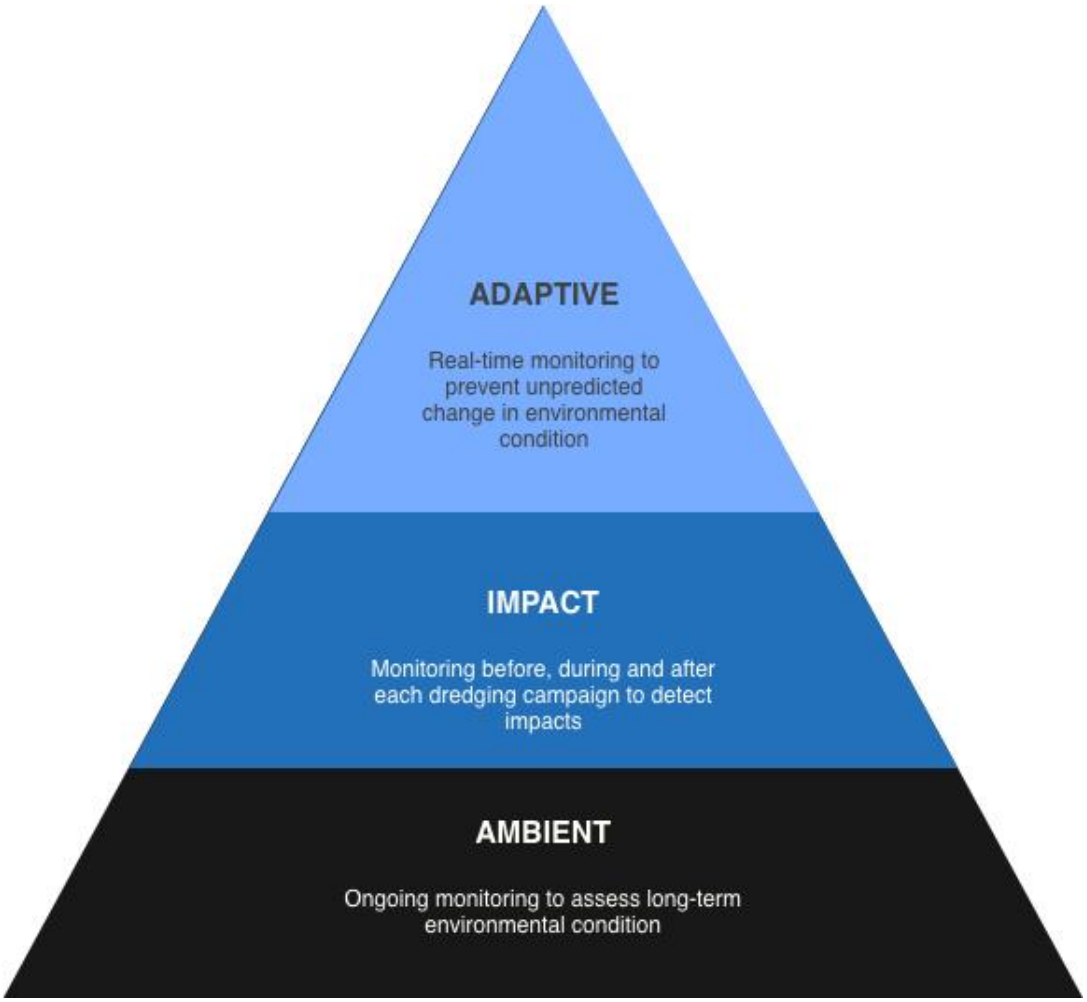


Figure 24: Tiered approach to monitoring

AMBIENT

The aim of this monitoring is to provide a long-term environmental health assessment of the Port and nearby sensitive receptors. The ambient monitoring program focuses on seagrass and invasive marine pests.

IMPACT

Impact monitoring will be implemented for each large maintenance dredging program, with the aim of detecting any adverse impacts due to dredging. If the results of the impact monitoring detect changes in the condition of sensitive receptors, the data can be used in conjunction with data from baseline and adaptive monitoring programs to understand likely cause of impact (i.e. was it dredging).

The impact monitoring program focuses on water quality and seagrass, as the two receptors most likely to be adversely impacted by dredging. The ephemeral nature of seagrass means that as a sensitive receptor is less suited to short term impact assessment monitoring and detection of dredging related changes. A long term seagrass data set is being established which will enable future analysis and correlation of seagrass health with other factors.

ADAPTIVE

Adaptive monitoring and management will be implemented for each 'worst case' maintenance dredging program. The program is focused on real time collection and analysis of data to detect potential environmental harm and undertake corrective actions where necessary. This is a key step in impact avoidance and management.

Monitoring of water quality, weather conditions and certain marine fauna will be undertaken, as detailed in the *Port of Weipa Marine Environmental Monitoring Plan*. Responses to monitoring results will be required if trigger values occur. The nature of the response will be scaled according to the environmental risk associated with the size of the dredging program.

Monitoring review and updates

The *Port of Weipa Marine Environmental Monitoring Plan* will be reviewed every 3 years and the Plan updated accordingly.

The review will examine the;

- Effectiveness of monitoring methods
- Response times and outcomes of adaptive monitoring actions
- Monitoring results and data
- Environmental changes and any incidents causing harm

The review will be undertaken in consultation with the TACC and their feedback incorporated into any future Plan revisions.

11. Performance Review

The *Environmental Code of Practice for Dredging And Dredging Material Relocation* (Ports Australia 2016) identifies that 'transparent and open information sharing is important to improve knowledge and to understand community values, client needs and government expectations. Communication and reporting is an important component of this, to demonstrate performance and provide for community accountability'.

In fulfilment of this principle, reporting under this Plan will involve:

- regular updates to the TACC on any planned or conducted dredging activities
- publication (on the NQPB website) of an annual report detailing:
  - dredging activity in the past 12 months
  - results of any environmental monitoring associated with dredging actions
  - indications of any possible upcoming dredging activities.

For any operations covered by a Commonwealth Sea Dumping Permit, an annual report meeting the International Maritime Organisation's reporting requirements will be submitted to the Australian Government each year. The report will summarise the dredging and monitoring activates undertaken during the year, including:

- permit number
- permit start and expiry dates
- locations and type of material dredged
- volume dredged at each location
- placement locations used
- placement method used.

RECORD KEEPING

During dredging activities, NQBP (or their contractors) will keep records which detail:

- the times and dates of when each material placement run is commenced and finished
- the position (by GPS) of the vessel at the beginning and end of each dumping run with the inclusion of the path of each dredge material relocation run
- the volume of dredge material (in cubic metres) dumped for the specific operational period. These records will be retained for audit purposes
- detail of any spill of oil, fuel or other potential contaminant, details of remedial action and monitoring instigated as result.
- details of any marine mega fauna observations during dredging activities
- time and duration of any alterations to the program, including stop work actions, as a result of any environmental mitigation measure.

Post the dredging program, NQBP will

- undertake a bathymetric survey of the dredged area and dredge material placement site within one month of completion of dredging.
- within two months of the completion of the bathymetric survey provide a digital copy of the final survey results to the Australian Hydrographic Office (AHO), copied to relevant regulatory agencies
- continue monitoring as per the Port of Weipa Marine Environment Monitoring Program.

INCIDENTS AND CONTINGENCY ARRANGEMENTS

All NQBP port staff, and any contractors involved, have the responsibility to report any significant incidents and emergencies.

- In the first instance, reporting should be to the operational works supervisor, but generally, the Environment Manager will have the responsibility to initiate corrective action for environmental incidents.
- All incidents should be reported to the Manager responsible for the Project, as specified by NQBP.

- In the case of an environmental emergency, after first notifying the Environment Manager, the operational works supervisor may make contact with NQBP's nominated consultants, who would help co-ordinate and manage a response. Depending on the nature and magnitude of the incident, the Environment Manager may be required to notify government regulators.

Significant environmental incidents should be logged in writing, with all relevant details recorded, after corrective action has been completed.

Should an environmental incident occur during the course of dredging or placement of material, NQBP will take measures to mitigate the risk or impact. NQBP would report the following information to DES/DAWE, within 48 hours:

- nature of incident and type of risk associated with the incident, including (where possible) volume, nature and chemical composition of substances released
- measures taken to mitigate the risk
- the success of the measures undertaken
- proposed future measures (if required) and monitoring.

AUDITING AND IMPROVEMENTS

NQBP will undertake an internal audit after the completion of each dredging program, as per the 'Notifications and Obligations Schedule'. Audit findings will be provided to the TACC and will be used to inform improvements and revisions to the Maintenance Dredging EMP and Marine Environment Monitoring Program.

12. Supporting Information

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