Marsden Point Refinery: A Resource Consent Application to Renew 20 Resource Consents from the Northland Regional Council

enspire

Prepared for: ChanceryGreen on behalf of The New Zealand Refining Company Limited, trading as **'Refining NZ'**

Prepared by: Gavin Kemble, *Director*
Bridgette Munro, *Chairperson*
Blair McLean, *Senior Planner*
George Sariak, *Planner*

Date Finalised: July 2020

Volume 3k:
Crude Shipping Project AEE

CRUDE SHIPPING PROJECT

PROPOSED DEEPENING AND REALIGNING OF THE WHANGAREI HARBOUR ENTRANCE AND APPROACHES

VOLUME ONE:

ASSESSMENT OF ENVIRONMENTAL EFFECTS REPORT AND RESOURCE CONSENT APPLICATIONS

Prepared for:

ChanceryGreen on behalf of the New Zealand Refinery Company Limited **August 2017**

Prepared by:

Ryder

Crude Shipping Project

Proposed Deepening and Realigning of the Whangarei Harbour Entrance and Approaches

Prepared for: The New Zealand Refining Company Limited

Prepared by: Gavin Kemble, *Managing Director and Environmental Planner*
Cole Burmester, *Associate and Environmental Planner*
Myaan Bengosi, *Environmental Planner*

Date Finalised: August 2017

TABLE OF CONTENTS

Glossary

Abbreviation or phrase	Term
%	Percent
°C	Degrees Celsius
μm	Micrometres
AEE	Assessment of Environmental Effects.
ALARP	As Low As Reasonably Practicable.
Anthropogenic	Caused or influenced by humans.
Bedload sediment transportation	Sediment that rolls, slides and bounces along the bottom of the seabed.
BHD	Backhoe Dredger
Bird	Avifauna.
Bow	Front of a vessel.
Brown NZ	Brown NZ Limited
Cawthron	Cawthron Institute Limited
CCR	Continuous Catalyst Regeneration
CD	Chart Datum
CEA	Cultural Effects Assessment
Clockwise tidal circulation	Pressure from both sides causing the tide to orientate in a clockwise circulation
cm	Centimetre
CMA	Coastal Marine Area
CMS	The Northland Conservation Management Strategy
Coastal Plan or RCP	Northland Regional Council Regional Coastal Plan
CSD	Cutter Suction Dredger
CSP	Crude Shipping Project
Currency Requirements	Achieving currency means that a pilot has met the requirements to act as a pilot in command of vessel within a certain time period
CVA	Cultural Values Assessment
dB	Decibels
demersal fish	Being fish that reside at the bottom of the ocean
Disposal Area 1-2	A 2.5 km^2 area of seabed situated on the southern end of the ebb tidal delta in water depth of between 7.0m and 15m Chart Datum.
Disposal Area 3-2	A 5.75 km^2 area of seabed situated in deep water that is around 45m below Chart Datum to the southeast of the channel.
DoC	The Department of Conservation
Ebb flow	Out-going flow
Ebb-jett	South-southeast directed out-going flows
ETD	Ebb Tide Delta
Estuarine Lagoon	A shallow body of water separated from a larger body of water by a barrier.
Flood Tide	Currents going towards the estuary
Fresh event	Flood event caused upstream, caused by rainfall.
Ha	Hectares

Halocline	A layer in the water in which there is a steep salinity gradient.
Harakeke and muka	Prepared flax fibres
hau kāinga	The local people of a marae.
Hen Island	Tauranga Island
Intertidal area	Being the areas situated between the high and low tide marks
Iwi Management Plan	An iwi management plan is a term commonly applied to a resource management plan prepared by an iwi, iwi authority, rūnanga or hapū
Jetties (Jetty 1, Jetty 2, Jetty 3).	The port facility associated with the Refinery has three jetties for berthing crude oil and 'product ships'. The three jetties are connected to the shoreline by one central arm that branches into two central jetties that are approximately 300 m apart, known as Jetty 1 and Jetty 2. Both jetties consist of a concrete platform that is 25m in length and 5.6m above Mean Low Water Springs, which supports the hose gantry and other ancillary equipment. A third, smaller jetty (known as Jetty 3) was commissioned in 2009 and extends to the west from Jetty 2, which has a 5.8 m long concrete platform that supports a pipe manifold arrangement and other ancillary equipment.
kaimoana	Seafood, shellfish.
kaitiaki	Guardian, trustee, minder, caregiver, keeper, steward.
km	Kilometres
km^2	Square Kilometres.
L	Litres
L_{Aeq}	Equivalent Continuous Level. When a noise varies over time, the Leq is the equivalent continuous sound which would contain the same sound energy as the time varying sound.
l/s	Litres per second
m	Metres
m^3	Cubic Metres
m^3/yr	Cubic metres per year
m/s	Metres per second
MACA Act	Marine and Coastal Area (Takutai Moana) Act 2011
Mahinga Mataitai	Customary seafood gathering site, shellfish bed
Mana moana	Authority over the sea and lakes
Manuhiri	Visitor or guest
Marine Mammals Assessment	Assessment of effects on marine mammals from proposed deepening and realignment of the Whangarei Harbour entrance and approaches prepared by Cawthron Institute
Mauri	Life force, life principle, vital essence, special nature, a material symbol of a life principle, source of emotions – the essential quality and vitality of a being entity. Also used for a physical object, individual, ecosystem or social group in which this essence is located.
Meatweight	The weight of shellfish excluding the shell.
MetOcean	MetOcean Solutions Limited
MfE	Ministry for the Environment
mg/L	Milligram per litre

MHWS	Mean High Water Springs
mm	Millimetres
MMbbl	One Million Barrels
MPI	Ministry of Primary Industries
MWMF	Marine Wildlife Management Plan prepared by Cawthron Institute in consultation with the Department of Conservation
Navaids	Navigational Aids
Navigatus	Navigatus Consulting Limited
Neap Tide	Being a period characterised by the least difference between high and low tide water.
NES	National Environmental Standard
nm	Nautical Miles
NMP	Noise Management Plan
Nohoanga	Seasonal occupation sites, places where food is gathered
Non-permanent marginal channel	Landward flow causing flooding in the lowest area of the bank, opening a marginal channel, and an accretion of sand forming within the marginal channel during fair-weather conditions.
NorthPort Limited	NorthPort
NPS	National Policy Statement
NPSFM	The National Policy Statement Freshwater Management (2014)
NRC	Northland Regional Council
NTB	Ngātiwai Trust Board
Nutrient recycling	The cycle of plants and animals dying and sinking to the bottom of the sea where they are feed on by bacteria and fungi, therefore keeping the nutrients in the system.
NTU	Nephelometric Turbidity Unit. NTU is a measurement of turbidity. The instrument used for measuring it is called nephelometer or turbidimeter, which measures the intensity of light scattered at 90 degrees as a beam of light passes through a water sample.
NZCPS	New Zealand Coastal Policy Statement 2010
NZIER	New Zealand Institute of Economic Research
ONL	Outstanding Natural Landscape
P&P	Poten and Partners Limited
Patuharakeke	Patuharakeke Te Iwi Trust Board
Peak flood flows	Incoming flows
PIANC	PIANC is the World Association for Waterborne Transport Infrastructure
RAP	Refinery to Auckland Pipeline
Regional Council	Northland Regional Council
RHDHV	Royal Haskoning DHV Engineering Limited
RL	Reduced Level
RNZ	New Zealand Refining Company Limited
rohe moana	Authority over the sea
RPS	The Northland Regional Policy Statement
Ryder	Ryder Consulting Limited

S.D.W.T	Summer Dead Weight Tonnage refers to the weight in metric tons of cargo stores, fuel, passengers and crew carried by a ship when loaded to its maximum summer load line.
Secchi depth visibility	A measure of water clarity
Shoal	Waves becoming steeper.
SPM	Single Point Mooring
Spring Tide	Strongest tidal period characterised by the most important water elevation variability.
Statutory Acknowledgements	A statutory acknowledgement is an acknowledgement by the Crown that recognises the mana of a tangata whenua group in relation to specified areas - particularly the cultural, spiritual, historical and traditional associations with an area. These acknowledgements relate to 'statutory areas ' which include areas of land, geographic features, lakes, rivers, wetlands and coastal marine areas, but are only given over Crown-owned land.
Stern	Rear of the vessel
Styles	Styles Group Limited
Sublittoral fringe	At and immediately below low tide
Subtidal areas	Being areas that are not exposed at low tide
SUP	Stand up paddle board
Suspension sediment transportation	Floating in the water column
SWAN model	Simulating Waves Nearshore model.
T&T	Tonkin and Taylor Limited
Takutai moana	Coast, foreshore and seabed.
Taonga	Treasures, anything prized. Applied to anything considered to be of value including socially or culturally valued objects, resources, phenomenon, ideas and techniques.
The Act	Resource Management Act 1991
The Applicant	New Zealand Refining Company Limited
The Clough Report	Archaeological Assessment prepared by Clough & Associates Limited
The Company	New Zealand Refining Company Limited
The Disposal Sites	Either one of two designated spoil disposal sites.
The Landscape Assessment	Landscape Assessment prepared by Brown NZ Limited
The Marine Reserve	Two sites, being an intertidal mudflat/mangrove environment at Waikaraka that is approximately eight kilometres from Whangarei city and is a total of 227.5 hectares in area, as well as, a mix of sandy beach, rocky reef and small high-current outcrops at Motukaroro (Passage) Island, which is 26.2 ha in area, is located near Busby Head.
The Proposal	Comprises five separate but interrelated components, being: 1. The initial dredging of the approaches to the Whangarei Harbour (including some realignment of the same), and the 'pocket' next to the Marsden Point Jetty (also referred to as '**Capital Dredging**');

	2. The dredging of the Harbour entrance and jetty pocket to maintain its depth (also referred to as '**Maintenance Dredging**'); 3. The disposal of the dredged material (from both Capital Dredging and Maintenance Dredging) to two locations in Bream Bay; 4. The type of vessels (and their operations) that could be used to undertake components (1) to (3) above (also referred to as the '**Dredging Methodology**'); and 5. Changes to the Aids to Navigation within the Whangarei Channel to facilitate the safe passage of vessels into and out of the Whangarei Harbour.
The Refinery	The Marsden Point Refinery.
Thermocline	A layer in which there is steep temperature gradient
The Site	The area that the Company will undertake the works listed in the Proposal. In broad terms, the Site is located within the CMA and extends from within the Whangarei Harbour (adjacent to the Marsden Point Refinery) through the Harbour channel entrance (adjacent to Home Point) to the two proposed disposal sites that are located in Bream Bay to the west of the Hen and Chicken Islands.
Total significant wave height	The average off the highest 1/3 wave heights
TSHD	Trailer Suction Hopper Dredge
Volcanoclastic Cliffs	Cliffs formed from volcanic activities. The deposits are influenced by the rate of supply and the flow transformations that occur.
Wāhi Tapu	Sacred place, sacred site. A place subject to long-term ritual restrictions on access or use.
Waiana koiwi	Underwater burial caves and ledges
Wave Refraction Patterns	The process by which wave crests realign themselves as a result of decreasing water depths.
Wave Runup	Waves breaking on the beach slope. This is one way shoal energy is transferred.
Wave setup	The Water level in the surf zone increasing. This is one way shoal energy is transferred.
WDC	Whangarei District Council
Windage	Being the exposure of the vessel above the waterline to wind

ANNEXURES

Annexure One: Northland Regional Council Application Forms

Annexure Two: Technical Reports

a) Establishment of Numerical Models of Wind, Wave, Current and Sediment Dynamics. MetOcean Solutions Limited. Peter McComb, Florian Monetti and Sarah Gardiner. Dated 25th July 2017
b) Predicted physical environmental effects from channel deepening and offshore disposal. MetOcean Solutions Limited. Peter McComb, Florian Monetti, Brett Beamsley and Sarah Gardiner. Dated 25th July 2017
c) Dredging and Disposal Options – Synthesis Report – Consultation Draft. T & T. Richard Reinen-Hamill. Dated July 2017
d) Crude Shipping Project – Coastal Processes Assessment. T & T. Richard Reinen-Hamill. Dated July 2017
e) Crude Shipping Project – Mid-point multi-criteria alternatives assessment. T & T. Monique Cornish. Dated March 2017
f) Report in Support of an Assessment of Effects on the Environment – Navigational Risk Assessment of Engineered Channel Designs. Navigatus. Geraint Bermingham and Paul Dickinson. Dated 15 August 2017
g) Environmental Spill Risk Assessment for Proposed Tanker Operations Associated with Engineered Channel. Navigatus. Kevin Oldham, Matt Bilderbeck and Geraint Bermingham. Dated 14 August 2017
h) Whangarei Harbour Entrance and Marsden Point Channel Realignment and Deepening: Assessment of Environmental (Airborne) Noise Effects. Styles Group. Jon Styles. Dated 31 July 2017
i) Assessment of effects on marine mammals from proposed deepening and realignment of the Whangarei Harbour entrance and approaches ('Marine Mammals Assessment'). Cawthron Institute. Deanna Clement and Deanna Elvines. Dated August 2017
j) AEE Report – Coastal Birds – Final. Bioresearches Group Limited. Graham Don. Dated 09 August 2017
k) Assessment of Marine Ecological Effects excluding Seabirds and Marine Mammals. Brian T Coffey and Associates. Brian Coffey. Dated 10 August 2017
l) Recreation and Tourism Effects Assessment. Rob Greenaway and Associates. Rob Greenaway. Dated August 2017
m) Marsden Point Crude Shipping Project – Landscape Assessment. Brown NZ Limited. Stephen Brown. Dated August 2017
n) Whangarei Harbour Dredging: Archaeological Assessment. Clough and Associates. Dr Rod Clough and Simon Bickler. Dated July 2017.
o) Crude Shipping Project – Economic Assessment of Channel Deepening at the Marsden Point Refinery. New Zealand Institute of Economic Research. Peter Clough and Mike Hensen. Dated 02 August 2017
p) Commercial Fishing in Whangarei Harbour and Bream Bay. Boyd Fisheries Consultants Ltd. Rick Boyd. Dated 11 August 2017
q) Peer Review Report of Refining NZ Crude Freight Proposal – Tangata Whenua o Whangarei Te Rerenga Paraoa DRAFT Cultural Effects Assessment. Te Onewa Consultants. Antoine Coffin. Dated 21 July 2017

Annexure Three: Key Resource Consents granted by Northland Regional Council for the operation of:

a) Refining NZ
b) NorthPort Limited
c) Marsden Cove Limited
d) NIWA

e) Whangarei District Council
f) Department of Conservation

Annexure Four: Environmental Management Plans

a) Ngātiwai Trust Board, Ngātiwai Iwi Environmental Policy Document 2015
b) Patuharakeke Te Iwi Trust Board, Hapū Environmental Management Plan 2015

Annexure Five: Consultation draft report technical review and Refining NZ's responses.

a) Hui outcomes and Technical Review of Refining NZ Documents Summary for Crude Shipping Project for Patuharakeke Te Iwi Trust Board
b) Refining NZ responses to "Hui Outcomes and Technical Review of Refining NZ Documents Summary for Crude Shipping Project" Dated April 2017

Annexure Six: Materials utilised for consultation

a) Introductory brochure to the Proposal
b) Flyers
c) Sample of Advertisements
d) Media releases
e) Facebook posts

Annexure Seven: Assessment against the Rules of the Regional Coastal Plan for Northland June 2004

Annexure Eight: Regional Coastal Policy Assessment Criteria

Annexure Nine: The Regional Coastal Plan for Northland June 2004 Cited Provisions.

Annexure Ten: Planning maps from Northland Regional Council – significant values

Annexure Eleven: The Operative Northland Regional Policy Statement 2016 Cited Provisions

Annexure Twelve: The New Zealand Coastal Policy Statement Cited Provisions

Annexure Thirteen: The Harbour Masters written approval

APPLICATION FOR RESOURCE CONSENTS UNDER SECTION 88 OF THE RESOURCE MANAGEMENT ACT: SCHEDULE 4 SUMMARY

We attach, for your consideration, an Assessment of Environmental Effects report ('**AEE**') that accords with Schedule 4 of the Resource Management Act 1991 ('**the Act**'). In that regard:

Clause 1: Information must be specified in sufficient detail

This AEE provides information and assessments that are relevant and to the extent that is necessary for the types of resource consent applications that are being sought, by Refining NZ. The level of detail provided in this AEE allows Refining NZ's resource consent applications to be fully understood.

Clause 2: Information required in all applications

Sections 1.0 and 2.0 of this AEE provides a description of the area that could be impacted by the Crude Shipping Project ('**the Site**') and a description of the activities that are part of the proposal. While case law seems to be questioning the need for such an assessment to be completed, an assessment against Part 2 of the Act is never-the-less set out in section 5.0 of this AEE. The same section of this AEE also contains an assessment of the Crude Shipping Project ('**the Proposal'** or '**the CSP**') against the relevant provisions of a document referred to in section 104(1)(b) of the Act.

Clause 3: Additional information required in some applications

Section 5.0 of this AEE sets out the aspects of the Proposal that are deemed to be permitted activities, and includes sufficient detail so that the Northland Regional Council ('**NRC**' or '**Regional Council**') can determine that these aspects of the Proposal are, indeed, permitted.

We note that these resource consent applications are not effected by section 124 or 165ZH(1)(c) of the Act. We also note that the Proposal will occur in an area within which there have been a number of applications for customary marine title under the Marine and Coastal Area (Takutai Moana) Act 2011 ('**MACA Act**'). In this regard, there twelve applications that have been made under the MACA Act that are of relevance, by the following parties:

1. Kare Rata CIV-2017-404-554;
2. Patuharakeke Te Iwi Trust Board CIV-2017-485-281;
3. Patuharakeke Te Iwi Trust Board CIV-2017-485-286;
4. Waimarie Kingi CIV-2017-404-579;
5. Louisa Collier CIV-2017-485-398;
6. Te Runanga o Ngati Whatua CIV-2017-404-563;
7. Ngatiwai Trust Board CIV-2017-485-283;
8. Pereri Mahanga CIV-2017-404-566;
9. Rihari Dargaville CIV-2017-404-538;
10. Elvis Reti CIV-2017-485-515;
11. Tarewa Rota CIV-2017-485-510; and

12. Cletus Maaunu Paul CIV-2017-485-512.

Each of these applicants has been written to prior to lodgement of these resource consent applications, in order to notify, and seek the view of, the applicants on the resource consent application.

Clause 4: Additional information required in application for subdivision consent

This resource consent application is not for subdivision consent and therefore Clause 4 is not relevant.

Clause 5: Additional information required in application for reclamation

This resource consent application is not for a reclamation and therefore Clause 5 is not relevant.

Clauses 6 & 7: Information required in assessment of environmental effects and Matters that must be addressed by assessment of environmental effects

1. As we discuss in section 3.0 of this AEE, the Proposal does not result in any significant adverse effects on the environment. Despite the finding that the Proposal does not cause significant adverse effects, an assessment of alternative methods and locations has been undertaken, and is report in section 1.0 and 3.0 of this AEE.
2. A comprehensive assessment of the Proposal's actual or potential effect on the environment of the activity is included within section 3.0 of this AEE.
3. An assessment of any risks to the environment that are likely to arise from the use of hazardous substances is set out in section 3.4 of this AEE.
4. As the Proposal includes the discharge of a contaminant (sediment with trace quantities of contaminants), a description of the nature of the discharge and the sensitivity of the receiving environment to adverse effects and any possible alternative methods of discharge, including discharge into any other receiving environment is provided in sections 1.0, 2.0 and 3.0 of this AEE.
5. A description of the avoidance, remediation and mitigation measures that are proposed is set out in section 1.0 and 3.0 of this AEE.
6. Section 4.0 of this AEE identifies the persons that are potentially affected by the activity and provides details of the consultation undertaken.
7. A description of the proposed monitored programmes is included in section 1.0 and 3.0 of this AEE.
8. There are 13 applications for protected customary rights orders, but no such orders have been put in place at this time of writing. As a consequence, it is not possible to undertake an assessment of the Proposal against any protected customary rights orders, as none exist. As is set out in section 4.0 of this AEE, however, all applicants for customary title have been notified of the resource consent application, and their views have been sought, and numerous discussions have been conducted with Tangata Whenua.
9. The information provided in this AEE is in accordance with that required by the applicable policy statement and plans of the Regional Council. A detailed assessment against the relevant provisions of those documents is provided at section 5.0 of this AEE.

Given the preceding, we are of the opinion that this AEE accords with the applicable provisions of Schedule 4 of the Act and can be accepted by the Regional Council for assessment.

1.0 INTRODUCTION

This AEE has been prepared to support the resource consent applications to undertake dredging within the entrance channel to the Whangarei Harbour. It incorporates the associated discharge of dredged material to the Coastal Marine Area ('**CMA**'), and several ancillary activities (such as the discharge of sediment laden water from the dredge and the abstraction of water while dredging). These activities will enable fully-laden Suezmax crude ships to deliver approximately one million barrels ('**MMbbl**') per shipment to the Marsden Point Refinery ('**the Refinery**').

The resource consent application is lodged by the New Zealand Refining Company Limited trading as Refining NZ (hereafter referred to as either '**the Applicant**', '**RNZ**', '**Refining NZ**' or '**the Company**').

1.1 Report Contents

Section 1 sets out the Proposal, including the measures proposed to avoid, remedy or mitigate adverse environmental effects, and the proposed monitoring programmes. This section introduces Refining NZ and summarises the resource consents required and those aspects of the CSP that can be undertaken as a permitted activity. In addition, Section 1 also sets out the assessment of alternative options undertaken by Refining NZ, the term sought for the resource consents, the proposed lapsing date of the same and discusses 'the permitted baseline'. A summary of the technical investigations that have been undertaken is also provided.

Section 2 sets out the existing environment, including the Site, its locality and context, and the existing activities undertaken on the Site.

An assessment of the actual and potential environmental effects is provided in **Section 3**.

Section 4 discusses the consultation undertaken by Refining NZ and sets out the feedback that was provided.

An assessment against the relevant planning documents and sections of the Act is provided within **Section 5**.

1.2 The Applicant & The Marsden Point Oil Refinery

Refining NZ operates New Zealand's only oil refinery at its site at Marsden Point. The Refinery is a nationally significant infrastructure resource. The Refinery processes approximately five million tonnes of crude oil per year – converting it into a range of refined fuels (primarily petrol, diesel and aviation fuels). In total, approximately 70% of the country's total fuel requirements are met by Refining NZ with the remainder imported as finished fuel products by the refinery's customers.

RNZ processes a wide range of crude oil types imported from key offshore markets as well as Taranaki, producing premium and regular motor gasoline, automotive and marine diesel, aviation and lighting kerosene, fuel oils and bitumen for the New Zealand market. Almost half of the fuel production at Marsden Point travels (via the purpose-built 170-kilometre ('**km**') 'Refinery to Auckland Pipeline' known as the '**RAP**') to Wiri, in South Auckland, for storage and subsequent distribution by road. The balance is transported by coastal tanker to destinations throughout New Zealand. The RAP is designated in the Whangarei District Plan, the Kaipara District Plan, and the Auckland Unitary Plan, pursuant to Part 8 of the Act.

As well as being the Companies largest customers, ExxonMobil, and Z Energy are significant shareholders in the Refinery. Other shareholders include a mix of both corporate and private investors.

In summary, Refining NZ supplies:

- Around 86% of New Zealand's jet fuel;
- Around 67% of all diesel;
- Around 63% of all petrol;
- Between 60 to 75% of all bitumen for roading;
- All fuel oil for ships;
- Sulphur for farm fertiliser; and
- Carbon dioxide to the beverage industry[1].

At a more local scale, the Northland and Auckland regional economies are heavily dependent on the petroleum products refined by Refining NZ and transported via the RAP. In that regard, Refining NZ produces approximately 92% of the Auckland region's road transport and aviation fuel needs. It is notable, for instance, that the Auckland International Airport is totally dependent on the Refinery and the RAP for supply of its aviation fuels. Any significant outage to the RAP would result in severe restrictions on fuel supplies to the airport and the Auckland region.

The Refinery's location was chosen due to the natural deep-water port at Marsden Point, low risk of earthquakes, flat topography of the site and close proximity to large residential populations in the North Island. Construction of the Refinery commenced in 1962, and the Refinery was opened in 1964. An expansion between 1979 and 1986 included the installation of a hydrocracker and the 170km long RAP pipeline to Wiri. In 2005, the Refinery undertook another expansion to allow for the desulphurising of diesel and removing of benzene from petrol to occur on site. Another expansion of the Refinery in 2009 increased the Refinery's capacity by 15%, which equates to approximately 135,000 barrels per day or some 80% of all fuel products in New Zealand. A further upgrade of the Refinery, known as Te Mahi Hou, was completed in 2015. The upgrade consisted of the installation of a Continuous Catalyst Regeneration Platformer unit to replace a Platformer unit that had been in service since the Refinery began operations in 1964.

1.3 The Site

The Proposal is to be located, in broad terms, within the outer reaches of the Whangarei Harbour and in the Northern half of Bream Bay. All of the works related to this resource consent application will be located within the CMA. The area, which we now refer to as '**the Site**', extends from within

[1] Clough, P, page 6, section 2.2.1, "Crude shipping project, Economic assessment of channel deepening at the Marsden Point Refinery". Dated 02 August 2017

the Whangarei Harbour (adjacent to the Refinery) through the Harbour channel entrance (adjacent to Home Point) to the two proposed disposal sites that are located in Bream Bay.

The city of Whangarei is located approximately 20km to the northwest of Marsden Point.

The Site encompasses approximately 9.69 square kilometres (‘**km²**’) of the CMA, which includes some 1.44km² within the entrance channel where dredging is proposed. The remainder of the Site area comprises two sea disposal sites, known as ‘**Disposal Area 3.2’** and ‘**Disposal Area 1.2**’. The total size of Disposal Area 3.2 is 5.75km², however, this includes an outer area (hereafter referred to as either a ‘buffer zone’ or ‘settlement area’) where the placed sediment is expected to settle over time. The depth of Disposal Area 3.2 is approximately 45 metres (‘**m**’) below Chart Datum (‘**CD**’). The total area of Disposal Area 1.2 is 2.5km², noting that it does not contain a wider settlement area. It is situated on the southern end of the Ebb Tide Delta (‘**ETD**’) in a water depth of between 7.0m and 15m CD.

We note, for completeness, that some dredged sediment could also be provided to alternative land based locations. While no plans for land-based disposal are advanced as part of this application, this could possibly be used for beach replenishment or reclamation works. Should however, the dredged sediment be used in this manner, it will occur in accordance with resource consents secured by the party that is receiving the sediment. As a consequence, potential sites are not discussed further in this AEE.

A map showing the extent of the area of the Site follows (please refer to **Figure 1.3.1**). **Figures 1.5.1.1** and **1.5.3.1** (which follow in section 1.5 of this AEE) highlight the location of the dredging and disposal works within this area.

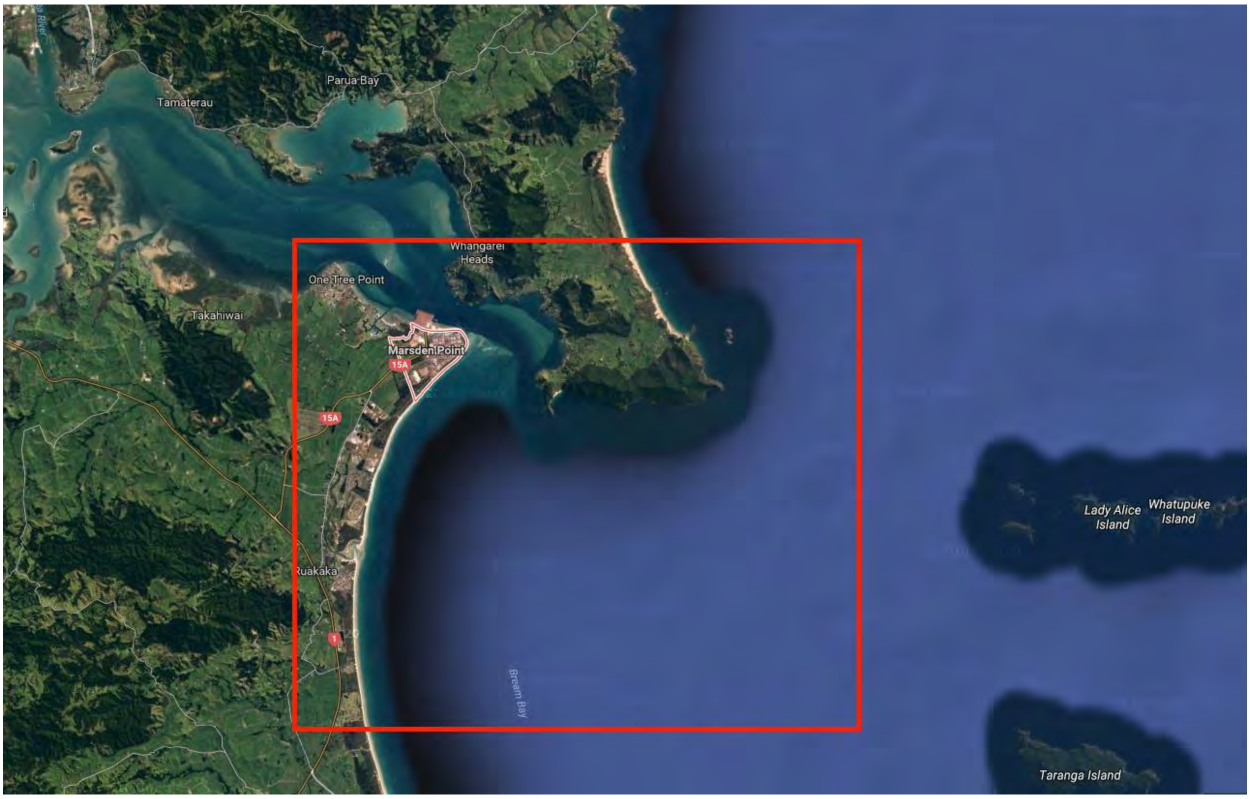


Figure 1.3.1: Location Plan – General Extent of the Site (outlined in red)

Bream Bay is located on the east coast of the North Island of New Zealand. Geographically, Bream Bay spreads 22km south from the mouth of Whangarei Harbour (Bream Head) to the southernmost point of Waipu Cove (Bream Tail).

To the east of Bream Bay lies the Hen and Chicken Islands, as they are commonly known, which consists of six islands. These islands are nature reserves that are managed by the Department of Conservation ('**DoC**') and located approximately 14km southeast of Bream Head. The NRC Regional Coastal Plan ('**Coastal Plan**' or '**RCP**') identifies that the Hen and Chicken Islands are protected as a 'Marine 1 (Protection) Management Area'. The largest island is Taranga Island ('**Hen Island**'), which lies 7.0km to the southwest of the rest of the chain. The indigenous flora of Hen Island is considered to be representative of northern New Zealand prior to European colonisation. Hen Island is also ranked as internationally important with the highest local ranking due to the presence of rare and endangered fauna and flora and local endemics. The five smaller islands are collectively known as the Chicken Islands, or Marotiri. These comprise a chain running northwest to southeast to the north of Hen Island. The island chain (from west to east) consists of Wareware and Muriwhenua Islands (together forming North West Chicken), Mauitaha (West Chicken), Lady Alice Island (Big Chicken or Motu Muka), Whatupuke (Middle Chicken), and Coppermine Island (Eastern Chicken). There is no human population on any of the Hen and Chicken Islands.

Sail rock, a natural rock stack, rises from the ocean 3.0km to the south of Hen Island and is a prominent navigational point for recreational yachts.

The Refinery sits at the end of a distal spit that marks the entrance to Whangarei Harbour. The Harbour is accessed through a relatively narrow tidal inlet which is around 790m wide and 32m at its deepest point.

The marine environment of the Whangarei Harbour is, in places, environmentally significant. To recognise this, the Whāngārei Harbour Marine Reserve was established on the 18th of October 2006. The Marine Reserve comprises two sites, being an intertidal mudflat/mangrove environment at Waikaraka that is approximately 8.0km from Whangarei city and is a total of 227.5 hectares ('**Ha**') in area, as well as, a mix of sandy beach, rocky reef and small high-current outcrops at Motukaroro (Passage) Island (hereafter referred to as '**the Marine Reserve**'), which is 26.2 Ha in area, is located near Busby Head, and therefore, abuts the Site.

Marsden Bay and One Tree Point enclose the shoreline to the west of the Refinery. While to the east runs the extensive shoreline of Bream Bay.

Opposite the Refinery is a succession of bays, including, from the entrance of the channel, Urquharts Bay, Mckenzie Bay, Taurikura Bay, McGregors Bay (which contains High Island), Little Munro Bay, Reotahi Bay (which contains Motukaroro Island), McLeod Bay, the Nook and Parua Bay. These make up the northern boundary of the Site. A number of small settlements are located within each of these bays, with views extending towards the Refinery, or towards Home Point and the channel entrance.

Due to the shallow nature of the Whangarei Harbour, it supports a number of sand banks. Mair and Marsden banks are situated on the southern side of the channel, adjacent to the Refinery. Calliope

Bank is situated on the northern side of the channel. Snake Bank and McDonald Bank are the two main flood-tidal deltas located within the Whangarei Harbour inlet.

The various bays, Marsden Point and the Banks are shown in **Figure 1.3.2**.

Figure 1.3.2: Identification of Marsden Point Refinery & the Bays and Banks of Whangarei Harbour[2]

The Whangarei Harbour is accessed through a natural tidal channel, which varies in depth from 14.7m to 32m at its deepest point. Home Point and Busby Head, two rocky outcrops, define the outer limits of the main channel.

A large portion of the Site is used for commercial operations (most notably those associated with NorthPort Limited ('**NorthPort**') and the Refinery). A large array of recreational pursuits also occurs within and adjacent to the Site, with fishing, shellfish gathering, diving, snorkelling, swimming and sailing being of particular note.

[2] Adapted from NZ Topo Map. https://www.topomap.co.nz/.

There are four commercial port facilities, and the 'Town Basin' facility (which exists in close proximity to the town centre of Whangarei) within the confines of Whangarei Harbour. Refining NZ and Northport are based at Marsden Point, while Golden Bay Cement are based at Portland. The Northport facility is New Zealand's newest port facility and, although primarily built for the export of Northland's forest products, the 585m berth terminal is a flexible multipurpose facility catering for a range of cargoes and their associated vessel types.

The port facility associated with the Refinery has three jetties for berthing crude oil and 'product ships'. The three jetties are connected to the shoreline by one central arm that branches into two central jetties that are approximately 300m apart, known as Jetty 1 and Jetty 2. Both jetties consist of a concrete platform that is 25m in length and 5.6m above Mean Low Water Springs, which supports the hose gantry and other ancillary equipment. A third, smaller jetty (known as Jetty 3) was commissioned in 2009 and extends to the west from Jetty 2, which has a 5.8m long concrete platform that supports a pipe manifold arrangement and other ancillary equipment. **Figure 1.3.3** provides an overview of the location of the three jetty structures at Marsden Point.

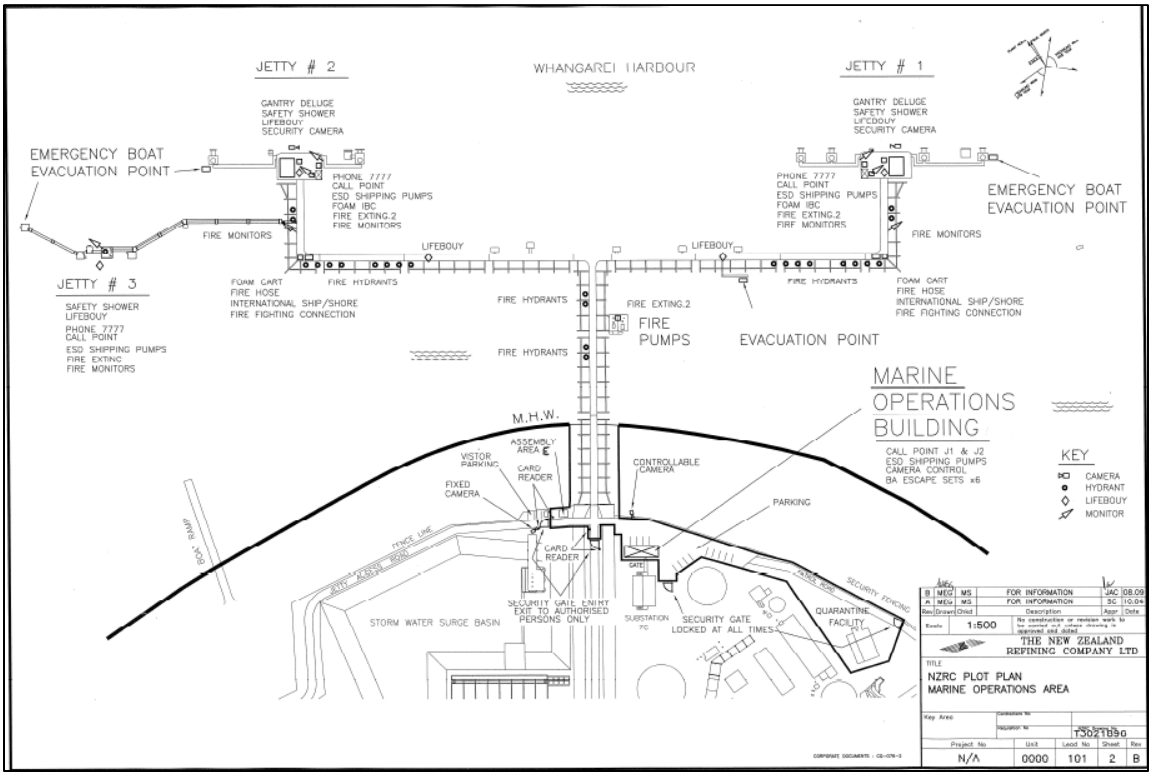


Figure 1.3.3: Marsden Point Refinery Jetties[3]

Jetties 1 and 2 receive both feedstock and blendstock, and are also used for loading black and white products. However, Jetty 1 cannot load Kerosene and Jet fuel, but is rather used (primarily) for the receipt of crude oil. All grades of bunker fuel can be loaded from these two jetties. Jetty 3 is utilised for loading Gasoil and various grades of Fuel oil.

Table 1.3.1 provides details of the capabilities of each of the three jetties below.

[3] AO6, page 21, section 13, "Refining NZ Port and Terminal Handbook"; Dated 15 February 2017

Capabilities	Jetty 1	Jetty 2	Jetty 3
Maximum length of visiting vessels	275.0m	220.0 m	79.9 m
Minimum length of visiting vessels	125.0m	175.0 m	26.0 m
Maximum displacement	162,500 tonnes	65,000 tonnes	5,668 tonnes
Minimum size of vessel	15,000 S.D.W.T[4]	15,000 S.D.W.T	N/A

Table 1.3.1: Refinery NZ Jetty Capabilities[5]

Of note is that Refining NZ has recently completed a small dredging project associated with the mooring 'dolphins' that extend to the West of Jetty 1. This dredging project enables the dolphins to accommodate the vessels that presently visit the Refinery, and saw the removal of 4,980 cubic metres ('**m^3**') of sediment. 1,500m^3 of the removed sediment was brought back to Refining NZ for the purposes of foreshore replenishment, with the remaining amount discharged to Port Nikau.

Navigation of vessels to Whangarei Harbour, and more specifically, the Refinery, is enabled through a completely buoyed and lit channel that is five nautical miles ('**nm**') long. Navigation is assisted by the Dynamic Under-Keel Clearance system which integrates real-time measurement of tide height and waves with modelled vessel motions in order to determine if a proposed transit for a particular vessel meets pre-determined under keel clearance safety criteria. The approach to the Refinery has a shallowest depth of 14.7m below CD. From a navigational perspective, the most critical buoys are as follows:

- Fairway Buoy: The most outermost buoy for approaching and departing ships; approach alignment marked by leading beacons;
- Buoy No. 6: Adjacent to Busby Head which forms the outermost land extent; change in channel alignment;
- Buoy No. 7: Adjacent to Home Point, which is considered a 'pinch point' in the channel; change in channel alignment;
- Buoy No. 14: Adjacent to Mair Bank area; change in channel alignment; and,
- Snake Bank Beacon: Adjacent to Marsden Point; alignment marked by leading beacons.

Between Fairway Buoy and Snake Bank Beacon, there are currently five channel alignments with two of those alignments (the inner and outer-most of the above) marked by leading beacons.

Given the Site is located within the CMA, there is no legal description and, in accordance with the MACA the Site is not owned by anyone. In saying that, a number of parties do manage the Site, including the Crown, the Regional Council, DoC and Tangata Whenua.

Tangata whenua places significant values on the CMA within the Site, as identified in detail within the Cultural Values Assessment ('**CVA**'), which was prepared by Patuharakeke Te Iwi Trust Board

[4] S.D.W.T stands for the Summer Dead Weight Tonnage, which refers to the weight in metric tons of cargo stores, fuel, passengers and crew carried by a ship when loaded to its maximum summer load line.
[5] AO6, pages 14 to 15, section 8.2, "Refining NZ Port and Terminal Handbook"; Dated 15 February 2017

(hereafter referred to as '**Patuharakeke**') on behalf of Nga Kaitiaki / Tangata Whenua o Whangarei Te Rerenga Paraoa, and summarised further in section 2.9 of this Report. The CVA details the extensive Tangata Whenua engagement process managed by the Company and identifies the interested hapu and iwi in the area, ecological values, cultural landscapes and seascapes, waahi tapu, mahinga mataitai and relevant Statutory Acknowledgements[6]. We note, for completeness, that Patuharakeke has also prepared a draft Cultural Effects Assessment ('**CEA**'), which is summarised in section 3.12 of this Report. Copies of both the CVA and draft CEA are attached in **Annexure Two**.

Several public conservation areas are located in close proximity to the Site. These include:

- Public conservation land, including scenic reserves, at Bream Head, Ruakaka, Marsden Point and Whangarei Heads;
- Priority ecosystems (at Bream Head);
- Gateway destinations (Bream Head Tracks);
- Blacksmiths Creek;
- Wildlife refuge areas (Ruakaka and Waipu Recreation Reserves); and
- Marine reserves (Whangarei Harbour Marine Reserve).

1.4 Background

Current deep water access to Marsden Point from Bream Bay is via a natural tidal inlet that is five nm long, is completely buoyed and lit, and varies in depth from 14.7m to 32m. We understand that this depth is adequate for vessels visiting the Northport log berth, which requires 14.5m clearance. However, crude shipments to the Refinery are currently brought to the Site via smaller fully loaded Aframax ships and larger partially loaded Suezmax ships. The Suezmax ships are partially loaded in order to safely and efficiently clear the shallower parts of Whangarei Harbour's tidal inlet.

The typical Aframax tanker that visits the Site has an overall length of 243m, a width of 43m and when fully laden with around 700,000 bbls, a draught of 14.7m. A Suezmax tanker has an overall length of 276m and a maximum width of 50m. When partially loaded with up to 120,000 tonnes of crude oil, a Suezmax tanker typically has a draught of 14.7m, while fully laden it has a draught of 16.6m.

Refining NZ are seeking to increase the amount of crude oil that can be brought to the Refinery on Suezmax tankers. This will enable more effective transport of crude, and will assist in sustaining Refining NZ's overall competitiveness with overseas refineries and the long-term sustainability of its business.

As we shortly set out, Refining NZ first sought to identify the means by which fully laden Suezmax tankers could discharge full (or close to full) loads to the Refinery. Having assessed those broad alternatives, dredging of the entrance channel was identified as the preferred approach. This led Refining NZ to commission an extensive range of investigations to better understand and

[6] A statutory acknowledgement is an acknowledgement by the Crown that recognises the mana of a Tangata Whenua group in relation to specified areas - particularly the cultural, spiritual, historical and traditional associations with an area. These acknowledgements relate to 'statutory areas ' which include areas of land, geographic features, lakes, rivers, wetlands and coastal marine areas, but are only given over Crown-owned land. Definition sourced from "Quality Planning website", http://www.qualityplanning.org.nz/index.php.

characterise the existing environment and to identify possible dredge and disposal options. This was followed by more detailed studies, investigations and analysis to refine the understanding of how the dredge and disposal options would affect the environment and to develop more preferred options that were ultimately refined to represent the Proposal.

After consideration of tide and wave conditions, navigation safety and manoeuvrability for a range of possible channel configuration alternatives, three channel options that provided safe all tide and 98% of wave condition access were shortlisted for more detailed assessment – including maritime risk assessment workshops involving the Harbourmaster, tugboat pilots, Refining NZ staff and independent experts[7]. Following that detailed assessment, the preferred option, both in terms of navigation safety and overall environmental effects, is Option 4.2. This option limits the majority of dredging to the establishment of a deeper channel within the existing channel in the outer reaches seaward of Home Point, which reduces potential environmental impacts and costs by not having to dredge to the full width of the outer channel, with targeted dredging at selected areas in the mid and upper parts of the channel and at the Refinery berth. In very simple terms, the dredging 'straightens' the existing channel to improve navigation and avoids dredging close to sensitive areas at the channel edges.

A similar exercise was undertaken to evaluate potential areas to place the dredged sediments. A range of adjacent and distant deep-water (greater than 60m water depth), intermediate water depth (30m to 60m) and shallower water depth disposal areas were considered by both desktop and physical surveys, together with land based disposal options. Two disposal options are preferred, as previously introduced in section 1.3 of this Report, and reiterated now, being Disposal Site 3.2 and Disposal Site 1.2.

We understand that the environmental assessments have been undertaken on the basis that up to 97.5% of the sediment from the Capital and Maintenance Dredging campaigns could be made available for land disposal. Refining NZ has not advanced any firm plans for land-based disposal. However, if there is a demand, and the party receiving the sediment has all of the necessary resource consents in place, sediment up to this volume can be supplied from Capital and Maintenance Dredging campaigns that are proposed. The relevant assessments of potential effects have been conservatively based on the full amount of dredged material being disposed at the offshore locations.

A plan of the area to be dredged and the location of the marine disposal areas is shown in **Figure 1.4.1**, and includes the areas of significance in the vicinity of the work areas.

[7] The Maritime Risk Assessment was held on the 17th of April 2015 and attended by representatives from RHDHV, Refining NZ, NorthTugz Limited, Northport, and the Harbour Master.

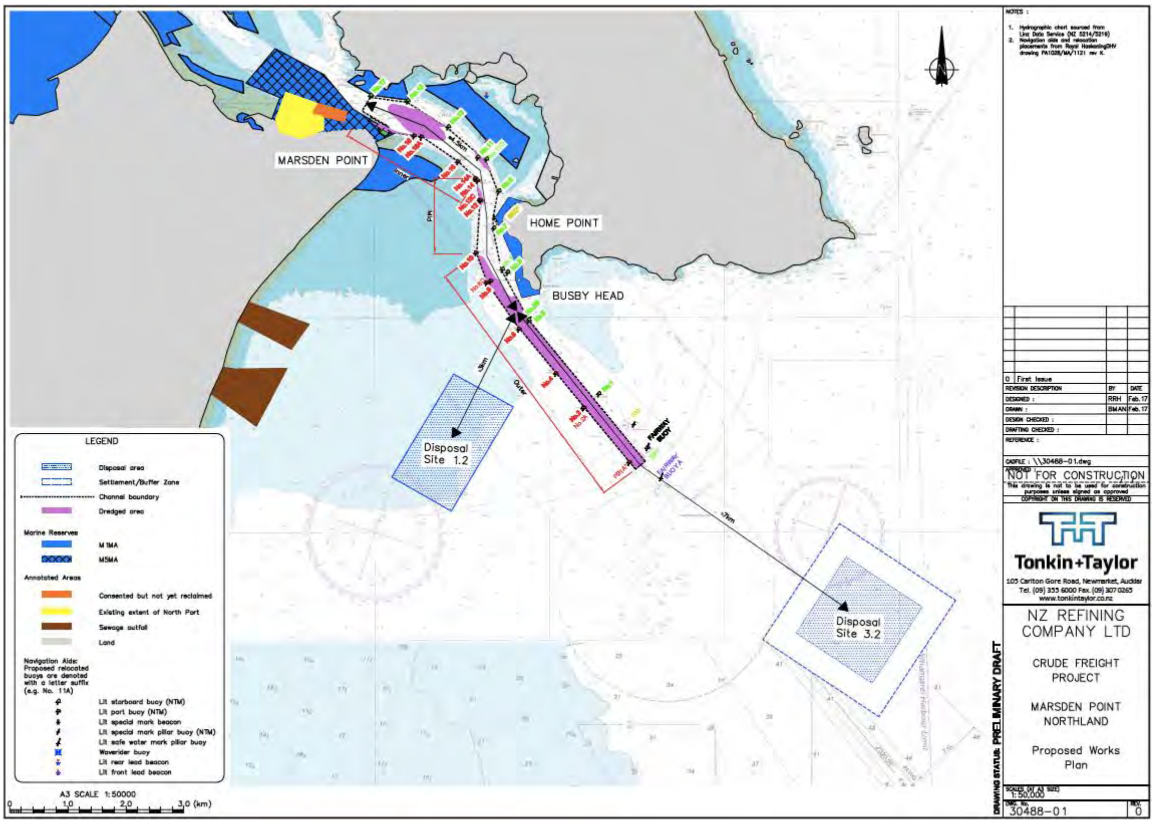


Figure 1.4.1: Proposed Works Plan[8]

1.5 The Proposal

The Proposal comprises five separate but interrelated components, being:

6. The initial dredging of the approaches to the Whangarei Harbour (including some realignment of the same), and the 'pocket' next to the Marsden Point Jetty (hereafter referred to as '**Capital Dredging**');
7. The dredging of the Harbour entrance and jetty pocket to maintain its depth (hereafter referred to as '**Maintenance Dredging**');
8. The disposal of the dredged material (from both Capital Dredging and Maintenance Dredging) to two locations in Bream Bay;
9. The type of vessels (and their operations) that could be used to undertake components (1) to (3) above (hereafter referred to as the '**Dredging Methodology**'); and
10. Changes to the Aids to Navigation ('**Navaids**') within the Whangarei Channel to facilitate the safe passage of vessels into and out of the Whangarei Harbour.

The details of the five components, and the construction and operation of the same, are set out in the reports listed in **Table 1.5.1**, which follows. Please note that copies of these reports are contained in **Annexure Two** of this AEE.

[8] Reinen-Hamill, R, page 3, section 1.2, "Dredging and Disposal Options – Synthesis Report", Dated July 2017

Technical Assessment	Principal Author(s):	Company / Organisation:
Shipping Channel – Concept Design Report – Dated 12th November 2016	Justin Cross, Matt Potter and Richard Mocke	RHDHV
Technical memo – Dredging Control Measures, Dated 2nd December 2016	Justin Cross	RHDHV
Dredging and Disposal Options – Synthesis Report, Dated July 2017	Richard Reinen-Hamill	T&T

Table 1.5.1: Technical Reports Detailing the Design of the Proposal

We now discuss the five components of the Proposal. In addition, section 1.5.17 provides a breakdown of the mitigation and avoidance measures that are to be implemented throughout the Proposal, while section 1.5.18 sets out the proposed monitoring programmes.

1.5.1 Capital Dredging

To allow fully laden Suezmax tankers to access the Refinery, Capital Dredging is required to establish a channel that is a minimum of 16.8m deep at low tide (noting that the outer sections of the channel are approximately 19m deep), including an over-dredge allowance of 0.3m. Channel width will vary from 210m to 280m wide. To achieve this minimum depth and width along the length of the proposed channel alignment, it is estimated that approximately 3,620,200m^3 (rounded up to 3,700,000m^3 for the purposes of this AEE and the associated resource consent applications) of sediment must be dredged from an area of approximately 1.44km^2 within the Whangarei Harbour channel. For completeness, the total area of the channel is approximately 3.9km^2 (in other words, only 'targeted' dredging will occur within the channel in order to achieve the minimum depth of 16.8m).

For the purposes of calculating dredging volumes, the Whangarei Harbour and Channel has been divided into three sections, being the inner (including the jetty pocket to the eastern extent of Mair Bank), the middle (between the end of Mair Bank and the southern end of Home Point) and the outer channel, as shown in **Figure 1.5.1** below. The approximate length of each channel section is as follows:

1. Inner-section: 2.4km;
2. Mid-section: 1.2km; and
3. Outer-section: 4.7km.

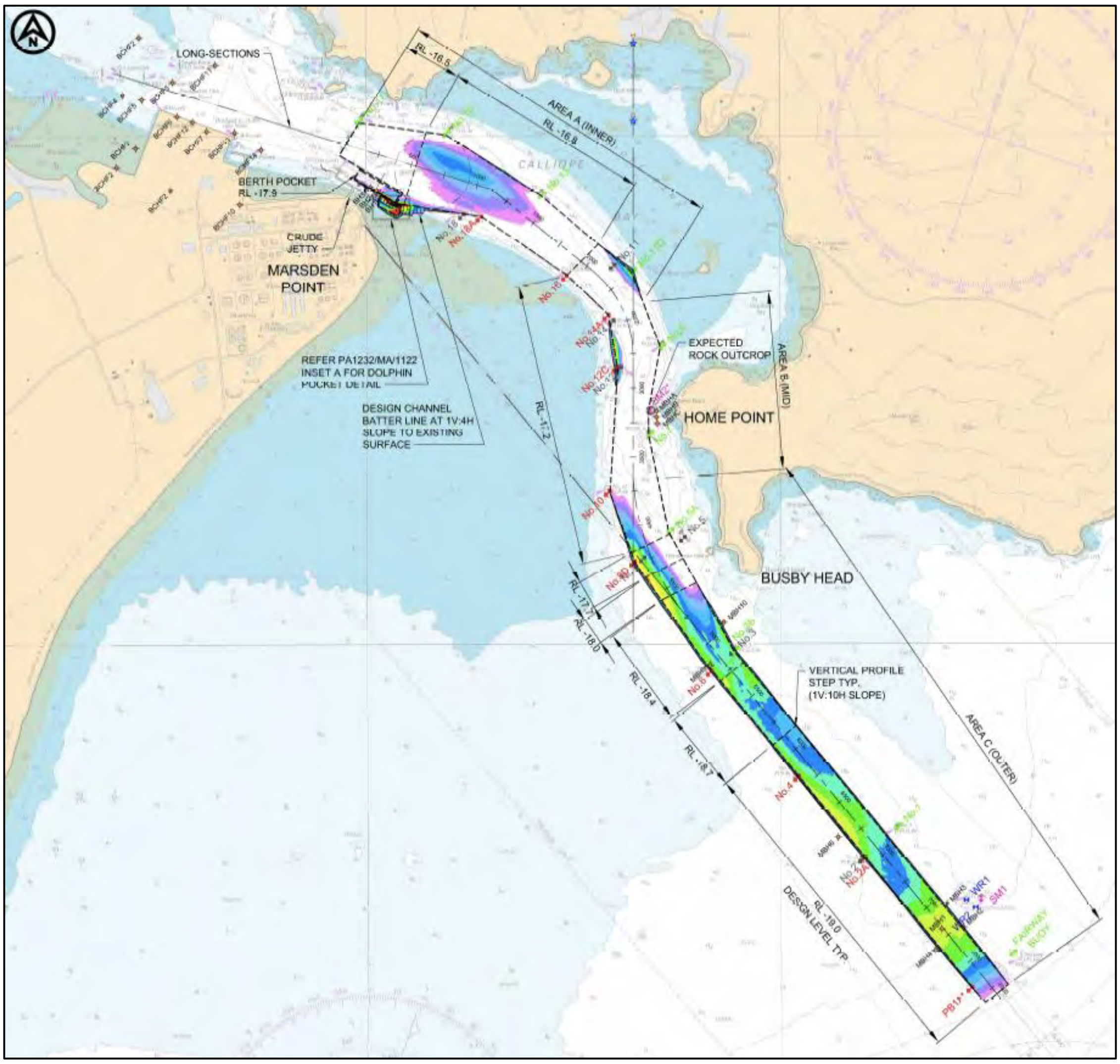


Figure 1.5.1: Channel Dredging Footprint (Option 4.2)[9]

The volumes of material that are required to be removed by Capital Dredging are set out in **Table 1.5.1** that follows.

Channel Area	Volume (m³)
Inner section A – Berth Pocket and Dolphin Area	153,000
Inner section B – Turning circle shoal	397,500
Inner section C – Channel edge – Ebb Tide Delta	43,400
Inner section D – Channel edge – Calliope Bank	57,200
Outer channel E – Port Buoy 10 to 6	851,500
Outer channel E – Port Buoy 6 to end	2,117,600
Total Volume & Area of the Capital Dredging	**3,620,200**

Table 1.5.1: Estimated Capital Dredge Volumes (including over-dredging)[10]

[9] "RHDHV Technical Memo – Dredging Methodology Assessment", Dated 11th August 2016, contained within Appendix A of the Reinen-Hamill, R, "Dredging and Disposal Options – Synthesis Report"; Dated July 2017

[10] Reinen-Hamill, R, page 5, section 2.1.1, "Dredging and Disposal Options – Synthesis Report", Dated July 2017

We note that the Capital Dredging volumes in **Table 1.5.1** include an allowance for the potential siltation of the channel and overdredging. In this regard, a siltation allowance of 0.5m in the outer section from Marker No.5, 0.3m in the inner section, and 0.37m at the Jetty Berth was added to the proposed channel depths. We understand that such allowances are common place, and reflect that the channel can fill during and following the dredging activity. The 0.5m allowance in the outer channel reflects that it is subject to greater rates of sedimentation due to it being more exposed to the weather. A lesser (0.3m) allowance is provided in the inner channel as it is less exposed[11].

It is proposed to undertake the Capital Dredging 24 hours per day, seven days per week, subject to suitable weather conditions, the results of the turbidity monitoring that is proposed, and the noise restrictions that Refining NZ are proposing as a consequence of the advice of Mr Styles[12]. It is expected that the Capital Dredge campaign will be undertaken in one stage that lasts up to six months.

1.5.2 Maintenance Dredging

Once the Capital Dredging has been completed, we understand that sedimentation rates within the entrance channel are expected to be in the range of 56,000m^3 and 122,000m^3 per year[13]. We understand that the majority of this sedimentation is expected during the first few years following the completion of the initial Capital Dredging works, before the system settles into a more balanced equilibrium.

The main areas of sedimentation are expected to occur in the vicinity of the berth pocket and at the outer section of the channel where the majority of Capital Dredging has occurred. In the berth pocket, we understand that sedimentation will occur as sand is transported over Mair Bank from the southern part of the ETD, a process that takes place today. The expected volume of sedimentation per annum in each section of the channel is detailed in **Table 1.5.2.1** below.

Location	Annual sedimentation range (m^3/year)	
	Lower Bound	Upper Bound
Inner section A – Berth Pocket	600	1,200
Inner section A – Dolphin Area	2,400	4,800
Inner section B – Turning circle shoal	3,000	6,000
Inner section C – Channel edge – Ebb Tide Delta	3,000	6,000
Inner section D – Channel edge – Calliope Bank	5,000	9,000
Outer channel E – Port Buoy 10 to 6	7,500	20,000
Outer channel E – Port Buoy 6 to end	34,500	75,000
Total	**56,000**	**122,000**

Table 1.5.2.1: Estimate of sedimentation rates[14].

[11] Cross, J, page 7, section 2.2.3, "Refining NZ Crude Shipping Project Shipping Channel – Concept Design Report", Dated 12 November 2016
[12] We discuss the noise restrictions recommended by Mr Styles in sections 1.5.17.4 and 1.5.18.4 of this AEE, but the restrictions are discussed within: Styles, J, "Whangarei Harbour Entrance and Marsden Point Channel Realignment and Deepening: Assessment of Environmental (Airborne) Noise Effects", Dated 31 July 2017.
[13] Reinen-Hamill, R, page 5, section 2.1.2, "Dredging and Disposal Options – Synthesis Report"; Dated July 2017
[14] Reinen-Hamill, R, Table 2, "Assessment of possible annual dredging regime – Memorandum"; Dated 27 June 2017

Mr Reinen-Hamill has estimated that Maintenance Dredging will be required once every 2 years over the first 6-year period, before ranging from every three to 10 years for the following 6 to 20 years[15]. We understand that recurrent (annual) surveys of the channel and harbour entrance bathymetry will ultimately determine when and where Maintenance Dredging is undertaken. Each Maintenance Dredging campaign is estimated to take in the order of three to six months.

Like the Capital Dredging, it is proposed to undertake Maintenance Dredging 24 hours per day, seven days per week, subject to suitable weather conditions and achieving the turbidity and noise restrictions proposed[16]. This dredging activity will occur until the necessary volumes of sediment have been removed in order to provide a minimum depth of 16.8m throughout the Channel (again noting that some portions of the channel are more than 19m deep). The length of time that the recurrent Maintenance Dredging campaigns will take will depend on the volume needing to be dredged and the vessel that is used to do the dredging.

1.5.3 Disposal of Dredged Material

Both the Capital Dredging and, to a significantly lesser degree, the Maintenance Dredging, will require the disposal of dredged material in to the CMA and/or to land. Please note that flexibility in the volume of material to be disposed at specific locations is sought in this application.

Any dredged material that is disposed to the CMA will be placed in either of the two marine disposal areas, being 'Disposal Area 3.2' and 'Disposal Area 1.2' - as shown in **Figure 1.5.3.1**, or to land should suitable sites be identified and possess the necessary environmental authorisations.

[15] Reinen-Hamill, R, Table 2, "Assessment of possible annual dredging regime – Memorandum"; Dated 27 June 2017

[16] Styles, J, "Whangarei Harbour Entrance and Marsden Point Channel Realignment and Deepening: Assessment of Environmental (Airborne) Noise Effects", Dated 31 July 2017

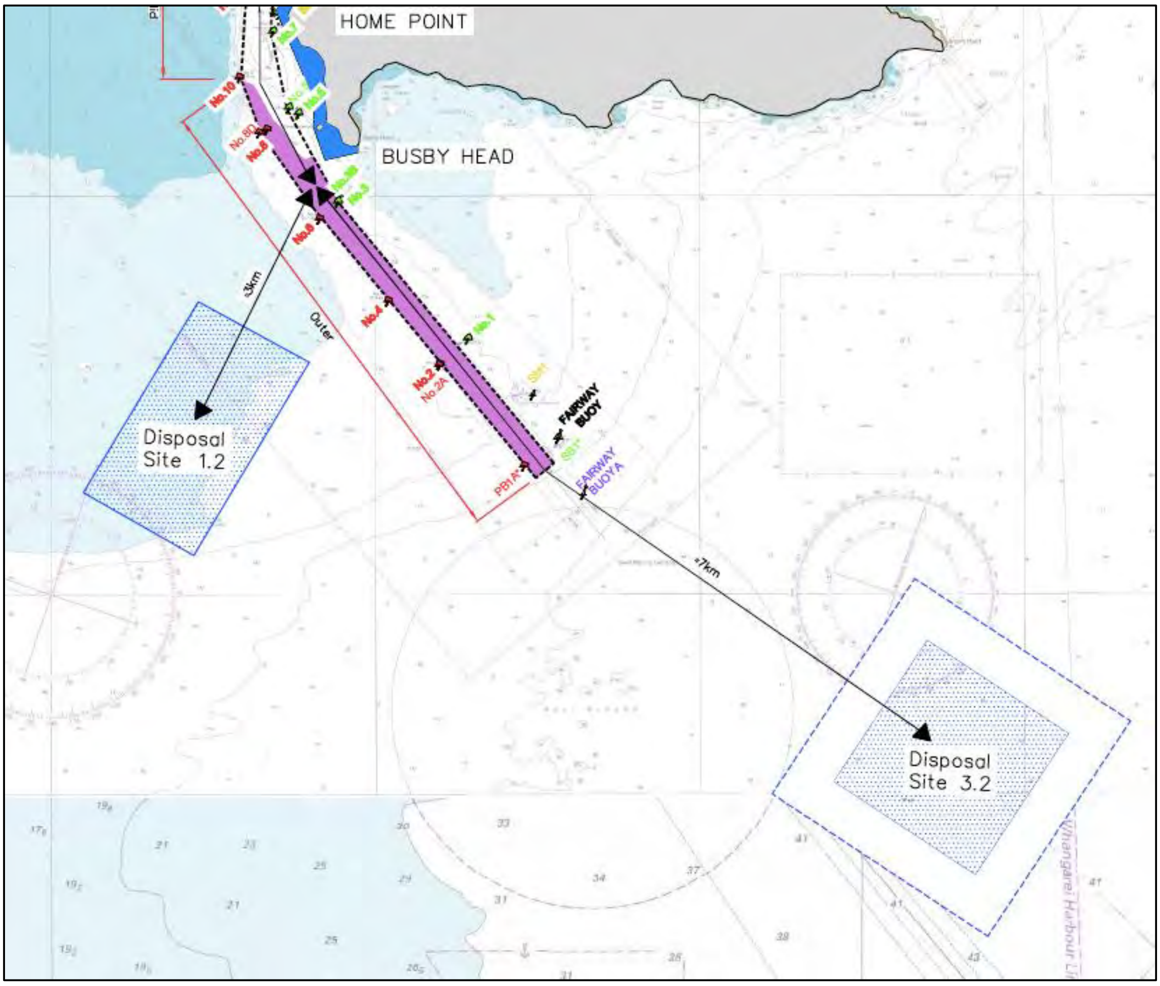


Figure 1.5.3.1: Location of Marine Disposal Areas[17]

We now discuss the disposal locations.

1.5.4 Disposal Area 3.2

Mr Reinen-Hamill[18] advises that Disposal Area 3.2 has been conservatively sized to enable **all** Capital Dredging and Maintenance Dredging to be disposed within this area for the duration of the maximum consent period allowed (being 35-years). Notably, however, Refining NZ propose to limit the amount of the dredged sediment that can be disposed to Disposal Area 3.2 to a maximum of 97.5% of the dredged volume. In that regard, at least 2.5% of the dredged volume must be placed in Disposal Area 1.2. We come back to that consideration shortly.

The depth of the water at Disposal Area 3.2 is approximately 45m below CD, although it varies.

The total size of Disposal Area 3.2 is 5.75km^2. This, however, includes the outer boundary of where the placed sediment is expected to settle over time. The area of placement of dredged material in Disposal Area 3.2 is approximately half of that area, being 2.5km^2. If the sediment that is discharged at this location is uniformly distributed, the average height of the placement mound, after the Capital

[17] Reinen-Hamill, R, page 3, section 1.2, "Dredging and Disposal Options – Synthesis Report", Dated July 2017
[18] Reinen-Hamill, R, pages 5 to 6, section 2.2, "Dredging and Disposal Options – Synthesis Report", Dated July 2017

Dredging campaign, is expected to be approximately 1.5m. It is possible, however, that targeted disposal could occur, which in turn would result in a maximum placement height of not more than 4.0m (which equates to, in approximate terms, 9% of the existing water depth). We note Mr Reinen-Hamill's[19] advice that this maximum placement height is conservative and based on the following assumptions:

1. The upper rate of predicted annual sedimentation;
2. All Maintenance Dredging sediment will be placed in this area; and
3. No settlement or loss of material from this area occurs over the maximum consent period of 35 years.

In summary, the maximum volume of material that may be placed in Disposal Area 3.2 during the Capital Dredging works is 3,607,500m^3 (being 97.5% of 3,700,000m^3). The projected volume of material that could be placed in Disposal Area 3.2 during Maintenance Dredging is up to 122,000m^3 per campaign[20], although the precise number can only be determined once the annual surveys of the bathymetry following the Capital Dredging Campaign, and once the needs of the ETD are known.

1.5.5 Disposal Area 1.2

A minimum of 2.5% (and up to 5%) of the material removed during the Capital Dredging Campaign will be placed within Disposal Area 1.2. This disposal area is also likely to be used during the Maintenance Dredging campaigns. In that regard, should there be a need, the Refining NZ wishes to be able to dispose of all of the dredged sediment at Disposal Area 1.2 during a Maintenance Dredging campaign.

Disposal Area 1.2 is a 2.5 km^2 area of seabed situated on the southern end of the ETD. The water depth at this site is between 7.0m and 15m below CD[21]. Disposal Area 1.2 has been sized to enable different locations to be targeted for the placement of Capital Dredging and Maintenance Dredging sediment, so as to improve the resilience of the ETD to both the changes brought about by the Proposal, and the expected consequences of sea level rise.

Disposal Area 1.2 was chosen to enable any disposed sediment to be slowly transported landward during higher energy wave events to maintain sediment volumes on the ebb delta. If the dredged sediment from the Maintenance Dredging Campaign is placed uniformly in this area, the average depth would be around 0.06m. However, it is more likely that there would be a smaller area targeted within this larger area during each campaign, with average placement depths of around 0.6m.

In summary, up to 185,000m^3 (or up to 5% of all dredged sediment) may be placed in Disposal Area 1.2 during the Capital Dredging works. All of the material dredged during a Maintenance Dredging campaign (or up to 122,000m^3) may be placed in Disposal Area 1.2.

[19] Reinen-Hamill, R, page 6, section 2.2, "Dredging and Disposal Options – Synthesis Report", Dated July 2017
[20] Reinen-Hamill, R, pages 5 to 6, section 2.1.2, "Dredging and Disposal Options – Synthesis Report", Dated July 2017
[21] Reinen-Hamill, R, page 6, section 2.2, "Dredging and Disposal Options – Synthesis Report", Dated July 2017

1.5.6 Land Based Disposal Areas

As we have previously highlighted, all but 2.5% of the dredged sediment from the Capital Dredging Campaign could also be provided to alternative land based locations. Some possible uses are beach replenishment (around, for example, Marsden Point/One Tree Point/Ruakaka) and Northport's proposed reclamation works that are not the subject of this application. It has been estimated, as an example, that up to approximately 25% of the dredged volume could be utilised for Northport's consented reclamation[22]. However, it is possible that other land based uses could arise, and Refining NZ does not wish to prematurely foreclose on those options, particularly given the indications that some within the community prefer land based disposal.

It is possible that sediment from the Maintenance Dredging campaigns may also be directed to a land-based disposal option. Should this be the case, it would only occur if there is no need for the sediment on the ETD. In that regard, the requirements of the ETD would take precedence over the disposal of the sediment to land.

Should dredged sediment be disposed of to land, it will occur in accordance with resource consents secured by the party that is receiving the sediment.

In summary, up to 97.5% of the dredged volume (from the Capital Dredging Campaign) may be disposed of on land, although approximately 900,000m^3 (or 25% of the dredged volume) is considered the realistic upper bound based on what is known of the existing demand for sediments. The maximum volume of material that may be disposed of to land during Maintenance Dredging is 122,000m^3, but that is prefaced on the basis that only the volume of sand not needed for the ETD may be disposed of to land during the Maintenance Dredging campaigns.

1.5.7 Dredging Methodology

While the final selection of the dredging methodology will be made by the company commissioned for each dredging campaign, it is expected that the majority of the dredging in the Whangarei Channel is to be undertaken by a Trailing Suction Hopper Dredger ('**TSHD**'). However, dredging in shallow water or in more inaccessible areas, such as around Refining NZ's Jetty, is likely to require a Barge Mounted Backhoe Dredger ('**BHD**') or Cutter Suction Dredger ('**CSD**'). We now discuss each of the dredge types, their suitability for the associated works, any necessary supporting vessels and the various control measures that could be implemented to avoid, remedy and mitigate any potential turbidity effects as a result of the Proposal.

1.5.8 Trailing Suction Hopper Dredger

As we have already noted, a TSHD is expected to undertake the majority of the dredging for the Proposal. An example of a TSHD is shown in **Figure 1.5.8.1**

[22] Cross, J, page 11, section 6, "RHDHV Technical Memo – Dredging Methodology Assessment", Dated 11th August 2016, contained within Appendix A of the Reinen-Hamill, R, "Dredging and Disposal Options – Synthesis Report"; Dated July 2017

Figure 1.5.8.1: Example of a TSHD[23]

TSHDs are self-propelled ships with in-built hoppers. TSHDs utilise articulated dredging pipes or 'drag-arms' that extend to the sea bottom and dredge material through a 'drag-head' while moving at very low speeds. The weight of the drag system ensures that the drag-head maintains contact with the seabed at all times. The suction generated by the TSHDs pump entrains the disturbed material and discharges it into the internal hopper. Solid material settles to the base of the hopper, with any water overflowing and discharging into the same environment where it was taken. We note that some of the very fine dredged material may still be entrained in the overflow water from the hopper.

The time required to fill the hopper and the resulting volume of sediment in the hopper depends on the types of sediment and dredge depth. The greater the depth, or denser the material, the longer it will take to fill the hopper. As we set out in more detail in section 2.1.6.1 of this AEE, the Site consists of predominantly medium and fine sands with low silt content (less than 6%)[24]. This will, we understand, increase the operational efficiency of filling and will significantly reduce both the extent of turbid plumes during dredging and placement of sediment in the two marine disposal areas.

When the loading of the vessel with dredged sediment is complete, the TSHD will proceed to the designated Disposal Area(s) described in section 1.5.3 of this AEE. During sailing to the Disposal Area(s), the watertight bottom doors of the hopper remain sealed. The maximum distance that the TSHD will travel is approximately 11.5km, which is the distance from the centre of Disposal Area 3.2 to the Refinery Jetty. For completeness, we note that the distance from Busby Point, being the approximate centre point of the Site of the dredging works, to the centre of Disposal Area 3.2, is

[23] Cross, J et al, RHDHV, "Technical Memo – Dredging Methodology Assessment", Dated 11th August 2016, contained within Appendix A of the Reinen-Hamill, R, "Dredging and Disposal Options – Synthesis Report"; Dated July 2017
[24] Reinen-Hamill, R, page 11, section 5.2.1.1, "Dredging and Disposal Options – Synthesis Report", Dated July 2017

approximately 7km. The distance from Busby Head to the centre of Disposal Area 1.2 is approximately 3km. The distance from Busby Head to the Refinery Jetty is approximately 4.5km[25].

We understand that when the TSHD reaches the marine disposal area it reduces speed and manoeuvres itself via GPS to the allocated area where the load can be discharged. When the vessel is at the correct location, the material is discharged either through doors, valves or, in the case of a split-hulled vessel, out of the bottom when the hull is longitudinally split. Alternatively, dredged material may be pumped from the hoppers through discharge lines to shore-based placement sites, for eventual disposal to land.

Once the TSHD hopper is empty, the dredge-master closes the hopper doors and the vessel sails back to the dredging areas and the cycle repeats until the channel is dredged to the required levels.

Mr Reinen-Hamill[26] notes that the size of the TSHD vessel to complete this work, based on hopper capacity, is likely to be between 1,800m^3 and 8,500m^3. These are generally regarded as being small to medium dredge vessels. Given the size of the vessel, production times and rates for the range of TSHD have been developed by Mr Cross. We understand his advice to be that a TSHD at this Site will have a full operational cycle (from the commencement of dredging to disposal and return to the dredging site) of between 110 to 180 minutes. This will enable some 55 and 90 dredging and disposal operations per week.

1.5.9 Backhoe Dredge

BHDs are mechanical dredges that consists of an excavator mounted on a barge. A BHD utilises a 'bucket shovel' to extract sediment directly from the seabed before placing it directly into the discharge site, or more commonly, onto temporary storage platform. The temporary storage platform (barge) is then typically used to transport the material to a discharge site. We understand, however, that sometimes the temporary storage platform will stay on site and the material is re-handled (which could involve pumping the sediment through a pipeline or transferring it to a truck or barge for transport to another location). An example of a BHD is shown in **Figure 1.5.9.1.**

[25] Reinen-Hamill, R, page 14, section 5.2.1.2, "Dredging and Disposal Options – Synthesis Report", Dated July 2017
[26] Reinen-Hamill, R, page 11, section 5.1, "Dredging and Disposal Options – Synthesis Report", Dated July 2017

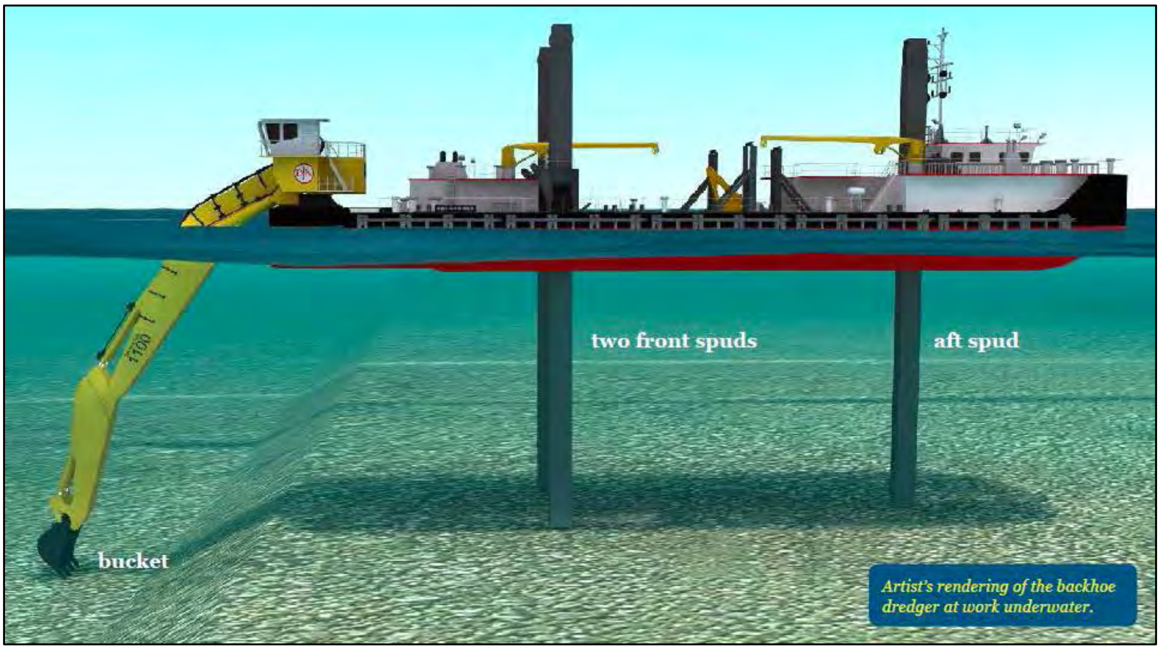


Figure 1.5.9.1: Example of a BHD[27]

A BHD operates from a fixed location. To ensure the stability of any BHD, and to counter the digging forces of the BHD, the pontoon on which the BHD sits is anchored (and its position maintained) by 'spud poles'. Spud poles are generally straight steel anchors that fix to the seabed directly below the pontoon. Lateral anchors are not usually required for stability.

The maximum depth that can be achieved with the largest BHDs is approximately 30m.

In this instance, a BHD is required for at least the dredging around the Refinery's jetties. We understand that it is very unlikely that a BHD would be used for the bulk of this dredging activity[28]. We further understand that the material dredged by a BHD in this instance would either be placed in a barge for marine disposal at sites 1.2 and/or 3.2, or discharged to land (via pipelines)[29].

Mr Cross[30] advises that BHD's typically operate in the following manner:

1. The excavator bucket is lowered into the water;
2. The bucket is filled by dragging it through the material to be dredged. During this process, the bucket is also tilted to prevent dredged material from falling out of the bucket;
3. The bucket is lifted out of the water;
4. The excavator swivels and dumps the contents of the bucket into a barge; and
5. The excavator swivels back and the process restarts.

---

[27] Cross, J et al; RHDHV, "Technical Memo – Dredging Methodology Assessment", Dated 11th August 2016, contained within Appendix A of the Reinen-Hamill, R, "Dredging and Disposal Options – Synthesis Report"; Dated July 2017
[28] Reinen-Hamill, R, page 12, section 5.2.2, "Dredging and Disposal Options – Synthesis Report", Dated July 2017
[29] Reinen-Hamill, R, page 12, section 5.2.2, "Dredging and Disposal Options – Synthesis Report", Dated July 2017
[30] Cross, J et al, "Technical Memo – Dredging Methodology Assessment", Dated 11th August 2016, contained within Appendix A of the Reinen-Hamill, R, "Dredging and Disposal Options – Synthesis Report"; Dated July 2017

A typical bucket capacity ranges from 4.0m^3 to 11.0m^3, while the barge capacity that is likely to be used will be in the order of 500m^3 to 1,000m^3. We understand that any barge used in tandem with a BHD in this instance that is used by a BHD will be split hull for ease of disposal[31].

Mr Cross[32] advises that the production times and rates for the BHD vary between 300m^3 to 500m^3 per hour. Based on this production rate, the proposed dredging of the berth pocket is expected to take up to two months to complete.

Due to the location of the BHD works adjacent to land, any dredging works it undertakes would only, we understand, occur during daylight hours (being 0700 to 1900). The operations would, however, extend over seven days per week[33].

1.5.10 Cutter Suction Dredge

CSD use rotating mechanical devices (cutter heads) to break material (in this instance, sediments) into pieces, which are then drawn into the suction pipe as water slurry and pumped to a discharge point. CSDs are characterised by production rates that are higher than BHD's, but lower than TSHDs. An example of a CSD is shown in **Figure 1.5.10.1**.

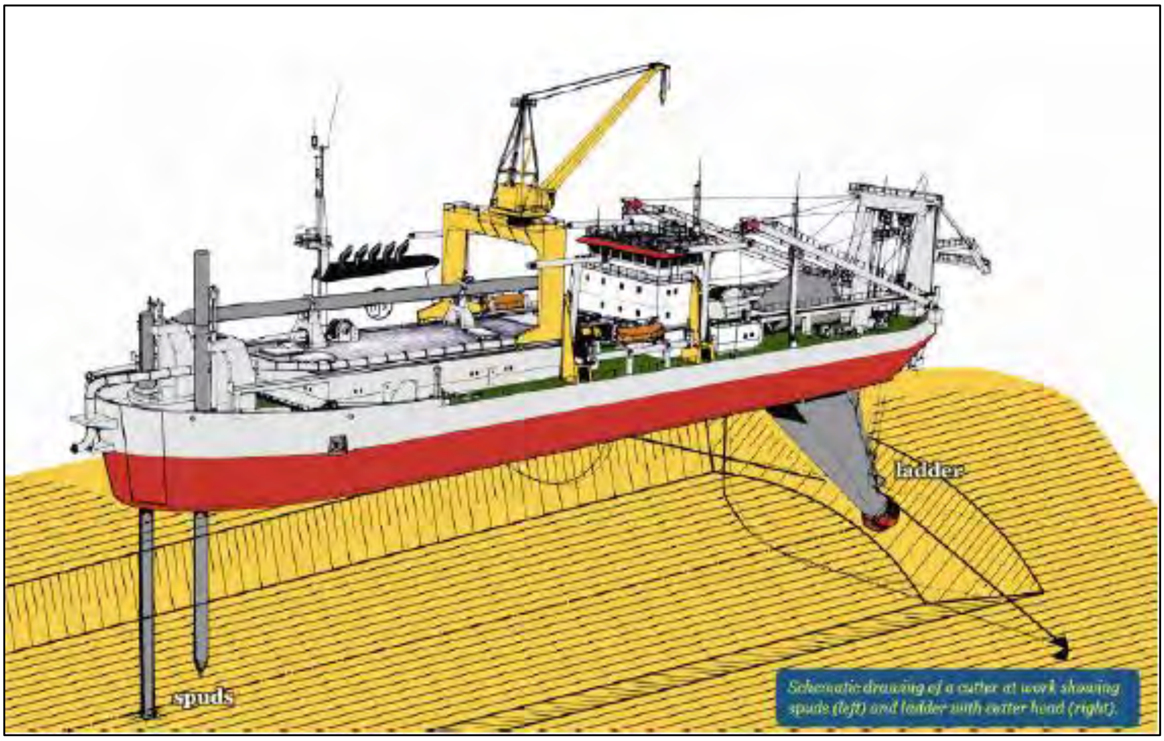


Figure 1.5.10.1: Example of a CSD[34]

A CSD generally uses anchors to secure the vessel to the seabed while it is operating. While a CSD may require a vessel to tow it, some of the larger dredgers are self-propelled. Given that a CSD

[31] Reinen-Hamill, R, page 12, section 5.2.2, "Dredging and Disposal Options – Synthesis Report", Dated July 2017
[32] Cross, J et al, "Technical Memo – Dredging Methodology Assessment", Dated 11th August 2016, contained within Appendix A of the Reinen-Hamill, R, "Dredging and Disposal Options – Synthesis Report"; Dated July 2017
[33] Reinen-Hamill, R, page 12, section 5.2.2, "Dredging and Disposal Options – Synthesis Report", Dated July 2017
[34] Cross, J et al, "Technical Memo – Dredging Methodology Assessment", Dated 11th August 2016, contained within Appendix A of the Reinen-Hamill, R, "Dredging and Disposal Options – Synthesis Report"; Dated July 2017

needs to be fixed in one position, it is only likely to be considered for the dredging around the berthing pocket and in the inner and mid-channel areas, or for the recurrent Maintenance Dredging campaigns. If a CSD is used at the Site, it could discharge dredged material into support barges. These barges will transport the dredged material, with assistance from support vessels. The CSD may discharge via a pipeline, as described for the BHD in section 1.5.9[35].

Where a CSD is to work adjacent to land near the berthing area, then as per the operation of the BHD, any dredging works it undertakes would only, we understand, occur during daylight hours (being 0700 to 1900). The operations would, however, extend over seven days per week[36]. If it is employed further afield, it would operate 24 hours per day, seven days per week.

1.5.11 Water takes

We note, for completeness, that all of the dredge vessels will take seawater when dredging. For a TSHD, the dredged material is typically between 5% to 15% solids, with the remaining volume consisting of seawater. Between 75% and 85% of the material dredged using a BHD is solid. When the dredged material is disposed to the marine disposal sites, all the water is returned to the CMA when the sediment is discharged to the marine disposal areas[37].

1.5.12 Support Vessels

The following ancillary vessels will, we understand, support the main dredge vessels[38]:

- Survey vessels to complete hydrographic survey of the dredged areas. These are typically small craft (around 9m to 11m in length) and will be present within the vicinity of the project area (channel and disposal areas) for the duration of the project;
- Crew boats for the transfer of crew members and project staff between the dredging vessels and shore. These vessels are typically a small launch that is 8m to 15m in length. These could average four trips per day; and
- A tugboat for towing any barge (if used) to the disposal location. It is anticipated that these would take two trips per day.

All support vessels, and indeed the dredges themselves, will generally sail within the shipping channel, but due to the shallower draft of these vessels they can go outside the channel if shipping traffic is present. All support vessels will obey Maritime New Zealand rules and regulations[39] when in operation.

All vessels, including both support and main dredging plant, will use VHF radios, as required by Maritime New Zealand rules and regulations, and be in communication with each other, as well as the harbourmaster, local Coastguard base and other recreational or commercial vessels operating in the area.

[35] Reinen-Hamill, R, page 13, section 5.2.3, "Dredging and Disposal Options – Synthesis Report", Dated July 2017
[36] Reinen-Hamill, R, page 12, section 5.2.2, "Dredging and Disposal Options – Synthesis Report", Dated July 2017
[37] Reinen-Hamill, R, page 12, section 5.2.2, "Dredging and Disposal Options – Synthesis Report", Dated July 2017
[38] Reinen-Hamill, R, page 13, section 5.2.4, "Dredging and Disposal Options – Synthesis Report", Dated July 2017
[39] Maritime and Marine Protection Rules. http://www.maritimenz.govt.nz/rules/

1.5.13 Aids to Navigation

As a result of the dredging to facilitate changes to the channel alignment, a number of Navaids are required to be relocated or added to maintain navigation safety. We understand that all of the Navaids in Whangarei Harbour are owned and maintained by Northport, in accordance with Maritime New Zealand guidelines. In summary, Refining NZ proposes to undertake the following, in association with Northport:

- Eight of the existing buoys will need to be relocated to accommodate the reconfigured channel alignment. The relocation proposed is set out in **Table 1.5.13.1** and highlighted on **Figure 1.5.13.1**;
- Due to the proposed deepening of the access channel, the channel will also become longer. Therefore, two additional channel marker buoys, one port buoy and one starboard buoy, are required. These will be installed at -17.7m Reduced Level ('**RL**');
- The existing fairway buoy will be moved to align with the starboard channel markers and installed at -25.0m RL;
- Due to the existence of a rocky outcrop, and therefore potential navigational hazard in the vicinity of Home Point, a 'West Cardinal Beacon' is to be installed 175m north of buoy number 7, at -15.8m RL. The West Cardinal Beacon will be approximately 4.5m in height at CD 1.8m at Mean High Water Springs ('**MHWS**'). An example of the proposed West Cardinal Beacon is presented in **Figure 1.5.15.1**;
- The Port Entry Light will be improved by removing the upper portion of the day shape on the forward lead and installing a day and night light in its place (if this Navaid has not already been replaced as part of scheduled ongoing Whangarei Harbour operation maintenance);
- The existing (rear) lead light marking the offshore approach channel will be upgraded so that the main lead adequately shows the navigation limits of the new channel and be bright enough to support operations in adverse environmental conditions; and
- A set of new lead lights will be established in Taurikura Bay to assist with the night time navigation of arriving Suezmax Tankers and other vessels. These leads will define the North to South centreline of the proposed channel between buoys 3/6 and buoy 14. An example of the proposed Taurikura front Lead Light is documented in **Figure 1.5.14.1**, while **Figure 1.5.14.2** is an example of the type of rear lead light that is proposed for Taurikura.

Buoy No.	Movement Distance and Direction	Reason	Justification
Fairway	-17.7mRL to -25.5mRL	The deeper approach channel requires the Fairway buoy to be moved to deeper water.	As per reason.
2	17m Northeast	Moved to match buoy offset.	Existing buoy is out of alignment in relation to the other Port buoys (PB1A, 4 and 6).

3	20m Northeast	Moved out to accommodate design channel along lead-line	PIANC channel width is wider than existing buoyed channel.
5	105m Northwest	Moved in to avoid dredging near Busby Head	PIANC 5xLOA radius is achievable and width is significantly greater than minimum width required.
8	76m Southwest	Moved out to align with the North to South centreline, as well as to accommodate the required PIANC bend in the channel.	Provides visual guide for pilots to follow N-S centerline.
11	153m Southeast	Moved out to align with the North to South centreline.	Provides visual guide for pilots to follow N-S centreline, additional bend width and bend apex defined.
12	28m West	Moved to accommodate the North to South channel alignment.	Reduce number of heading changes past Home Point.
14	53m Northwest	Moved out to accommodate increased bend radius.	Improved navigability of critical Bend No.2.
18	128m East	Moved East to avoid dredging Mair Bank and keep turning circle inside channel.	PIANC channel width wider than existing buoyed channel.

Table 1.5.13.1: Proposed Navaid Movements[40]

[40] Cross, J, pages 26 to 27, section 3.7, "Refining NZ Crude Shipping Project Shipping Channel – Concept Design Report", Dated 12th November 2016, contained within Appendix B of the Reinen-Hamill, R, "Dredging and Disposal Options – Synthesis Report"; Dated July 2017

***Figure 1.5.13.1: Proposed Navaids Movement*[41]**

The installation of the Navaids will, we understand, be in accordance with Maritime New Zealand standards and confirmed prior to the works commencing. Mr Cross advises that, based on advice from Northport, the installation will be as follows[42]:

1.5.14 Taurikura Lead Lights

The installation of the new lead lights will involve a jack-up barge, tugboat, piling rig, crane and either a vibro Hammer or traditional hammer piling. The piles will be pre-painted on shore prior to installation. The piling rig will be positioned on site by the supporting tugboat with the jack-up barge legs lowered into place and jacked up above the MHWS tide, usually in excess of 1.0m. Part of the pile will be installed below the seabed, with an excess of 1.0m above MHWS. The remaining sections

[41] Cross, J, pages 52, section 9, "Refining NZ Crude Shipping Project Shipping Channel – Concept Design Report", Dated 12th November 2016, contained within Appendix B of the Reinen-Hamill, R, "Dredging and Disposal Options – Synthesis Report"; Dated July 2017

[42] Cross, J, pages 45 to 47, section 7, "Refining NZ Crude Shipping Project Shipping Channel – Concept Design Report", Dated 12th November 2016, contained within Appendix B of the Reinen-Hamill, R, "Dredging and Disposal Options – Synthesis Report"; Dated July 2017

of pile will be welded into place, along with a ladder and platform for any maintenance requirements. The light assembly is the last part of the lead assembly.

The process will be dependent on weather but is expected to take a total of six days.

Figure 1.5.14.1: Example of proposed Taurikura front Lead Light

Figure 1.5.14.2: Example of proposed Taurikura rear Lead Light

1.5.15 Home Point West Cardinal Beacon

To prevent the requirement to fix to or drill into the rocky substrate, it is proposed to fix the Beacon to the seafloor via a tripod base utilising blocks that weigh two-Metric Tonnes on each leg to hold it in position. Installation will involve a tug and barge, crane and commercial divers. The Beacon will be constructed and prepared on land before being loaded onto the barge and transported to the Site. The tugboat and barge will anchor in place. The crane will lift the beacon into the water, while divers will inspect positioning prior to disconnection.

Figure 1.5.15.1: Example of proposed West Cardinal Beacon

It is noted that this process is heavily dependent on the weather, but installation should take no longer than one day total.

For completeness, in the event that it considered unsafe to install the Beacon to the rocky substrate, the Navaid located at Home Point may be instead be replaced with a buoy. In this instance, the mooring system for a buoy would consist of three separate mooring blocks and chain, connected to an equaliser plate before connecting the buoy via a chain and swivel assembly. This would provide a small swing circle to ensure that the safe water is marked at all times.

1.5.16 Enhancement, Mitigation & Monitoring Activities

A number of environmental enhancement and mitigation mechanisms are proposed as a consequence of the recommendations made by a panel of independent experts. A comprehensive monitoring programme is also proposed on the same basis and is intended to be encapsulated within a suite of draft conditions advanced by Refining NZ as part of its application. We set out the basis for the mechanisms and monitoring programme in the sections of this AEE that follow. They are, however, listed here also as they form an important component of the Proposal that is being advanced by Refining NZ.

1.5.17 Proposed Environment Enhancement & Mitigation Measures

1.5.17.1 Coastal Processes

Mr Reinen-Hamill[43] has recommended the placement of dredged sediment within Disposal Area 1.2, during both the Capital and Maintenance Dredging campaigns, will enable a proportion of the placed sand to be transported within the nearshore sediment transport pathways, thus reducing the overall volume of sediment removed from the ETD. This movement will, we understand, not only address any geomorphological change that is caused by the Proposal, but it will also replace some of the naturally occurring observed sediment loss and improve the resilience of the ETD to the expected effects of sea level rise.

1.5.17.2 Coastal Birds

Mr Don[44] recommends the following mitigation measures, which have been adopted by Refining NZ:

1. In consultation with DoC, the breeding opportunity for, and potential breeding success of, little penguin, should be enhanced via predator control and the provision of nesting boxes on Motukaroro Island. Predator eradication will commence six months prior to the start of any Capital Dredging campaign and will include traps on both Motukaroro Island (five traps), and along the mainland foreshore facing Motukaroro Island (ten traps) to minimise pest incursions. The pest eradication will be in parallel with the establishment of tracking tunnels on Motukaroro Island to monitor pest presence. Following the period of pest eradication work, 24 little penguin nesting boxes are to be established prior to June, which is when little penguins start to utilise their burrows. The pest control measures will be continued for a minimum of five years.
2. In consultation with the Bream Head Conservation Trust and DoC, enhance the breeding opportunity for, and potential breeding success of, grey-faced petrels, by installing nesting boxes and undertaking predator control. More particularly, Refining NZ will install 20 nesting boxes, which will enhance existing earth burrows and be undertaken in accordance with a specific management plan that will be agreed with the Bream Head Conservation Trust and DoC. In terms of predator control, Refining NZ will continue to support the Bream Head Conservation Trust, which already operates a comprehensive predator control program.
3. A lighting audit of all vessels used during the works will be undertaken. The purpose of the lighting audit is to identify where changes may be required to vessel lighting, such as orientating deck lighting downwards, to limit glare from the vessels at night. This mitigation is proposed to minimise the number of birds that are attracted to the vessels, which is expected to reduce the change of bird strike.

1.5.17.3 Marine Ecology

Dr Coffey[45] recommends the following avoidance and enhancement / rehabilitation measures, which have been adopted by Refining NZ:

[43] Reinen-Hamill, R, pages 66 to 67, section 6, “Coastal Processes Assessment”, Dated July 2017
[44] Don, G, pages 52 to 54, section 7, "Crude Shipping Project, AEE Report, Coastal Birds, Final”; Dated 09 August 2017.
[45] Dr Coffey, page 51, section 5.1, “Crude Shipping Project, Proposal to Deepen and Partially Realign the Approaches to Marsden Point, Assessment of Marine Ecological Effects, Excluding Seabirds and marine Mammals”, Dated 10 August 2017.

1. In consultation with the Regional Council, Tangata Whenua, and other interested parties, support will be provided to enhance, for example, harbour water quality and / or seagrass communities within and adjacent to the Site. The collaboration with the aforementioned parties will enable Refining NZ to provide a reasonable and constructive contribution for enhancements of this nature.
2. Monitor of the dredging and disposal areas to determine whether any adventive pests are dominating the re-colonisation of these disturbed areas.
3. Work with the Ministry of Primary Industries ('**MPI**') in their response to pest and weed species, in the event that monitoring identifies that adventive pests are found to have dominated the re-colonisation of the areas that are disturbed by the dredging and disposal activities.
4. Adopt mechanisms to react to the real time monitoring of turbidity levels at key locations within the Whangarei Harbour, as discussed further in section 1.5.18.2 of this AEE. These responses will be linked to a three tier response mechanism, the first response being to investigate the cause of the turbidity, the second response being to employ one of a number of mechanisms to reduce the turbidity being caused by the dredge, and the third triggering a cessation of dredging works in close proximity to the turbidity monitors until turbidity drops below the third level that Dr Coffey has proposed.

1.5.17.4 Noise

Mr Styles[46] has recommended the following mitigation measures, which have been adopted by Refining NZ:

1. Noise monitoring, as set out in section 1.5.18.4 of this Report, will ultimately confirm what noise restrictions are to be put in place. This could include, as an example, limiting dredging north of the No. 18 navigation buoy inside Whangarei Harbour, when the wind direction is outside the northern quarter (between >315º and <45º) (that is, it is from the east, west or south direction). Any such restrictions would seek to ensure that noise levels experienced at residential properties at Whangarei Heads are compliant with relevant district plan thresholds.
2. All works are to be undertaken in accordance with the Noise Management Plan ('**NMP**'), a draft of which is attached as Appendix H of Mr Styles report (attached as part of **Annexure Two** of this AEE). The NMP will set out the procedures that the crew of the dredging vessel shall undertake to manage noise, including the process for any complaints.

1.5.17.5 Marine Mammals

Dr Clement[47] has recommended the following mitigation measures, which have been adopted by Refining NZ:

1. A marine mammal observer will be on Site during daylight dredging activities so that they may notify the dredge vessels operators if a marine mammal is sighted within or entering a 50m

[46] Styles, J, page 16, section 6, "Whangarei Harbour Entrance and Marsden Point Channel Realignment and Deepening: Assessment of Environmental (Airborne) Noise Effects", Dated 31 July 2017.
[47] Clement, D, pages 22 to 27, section 3.3, "Assessment of Effects on Marine Mammals from proposed Deepening and Realignment of the Whangarei Harbour Entrance and Approaches", Dated August 2017.

'precautionary' safety zone. On notification by the marine mammal observer, dredging will cease until the marine mammal leaves the precautionary safety zone.

2. The Proposal will be undertaken in accordance with a Marine Wildlife Management Plan ('**MWMP**'), a draft copy of which is attached to Dr Clement's report as in **Annexure Two**, and will be finalised in consultation with DoC.
3. All dredge vessel operators, and other vessels associated with the proposed works, will adopt and use simple and common-sense boating behaviour guidelines, such as introducing speed limits around marine mammals.
4. Real-time / recent sighting information is to be obtained from DoC (or other project vessels) throughout the duration of the Proposal, in order to anticipate and mitigate potential interactions with any whale species sighted in and near the project area.
5. Refining NZ will utilise the smallest practicable dredge vessel and satisfy itself that the dredge is regularly maintained to a high standard to minimise (again, to the point that is practicable) underwater noise.
6. Refining NZ will utilise the best practicable option for pile driving to minimise underwater noise levels. Standard operational procedures will be followed, which includes, but are not limited to, soft-starts and a safety / shut-down zone around the work area to further minimise any risk of hearing impairment or injury to marine mammals from the proposed modifications to Navaids. A marine mammal observer will be on Site during daylight dredging and pile driving activities will notify the operator of the dredge or pile driver vessel if a marine mammal is sighted within or entering a precautionary safety zone (of 50m from dredging activities, 100m from vibro-driving piling, and 300m from impact pile driving). If the operator receives a notification from the marine mammal observer, all dredging or pile driving will cease until the marine mammal leaves the precautionary safety zone.
7. Ropes and other lines will be kept taut so as to reduce the potential for marine mammal entanglements.
8. All vessels associated with the Proposal will have Waste Management Plans in place before the works commence.
9. The sediments that are to be dredged before a Maintenance Dredging campaign will be tested in advance of each operation of this nature, to minimise or lower the risk of marine mammals being exposed to any contaminated sediments.

1.5.17.6 Archaeology and Heritage

Dr Clough[48] has recommended the following mitigation measures, which have been adopted by Refining NZ:

1. An Accidental Discovery Protocol will be put in place (via conditions of consent) to ensure that unrecorded archaeological sites unearthed during the dredging will be treated in the manner required by the applicable statutes, and in keeping with accepted practice.

[48] Clough, Dr R, page 27, "Marsden Refinery, Whangarei Harbour Dredging: Archaeological Assessment", Dated July 2017.

1.5.18 Proposed Monitoring Activities

As we have previously noted, the panel of independent experts retained by Refining NZ have recommended the following comprehensive monitoring programme. The following is a concise summary of the programmes that have been recommended. Further detail is set out in section 3.0 of this AEE and in the technical assessments themselves, all of which are attached as **Annexure Two** to this AEE.

1.5.18.1 Coastal Processes

Mr Reinen-Hamill[49] has recommended the following monitoring programme, which has been adopted by Refining NZ:

1. Annual monitoring of bathymetry of Mair Bank, the upper part of the ebb tide shoal (above the 5.0m depth contour), Disposal Area 1.2 and the dredged channel for a period of up to five years after Capital Dredging has been completed. The monitoring will assist in accurately plotting the exact shape of the channel and disposal areas over time. Furthermore, the monitoring will determine whether any ongoing consent related monitoring is necessary. It will also be useful, we understand, in recording any elevation changes in the seabed or shoreline. We note, for completeness, that annual monitoring of the Channel is already undertaken by Northport, in association with Refining NZ. We are advised that such monitoring is expected continue regardless of the Proposal (Martin, D; pers. com).
2. Annual monitoring of waves and water levels at the Wave Rider Buoy will be combined with the above bathymetry monitoring, which will assess any potential changes in wave energy and water level fluctuations.

1.5.18.2 Marine Ecology

Dr Coffey[50] recommends the following monitoring measures, which have been adopted by Refining NZ:

1. Immediately prior to any dredging or disposal activities, a benchmark description of seagrass beds in the areas adjacent to the Site, and shellfish communities on Mair Bank shall be completed.
2. During dredging and disposal activities, Refining NZ will deploy six fixed turbidity meters that will provide real-time continuous recording and data transmitting of sediment plumes to the dredging vessel. Three turbidity meters will be located at both the southern boundary of the Motukaroro Marine Reserve and the western boundary of the Home Point Marine 1 Management Area. The turbidity meters will provide a running six-hour average Nephelometric Turbidity Unit ('**NTU**')[51] value that can be used to modify (if necessary) engineering and operational measures to meet the NTU guidelines for those receiving environments.
3. Hand-held turbidity meters will be used when dredging in the entrance channel or when disposing material at either of the two Disposal Areas. These hand-held meters will be used

[49] Reinen-Hill, R, page 65, section 7, "Crude Shipping Project, Coastal Processes Assessment", Dated July 2017.
[50] Dr Coffey, B, pages 55 to 59, sections 7.0 to 7.3, "Crude Shipping Project, Proposal to Deepen and Partially Realign the Approaches to Marsden Point, Assessment of Marine Ecological Effects, Excluding Seabirds and marine Mammals", Dated 10 August 2017.
[51] NTU is a measurement of turbidity. The instrument used for measuring it is called nephelometer or turbid meter, which measures the intensity of light scattered at 90 degrees as a beam of light passes through a water sample.

to track the downstream movement of any sediment plume by comparing the up-current reading with the down-current reading at depths of 1.0m. Data will be recorded over four days each month. The data will be used to assess compliance of the Proposal with turbidity thresholds in soft-bottomed receiving environments.

4. Benthic ecological surveys will be undertaken immediately following the Capital Dredging and disposal activities have been completed, and then annually thereafter for up to three years. This monitoring will provide ecological information on the recovery of benthic communities within the dredging footprint and Disposal Areas, and any ecological effects adjacent soft and hard-bottomed habitats. After three years, the annual benthic ecological surveys will cease, unless it is determined that the benthic community habitats have not recovered. If the habitats have not recovered, a review of the Maintenance Dredging works will take place to avoid, remedy and mitigate any potential effects.

1.5.18.3 Coastal Birds

Mr Don[52] recommends the following monitoring programme, which has been adopted by Refining NZ:

1. On completion of the Capital Dredging works, the coastal bird populations in specific areas is to be recorded so that both before and after data is available on record. This includes undertaking the following state-of-environment surveys:
   a. One off survey in November: of the breeding season habitat use of coastal birds between both Marsden Point to Northport, and Darch Point to Home Point.
   b. In February to March: two surveys of coastal birds at Mair Bank, one survey between the Refinery Jetty to Northport, and one survey at Urquharts Bay.
   c. One off survey in November to January: daylight counts and dusk arrival counts of little penguins.
2. In consultation with DoC and the Bream Head Conservation Trust, the Company proposes to undertake the monitoring program to record the use of little penguin and grey faced petrel nesting boxes for a period of 5 years.

1.5.18.4 Noise

Mr Styles[53] recommended the following monitoring, which have been adopted by Refining NZ:

1. Noise emissions from dredging operations shall be monitored at the commencement of first use of each dredging vessel to determine whether any updates are required to the NMP.
2. Periodic noise monitoring is to be undertaken during times when dredging is occurring at the closest points to the shoreline on the northern side of the harbour, and also in response to any reasonably justified complaint, if there are any. For the purpose of determining whether monitoring should be undertaken, reference to ‘the reasonable request of the Council’ is often made in conditions of consent and shall be used in this instance also.

[52] Don, G, pages 52 to 56, section 7, "Crude Shipping Project, AEE Report, Coastal Birds, Final"; Dated 09 August 2017.

[53] Styles, J, page 16, section 6, “Whangarei Harbour Entrance and Marsden Point Channel Realignment and Deepening: Assessment of Environmental (Airborne) Noise Effects”, Dated 31 July 2017.

3. For completeness, we understand that a key purpose of the acoustic monitoring that is conducted, in accordance with bullet points (1.) and (2.), is to confirm that the noise emissions from the dredges are no greater than what the relevant Whangarei District Council ('**WDC**') District Plan permitted activity noise limits allow.

1.5.18.5 Marine Mammals

Ms Clement[54] has recommended the following monitoring programme, which has been adopted by Refining NZ:

1. Opportunistic visual sightings are to be completed over a period lasting approximately one month before, and one month after Capital Dredging. These surveys will record the species that visit the habitats within the vicinity of the Site and be provided to DoC for collation in a national database.
2. Passive underwater acoustic monitoring will also be undertaken during the two periods of visual sightings. This will be done by installing four passive acoustic moorings near the Harbour entrance and Disposal Areas to record marine mammal detections.
3. During the works, records of species presence within the Site vicinity will be made by a designated marine mammal observer on board the dredge vessel during daylight hours. The marine mammal observer will enforce a 50m precautionary safety zone around dredging operations so that activities cease if a marine mammal enters that zone. Records will be kept of any marine mammal visual observations, as well as any unlikely vessel strike incidents or near incidents. All records will be provided to DoC.
4. Passive acoustic recorders should be placed at approximately four locations near the Harbour entrance, disposal areas, and near the 120 dB underwater noise boundary to record marine mammal detections. This monitoring is not intended to assess species frequency or intensity of use but rather, determine whether any marine mammals are present within the Site during different cycles and noise levels during the Capital Dredging works. Dr Clement proposes monitoring acoustic levels before and after dredging, for a period of one month. In addition, Dr Clement proposes two separate monitoring periods of approximately 14 days each are necessary within the estimated six-month project duration to sufficiently detect the potential presence of marine mammals across several dredging cycles. Overall, 4 monitoring periods are proposed.
5. Dredging noises will be monitored underwater periodically throughout the different work phases, such as when dredging in different sediments. This will assist in validating the assumptions made in the Marine Mammals Report and effects assessment set out in section 3.8 of this Report.
6. Similar monitoring activities are proposed during Maintenance Dredging activities however, the information compiled via direct observation and passive acoustic monitoring during the Capital Dredging project can be used to inform aspects of any program for Maintenance Dredging; especially regarding marine mammal response to dredging and spoil disposal operations and seasonal use of the area by individual species. Any additional monitoring practices, if required, will be determined after analysis of the capital dredging project data.

[54] Clement, D, pages 28 to 32, section 3.4, "Assessment of Effects on Marine Mammals from proposed Deepening and Realignment of the Whangarei Harbour Entrance and Approaches", Dated August 2017.

1.6 Resource Consents Required

Having applied the bundling principle (as convention dictates is appropriate in this instance) we conclude that several resource consents are required for the Proposal to be undertaken. The resource consents required are a **discretionary / innominate activity**, given that it is the most restrictive of the activity classifications that apply. A more complete description of the resource consents required, and why, is set out in section 5 of this AEE. The associated table summarising the rule assessment that was completed to aid in the determination of the resource consents that are required is attached in **Table A** of **Annexure Seven** to this AEE.

As we come back to in section 5 of this AEE, when considering an application for a resource consent, a consent authority must have regard to the matters set out in section 104 of the Act, being:

1. Any actual and potential effects on the environment of allowing the activity; and
2. Any relevant provisions of:
   a. A National Environmental Standard ('**NES**');
   b. Other regulations;
   c. A National Policy Statement ('**NPS**');
   d. A New Zealand Coastal Policy Statement ('**NZCPS**');
   e. A Regional Policy Statement or proposed Regional Policy Statement;
   f. A plan or proposed plan; and
3. Any other matter the consent authority considers relevant and reasonably necessary to determine the application.

Of some note is that when forming an opinion for the purposes of paragraph (a), a consent authority may disregard an adverse effect of the activity on the environment, if an NES or the plan permits an activity with that effect. We discuss the permitted baseline in section 1.7 of this AEE. We then discuss the proposed lapsing period and term of the resource consent, both of which are key parameters that apply to all of the resource consents that are sought.

1.7 The Permitted Baseline

In accordance with sections 95D and 104(2) of the Act, a Consent Authority may disregard an adverse effect that is permitted by a Plan and an NES. Given this, we now set out what we believe forms the 'permitted baseline' for the Site. The Site straddles two 'zones' within the RCP. The two zones are the Marine 2 (Conservation) Management Area ('**M2MA**') and the Marine 5 (Port Facilities) Management Area ('**M5MA**'). Both zones have a different suite of permitted activity rules. As is apparent from **Figure 1.4.1** in section 1.4 of this AEE, only a very small area of dredging occurs within the M5MA. The vast majority of the dredging, all of the disposal, and all of the changes to Navaids occur within the M2MA.

As we also note in section 5.2 of this AEE, only two components fall squarely within the bounds of a permitted activity rule. Those components are the discharges from the dredge(s) to the CMA when it is operating in the M5MA[55]. In all other instances, the various components of the Proposal require a resource consent. That is not to suggest, however, that the permitted baseline does not apply to those 'other' components of the Proposal. In this regard, the permitted baseline may, we understand, continue to apply if there are similar activities to those that are proposed that may also be undertaken as a permitted activity. We have considered the various rules of the RCP with that in mind. We summarise our findings in the following bullet points.

Dredging and Disposal

1. Permitted dredging and disposal within the M2MA is confined to the removal of obstructions from land drainage channels[56], presumably where they discharge to the CMA. All other dredging and disposal activities are either controlled or discretionary activities within the M2MA.
2. In the M5MA, dredging and disposal is deemed to be a controlled or discretionary activity[57]. That is, there are no permitted dredging and disposal activities.

Sand Extraction (Associated with the Disposal of Dredged Sediment to Land)

3. There is no permitted baseline for the extraction of sand from the M2MA. In that regard, section 31.4.11 is clear, in our opinion, that the abstraction of sand is either a controlled or discretionary activity.
4. There are no rules that govern the extraction of the sediment dredged from the area zoned M5MA. As a consequence, there is, in our opinion, no permitted baseline for dredging in M5MA.

Taking of Water associated with Dredging

5. There are three permitted activity rules that govern the taking of water in the M2MA. Of those provisions, Rule 31.4.7 is, in our opinion, the most applicable, as it enables the wide-ranging abstraction of water, subject to a series of standards. Of the standards listed, the Proposal can achieve all but two, being 31.4.7(ii) and (iii). In that regard, in the act of taking the water, Refining NZ will change the natural water quality and damage or destroy flora and fauna within the dredged footprint.
6. The taking of water within areas zoned M5MA is governed by a very similar suite of rules to that which applies to the M2MA. Of those provisions, Rule 31.7.7(b) is, in our opinion, the most applicable to the Proposal. While the abstraction can be undertaken to achieve the General Standards set out in Rule 31.7.12, the act of taking water will, albeit in a very minor way, change natural water quality and could change the movement patterns of localised areas of sediment.

Discharges to Water associated with Dredging and Disposal

7. Discharges to the coastal waters zoned M2MA occur as a consequence of the dredging and disposal activities, and as a consequence of the construction of the proposed new Navaids. A limited number (four[58]) of discharges to water can proceed as a permitted activity within the M2MA. Of those discharge rules, in our opinion, only 31.4.6(b) has any particular relevance to the Proposal. In this regard, Rule 31.4.6(b) allows discharges where, amongst other things,

[55] Both discharges can be conducted within the bounds of permitted activity rule 31.7.6 of the RCP
[56] Rule 31.4.8(a) of the RCP
[57] Rules 31.7.8(a) to (c) of the RCP
[58] Rules 31.4.6(a), (b), (j) and (t) of the RCP

the discharge is free from contaminants. The Proposal cannot, we understand, achieve this requirement, but can achieve other standards that do apply, including meeting the applicable water quality standards.

8. As we have already noted, the discharges from the dredge in the area zoned M5MA are, in our opinion, a permitted activity. We also reiterate that there is no sediment disposal proposed within M5MA. As a consequence, where the Proposal causes discharges within the portion of the Site zoned M5MA, they fall, in our opinion, within the permitted baseline.

Aids to Navigation

9. While the maintenance and repair of Navaids can occur as a permitted activity[59], no new Navaids, or the relocation to existing Navaids (as is proposed here) can. In that regard, such structures / modifications are deemed to be a controlled activity in accordance with Rule 31.4.4(o). Notably, however, a range of structures can be erected within the M2MA as a permitted activity. They include signs placed by a statutory authority that impart safety or other information about the CMA[60]. Notably, there are no constraints on the size of this type of sign, and the limits that do apply[61] to their construction and operation can, we understand, be achieved by the relocated and new Navaids that are proposed.

10. No Navaids are to be constructed within, or relocated to the portion of the Site zoned M5MA, so it follows that there is no applicable permitted baseline.

1.7.1 Summary

An argument could, in our opinion, be made that the permitted baseline should be applied to the discharges to the M5MA and to, potentially, the installation and relocation of the Navaids. In all other respects, we question the validity of applying the permitted baseline. In that regard, there is no permitted baseline for the two central activities (dredging and disposal) and for the extraction of the sediment from the CMA. Equally, while the abstraction of water associated with the proposed dredging operations, and the discharges associated with the various activities that are to be undertaken in the M2MA, comply with some of the permitted activity standards, they do not achieve what we consider to be the key performance standards that apply to a proposal with the attributes of the CSP.

Notwithstanding the foregoing, we also question if applying the permitted baseline would serve any real purpose in this instance. In this regard, while some elements of the Proposal could be assessed on the basis of the permitted baseline, it would, in our opinion, achieve little. In that regard, the elements that do, or could, qualify for consideration (the Navaids and the discharges in the M5MA) are minor components of the Proposal. Even without the permitted baseline applied, we understand the advice of the independent experts advising Refining NZ to be that the adverse effects (if any) of these aspects of the Proposal will be both manageable and very minor.

Further, and lastly on this topic, we question if it would be realistic (or non-fanciful) to expect that signs of the size and location of the Navaids would be installed and operated by a statutory authority.

[59] Rule 31.4.4(n) of the RCP
[60] Rule 31.4.4(s) of the RCP
[61] Rule 31.4.13 (General Standards) of the RCP

Given the foregoing, we have not applied the permitted baseline to the assessment of environmental effects that is set out in section 3.0 of this AEE. Neither have, we understand, any of the independent experts. In our opinion, that represents a slightly conservative starting position, but one that also reflects the integrated nature of the Proposal and the assessments that have been completed by Refining NZ.

1.8 Summary of Investigations Undertaken

The Proposal has been advanced carefully, with several parties influencing the design that Refining NZ is now seeking the necessary resource consents for. Design leadership has, however, been apparent with RHDHV being the principal advisor in the design of the dredged channel and in the choice of the dredge to be used. All of the contributors to the design of the entrance channel have also contributed to the risk assessment that has been conducted by Navigatus Limited, alongside the Harbourmaster, NorthPort, North Tugz, and Refining NZ staff.

1.8.1 Technical Assessments

Tonkin and Taylor Limited ('**T&T**') has been the principal designer for the spoil disposal sites. **Table 1.8.1.1**, which follows, lists all of the experts that have been retained to advise Refining NZ on the advancement of the Proposal, and quotes the title of their various reports. The names highlighted in bold are the principal advisers to Refining NZ in each of the areas.

Technical Assessment	Principal Author(s):	Company / Organisation:
Shipping Channel – Concept Design Report	**Justin Cross**, Matt Potter and Richard Mocke	RHDHV
Technical memo – Dredging Control Measures	**Justin Cross**	RHDHV
Establishment of Numerical Models of Wind, Wave, Current and Sediment Dynamics	**Peter McComb**, Florian Monetti, Brett Beamsley and Sarah Gardiner	MetOcean
Predicted Physical Environmental Effects from Channel Deepening and Offshore Disposal	**Peter McComb**, Florian Monetti, Brett Beamsley and Sarah Gardiner	MetOcean
Dredging and Disposal Options – Synthesis Report	**Richard Reinen-Hamill**	T&T
Crude Shipping Project – Coastal Processes Assessment	**Richard Reinen-Hamill**	T&T
Crude Shipping Alternatives: Marsden Point – NZ	**Erik Broekhuizen**	P&P
Crude Shipping Project – Mid-point multi-criteria alternatives assessment	**Monique Cornish**	T&T
Report in Support of an Assessment of Effects on the Environment – Navigational Risk Assessment of Engineered Channel Designs	**Geraint Bermingham** and Paul Dickinson	Navigatus

Environmental Spill Risk Assessment for Proposed Tanker Operations Associated with Engineered Channel	**Kevin Oldham**, Matt Bilderbeck and Geraint Bermingham	Navigatus
Whangarei Harbour Entrance and Marsden Point Channel Realignment and Deepening: Assessment of Environmental (Airborne) Noise Effects	**Jon Styles**	Styles Group
Whangarei Harbour Entrance and Marsden Point Channel Realignment and Deepening: Underwater Acoustic Modelling for the Marine Mammal Impact Assessment	**Matt Pine** and Jon Styles	Styles Group
Assessment of effects on marine mammals from proposed deepening and realignment of the Whangarei Harbour entrance and approaches ('Marine Mammals Assessment')	**Deanna Clement** and Deanna Elvines	Cawthron Institute ('**Cawthron**')
Crude Shipping Project, AEE Report, Coastal Birds, Final	**Graham Don**	Bioresearches Group Limited ('**Bioresearches**')
Assessment of Marine Ecological Effects excluding Seabirds and Marine Mammals	**Brian Coffey**	Brian T Coffey and Associates
Recreation and Tourism Effects Assessment	**Rob Greenaway**	Rob Greenaway and Associates
Whangarei Harbour Dredging: Archaeological Assessment	**Rod Clough** and Simon Bickler	Clough and Associates
Marsden Point Crude Shipping Project – Landscape Assessment	**Stephen Brown**	Brown NZ Limited
Crude Shipping Project – Economic Assessment of Channel Deepening at the Marsden Point Refinery	**Peter Clough** and Mike Hensen	New Zealand Institute of Economic Research
Commercial Fishing in Whangarei Harbour and Bream Bay	**Rick Boyd**	Boyd Fisheries Consultants Ltd

Table 1.8.1.1: Technical Assessments Undertaken

1.8.2 Peer Reviews

In addition, four peer reviewers have been retained to consider the aspects of the Proposal. In this regard, Dr Paul Kench of the University of Auckland was retained to provide peer review services for the hydraulic modelling and geomorphological service areas (his peer review report is titled "Peer Review Coastal Processes Assessments and Effects of the Crude Shipping Project Whangarei Harbour"), Neil Pollock of DNV-GL undertook a peer review of the navigation risk (his peer review report is titled "DNV GL Peer Review of 'Navigational Risk Assessment of Channel Designs' prepared for Chancery Green on behalf of Refining NZ by Navigatus Consulting – Draft for Public Consultation"), Dr Brian Stewart of Ryder was retained to act as a peer reviewer of the marine ecology (including marine mammals and avifauna) and water quality work-streams (his peer review report is titled "Crude Shipping Project: Review of Refining NZ Dredging Project Reports on Ecological Effects"), and Antoine Coffin of Te Onewa Consultants undertook a peer review of the Cultural Effects Assessment (his peer review report is titled "Peer Review Report of Refining NZ Crude Freight Proposal – Tangata Whenua o Whangarei Te Rerenga Paraoa DRAFT Cultural Effects Assessment").

1.9 Resource Consent Lapse Period

Section 125 of the Act states that if there is no lapse date specified on a resource consent, the consent shall lapse five years after the commencement of the consent, unless it is given effect to, or an application is made to extend the lapse date.

The Applicant seeks that a 10 year lapse period be applied to the resource consents it seeks, which accords with Section 125(1)(a) of the Act and, as such, is considered appropriate in this instance.

1.10 Term of Resource Consent

Section 123 of the Act establishes a maximum term of 35 years for all resource consents, except for land use consents (being for activities that exist outside of riverbeds, lakebeds and the CMA) where an unlimited term can be applied.

The Applicant seeks a 35-year term for all of the resource consents that are sought from the Regional Council, other than for the Navaids where, in accordance with the standards that apply to Rule 31.4.4(o) of the RCP, a 25-year term is sought.

In this regard, Refining NZ contends that both of these consent terms would accord with the sustainable management purpose of the Act. We agree, and note that there are several cases when the Environment Court (and some superior courts) have confirmed that long consent terms are acceptable for large infrastructural projects. In this instance, we note that the likely actual and potential adverse effects are known, good information exists about the existing environment, on-going monitoring is proposed to certify that the predicted effects are realised.

We also understand (Martin, D, pers. com) that a 35-year term for the main body of the Proposal (being the dredging and disposal works) will provide Refining NZ with an acceptable level of investment security, which is, in our opinion and experience, a relevant consideration.

We also understand that Refining NZ is happy to abide by the specific direction provided by the rule framework within the RCP for the term of the resource consents that apply to the proposed Navaids.

These combined factors lead us to the opinion that the proposed 25-year and 35-year terms are reasonable, and accords with Part 2 of the Act.

2.0 THE EXISTING ENVIRONMENT

When considering Refining NZ's resource consent application, one of the central matters that must be assessed is the nature and magnitude of the actual and potential effects of the Proposal on the environment.

The environmental effects of the Proposal have been assessed against the environment, as it actually exists now. Refining NZ has commissioned a number of reports that, amongst other things, describe the environmental values that are present within and adjacent to the Site, or which otherwise have relevance to the Proposal (such as the regional economy). As we have already noted, full copies of those reports are attached as **Annexure Two** to this AEE.

It is, in our experience, generally accepted that when assessing the actual and potential effects of a Proposal, the existing environment needs to be 'overlaid' with both activities permitted in the relevant plan and any consented, but as yet unimplemented activities. With respect to the latter, while some contend that regard only needs to be paid to those unimplemented activities that are 'likely' to be advanced, this filter is difficult, if not impossible, to apply. In that regard, the advancement of a resource consent is a matter that is determined by the circumstances of the consent holder. Given this, for the purpose of this AEE, in the absence of information to the contrary, we have adopted the position that all unimplemented consents are 'likely' to be advanced.

We have engaged with staff of the NRC[62] who advise us that there are no unimplemented consents within the Site or in its immediate vicinity. We are aware, however, that while it has been exercised, Northport's resource consent (numbered CON20030505523) has not been fully exercised, insofar as the full extent of the possible reclamation is yet to be built. As is apparent from Dr McComb's report[63], the independent experts advising Refining NZ have advanced their assessments on the basis that this reclamation is in place.

We are also aware that WDC hold a suite of resource consents for the Ruakaka Wastewater Treatment Plant ocean outfall (being resource consents numbered AUT.021532.01.01 through to AUT.02153.09.01). Whilst the ocean outfall has yet to be constructed or commissioned, the independent experts advising Refining NZ, in particular Dr Coffey[64], have also included this in their assessment.

NRC staff have also provided a list of resource consents which are contained in and around the Site (in the location outlined in **Figure 1.3.1** in section 1.3 of this AEE). A list of the key resource consents granted by NRC for the operation of Refining NZ, NorthPort, Marsden Cove Limited, NIWA, WDC and DoC are attached as **Annexure Three** to this AEE.

Further, and as we discuss in section 1.7 of this AEE, while it is possible to apply a permitted baseline to aspects of the Proposal, we see little benefit, and no real resource management reason for doing so. As a consequence, we have adopted the slightly conservative approach of not applying the permitted baseline in this instance.

---

[62] Paul Maxwell, Coastal Consents Specialist, Biosecurity & Projects Advisor at Northland Regional Council, email correspondence dated 23rd September 2016 to the 3rd March 2017.

[63] MetOcean Solutions Limited, page 8, section 1.5, "Crude Shipping Project, Establishment of Numerical Models". Dated 25 July 2017 and MetOcean Solutions Limited, "Predicted physical environmental effects from channel deepening and offshore disposal". Dated 25 July 2017.

[64] Dr Coffey, B, pages 32 to 33, section 2.8.2, "Crude Shipping Project, Proposal to Deepen and Partially Realign the Approaches to Marsden Point, Assessment of Marine Ecological Effects, Excluding Seabirds and marine Mammals". Dated 10 August 2017

We now, drawing on the technical reports that have been produced, summarise the existing environment, as it applies to the Site and its surrounds:

a. Coastal Processes & Marine Geology
b. Channel and Navigation.
c. Marine Ecology
d. Avifauna (coastal birds)
e. Marine Mammals
f. Commercial Fishery
g. Landscape, Visual and Natural Character (system Benthic)
h. Archaeological and Historic Heritage
i. Cultural values
j. Recreation and Tourism values
k. Economic values

We now discuss each of these aspects of the existing environment in turn.

2.1 Coastal Processes

Mr Reinen-Hamill and his colleagues at T&T has produced a report[65] that describes the coastal and geomorphological processes that exist within the Site. Dr McComb and his colleagues at MetOcean Solutions Limited ('**MetOcean**') supplement the detail provided by T&T. We now summarise the key aspects of Mr Reinen-Hamill's and Mr McComb's assessments.

2.1.1 Geology

Mr Reinen-Hamill advises that a very variable geology underlies the Site. We understand his advice to be that Whangarei Harbour has experienced relatively recent submergence followed by considerable infilling. He cites other work that indicates that Whangarei Harbour may technically be termed an 'estuarine lagoon[66]', and notes that a number of tectonic movements may have contributed to the harbour's formation[67].

The oldest rocks in the Marsden Point area are Palaeozoic greywackes and argillite of the Waipapa Group. Mr Reinen-Hamill advises that these rocks exist as outcrops to the north, south and southwest of Whangarei Harbour and constitute the basement to Quaternary costal and estuarine sediments at the Site. Mr Reinen-Hamill goes on to note that andesitic agglomerate, lava and dikes and small areas of andesitic tuffs, cones and lava outcrop with tertiary mudstones, together comprise the Whangarei Heads, which are situated directly across Whangarei Harbour, to the north east from the Site.

[65] Reinen-Hill, R, "Crude Shipping Project, Coastal Processes Assessment". Dated July 2017.
[66] Defined by Mr Reinen-Hamill as a shallow body of water separated from a larger body of water by a barrier.
[67] Reinen-Hill, R, page 8 to 9, section 3.2, "Crude Shipping Project, Coastal Processes Assessment". Dated July 2017

The Site is, we understand, located between two parallel inferred faults that are orientated northwest to southeast. To the west, a fault (which is in part concealed beneath recent alluvial materials) extends along the Ruakaka River Valley and the Otaika Stream. The second fault, which is situated immediately north of the Site, is said to have resulted in the present alignment of the Whangarei Harbour. Neither fault is considered to be active. The faults, and indeed all of the other faults in the general vicinity of the Site are shown in **Figure 2.1.1.1**, which follows.

Mr Reinen-Hamill also advises that Home Point to Smugglers Bay comprises volcanoclastic cliffs[68] with narrow alluvial beach at Home Point and a wider sandy beach within Smugglers Bay[69]. He states that the cliff shorelines are (generally speaking) stable due to the nature of the underlying geology. Mr Reinen-Hamill advises that some cliff retreat has occurred over the last 6,500 years as sea level rise stabilised at its present levels. He goes on to note that the shoreline also shows evidence of erosion from Home Point to Busby Head, both on the alluvial beach area adjacent to Home Point and along the cliff coast from Home Point to Busby Head. Mr Reinen-Hamill reports that it is likely that the cliff erosion processes are probably dominated by weathering of the subaerial cliffs and the continued removal of debris that falls from the cliff face to the sea by ongoing tidal flows and low wave energy conditions along the entrance channel, this is discussed further in section 2.1.5.

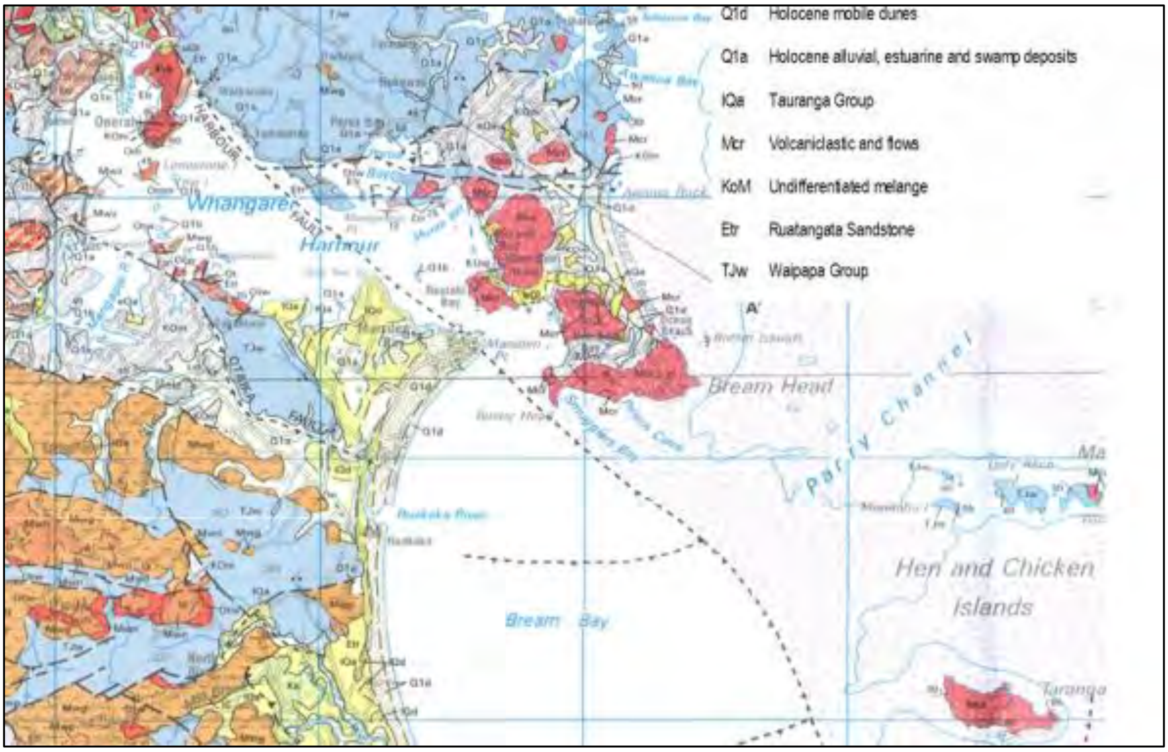


Figure 2.1.1.1: Known faults in and around the Site[70]

2.1.2 Bathymetry

An analysis of the ETD by Mr Reinen-Hamill shows that between 1939 and 2015 it has been relatively stable, and that there was no significant change when comparing the 5m, 10m and 15m depth

[68] Defined by Mr Reinen-Hamill as cliffs formed from volcanic activities, however the deposits are influenced by the rate of supply and the flow transformations that occur.
[69] Reinen-Hill, R, page 12 to 13, section 3.4.3, "Crude Shipping Project, Coastal Processes Assessment". Dated July 2017
[70] Reinen-Hill, R, page 9, section 3.2, "Crude Shipping Project, Coastal Processes Assessment". Dated July 2017

contours[71]. A more detailed analysis by Mr Reinen-Hamill of Mair Bank (which sits within the shallower part of the ETD) shows that this feature has also been dynamically stable, but with natural fluctuations in the surface topography as banks and channels shift in response to storm events and tidal currents. **Figure 2.1.2.1**, which follows, shows the differences in Mair Bank's bathymetry from 2000 to 2013.

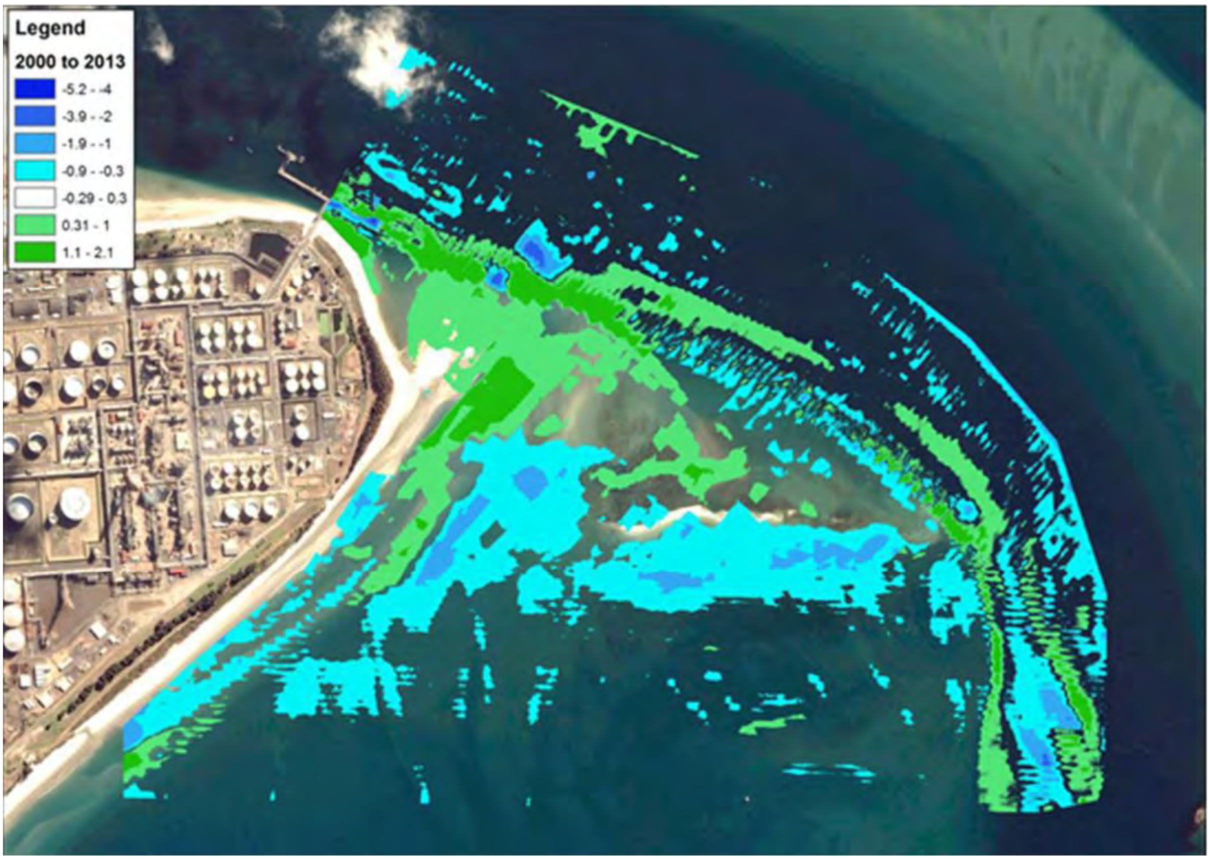


Figure 2.1.2.1: Mair Bank Bathymetry from 2000 to 2013[72]

Mr Reinen-Hamill reports that old surveys of the entrance channel at One Tree Point and Snake Bank show its depth to be 17m in 2004[73]. Since this time, however, dredging modifications and reclamations have taken place at NorthPort.

Mr Reinen-Hamill notes that over the last 16 years, there appears to have been a northerly migration of sand towards and extending into the entrance channel, with this change largely occurring between 2000 and 2010. He highlights that surveys undertaken in 2015 and 2016 show much smaller changes. We understand Mr Reinen-Hamill's advice to be that this process has resulted in accretion of the upper part of the channel slopes with some evidences of slight steepening with some erosion of the lower slopes, this is discussed further in section 2.1.5.

Historical shoreline change has been investigated near the entrance of the Whangarei Harbour. Having completed this investigation, Mr Reinen-Hamill reports that the development at Marsden Point

[71] Reinen-Hill, R, page 10, section 3.3, "Crude Shipping Project, Coastal Processes Assessment". Dated July 2017
[72] Reinen-Hill, R, page 43, section 4.1.4, "Crude Shipping Project, Coastal Processes Assessment". Dated July 2017
[73] Reinen-Hill, R, page 10, section 3.3, "Crude Shipping Project, Coastal Processes Assessment". Dated July 2017

(being those works associated with the establishment and on-going operation of the Refinery) and NorthPort, do not seem to have caused large scale changes to the coastal processes.

2.1.3 Wave Climate

We understand Mr Reinen-Hamill to advise that water levels within and adjacent to the Site are principally driven by astronomical tides, barometric and wind effects (storm surge), medium term fluctuations and long term changes in sea level due to wave transformation processes. These processes include wave's becoming steeper (shoal) and eventually breaking when they reach shallow water. Shoal energy is then transferred in two ways, either by the water level in the surf zone increasing (wave setup) or by waves breaking on the beach slope (wave runup).

Mr Reinen-Hamill advises that the Site has a mean tide range of around 2.3m during spring tide and 1.5m during neap tides. He also records that storm surges around New Zealand's coastline have an upper limit of approximately 1.0m[74]. Given this, he notes that a storm surge of 0.9m is considered representative of a return period of 80 to 100 years. Mr Reinen-Hamill concludes that the Peak storm tide level for Bream Bay was 1.6m (calculated for a 10-year average reoccurrence interval), and 1.83m (calculated for a 100-year average reoccurrence interval).

For his part, Dr McComb advises that the wave climate in the northern region of Bream Bay at position WRB (which is shown in **Figure 2.1.3.1)**, is characterised by a mean annual significant wave height of 0.80m[75]. Mr Reinen-Hamill reports that on average, the total significant wave heights[76] are less than 1.0m (as observed over 36 hours). This indicates, we understand, a typically low energy wave environment that is occasionally affected by strong storms and cyclonic systems. Wave height maps for a range of wave conditions are provided in **Figure 2.1.3.2** and **Figure 2.1.3.3**, which follow. Dr McComb notes that sea effected by easterly winds are most common and there is no suggestion of any strong variations of wave climate over the course of a year.

[74] Reinen-Hill, R, page 22, section 3.6.2, "Crude Shipping Project, Coastal Processes Assessment". Dated July 2017

[75] MetOcean Solutions Limited, page 23, section 4.1, "Predicted physical environmental effects from channel deepening and offshore disposal". Dated 25 July 2015.

[76] Defined by Reinen-Hamill as the average off the highest 1/3 wave heights.

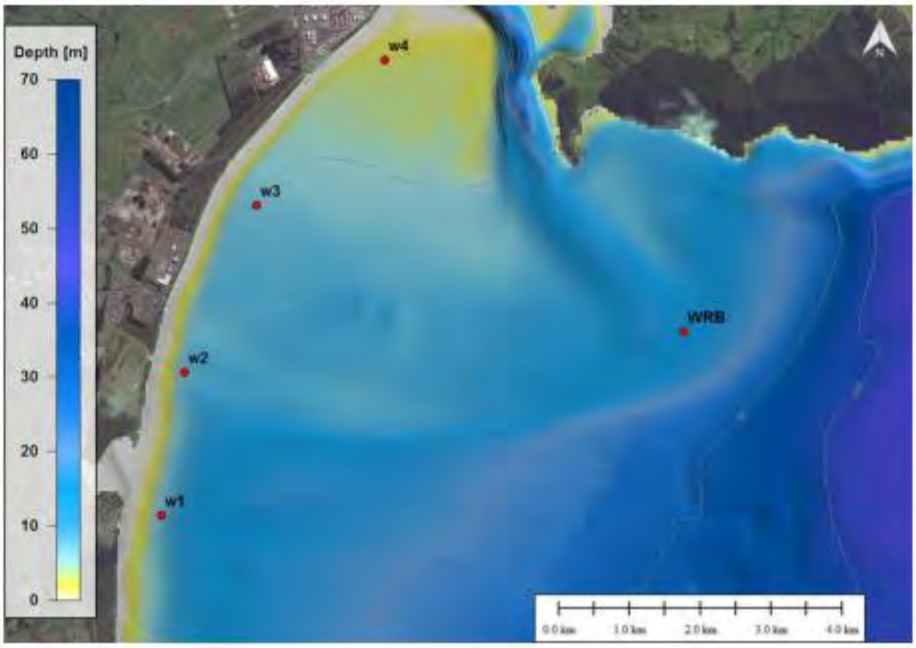


Figure 2.1.3.1: Wave Gauges Locations (red circles)[77]

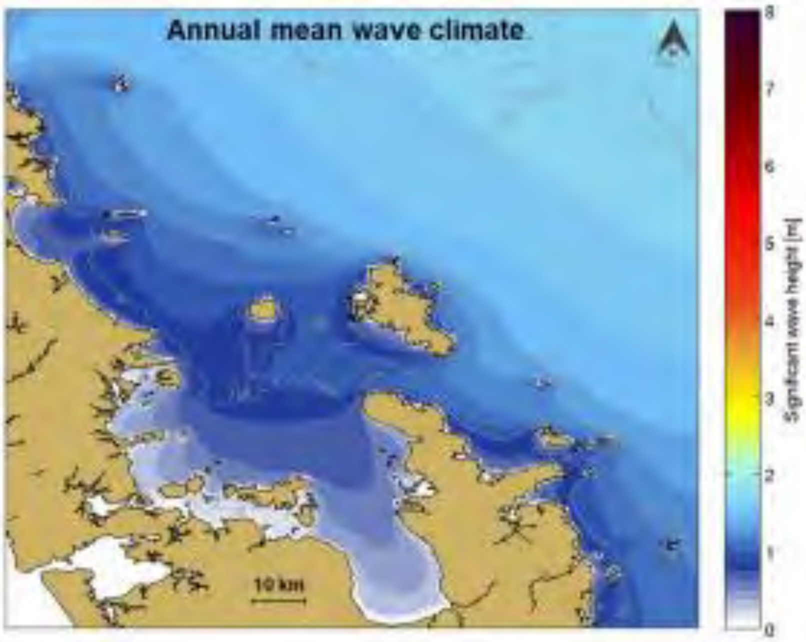


Figure 2.1.3.2: Annual Mean Wave Climate (2015)[78]

[77] MetOcean Solutions Limited, page 24, section 4.1, "Predicted physical environmental effects from channel deepening and offshore disposal". Dated 25 July 2017.
[78] MetOcean Solutions Limited, page 25, section 4.1, "Predicted physical environmental effects from channel deepening and offshore disposal". Dated 25 July 2017

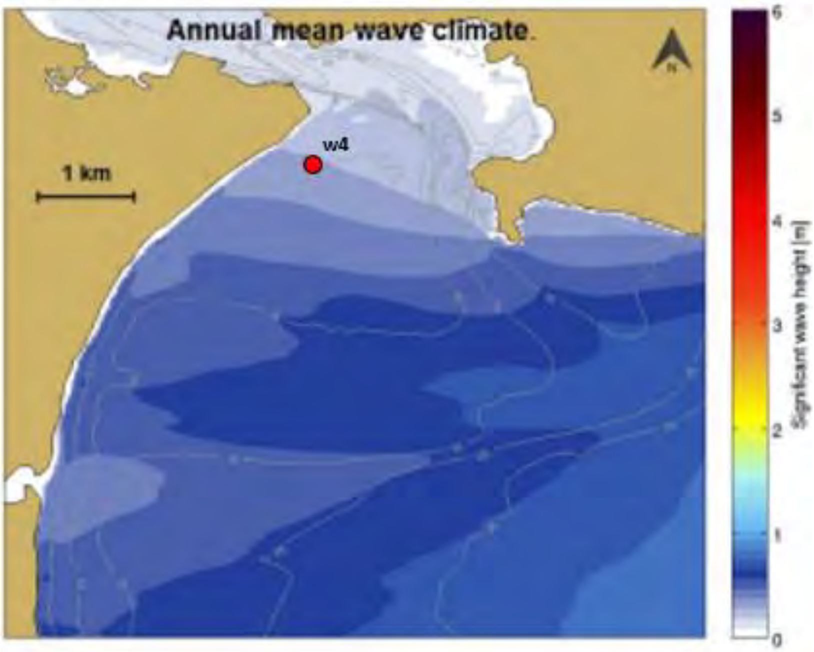


Figure 2.1.3.3: Annual Mean Wave Climate (2015)[79]

Dr McComb advises that the seabed morphology of the ETD and adjacent headland influences the wave climate along Ruakaka Beach and at the Whangarei Harbour entrance. He notes that due to the shape of Busby Head, wave refraction patterns[80] develop over the delta and near Busby Head, causing the waves (coming from the northeast) to refract off Busby Head and move east at WRB and southeast. This results, in his opinion, in waves focusing along the eastern edge of the delta entrance toward Busby Head and the penetration of a fraction of wave energy through the entrance channel. Dr McComb also states that the configuration of the Whangarei Harbour entrance significantly decreases the amount of wave energy that enters the Harbour. Variations of the surface elevation, currents (caused by tides) and the profile of roughness increasing through the water column with depth (caused by bottom friction) have an effect on the wave height near Mair Bank, ultimately resulting in wave height and period as observed at position W4 (see **Figure 2.1.3.3** above). Dr McComb also states that this wave refraction process increases the exposure of the southwestern flank of Mair Bank to waves during strong storm events.

We understand him to state that the extended and gradual bed slope of the western flank of the ETD dissipates the amount of refracted wave energy due to bottom frictions with the sea bed, which he states significantly reduces the wave energy that reaches Mair Bank. This, he states contributes to the relative stability of Mair Bank. He also advises that during extreme wave events (such as cyclonic conditions), wave breaking and landward flow of water over Mair Bank can occur. These events can potentially lead to the formation of a non-permanent marginal channel (landward flow causing flooding in the lowest area of the bank, opening a marginal channel, and an accretion of sand forming within the marginal channel during fair-weather conditions) between Marsden Bank and Mair Bank.

[79] Adapted from MetOcean Solutions Limited, page 26, section 4.1, "Predicted physical environmental effects from channel deepening and offshore disposal". Dated 25 July 2017.
[80]The process by which wave crests realign themselves as a result of decreasing water depths. Definition provided by Monetti, F.

2.1.4 Hydrodynamics

Dr McComb also describes the existing hydrodynamics of the Whangarei Harbour. He records that ebb (or out-going) flows from the Harbour gradually accelerate through the inlet with velocities ranging between 0.8 metres per second (‘**m/s**’) near One Tree Point and increasing to 1.3m/s through the narrow constriction of the channel during spring tides (strongest tidal period characterised by the most important water elevation variability)[81]. During neap tide (being a period characterised by a low tidal water elevation variability), ebb flow velocities range between 0.3m/s and 0.8m/s. The south-southeast directed out-going flows (ebb-jet) drives a velocity field on the ETD that extends up to 3.5km into Bream Bay. On the western flank of the ETD, the ebb-jet contributes to a clockwise tidal circulation (pressure from both sides causing the tide to orientate in a clockwise circulation) along Ruakaka Beach and Mair Bank, with current velocities up to 0.35m/s during the spring tide. The northern subtidal area of Mair Bank adjacent to the channel presents the highest exposure to strong currents (up to 1.4m/s). Interactions of the tidal flow and Mair Bank bathymetry results in accelerated and diverted flow velocities toward the inlet entrance. Between Marsden Point and Mair Bank, this acceleration occurs particularly over the southern edge of the channel where the depth exhibits steeper bed slopes. On the opposite flank, ebb flows do not exceed 0.8m/s along Calliope Bank.

Dr McComb advises that at peak flood (or incoming) flows, the strongest velocities are located near Motukaroro Island and Marsden Point. Mair Bank, he observes, is dominated by large uni-directional flood flow velocities ranging from 1.2 m/s over the subtidal areas (being areas that are not exposed at low tide) to 1.6m/s over the intertidal area (being the areas situated between the high and low tide marks), which are directed from southwest to northeast. We understand his advice to be that a weak counter current develops along Mair Bank to the southern flank of the entrance channel. Within Whangarei Harbour, due to marginal channels and bottom friction, flow velocities tend to reduce for both flood (currents going towards the estuary) and neap tides (where there is the least difference between high and low water) leading to current speeds which do not exceed 0.9 m/s.

2.1.5 Sediment Dynamics

Dr McComb and his colleagues have also described the sediment dynamics of the Site. This includes the sediment dynamics for the proposed Disposal Site 1.2 and 3.2.

With respect to Disposal Site 1.2, Dr McComb advises that it is located over the southern extent of the ETD where water depths range from 7m to 15m[82]. He advises that the tidal currents over this area are not strong, with peak ebb and flood velocities both being lower than 0.2m/s and oriented in a northeast direction. He goes on to note, however, that the maximum orbital velocities (due to the effect of waves over shallow areas) are expected to reach 0.4m/s to 0.5m/s during storms. We understand this to mean that sediment is expected to move when there are storm driven waves.

Dr McComb advises that although Disposal Site 3.2 is located offshore, with a depth of approximately 40m to 45m in Bream Bay, wave and currents can occasionally mobilise sediment in this area. Dr McComb advises that this will only occur during high energy processes such as storm conditions, when sediments can be transported in suspension (floating in the water column) or by bedload processes (sediment that rolls, slides and bounces along the bottom of the seabed). We understand

[81] MetOcean Solutions Limited, page 38, section 6.1, “Predicted physical environmental effects from channel deepening and offshore disposal”. Dated 25 July 2017.

[82] MetOcean Solutions Limited, page 113, section 9.4, “Predicted physical environmental effects from channel deepening and offshore disposal”. Dated 25 July 2017.

his advice to be that less than 5% of the disposed material is expected to be eroded and transported over a 1-year period.

Mr Reinen-Hamill and his colleagues have developed a plan that shows the expected sediment transport pathways in and around the Site. That plan is repeated as **Figure 2.1.5.1** below and shows that the volume of sediment that moves into and out of the Harbour (as suspended sediment in the water) of approximately 260,000 cubic metres per year ('**m^3/yr'**). The sediment is supplied, via alongshore drift, from Ruakaka River mouth[83]. In addition to sediment transportation via wave orbital velocities, Mr Reinen-Hamill states that another sediment transport pathway (due to tidal flows and the relatively erosion resistant surface of Mair Bank) moves sediment in a south easterly direction along the southern face of Mair Bank, before it enters the entrance channel and flows into Whangarei Harbour. He goes on to note that there are several return mechanisms with sand transport pathways to the various shoals both in Bream Bay and within the inlet and inner harbour.

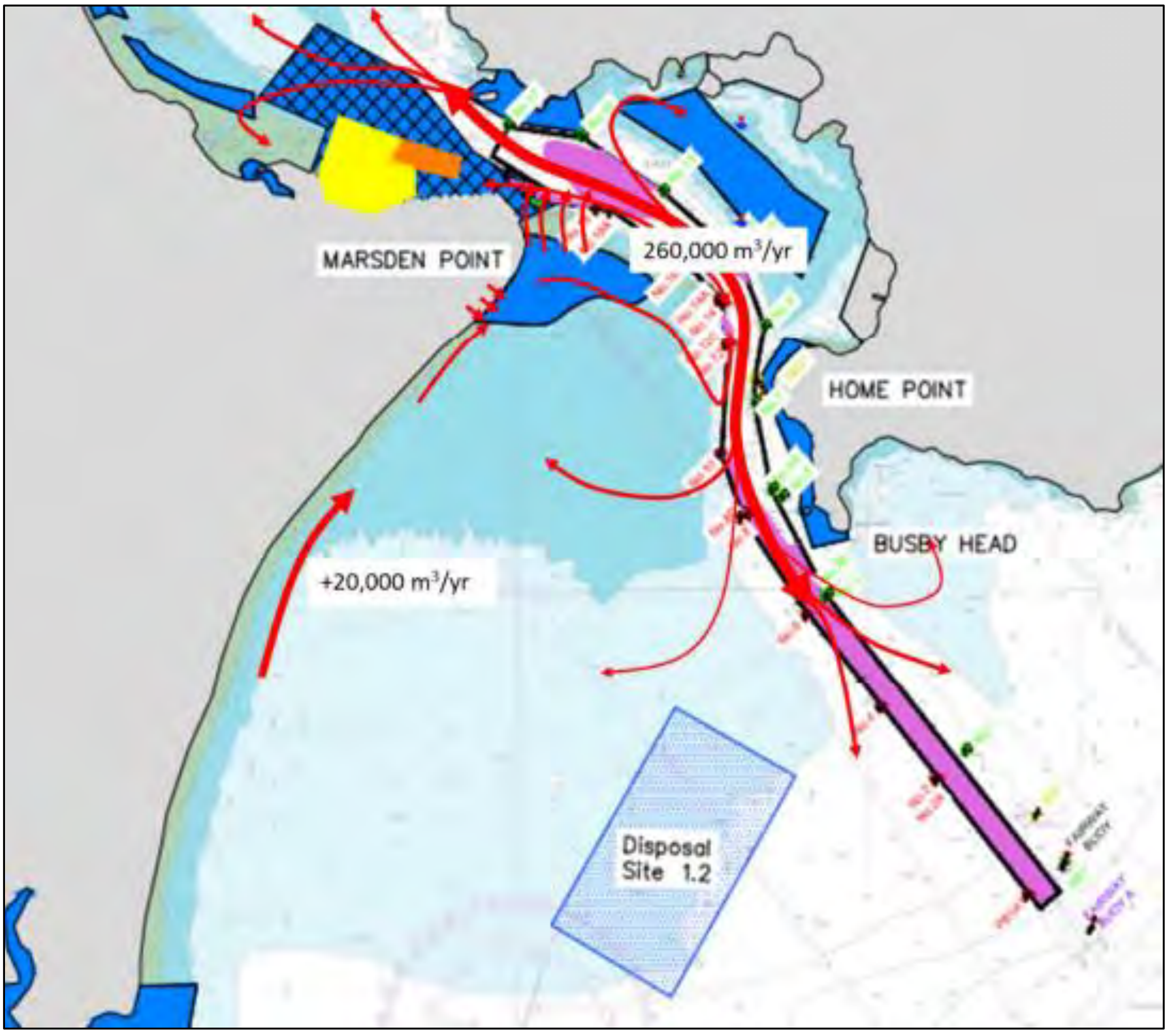


Figure 2.1.5.1: Inferred Sediment Transport Pathways [84]

[83] Reinen-Hamill, R, pages 35 to 38, section 4.1.2, "Crude Shipping Project, Coastal Processes Assessment". Dated July 2017
[84] Reinen-Hamill, R, page 38, section 4.1.2, "Crude Shipping Project, Coastal Processes Assessment". Dated July 2017

2.1.6 Sediment Composition

2.1.6.1 Areas to be Dredged

Mr Reinen-Hamill and his colleagues have evaluated the sediment within the areas to be dredged[85]. We understand his advice to be that the proposed areas of dredging site consist of a predominantly fine to medium sand layer that overlies predominantly clay and silts. Bedrock is situated well below the base of the entrance channel. He advises that the surficial sediments within the main channel of Whangarei Harbour are a mix of fine to medium sands with shells in varying proportions.

Mr Reinen-Hamill advises that a minor fraction of silty material is also found within the area to be dredged (around 3% silts and 0.3% clay). He notes that the subtidal regions of the ETD along the edges of the proposed channel are mainly made up of sandy material (around 95%) with around 5% silts[86].

Importantly, Mr Reinen-Hamill reports that the dredged sediment is clean with most potential contaminant levels either below detection or within the lower range of acceptable guidance criteria[87]. **Table 2.1.6.1.1** shows the volumes of sediment to be dredged, and the portions of the various types of sediment that are to be found in each area, while **Table 2.1.6.1.2** shows the proportion of silts and clays based on total volumes for each location.

Location	Clays	Silt	Fine Sand	Medium Sand	Coarse Sand	Gravels (shells)	Total
Berth pocket	200	3,000	8,000	49,000	3,000	8,000	81,200
Inner channel	4,900	24,000	78,000	274,000	29,000	75,000	484,900
Mid channel	200	2,000	9,000	64,000	10,000	15,000	100,200
Outer channel (3.5 to 5.5 km)	3,100	17,000	36,000	643,000	185,000	144,000	1,028,100
Outer channel (5.5km to end)	1,900	56,000	327,000	1,227,000	104,000	227,000	1,942,900
Total	10,300	102,000	468,000	2,257,000	331,000	469,000	3,637,300

Table 2.1.6.1.1: Volume of Material (in cubic metres) to be Dredged by Average Sediment Classification[88]

Location	Percentage of silt and clays
Berth pocket	3.9%
Inner channel	6.0%
Mid channel	2.2%
Outer channel (3.5 to 5.5 km)	2.0%
Outer channel (5.5km to end)	3.0%

Table 2.1.6.1.2: Percentage of Silt & Clays for Each Dredged Area Based on Total Volume[89]

[85] Reinen-Hamill, R, "Dredging and Disposal Options – Synthesis Report", Dated July 2017
[86] Reinen-Hamill, R, page 14, section 3.5.1, "Crude Shipping Project, Coastal Processes Assessment". Dated July 2017
[87] Reinen-Hamill, R; page 9, section 3.1, "Dredging and Disposal Options – Synthesis Report", Dated July 2017
[88] Reinen-Hamill, R, page 9, section 3.1, "Dredging and Disposal Options – Synthesis Report", Dated July 2017
[89] Reinen-Hamill, R; page 9, section 3.1, "Dredging and Disposal Options – Synthesis Report", Dated July 2017

2.1.6.2 Disposal Area 3.2

Mr Reinen-Hamill advises that the seabed in Disposal Area 3.2 comprises predominantly fine to medium sands with some areas of silt and shell deposits. **Table 2.1.6.2.1** records the sediment composition that has been found during a number of investigations associated with the Proposal below.

Site ID	Clays	Silt	Fine Sand	Medium Sand	Coarse Sand	Gravels (shells)
	<0.002mm	**0.063mm**	**.30mm**	**.63mm**	**2mm**	**25mm**
11-3.2	3%	14%	72%	87.34%	91%	100%
12-3.2	6%	27%	62%	81%	93%	100%
13-3.2	6%	8%	13%	40%	78%	100%
14-3.2	0%	1%	10%	54%	97%	100%
15-3.2	0%	6%	22%	65%	95%	100%
16-3.2	0%	2%	12%	57%	89%	100%
Minimum	0%	1%	10%	40%	78%	100%
Average	3%	10%	32%	64%	91%	100%
Maximum	6%	27%	72%	87%	97%	100%

Table 2.1.6.2.1: Sediment Grading (percent passing) in the Vicinity of Disposal Area 3.2[90]

2.1.6.3 Mair Bank and Disposal Area 1.2

Mr Reinen-Hamill advises that Mair Bank is covered with a shell substrate, mostly consisting of Pipi shells, with deposits of fine sands in the lee of shell ridges. He goes on to advise that with increasing water depth the amount of sand interspersed with the shells increases down the edge of the bank.

With respect to Disposal Area 1.2, he notes that the sands are predominantly fine to medium with no significant portions of clays and silts. Mr Reinen-Hamill advises that, compared to the dredged channel area, the sand in Disposal Area 1.2 is less coarse with a lower proportion of shell and more fine sands. **Table 2.1.6.3.1** records the sediment composition that has been found during a number of investigations associated with the Proposal below.

Site ID	Clays	Silt	Fine Sand	Medium Sand	Coarse Sand	Gravels (shells)
	<0.002mm	**0.063mm**	**.30mm**	**.63mm**	**2mm**	**25mm**
DA1A04	0.0%	3.2%	57.7%	99.1%	100.0%	100%
DA1A05	0.0%	3.0%	56.7%	98.9%	100.0%	100%
DA1A06	0.0%	4.0%	59.8%	99.1%	100.0%	100%
DA1A07	0.0%	3.3%	56.1%	98.6%	100.0%	100%
DA1A08	0.0%	4.2%	60.1%	99.1%	100.0%	100%
DA1A09	0.0%	4.5%	52.7%	95.9%	100.0%	100%
Minimum	0.0%	3.0%	52.7%	95.9%	100.0%	100%
Average	0.0%	3.7%	57.2%	98.5%	100.0%	100%

[90] Reinen-Hamill, R; page 10, section 3.1, "Dredging and Disposal Options – Synthesis Report", Dated July 2017

Maximum	0.0%	4.5%	60.1%	99.1%	100.0%	100%

Table 2.1.6.3.1: Sediment Grading (percent passing) in the Vicinity of Area 1.2[91]

2.1.7 Sea Level Change

Mr Reinen-Hamill notes that the NZCPS requires that the identification of coastal hazards, including considerations that arise from sea level rise over at least a 100-year planning period. He goes on to advise that sea level rise over this time frame is likely to significantly alter the coastal hazard risk facing the Site and highlights that the Ministry for the Environment ('**MfE**') recommends that planning occur around 'a base value sea level rise' of 0.5m by 2100 (relative to the 1980 to 1999 average)[92]. Mr Reinen-Hamill records that MfE also recommends that consideration be given to the consequences of sea level rise of at least 0.8m by 2100, with an additional sea level rise of 10 millimetres ('**mm**') per year beyond 2100[93]. He goes on to note that modelling presented within the most recent Intergovernmental Panel on Climate Change report predicted global sea level rise values by 2100 to range from 0.27m, which is slightly above the current rate of rise, to 1.0m. Extrapolating this scenario to the year 2115 results, we understand, in a sea level range from 0.27m to 0.47m by 2065 and 0.62m to 1.27m by 2115[94].

Overall, Mr Reinen-Hamill advises that historic sea level rise in New Zealand has averaged approximately 1.7mm/year with Northland exhibiting a slightly higher rate of approximately 2.2mm/year.

2.2 The Entrance Channel & Existing Navigation Consideration

Mr Bermingham and his colleagues at Navigatus Consulting Limited ('**Navigatus**') have prepared a navigational risk assessment of the various channel designs[95]. That report includes the details of the existing channel at Whangarei Harbour. Mr Oldham (also from Navigatus) has also prepared a report which assesses the environmental spill risk for the channel[96]. We now summarise those aspects of the reports from Mr Bermingham and Mr Oldham's that describe the existing environment.

Mr Bermingham notes that much of the Whangarei Harbour is shallow, with exposed mud banks and sand bars at low tide. He advises that vessels visiting the Refinery must contend with these banks and bars, as well as the comparatively narrow entrance channel that leads to Marsden Point and beyond[97]. Further, he notes that the large size of the Whangarei Harbour, which has a spring tidal range of 2.3m at Marsden Point and the narrow entrance, results in notable tidal currents, particularly at the entrance of the Harbour. In this regard, he advised that currents are, on average, 2.1 knots at Marsden Point and 3.1 knots at Home Point, with local information indicating localised areas of higher rates of flow. Mr Oldham advises that the oil tanker access to Marsden Point is limited to vessels with a maximum draft of 14.7m, due to the constraints of the natural channel and existing approach[98]. This only allows fully laden Aframax tankers, and partly laden Suezmax tankers (which bring in crude

[91] Reinen-Hamill, R; page 11, section 3.1, "Dredging and Disposal Options – Synthesis Report", Dated July 2017
[92] Reinen-Hamill, R, page 31, section 3.10.1.1, "Crude Shipping Project, Coastal Processes Assessment", Dated July 2017
[93] Reinen-Hamill, R, page 31, section 3.10.1.1, "Crude Shipping Project, Coastal Processes Assessment", Dated July 2017
[94] Reinen-Hamill, R, page 31, section 3.10.1.1, "Crude Shipping Project, Coastal Processes Assessment", Dated July 2017
[95] Bermingham, G, "Report in Support of an Assessment of Effects on the Environment, Navigational Risk Assessment of Engineered Channel Designs". Dated 15 August 2017.
[96] Oldham, K, "Environmental Spill Risk Assessment for Proposed Tanker Operations Associated with Engineered Channel". Dated 14 August 2017
[97] Bermingham, G, page 6, section 4.1.1, "Report in Support of an Assessment of Effects on the Environment, Navigational Risk Assessment of Engineered Channel Designs". Dated 15 August 2017.
[98] Oldham, K, page 7, section 4.1, "Environmental Spill Risk Assessment for Proposed Tanker Operations Associated with Engineered Channel". Dated 14 August 2017

oil) access. Mr Oldham advises that there has been an average of 55 tanker visits per year (from 2006 to 2015).

Mr Bermingham and his colleagues also report that the reach of the existing channel that leads to the Refinery is five nm in length (when measured from the Fairway Buoy offshore to Marsden Point jetty). He also records that the existing channel is demarcated by a safe water mark (fairway buoy) and eighteen channel markers, consisting of nine starboard buoys and nine port buoys. Further, Mr Bermingham notes that the approach to Marsden Point has a shallowest depth of 14.7m below CD between the Fairway Buoy and the No 1 Buoy. We understand his advice to be that from a navigational perspective, the most critical buoys are (as illustrated on **Figure 2.2.1**):

- The Fairway Buoy, which is the most seaward buoy for ships approaching and departing Marsden Point. In theory, ships can pass either side of the buoy, however, the 'wave rider' Buoys that feeds data to the Dynamic Under Keel Clearance system used to inform ships of safe entry are located 0.3nm to the north west of the Fairway Buoy and form a prohibited area. We understand this to mean that large vessels will normally pass to the South of the Fairway Buoy. The Dynamic Under Keel Clearance system takes into account the swell conditions of the entrance of Whangarei Harbour, and uses this to determine that a safe minimum bottom clearance can be maintained for large vessels entering the channel[99].
- Buoys #1 and #2 mark the seaward end of the channel. There is a limiting depth of 14.7m between Buoy #1 and the Fairway Buoy.
- Buoys #3 and #6 are close to Busby Head. The channel turns to the north at this point.
- Buoy #7 is close to Home Point. The coast from Busby Head around Home Point has a rocky foreshore and is therefore, considered hazardous by Mr Bermingham. There is a rocky outcrop extending from the Home Point shoreline to the edge of the channel 0.1nm to the north east of Buoy #7. The outer extent of the rock is charted at 4.8m and so presents a significant hazard to vessels with a deep draft. Although close to the edge of the channel, this rock is currently unmarked. There is a change in the channel alignment at this buoy which requires that inward ships make a starboard turn at Buoy #3 changing to a port turn to Buoy #14. In effect, there is an 'S' bend in the channel as it passes Home Point.
- Buoy #14 marks the north-eastern extent of the boundary of the Mair Bank. It also marks a change in channel alignment as the end of the bend around Home Point.
- Sinclair Leading Lights align to show the channel to the Refinery's jetty.

Between Fairway Buoy and Snake Bank Beacon, there are currently five channel alignments with two of those alignments (the inner and outer-most of the above) marked by leading beacons.

[99] Bermingham, G, page 6, section 4.1.1, "Report in Support of an Assessment of Effects on the Environment, Navigational Risk Assessment of Engineered Channel Designs". Dated 15 August 2017.

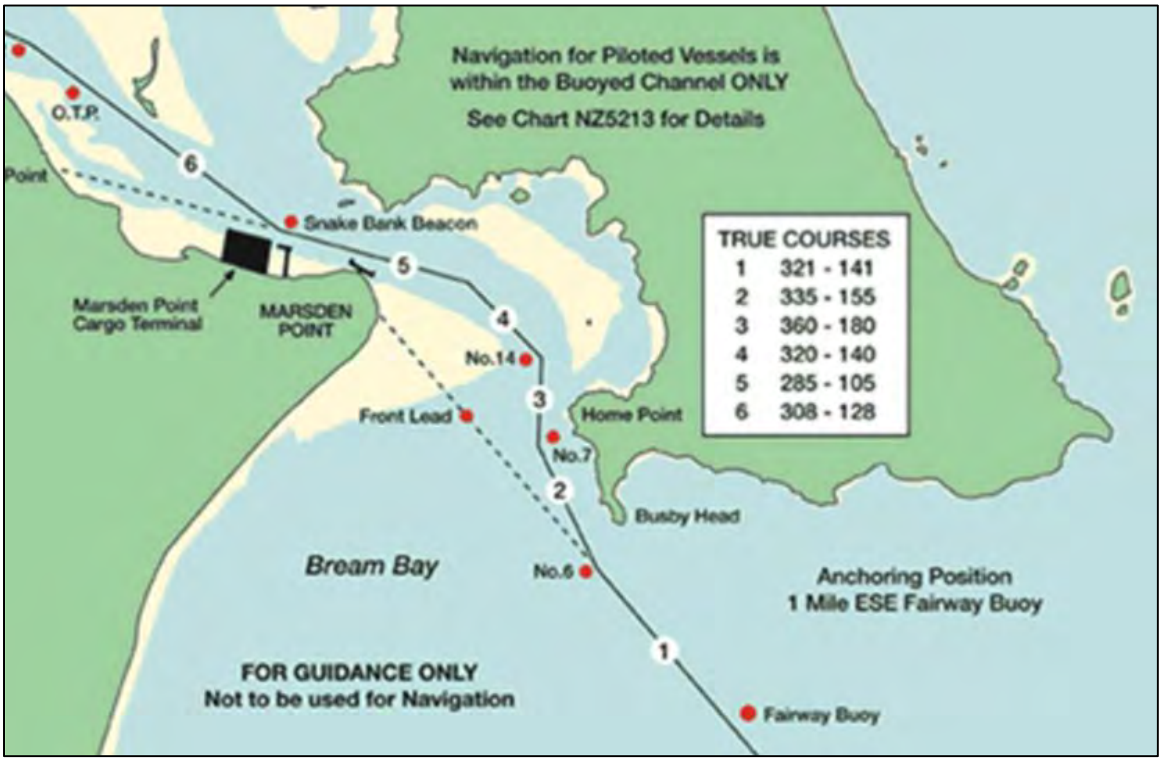


Figure 2.2.1: Existing Navigation Channel Alignments[100]

Mr Cross and his colleagues at Royal Haskoning DHV prepared a report which also provides detail and describes the entrance channel[101]. One of the matters that Mr Cross provides is an assessment of the constraints and navigational challenges that apply to the entrance channel, as it is presently configured[102]. **Table 2.2.1**, which also follows, summarises the findings of that assessment.

Factor	Existing Channel
Design vessel suitability	Not suitable for 16.6m draft Suezmax.
Buoyage locations	Buoyage used for turning transits is familiar to pilots.
Sea room area – Inner channel	Between Buoy 14, 11, 9 and 12 – 117300m^2
Sea room area – Mid channel	Between Buoy 14, 12, 7 and 9 – 137500m^2
Constraint at Buoy 11	Buoy 11 is a constraint when arriving ships turn around Buoy 14.
Constraint at Buoy 12	Buoy 12 is a constraint for both arriving and departing ships as it necessitates a series of turns when rounding Buoy 14.
Mid channel alignment	Channel alignment in approach to Buoy 14 on the arriving ship is not straight.

[100]Cross, J, page 1, section 1, "Refining NZ Crude Shipping Project Shipping Channel – Concept Design Report", Dated 12th November 2016, contained within Appendix B of the Reinen-Hamill, R, "Dredging and Disposal Options – Synthesis Report"; Dated July 2017
[101]Cross, J, "Refining NZ Crude Shipping Project Shipping Channel – Concept Design Report", Dated 12th November 2016, contained within Appendix B of the Reinen-Hamill, R, "Dredging and Disposal Options – Synthesis Report"; Dated July 2017
[102] Cross, J, page 6, section 2, "Refining NZ Crude Shipping Project Shipping Channel – Concept Design Report", Dated 12th November 2016, contained within Appendix B of the Reinen-Hamill, R, "Dredging and Disposal Options – Synthesis Report"; Dated July 2017

Constraint at Home Point	Rocky outcrop at Home Point is a constraint for departing ships.
Emergency anchorage	Emergency anchorage is available between Buoys 11 to 15.
Outer Channel Width	Outer Channel is naturally wide for vessels up to a draft of 14.8 m
Overall Assessment	Marginal. Can be brought up to Adequate by improvements around Buoy 11.

Table 2.2.1: Summary: Existing Channel Navigation Assessment[103]

2.3 Marine Ecological Values

Dr Coffey has produced a report that details the existing marine environment and values within, and adjacent to the Site[104]. We now summarise his findings in the following sub-sections of this AEE. Please note that we address the matters in the same order that they have been raised by Dr Coffey.

1. Reef structures and hard shorelines
2. Water quality
3. Plankton
4. Benthos
5. Soft-bottomed communities in the Whangarei Harbour
6. Hard shore habitat and submerged reefs
7. Fish
8. Marine Sites of Special Scientific or Conservation Value

2.3.1 Reef Structures and Hard Shorelines

Dr Coffey advises that the reef structures and hard shorelines exist along the northern shoreline of Bream Bay (Busby Point to Bream Head). He notes that hard shore communities are also located between Busby Head and Home Point, at High and Motukaroro Island (including within the Marine Reserve), and on headlands between Darch Point and Home Point. Drawing on advice from various other ecologists, Dr Coffey advises that these reef structures and hard shoreline communities are high quality habitats[105].

[103] Cross, J, page 29, section 10.2, "Refining NZ Crude Shipping Project Shipping Channel – Concept Design Report", Dated 12th November 2016, contained within Appendix B of the Reinen-Hamill, R, "Dredging and Disposal Options – Synthesis Report"; Dated July 2017
[104] Dr Coffey, B "Crude Shipping Project, Proposal to Deepen and Partially Realign the Approaches to Marsden Point, Assessment of Marine Ecological Effects, Excluding Seabirds and marine Mammals". Dated 10 August 2017
[105] Dr Coffey, B, page 13, section 2.4, "Crude Shipping Project, Proposal to Deepen and Partially Realign the Approaches to Marsden Point, Assessment of Marine Ecological Effects, Excluding Seabirds and marine Mammals". Dated 10 August 2017

2.3.2 Water Quality

2.3.2.1 General

Dr Coffey advises that Bream Bay and the Whangarei Harbour enjoys 'generally good' water quality, due to regular tidal flushing with ocean water. We understand him to advise that this is one of the reasons why significant ecological areas exist within the Bay and the Harbour[106].

Dr Coffey also records his understanding that the monitoring sites recording the best water quality are located close to the entrance to the Whangarei Harbour. Conversely, he advises that the monitoring sites with the worst water quality are located in the Hatea River and the Mangapai River. He also notes that the monitoring sites located near the entrance to Whangarei Harbour are more influenced by coastal water, whilst those sites in the Hatea and Mangapai Rivers are influenced by freshwater inputs from rivers and streams. More particularly, Dr Coffey advises that the monitoring site with the best water quality is located at Marsden point, and the Site with the worst water quality is located in the Waiharohia Canal.

Dr Coffey also advises that freshwater inputs from the Ruakaka River can adversely impact on water quality in Bream Bay during wet weather events. He goes on to note that Bream Bay is generally flushed with highly transparent oceanic water which is high in nutrients, that may, during winter and spring, support planktonic algae blooms[107].

2.3.2.2 Water Temperatures & Nutrients

Dr Coffey advises that water temperatures were lower in Blacksmith Creek than at One Tree Point, Snake Bank, Marsden Point or Mair Bank.

Dr Coffey also states that the lowest nutrient concentrations were present at the entrance to the Harbour, but advises that nutrients such as Dissolved Reactive Phosphorus exceeded values at all of the monitoring sites situated within the Harbour[108]. He records that the Bream Bay's peak nutrient levels occur in winter and reduce over summer[109]. He attributes this reduction to the uptake of nutrients by phytoplankton.

Dr Coffey advises that the Ruakaka River has a significant influence on the water quality of a large portion of Bream Bay when it is experiencing 'fresh event'[110] or flood. Similarly, Dr Coffey states that watercourses discharging to upper Whangarei Harbour and Bream Bay also contribute to changes in Bream Bay water quality during rainfall events.

2.3.2.3 Suspended Solids, Turbidity and Light Penetration

Table 2.3.2.3.1, which follows, identifies the turbidity conditions for the Whangarei Harbour. Dr Coffey notes that the highest median values for turbidity (therefore lowest water clarity) were found

[106] Dr Coffey, B, page 14, section 2.5, "Crude Shipping Project, Proposal to Deepen and Partially Realign the Approaches to Marsden Point, Assessment of Marine Ecological Effects, Excluding Seabirds and marine Mammals". Dated 10 August 2017
[107] Dr Coffey, B, page 20, section 2.5.4, "Crude Shipping Project, Proposal to Deepen and Partially Realign the Approaches to Marsden Point, Assessment of Marine Ecological Effects, Excluding Seabirds and marine Mammals". Dated 10 August 2017
[108] Dr Coffey, B, page 17, section 2.5.2, "Crude Shipping Project, Proposal to Deepen and Partially Realign the Approaches to Marsden Point, Assessment of Marine Ecological Effects, Excluding Seabirds and marine Mammals". Dated 10 August 2017
[109] Dr Coffey, B, page 17, section 2.5.1b, "Crude Shipping Project, Proposal to Deepen and Partially Realign the Approaches to Marsden Point, Assessment of Marine Ecological Effects, Excluding Seabirds and marine Mammals". Dated 10 August 2017
[110] Definition provided by Dr Coffey, B. Flood event caused upstream, caused by rainfall.

at sites close to freshwater inputs in the Mangapai River and the Hātea River[111]. He then advises that the monitoring sites with the lowest median turbidity (highest water clarity) were located near the entrance to Whangarei Harbour, at One Tree Point, Blacksmith's Creek, Marsden Point and Mair Bank, where freshwater inflows are likely to have less influence on water quality. Dr Coffey also record that turbidity at the Snake Bank monitoring site ranged from 1.0 to 15.3 NTU.

Site Name	No. of Samples	Range (NTU)	Median (NTU)	% of samples within guideline value (< NTU)
One Tree Point	25	0.5 – 5.7	1.0	100
Blacksmith's Creek	18	1.0 – 3.4	1.0	100
Marsden Point	38	0.4 – 6.6	1.0	100
Mair Bank	39	0.2 – 2.4	1.0	100
Snake Bank	18	1.0 – 15.3	2.1	94
Tamaterau	39	1.0 – 37.0	2.9	92
Town Basin	25	3.4 – 63.0	5.0	92
Onerahi	18	2.5 – 12.4	5.1	89
Lower Port Road	18	3.6 – 11.9	5.4	89
Kaiwaka Point	22	3.4 – 11.7	5.4	91
Kissing Point	50	2.8 - 92.0	5.4	94
Riverside Drive	18	3.4 – 11.1	5.7	94
Waiharohia Canal	18	3.4 -13.2	6.6	83
Portland	18	4.0 – 18.1	7.4	78
Limeburners Creek	25	4.1 – 67.0	7.9	88
Mangapai	18	4.6 – 15.2	9.3	67

Table 2.3.2.3.1: Turbidity (NTU) at 16 sites in Whangarei Harbour, from 2000 to 2010[112]

Table 2.3.2.3.2, which also follows, summarises the 'Secchi depth visibility' (which is a measure of waters clarity) at a number of Whangarei Harbour sites. Dr Coffey reports that a similar spatial trend to turbidity was observed, with the lowest median Secchi depths (therefore lowest water clarity) found at the Hātea River and Mangapai River monitoring sites, and the highest median Secchi depths (highest water clarity) being recorded at the monitoring sites near Whangarei Harbour's entrance. Further, Dr Coffey notes that median Secchi disc values of 3.65m to 4.5m for One Tree Point, Snake Bank, Blacksmith Creek, Marsden Point and Mair Bank represent good water clarity.

Site Name	No. of Samples	Range (m)	Median (m)	% of samples within guideline value
Marsden Point	37	0.9 – 9.0	4.5	N/A
Blacksmith's Creek	15	1.6 – 6.0	4.0	N/A

[111] Dr Coffey, B, pages 17 to 19, section 2.5.2, "Crude Shipping Project, Proposal to Deepen and Partially Realign the Approaches to Marsden Point, Assessment of Marine Ecological Effects, Excluding Seabirds and marine Mammals". Dated 10 August 2017

[112] Dr Coffey, B, page 18, section 2.5.2, "Crude Shipping Project, Proposal to Deepen and Partially Realign the Approaches to Marsden Point, Assessment of Marine Ecological Effects, Excluding Seabirds and marine Mammals". Dated 10 August 2017

Mair Bank	34	1.8 – 7.5	3.85	N/A
One Tree Point	24	2.0 – 6.3	3.8	N/A
Snake Bank	14	1.3 – 7.0	3.65	N/A
Tamaterau	33	0.3 – 4.7	2.4	N/A
Onerahi	17	0.9 – 2.2	1.5	N/A
Kaiwaka Point	18	0.47 – 1.8	1.4	N/A
Lower Port Road	17	0.8 – 1.7	1.3	N/A
Portland	17	0.6 – 2.1	1.3	N/A
Town Basin	18	0.5 – 1.9	1.23	N/A
Kissing Point	47	0.15 – 2.1	1.2	N/A
Waiharohia Canal	17	0.7 – 2.0	1.1	N/A
Riverside Drive	17	0.7 -1.8	1.0	N/A
Limeburners Creek	21	0.3 – 2.2	1.0	N/A
Mangapai	17	0.2 – 1.5	0.9	N/A

Table 2.3.2.3.2: Secchi depth visibility in Whangarei Harbour, 2000-2010[113]

2.3.2.4 Water Quality Standards

Dr Coffey has assessed the water quality at Marsden Point and Mair Bank (between 2000 and 2010) in relation to the applicable water quality standards set out in the RCP. His advice is summarised in **Table 2.3.2.4.1** of this AEE. He concludes that the water quality at Marsden Point and Mair Bank is generally compliant with RCP water quality standards.

Parameter and standard	Marsden Point: Median (range)	Mair Bank: Median (range)
Turbidity <10 NTU	1.0 (0.4 – 6.6)	1.0 (0.2 – 2.45)
Dissolved oxygen >80% saturation	96.8 (80.9 – 137.2)	98.1 (81.2 – 135.5)
Enterococci <14/100ml	5 (1- 31)	5 (1 – 42)
Faecal Coliforms <14/100ml	1 (1 – 20)	1 (1 – 68)
Total Phosphorus <0.03mg/L	0.015 (0.005 – 0.03)	0.014 (0.005 – 0.032)
Dissolved Reactive P 0.01mg/L	0.008 (0.005 – 0.015)	0.007 (0.005 – 0.028)
Nitrate nitrogen <0.015mg/L	0.015 (0.001 – 0.057)	0.017 (0.001 – 0.050)
Ammonium (<0.015mg/l)	0.005 (0.005 – 0.36)	0.005 (0.005 – 0.37)

Table 2.3.2.4.1: Water quality at Marsden Point and Mair Bank between 2000 and 2010 in Relation to the RCP's Water Quality Standards[114]

2.3.3 Plankton

As we have already noted, the advice of Dr Coffey is that the coastal waters of Bream Bay have higher nutrient levels in winter (due to higher winds causing upwelling of nutrients from the bottom of

[113] Dr Coffey, B, page 18, section 2.5.2, "Crude Shipping Project, Proposal to Deepen and Partially Realign the Approaches to Marsden Point, Assessment of Marine Ecological Effects, Excluding Seabirds and marine Mammals". Dated 10 August 2017
[114] Dr Coffey, B, page 19, section 2.5.3, "Crude Shipping Project, Proposal to Deepen and Partially Realign the Approaches to Marsden Point, Assessment of Marine Ecological Effects, Excluding Seabirds and marine Mammals". Dated 10 August 2017

the sea) and that they become depleted over summer, due to phytoplankton uptake[115]. Dr Coffey advises that there are three sources of nutrients in the Bay, being replenishment (via nutrient recycling[116]) from the seafloor, nutrients from deep oceanic upwelling (nutrients that have been brought up from material on the sea floor) and inputs from land following fresh events and/or floods in the Ruakaka River and other watercourses. More particularly, Dr Coffey notes that extensive plankton blooms within this area might be directly related to the oceanic upwelling that we have previously highlighted.

Dr Coffey goes on to advise that various phytoplankton species produce toxins, which can grow and reproduce in suitable conditions, creating a toxic bloom. He then notes that toxic blooms produce poisons that can (and do) accumulate in the bodies of filter-feeding shellfish such as oysters and mussels. While we understand his advice to be that the shellfish usually remain unaffected, fish, birds and marine mammals which feed on the shellfish can be poisoned and die. Dr Coffey reports that in humans, they can cause paralysis, respiratory difficulty, memory loss or diarrhoea.

Dr Coffey records that Whangarei Harbour has a history of toxic algae blooms, and advises that the Regional Council had previously imposed restrictions on dredging in Whangarei Harbour outside of winter months. The Regional Council have since come to the conclusion these restrictions were not necessary, and that dredging is not directly related to toxic algae blooms. In addition, Dr Coffey reports that the species that caused a toxic bloom outbreak between 1992 to 1993 has no known benthic resting cyst in its life cycle. As a consequence, Dr Coffey advises that there is no evidence to suggest toxic shellfish blooms will reoccur in the Whangarei Harbour.

2.3.4 Benthos

Drawing on advice from various ecologists, Dr Coffey sets out his understanding of the marine species that are encountered within and beyond the dredging footprint. We summarise his advice as follows.

As we have already recorded, Dr Coffey also notes that the Site is close to Home Point, the Marine Reserve and a number of other rocky habitats. While all of these habitats are outside of the proposed dredging footprint, they have been considered so that any potential effects on them can be adequately assessed. Dr Coffey goes on to advise that the proposed dredging footprint and the footprints of Disposal Sites 1.2 and 3.2 are soft bottom areas of seabed that support a benthic community which he considers to be typical of the coastal environment off the north-east coast of the North Island.

More specifically:

[115] Dr Coffey, B, page 20 - 21, section 2.6.1, "Crude Shipping Project, Proposal to Deepen and Partially Realign the Approaches to Marsden Point, Assessment of Marine Ecological Effects, Excluding Seabirds and marine Mammals". Dated 10 August 2017

[116] Definition provided by Dr Coffey, B. The cycle of plants and animals dying and sinking to the bottom of the sea where they are feed on by bacteria and fungi, therefore keeping the nutrients in the system.

2.3.4.1 *Open Sandy Beaches in Bream Bay*

Dr Coffey advises that seven species of crustacean were identified at various beaches in Bream Bay[117]. They include the sea-slater, common sandhopper, isopods of the families Sphaeromidae and Eurydicidae, paddle crab, ghost shrimp, mantis shrimp, and tuatua.

2.3.4.2 *Sub-Tidal Sand Flats in Bream Bay*

Dr Coffey advises that the benthic communities through the subtidal areas in Bream Bay are generally dominated by sand dollars, starfish, polychaete worms, hermit crabs, flatfish, morning star shell, gastropod Amalda depressa, and other species of crabs[118].

2.3.4.3 *Disposal Site 1.2*

We understand Dr Coffey's advice to be that the footprint of Disposal Site 1.2 is dominated by the nematodes, urchins, polychaetes, amphipods, isopod Exosphaeroma species, and cumacea[119].

2.3.4.4 *Disposal Site 3.2*

Dr Coffey also reports the footprint of Disposal Site 3.2 is dominated by nematodes, oligochaetes, polychaetes, amphipods, and bryozoans and ostracods[120].

2.3.5 Soft-bottomed Communities in the Whangarei Harbour

Again, drawing on the results of other scientists, Dr Coffey has described the soft-bottomed communities within and outside of the dredged footprint. We record our understanding of his advice as follows.

2.3.5.1 *Within the Dredging Footprint*

Dr Coffey advises that the fine sand habitat was most common within the dredging footprint and supported the most diverse benthos. In doing so, he advises that this habitat type is dominated by smaller biota such as polychaete worms and amphipods[121].

Dr Coffey then records that a coarse sand habitat was present around Busby Head, but this habitat differs slightly in composition in different locations. Dr Coffey advises that seaward of Busby Head, the biota was dominated by the bivalve Tawera spissa and the primitive chordate, Epigonichthys hectori. He then records that inside the mouth of Whangarei Harbour, the coarse sand habitat was dominated by the community defining bivalve Venerupis largillierti and juvenile gastropods.

Dr Coffey records that the shell gravel habitat, located on the outer channel towards Home Point, has a higher proportion of larger species compared to the sandy habitats. He notes, however, that

---

[117] Dr Coffey, B, page 26, section 2.6.2a, "Crude Shipping Project, Proposal to Deepen and Partially Realign the Approaches to Marsden Point, Assessment of Marine Ecological Effects, Excluding Seabirds and marine Mammals". Dated 10 August 2017

[118] Dr Coffey, B, page 26, section 2.6.2b, "Crude Shipping Project, Proposal to Deepen and Partially Realign the Approaches to Marsden Point, Assessment of Marine Ecological Effects, Excluding Seabirds and marine Mammals". Dated 10 August 2017

[119] Dr Coffey, B, page 26, section 2.6.2c, "Crude Shipping Project, Proposal to Deepen and Partially Realign the Approaches to Marsden Point, Assessment of Marine Ecological Effects, Excluding Seabirds and marine Mammals". Dated 10 August 2017

[120] Dr Coffey, B, page 27, section 2.6.2d, "Crude Shipping Project, Proposal to Deepen and Partially Realign the Approaches to Marsden Point, Assessment of Marine Ecological Effects, Excluding Seabirds and marine Mammals". Dated 10 August 2017

[121] Dr Coffey, B, page 27, section 2.6.2e, "Crude Shipping Project, Proposal to Deepen and Partially Realign the Approaches to Marsden Point, Assessment of Marine Ecological Effects, Excluding Seabirds and marine Mammals". Dated 10 August 2017

the species composition differed from the sandy habitats, with less taxa being recorded in the shell gravel habitat. Dr Coffey advises that the 'community defining' bivalve Tucetona laticostata and the primitive chordate, Epigonichthys hectori were abundant in the shell gravel seaward of Home Point. Interestingly, however, these species were almost absent inside Whangarei Harbour. The shell gravel habitat existing inside the mouth of Whangarei Harbour does, however, support greater numbers of the bivalves Corbula zelandica and Venerupis largillierti and juvenile gastropods.

Importantly, the advice of Dr Coffey is that there are no species of marine invertebrates or marine fish in the dredge footprint that are listed as 'Threatened' or 'At Risk' under the New Zealand Threat Classification System[122], and advised that the habitats within the proposed dredge area are not of national significance.

2.3.5.2 Outside of the Dredging Footprint

Dr Coffey reports that pipi beds (Paphies australis), and cockle (Austrovenus stutchburyi) are present on intertidal and adjacent subtidal sandy substrates within the lower harbour, and that scallops (Pecten novezealandiae) are locally common in subtidal channels and in Bream Bay[123]. He also notes that benthic communities on Mair Bank have undergone significant changes recently, whereby the pipi population largely collapsed, and records his opinion that there is presently no accepted explanation of what has caused the change that is being observed. In addition, Dr Coffey notes that in recent years, an expanding green-lipped mussel bed (Perna canaliculus) has established on Mair Bank.

Figures 2.3.8.1 and **2.3.8.2**, which follow in section 2.3.8, identify areas such as Urquharts Bay, Home Point, Calliope Bank and Taurikura as being significant, in marine ecological terms. We understand Dr Coffey's advice to be that he agrees with the classification of these areas.

2.3.6 Hard Shore Habitat & Submerged Reefs

Dr Coffey advises that he has characterised the distribution of the hard shore communities between Darch Point and Bream Head in the following manner:

He advises that the sheltered rocky intertidal shore is characterised by zones of barnacles, rock oysters, Pomatoceros tubeworms, red algae and brown algae, and Neptune's necklace. The sublittoral fringe (at and immediately below low tide) consists of large brown algae (notably species of Carpophyllum and Cystophora) that are, he records, typically separated from submerged forests of tall-growing kelp by rock or kina flats. Dr Coffey reports that the kelp forests are dominated by the attached brown alga Ecklonia radiata, whose canopy provides shelter for a wide range of fish and mobile / attached invertebrates. He also advises that rock overhangs and caves are common throughout the rocky shore profile and the taxa that colonise these shaded habitats add to the diversity of the zones. Below the Ecklonia forests there are deep zones of rock habitat that are dominated by sponge gardens.

Dr Coffey advises that a diverse range of fish and invertebrates (mobile and attached) are found on and under the cover of seaweeds, and within sponge gardens. He also notes that within more turbid

[122] New Zealand Threat Classification System lists the New Zealand wild species accordingly to its threat of extinction. Available from http://www.doc.govt.nz/nztcs

[123] Dr Coffey, B, page 27, section 2.6.2f, "Crude Shipping Project, Proposal to Deepen and Partially Realign the Approaches to Marsden Point, Assessment of Marine Ecological Effects, Excluding Seabirds and marine Mammals". Dated 10 August 2017

waters of Whangarei Harbour, the kelp forests may only penetrate 10m deep, whereas on the clearer, open coast, kelp forests can extend up to 30m deep[124]. Dr Coffey advises that these sponge gardens and kelp forests are ecologically significant, as they provide a sheltered habitat for species.

Dr Coffey advises that the Three Mile Reef, located west of Disposal Area 3.1, includes a rocky-boulder lined seabed that supports a low-profile reef community that is partially covered by sand and shell movement along the seabed. While this reef is not recognised in the RCP, Dr Coffey advises that it has local recreational (principally fishing) and ecological value.

2.3.7 Fish

Dr Coffey reports that the six most common fish in the Marine Reserve are goatfish, jack mackerel, parore, spotty, sweep and snapper. Dr Coffey advises that these fish are likely to be found in other reefs within the study area[125]. Dr Coffey also notes that flounder has been found in Whangarei Harbour, and eels and whitebait migrate through Whangarei Harbour to freshwater streams. Subtropical species found at the Hen and Chicken Islands can also be found around Bream Head, including half-banded perch, single-spot demoiselle, red pigfish, Coris sandageri and Sandagers wrasse.

Dr Coffey notes that the Regional Council has sponsored a 'fish ladder' in a culvert under Whangarei's Western Hills bypass to enable native fish access to the Kirikiri Stream from Whangarei Harbour.

We understand Dr Coffey advice to be that none of the fish species present within or adjacent to the Site are endangered, or considered to be ecologically significant, however, those from sub-tropical waters are considered to have a high interest value for some recreational users of the area.

2.3.8 Marine Sites of Special Scientific or Conservation Value

Dr Coffey notes that the RCP recognises four marine sites of special scientific or conservation value within and / adjacent to the Site[126].

The first is the Marine Reserve site at Motukaroro Island. Dr Coffey notes that this area is also zoned as the Reotahi M1MA in the RCP. He advises that the Marine Reserve was established to preserve the habitat it contains in its natural state, and points to this benefitting scientific study. He notes that this area is valued for its high species diversity (including subtropical species). He states that this area is nationally significant.

Dr Coffey reports that two other areas (being the Calliope and Mair Bank M1MA's) are protected in the RCP on the basis of values they support, which he lists as including ecosystems, birds, habitats and coastal landforms. He notes that the RCP records that inter-tidal areas (being those areas between high and low tides) provide internationally significant habitat for international migratory and

[124] Dr Coffey, B, page 28 - 29, section 2.6.2g, "Crude Shipping Project, Proposal to Deepen and Partially Realign the Approaches to Marsden Point, Assessment of Marine Ecological Effects, Excluding Seabirds and marine Mammals". Dated 10 August 2017

[125] Dr Coffey, B, section 2.6.3, "Crude Shipping Project, Proposal to Deepen and Partially Realign the Approaches to Marsden Point, Assessment of Marine Ecological Effects, Excluding Seabirds and marine Mammals". Dated 10 August 2017

[126] Dr Coffey, B, page 33 - 34, section 2.9, "Crude Shipping Project, Proposal to Deepen and Partially Realign the Approaches to Marsden Point, Assessment of Marine Ecological Effects, Excluding Seabirds and marine Mammals". Dated 10 August 2017

NZ endemic wading (at Mair Bank) and wetland birds, including some threatened species. Mr Don's more detailed assessment of avifauna habitats is discussed shortly and in section 2.4 of this AEE.

The fourth area, (Busby Head) is also, Dr Coffey advises, zoned M1MA by the RCP on the basis of its protected areas, ecosystems and habitats. He reports that the RCP specifically records that the rocky shore is an internationally significant habitat for endemic wading and coastal birds, and also supports threatened species.

Dr Coffey states that the M1MA zoning is applied to those areas within Northland's CMA that are identified as being Areas of Important Conservation Value. Having considered this mechanism, and the findings of the research that he has relied upon, we understand Dr Coffey to conclude that the Calliope Bank, Mair Bank and Busby Head M1MA's are of regional significance. He advises that the Marine Reserve is of national significance.

Dr Coffey also records that the Regional Council recently released a draft version of its proposed Northland Regional Plan. He notes that while the rules in the Draft Northland Regional Plan do not have legal effect, it is proposing to, effectively, join the three Marine 1 Management Areas on the northern side of the access channel into one combined 'Significant Ecological Area'. **Figure 2.3.8.1** records the extent of the area now proposed.

Figure 2.3.8.1: Significant Ecological Area Overlay, draft Northland Regional Plan[127]

[127] Dr Coffey, B, page 34, section 2.9, "Crude Shipping Project, Proposal to Deepen and Partially Realign the Approaches to Marsden Point, Assessment of Marine Ecological Effects, Excluding Seabirds and marine Mammals". Dated 10 August 2017

Dr Coffey also advises that Castle Rock, High Island and other rocky points between Reotahi Bay and Busby Point are likely, in his opinion, to support significant ecological values, and that the northern shoreline of Bream Bay from Busby Point to Bream Head would qualify for a similar status. We understand this to mean that he agrees with their incorporation into the enlarged area of ecological significance. However, given the current ecological condition of Mair Bank where there has been a significant, recent population decrease for pipi and a recent proliferation of green lipped mussels, Dr Coffey advises that it is more difficult, in his opinion, to justify an expansion of the significant ecological area around Mair Bank[128].

Dr Coffey also notes that 'Significant Bird Areas' are part of a more extensive overlay area in the Draft Northland Regional Plan than the Significant Marine Ecological Areas shown in **Figure 2.3.8.1**. **Figure 2.3.8.2** highlights the extent of the 'Significant Bird Areas'. Mr Don advises there are a number of bird habitats that are identified as being a 'significant bird area' in the draft Northland Regional Plan ('**the dRCP**') within the site and surrounding area are; being Snake Bank, Marsden Bay to One Tree Point, the Northern Coastline to Darch Point to Busby Head, Mair Bank to Marsden Point and the nearshore area of Bream Bay and Mair Bank across to Busby Head and then to Bream Head.[129] Mr Don also notes that the wider Bream Bay pelagic habitat and the intertidal area between the Refinery's Jetty and NorthPort are not identified as being significant birds areas in the dRCP. He then advises that Bream Bay is reported to have national significance for seabirds and the Refinery's Jetty to Northport shoreline was reported to be of regional significance during high tide periods. These areas are discussed in more detail in section 2.4 of this AEE.

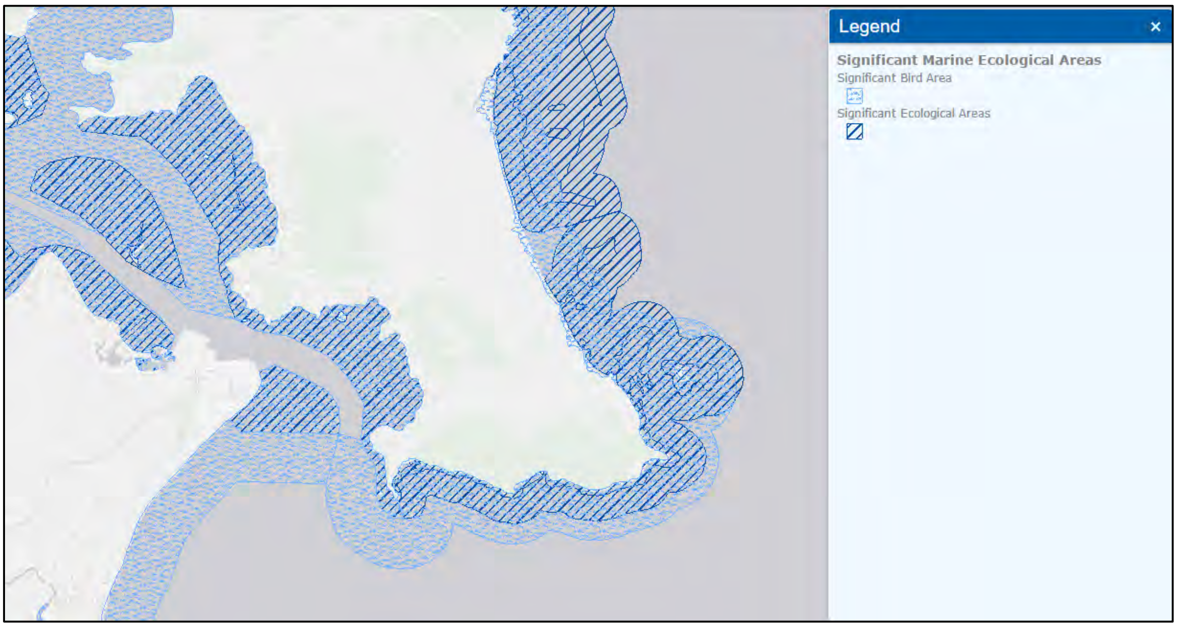


Figure 2.3.8.2: Significant Bird Area Overlay, draft Northland Regional Plan[130]

Dr Coffey then notes that the areas of ecological significance can be grouped into two headings for the purposes of the NZCPS. Firstly, those areas falling within Policy 11(a)[131] of the NZCPS are the

[128] Dr Coffey, B, page 33 - 34, section 2.9, "Crude Shipping Project, Proposal to Deepen and Partially Realign the Approaches to Marsden Point, Assessment of Marine Ecological Effects, Excluding Seabirds and marine Mammals". Dated 10 August 2017
[129] Don, G, page 27, section 4.1, "Crude Shipping Project, AEE Report, Coastal Birds, Final", Dated 09 August 2017
[130] Draft Northland Regional Plan. Dated August 2016.
[131] Avoid adverse effects of activities on: (i) indigenous taxa4 that are listed as threatened or at risk in the New Zealand Threat Classification System lists;

Marine Reserve, kelp beds, and sponge gardens associated with the rocky reef habitats extending roughly from Motukaroro Island to Busby Point. He then advises that the coastal areas which fall within the ambit of Policy 11(b)[132] of the NZCPS include the entrance channel, Disposal Sites 1.2 and 3.2, Calliope and Mair banks, and Three Mile Reef.

2.4 Coastal Birds

Mr Don has considered the existing avifauna (birds) values that are supported within and adjacent to the Site[133]. We now provide a summary of his findings as follows.

Mr Don's description of the existing environment is based on a desk top assessment that was supplemented by a series of surveys that were completed in February to March 2015, November 2015 and February to March 2016.

There were nine distinct coastal bird survey locations situated near or adjacent to the Site, being:

1. Bream Bay Beach
2. Mair Bank
3. Refinery Jetty to Northport
4. One Tree Point
5. Snake Bank
6. Reotahi Bay
7. Taurikura Bay
8. McKenzie Bay
9. Urquharts Bay

In addition, four locations were visited during the breeding activity surveys in November 2015, being:

1. Mair Road to Northport
2. Marsden Point to the Refinery Jetty
3. The Refinery Jetty to Northport
4. Darch Point to Home Point

(ii) taxa that are listed by the International Union for Conservation of Nature and Natural Resources as threatened; (iii) indigenous ecosystems and vegetation types that are threatened in the coastal environment, or are naturally rare; (iv) habitats of indigenous species where the species are at the limit of their natural
range, or are naturally rare; (v) areas containing nationally significant examples of indigenous community types; and (vi) areas set aside for full or partial protection of indigenous biological diversity under other legislation.

[132] Avoid significant adverse effects and avoid, remedy or mitigate other adverse effects of activities on: (i) areas of predominantly indigenous vegetation in the coastal environment; (ii) habitats in the coastal environment that are important during the vulnerable life stages of indigenous species; (iii) indigenous ecosystems and habitats that are only found in the coastal environment and are particularly vulnerable to modification, including estuaries, lagoons, coastal wetlands, dunelands, intertidal zones, rocky reef systems, eelgrass and saltmarsh; (iv) habitats of indigenous species in the coastal environment that are important for recreational, commercial, traditional or cultural purposes; (v) habitats, including areas and routes, important to migratory species; and (vi) ecological corridors, and areas important for linking or maintaining biological values identified under this policy.

[133] Don, G, "Crude Shipping Project, AEE Report, Coastal Birds, Final", Dated 09 August 2017

Mr Don describes the avifauna values for each of these locations in his report. We summarise his description in the following subsections.

2.4.1 Coastal Birds Surveys

2.4.1.1 Bream Bay Beach

The section of Bream Bay Beach surveyed extended for a distance of approximately 2,350m, from near the end of Rama Road to south of Marsden Point. Mr Don notes that this section of Bream Bay Beach is open coastline habitat that did not contain a high tide roost for wading birds, and was not used by significant numbers of birds for feeding in either the intertidal habitat or nearshore open water habitat.

Mr Don goes on to advise that the intertidal habitat at this location is similar to that along the length of the 30km beach of Bream Bay, from Marsden Point to Bream Tail. In this regard, he states that the environment has relatively low coastal bird values and is considered of local significance only[134]. Notably, Mr Don excludes both Ruakaka River mouth and Waipu River mouth and their associated estuaries from this local significance categorisation, stating that they have high coastal bird values in a national context.

2.4.1.2 Mair Bank

The Mair Bank survey area included the beach between Marsden Point and the Refinery's jetty, the inner bank adjacent to the Refinery mooring dolphins and the outer banks. Mr Don reported that the Mair Banks habitat consists of sand and shell ebb-tidal delta swept by strong currents and contain shellfish beds.

Mr Don goes on to advise that the avifauna habitat that is present at Mair Bank is entirely different from the habitats of both Bream Bay Beach and other areas close to the Harbour's entrance. Bream Bay, he advises, consists of an open, sandy surf beach whilst the Taurikura to Home Point area is relatively sheltered and contains a diversity of soft sediment and rocky habitats.

Mr Don notes that Mair Bank was utilised for feeding, mainly for the two hours either side of the low tide period (for approximately one third of a twelve-hour tidal cycle). The predominant habitat use was resting in the intertidal zone. Within this survey area, the outer banks were the more important feeding habitats from the survey area. Mr Don considers that this is likely to reflects the presence of shellfish beds in these banks. He also records that juvenile NZ Dotterel were observed being reared and feeding along the intertidal habitat of this survey area.

Mr Don advises that Mair Bank is a nationally significant coastal bird habitat[135].

2.4.1.3 Refinery Jetty to North Port

The Refinery Jetty to Northport survey area of habitat is described by Mr Don as being a sandy intertidal area. Mr Don records that this area is a notable high tidal roosting area and supports a significant portion of the outer Harbour's Variable Oystercatcher population at high tide, with other

[134] Don, G, page 10 to 11, section 3.3.1, "Crude Shipping Project, AEE Report, Coastal Birds, Final", Dated 09 August 2017
[135] Don, G, page 11 to 12, section 3.3.2, "Crude Shipping Project, AEE Report, Coastal Birds, Final", Dated 09 August 2017

roosting and resting birds being South Island Pied Oystercatcher, Red Billed Gull, NZ Dotterel and White-fronted Tern. He notes that no NZ juvenile Dotterel or Variable Oystercatchers were observed during his investigations.

Mr Don records that the area is of significance in the context of the outer Harbour and functions as an alternative to the Marsden Bay high tide roosting areas[136]. He advises that this area is, in his opinion, of regional significance during high tide periods as a roosting site for threatened and at risk species, but is otherwise of local significance only.

2.4.1.4 One Tree Point

The coastline from the western side of Marsden Bay to One Tree Point contrasts with the survey area discussed in the subsection above in that it is a significant feeding and resting habitat (in the context of the Whangarei Harbour), but it does not contain a high tide roosting area for wading birds, the closest of which is in the contiguous Marsden Bay[137].

Mr Don advises that both the Marsden Bay and the One Tree Point area are 'stepping stone' habitats to Snake Bank in particular. The Marsden Bay to One Tree Point to Snake Bay complex is, in his opinion, a regionally significant coastal bird habitat. Mr Don notes that One Tree Point is a key feeding habitat for reasonably high proportions of wading birds.

2.4.1.5 Snake Bank

Mr Don advises that the average number of individuals recorded was relatively low at Snake Bank, but birds were only common over the low tide period (which he notes is similar to his observations at Mair Bank).

Mr Don states that the southern part of Snake Bank is a significant feeding area in the context of Whangarei Harbour, especially when it is considered in context with the Marsden Bay to One Tree Point habitats. We understand his advice to be that this is particularly true for South Island Pied Oystercatcher[138].

Mr Don advises that Snake Bank is a relatively short commute for birds roosting at Marsden Bay over the high tide period and contains a notable population of cockles as a food source. Like One Tree Point, he advises that Snake Bank stands out as a key feeding habitat for a number of wading birds.

Ultimately, Mr Don advises that the Marsden Bay to One Tree Point to Snake Bank complex is a regionally significant coastal bird habitat.

2.4.1.6 Reotahi Bay

Mr Don states that Reotahi Bay is a small area of soft intertidal habitat amongst a rocky shoreline. Of the six species recorded in this area, one is threatened (Caspian Tern) and three are at risk[139] (Red-billed Gull, Variable Oystercatcher and White-fronted Tern).

[136] Don, G, page 12 to 14, section 3.3.3, "Crude Shipping Project, AEE Report, Coastal Birds, Final", Dated 09 August 2017
[137] Don, G, pages 14 to 16, section 3.3.4, "Crude Shipping Project, AEE Report, Coastal Birds, Final", Dated 09 August 2017
[138] Don, G, page 15 to 17, section 3.3.5, "Crude Shipping Project, AEE Report, Coastal Birds, Final", Dated 09 August 2017
[139] New Zealand Threat Classification System lists the New Zealand wild species accordingly to its threat of extinction. Available from http://www.doc.govt.nz/nztcs

Mr Don advises that the overall number of birds recorded at this site was low, and the area was predominantly used for resting (in the intertidal area) or roosting on the boulders and trees. Mr Don then states that Reotahi Bay is not a significant coastal bird habitat outside of the breeding season. He also advises that during the breeding season, Variable Oystercatcher nest in Reotahi Bay.

2.4.1.7 Taurikura Bay

Mr Don advises that both rocky and soft intertidal habitats are present in Taurikura Bay. He notes that the surveys undertaken in this area concluded that there were two threatened species (Caspian Tern and Reef Heron) and three at risk species (Variable Oystercatcher, Red-billed Gull and Pied Shag), occupying the area. Mr Don advises that the number of birds recorded were low, however, this area was predominantly used for resting in March.

Overall, Mr Don advises that Taurikura Bay is a low value coastal bird habitat.

2.4.1.8 McKenzie Bay

Mr Don reports that the McKenzie Bay is a small enclosed area that was found to have low numbers of avifauna and a low diversity of species. Of the birds recorded at this site, one is threatened (Caspian Tern) and two are at risk (Variable Oystercatcher and Red-billed Gull). Overall, Mr Don advises that McKenzie Bay is not a significant coastal birds habitat outside of the breeding season.

2.4.1.9 Urquharts Bay

Mr Don reports that the Urquharts Bay is relatively large area and comprises both rocky and soft intertidal substrate. Mr Don notes that this area supports a relatively high number of coastal birds, including two threatened (Caspian Tern and Reef Heron), and five at risk (White fronted Tern, Pied Shag, Red-billed Gull, Variable Oystercatcher and South Island Pied Oystercatcher).

Mr Don notes that Urquharts Bay is favoured by Little Shag (he notes that the greatest numbers of little shag were recorded at Urquharts Bay[140]), especially for roosting. This habitat is, we understand, favoured by Little Shag as they commonly roost on moored vessels in the Bay and nest at the nearby Home Point. He ultimately advises that it is a locally significant habitat for coastal birds outside the breeding season[141].

2.4.2 Pelagic Birds

Mr Don notes that a total of 17 pelagic (open water seabird) species have been recorded (in literature) as being known to frequent the Site or the surrounding environments. Of those species one (the Flesh-footed Shearwater) is considered 'threatened' and eleven are recorded as being 'at risk' (being the Little Penguin, Sooty Shearwater, Little Shearwater, Pycroft's Petrel, Fairy Prion, Fluttering Shearwater, Northern Diving Petrel, White-faced Storm Petrel, Buller's Shearwater Giant Petrel and Shy Mollymawk)[142].

[140] Don, G, page 26, section 3.3.2, "Coastal Birds Survey, February to March 2015", Dated June 2015
[141] Don, G, page 19 to 21, section 3.3.9, "Crude Shipping Project, AEE Report, Coastal Birds, Final", Dated 09 August 2017
[142] Don, G, page 21 to 23, section 3.4, "Crude Shipping Project, AEE Report, Coastal Birds, Final", Dated 09 August 2017

Mr Don advises that Bream Bay is a feeding habitat for pelagic bird species, either regularly, or on a seasonal basis. He notes, drawing on advice from other scientists, that large numbers of Australasian Gannets feed in the vicinity of the Ruakaka Estuary mouth from September onwards, Little Penguins are common in the northern part of Bream Bay in spring and summer, and hundreds of fluttering shearwaters have been observed in Bream Bay, Mair bank and the outer Harbour open water areas in April.

We understand Mr Don to conclude that Bream Bay has a high diversity of species that utilise Bream Bay's open water habitat. Mr Don therefore advises that this area is ecologically significant, as shown in **Figure 2.4.4.1** (which follows in section 2.4.4 of this AEE).

2.4.3 Breeding Season Surveys

From the desk top research and surveys he conducted, Mr Don makes a number of observations regarding the breeding activity in and around the Site. We understand his advice to be as follows.

2.4.3.1 Mair Road to Northport

Mr Don records that no nesting birds were present during the breeding surveys. Mr Don therefore advises that this is not a significant breeding habitat.

2.4.3.2 Marsden Point to the Refinery Jetty

Mr Don notes that this section of coastline was used by a pair of New Zealand Dotterel for juvenile rearing. He also advises that up to four NZ Dotterel adults were recorded feeding along the intertidal habitat and returning to within the grounds of the Refinery. He also observed that this survey area was utilised by Variable Oystercatcher for juvenile rearing and adult feeding. Mr Don advises that this area is considered to be of national importance during the breeding season of both the New Zealand Dotterel (August to December) and the Variable Oystercatcher (September to March).

2.4.3.3 The Refinery Jetty to Northport

Mr Don records that no juveniles of either New Zealand Dotterel or Variable Oystercatcher were recorded during the breeding survey in this survey area, and the feeding frequency of adults of both species was low. Mr Don advises that this area is considered to be of regional significance during high tide periods only, but is otherwise of low coastal bird value.

2.4.3.4 Darch Point to Home Point

Mr Don notes that this area contained a high diversity of potential breeding habits consisting of rocky outcrops, overhanging trees (especially pohutukawas), caves, rock platforms, Harbour edge scrub and sandy beach. Of those nesting birds he recorded, the highest numbers were Little Shag and Pied Shag[143]. Mr Don advises that this area is considered to contain significant breeding habitats in a national context.

[143] Don, G, pages 24 to 26, sections 3.5.4 to 3.6, "Crude Shipping Project, AEE Report, Coastal Birds, Final", Dated 09 August 2017

2.4.3.5 Little Penguin

Mr Don records that Little Penguins are present at nesting burrows in all months except April and May[144]. Other scientists have reported dead individuals of Little Penguins found washed up on Bream Bay Beach and between Mair Road and Northport[145].

Mr Don reports that in the November 2016 to December 2016 nesting period, specific surveys were undertaken and a population of Little Penguin were recorded as utilising the area between Busby Head and McLeods Bay. He advises that nesting is highly likely to be undertaken between McLeods Bay and Reotahi Bay, and on High, Callliope and Motukaroro Islands[146].

Mr Don also records that the Little Penguins hunt prey visually in daylight (such as quid and small fish), and that during the breeding season, Little Penguins forage within 20km of the colony, and dive for prey generally in waters less than 50m deep.

2.4.4 Significance of the Site

Mr Don reflects on all of the information at his disposal he advises that the avifauna habitat within, or in close proximity to the Site supports varying values. **Figure 2.4.4.1**, which follows summarises the coastal birds values that he has assigned.

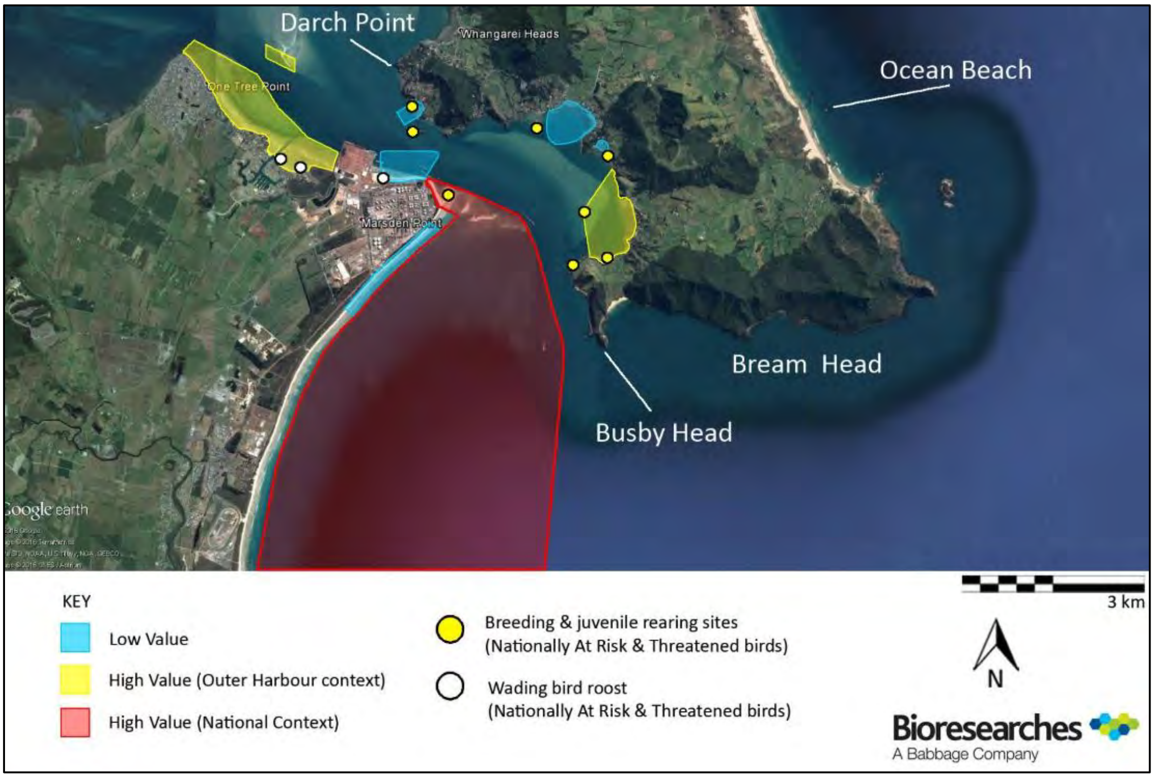


Figure 2.4.4.1: Overview of Coastal Bird Value[147]

---

[144] Don, G, page 34, section 4.12, "Crude Shipping Project, AEE Report, Coastal Birds, Final", Dated 09 August 2017
[145] Don, G, pages 22 to 23, section 3.4, "Crude Shipping Project, AEE Report, Coastal Birds, Final", Dated 09 August 2017
[146] Don, G, page 25, section 3.6, "Crude Shipping Project, AEE Report, Coastal Birds, Final", Dated 09 August 2017
[147] Don, G, page 30, section 4.12, "Crude Shipping Project, AEE Report Coastal Birds, Final", Dated 09 August 2017

2.5 Marine Mammals

Dr Clement and her colleagues at the Cawthron Institute Limited ('**Cawthron**') describe the existing marine mammal environment in the Site, and the surrounding area[148]. Her description draws on a report prepared by Dr Pine (of Styles Group Limited ('**Styles**')) that has modelled the underwater dredging noise associated with the Proposal[149]. We provide a summary of Dr Clements description of the existing environment in the following sub-sections of this AEE.

2.5.1 Species of Marine Mammals In and Around the Site

Dr Clement advises that whale migrations past Northland saw the establishment and operation of a number of whaling stations (such as near Whangamumu, which is to the north of the Site) along the eastern coastline in the late 1800s and early 1900s.

Dr Clement reports that at least 27 cetaceans (whales, dolphins and porpoises) and two pinniped species (seal and sea lions) have been sighted or stranded along the north-eastern coastline of the North Island[150]. She records, however, that only four species regularly or seasonally frequent these coastal waters. The species are bottlenose dolphins, orca, Bryde's whale and common dolphins.

Table 2.5.1.1, which follows, identifies marine mammals which have been recorded in, and around the Site. It also records the 'conservation concern' that is associated with each species in New Zealand. Although stating the infrequent visitors, Dr Clement notes other species of concern (in the context of the Proposal) include those that are more vulnerable to anthropogenic (caused or influenced by humans) impacts due to various life-history dynamics (such as southern right whales) or species-specific sensitivities (such as pilot whales).

Species	Resident or semi-resident	Conservation concern	Acoustic concern
Bottlenose dolphin	x	Nationally endangered	Mid frequency cetacean
Orca	x	Nationally critical	Mid frequency cetacean
Bryde's whale	x	Nationally critical	Low frequency cetacean
Common dolphin	x		Mid frequency cetacean
NZ fur seal			Otarlid Pinniped group
Pilot whale			Mid frequency cetacean / species thought to be more Acoustically Sensitive to underwater noise than other species.
Beaked whale			Mid frequency cetacean / species thought to be more Acoustically

[148] Clement, D, "Assessment of Effects on Marine Mammals from Proposed Deepening and Realignment of the Whangarei Harbour Entrance and Approaches". Dated August 2017

[149] Styles, J, "Whangarei Harbour Entrance and Marsden Point Channel Realignment and Deepening: Assessment of Environmental (Airborne) Noise Effects", Dated 31 July 2017

[150] Clement, D, page 2, sections 2.1 to 2.2 "Assessment of Effects on Marine Mammals from Proposed Deepening and Realignment of the Whangarei Harbour Entrance and Approaches". Dated August 2017

			Sensitive to underwater noise than other species.
Southern right whale		Nationally vulnerable	Low frequency cetacean
Humpback whale			Low frequency cetacean
Sperm Whale			Mid frequency cetacean
Pygmy sperm whale			High frequency cetacean / species thought to be more Acoustically Sensitive to underwater noise than other species.

Table 2.5.1.1: Marine Mammal Species Potentially Affected by the Proposal[151]

Ms Clement advises that Whangarei Harbour and nearby Bream Bay waters are not considered ecologically significant in terms of feeding, resting or breeding habitats for any particular marine mammal species relative to other regions along the north-eastern coastline[152]. She goes on to note that the Whangarei Harbour and Bream Bay coastal waters support species (such as common dolphins, bottlenose dolphins, beaked whale species, orca and Bryde's whale), and that these and other species migrate through Northland. Ultimately, however, she concludes, that neither the Harbour nor Bream Bay are ecologically important migration corridors. In this regard, we understand her advice to be that most of the marine mammals pass by the area further offshore.

2.5.2 Existing Ambient Underwater Sound Level

Dr Pine has prepared a report which assesses the existing ambient underwater sound level for Whangarei Harbour[153]. He advises that main contributors to underwater noise in Whangarei Harbour are vessels, physical processes (such as wind and waves) and biological factors (such as snapping shrimp and marine mammals). In that regard, Dr Pine found that the ambient background sound levels for the Whangarei Harbour varied but generally ranged from 105dB (decibels) within Bream Bay to 119db near the current berthing area (Lort Point). He also advises that this is comparable to other nearshore habitats around New Zealand [154] and is similar to other harbours in New Zealand.

In addition, Dr Pine advises that the speed of underwater sound is effected by the temperature, density (salinity) and depth. During the summer months, a thermocline (a layer in which there is steep temperature gradient) and halocline (a layer in which there is a steep salinity gradient) develops which causes a change in sound speeds above a certain depth. Given this, he advises that sound levels tend to increase in the summer months due to warmer surface temperatures and a shallow thermocline, which result in sounds travelling faster. Dr Pine also advises that sound in shallow water is dominated by boundary effects, and the extent of these effects is related to water depth, as well as the sea-floor and surface roughness. Sediments also impact the boundary effects through sound absorption, the different sediment types and their absorption of sound are shown in **Table 2.5.2.1**.

[151] Clement, D, page 4, section 2.2 "Assessment of Effects on Marine Mammals from Proposed Deepening and Realignment of the Whangarei Harbour Entrance and Approaches". Dated August 2017
[152] Clement, D, page 4, section 2.2 "Assessment of Effects on Marine Mammals from Proposed Deepening and Realignment of the Whangarei Harbour Entrance and Approaches". Dated August 2017
[153] Pine, M, "Whangarei Harbour Entrance and Marsden Point Channel Realignment and Deepening: Underwater Acoustic Modelling for the Marine Mammal Impact Assessment". Dated 21 August 2017, contained within Appendix 2 of the Clement, D, "Assessment of Effects on Marine Mammals from proposed Deepening and Realignment of the Whangarei Harbour Entrance and Approaches", Dated August 2017.
[154] Clement, D, page 8, section 3.1.2 "Assessment of Effects on Marine Mammals from Proposed Deepening and Realignment of the Whangarei Harbour Entrance and Approaches". Dated August 2017

Sediment Type	Density (kg/m³)	Compressional wave velocity (m/s)	Absorption (dB / lambda)
Sand-silt-clay	1600	1560	0.20
Sand-silt	1700	1605	1.0
Silty sand	1800	1650	1.1
Very fine sand	1900	1680	1
Fine sand	1950	1725	0.8
Coarse sand	2000	1800	0.9
Gravel	2000	1800	0.6

Table 2.5.2.1: Sediment Types and their absorption of sound[155]

2.5.3 Existing Ambient Airborne[156] Sound Level

Mr Styles and his colleagues at Styles Group Limited prepared a report which assesses the terrestrial noise in and around the Whangarei Harbour[157]. Mr Styles advises that the receivers of noise are limited to occupied buildings on the Northport site and all occupied buildings on the northern side of Whangarei Harbour. Mr Styles advises that during day light hours, the ambient noise levels vary with the wind direction, but are generally between 45dB to 50dB when the wind direction is from the west or south, and between 40dB and 45dB when the wind is offshore (from the north or east). He also advises that noise sources (such as the Refinery, NorthPort and waves on the shore and in Whangarei Harbour) are more predominant when the receivers are downwind. Mr Styles also states that noise level measurements undertaken in and around Whangarei Harbour showed that noise varies by approximately 5dB depending on if the measurement is taken from upstream or downstream of wind. He also states that some higher noise levels (up to approximately 60dB) were recorded. We understand his advice to be that the higher noise levels are likely to be due to traffic, birds and insects, construction or other anthropogenic sources[158].

2.6 Commercial Fishery

Mr Boyd has prepared a report[159] that discusses the commercial fishery in the Whangarei Harbour and Bream Bay. More specifically, he sets out the types of species that are fished, the fishing methods that are utilised and the areas fished in and in close proximity to the Site. The sections that follow summarise our understanding of his advice, and include discussions on:

a. Context: Commercial Fish and Shellfish

b. Commercial Fishing and Closures

c. Inshore Commercial Fisheries methods

d. Paddle Crab Fishery

---

[155] Pine, M, page 12, "Whangarei Harbour Entrance and Marsden Point Channel Realignment and Deepening: Underwater Acoustic Modelling for the Marine Mammal Impact Assessment". Dated 21 August 2017, contained within Appendix 2 of the Clement, D, "Assessment of Effects on Marine Mammals from proposed Deepening and Realignment of the Whangarei Harbour Entrance and Approaches", Dated August 2017.

[156] Ambient Airborne is defined as above water sound.

[157] Styles, B, "Whangarei Harbour Entrance and Marsden Point Channel Realignment and Deepening: Assessment of Environmental (Airborne) Noise Effects". Dated 31 July 2017

[158] Styles, B, page 8, section 4, "Whangarei Harbour Entrance and Marsden Point Channel Realignment and Deepening: Assessment of Environmental (Airborne) Noise Effects". Dated 31 July 2017

[159] Boyd, R, "Commercial Fisheries in Whangarei Harbour and Bream Bay". Dated 11 August 2017

e. Scallop Fishery

f. Commercial cockle and pipi fisheries; and

g. Rock lobster fishery

2.6.1 Context: Commercial Fish and Shellfish

Mr Boyd advises that research undertaken around Bream Bay shows a high diversity of demersal fish (being fish that reside at the bottom of the ocean) present in and adjacent to the Site. He records that the fish within the Harbour are widely distributed throughout northern New Zealand, and are susceptible to commercial fishing (insofar as they are susceptible to getting caught). He also advises that many of the species are commercially valuable. Mr Boyd also advises that the Bream Bay fishery mainly consists of small reef fish which are not vulnerable to commercial fishing. He goes on to discuss, however, that commercial valuable species such as snapper, gurnard and John dory are common in Bream Bay, and throughout Northland. Mr Boyd also notes that intertidal and shellfish species located in Whangarei Harbour and Bream Bay also support commercial fisheries.

2.6.2 Commercial Fishing and Closures

Mr Boyd states that in some areas, such as around Motukaroro Island to Lort Point and Waikaraka, commercial fishing is prohibited under the Fisheries Regulations[160]. The prohibitions that exist are summarised in the following bullet points and shown are in **Figure 2.6.2.1**:

a. Commercial trawling and Danish seining is prohibited inside a straight line drawn from the southernmost extremity of Busby Head to the shore on the southern end of Bream Bay.

b. Fishing with a box or teichi net, purse seine net, Danish seine net, trawl net, or lampara net, or set nets (commercial fishing methods) of a total length exceeding 1000m is prohibited in the waters of Whangarei Harbour lying inside a straight line drawn from the south-western extremity of Busby Head to the northern chimney of the Marsden Point power station.

c. Commercial drag netting is prohibited in Whangarei Harbour lying inside a straight line drawn from Marsden Point to Lort Point except in certain waters around Snake Bank.

d. Commercial scallop fishing is prohibited from the waters of Whangarei Harbour that are inside a straight line drawn from the southern westernmost extremity of Peach Cove to the southernmost extremity of Busby Head to the northern chimney of the Marsden Power Station.[161]

[160] Fisheries (Auckland and Kermadec Areas Commercial Fishing) Regulations. Dated 1986.
[161]Boyd, R, pages 8 to 10, section 3.2 "Commercial Fisheries in Whangarei Harbour and Bream Bay". Dated 11 August 2017.

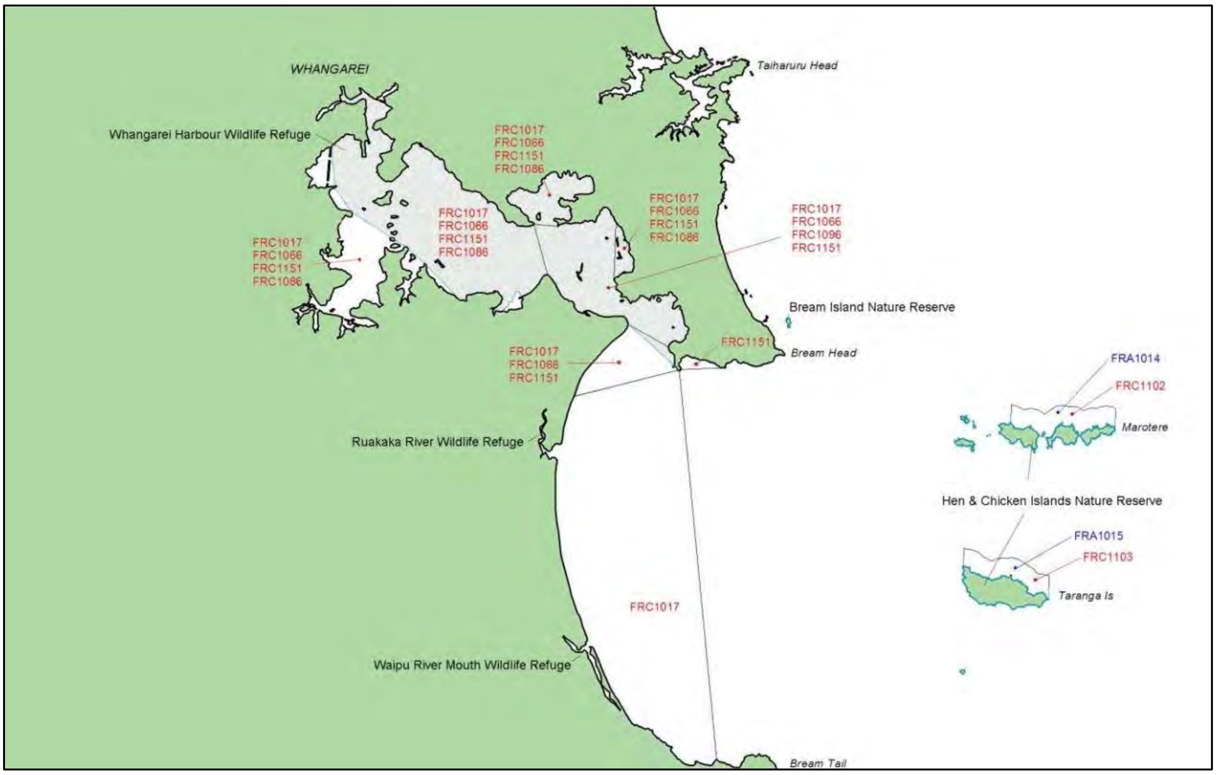


Figure 2.6.2.1: Prohibited commercial fishing areas in Whangarei Harbour[162]

2.6.3 Inshore Commercial Fisheries Methods

Mr Boyd advises that a range of fishing methods are used to target different species in the Whangarei Harbour and Bream Bay. He notes that the data available on commercial fisheries covers a wide area of the coast, but does not separate out the local coastal areas. **Table 2.6.3.1**, which follows, provides an overview of the estimated commercial catches of the main inshore commercial finfish species by fishing method (from 1 October 2008 to 20 March 2013).

Species	Bottom longline	Bottom trawl	Danish seine	Set net	Beach seine	Other methods	All methods total catch	% of total catch
Snapper	929.1	630.6	498.3	11.1	0.3	48.6	2,118.0	64.2%
Gurnard	76.3	53.5	118.6	2		4.2	254.6	7.7%
John dory		123.9	24.3	0.7		5.4	154.3	4.7%
Grey mullet				110.1		3.2	113.3	3.4%
School shark	66.1	31.5		10.7		1.4	109.7	3.3%
Flounders	0	0	0.9	106.3		0.2	107.4	3.3%
Trevally	8.9	74.1	1.5	10.4	2.4	4.0	101.3	3.1%
Leatherjacket		56.6	2.9			4.1	63.6	1.9%
Parore				55.4	1.6	0.4	57.4	1.7%
Rig	4.2	1.9		37		1.3	44.4	1.3%
Kingfish	12.9	4.9	0.5	2.1		5.2	25.6	0.8%

[162] Department of Conservation "Area-based restrictions in the New Zealand marine environment". Dated December 2004.

Kahawai	4.7	0.6		19.2		0.0	24.5	0.7%
Porae	7.5	3.7	0.1	6.9		0.4	18.6	0.6%
Garfish				12.4	4.4	0.2	17.0	0.5%
Yellow-eyed mullet				14.7		0.9	15.6	0.5%
Jack mackerel		12.6				0.0	12.6	0.4%
Red snapper	10.2	0.6				0.6	11.4	0.3%
Blue cod	2.3					1.0	3.3	0.1%
Total	**1,122.2**	**994.5**	**647.1**	**399**	**8.7**	**81.1**	**3,252.6**	

Table 2.6.3.1: Estimated commercial catch (t) of finfish species caught in waters less than 50m deep by method from 1 Oct 2008 to 20 March 2013. Species listed in order of highest to lowest combined methods total catch[163].

Although **Table 2.6.3.1** includes a much larger area than Whangarei Harbour and Bream Bay, Mr Boyd advises that the methods and species caught are representative of commercial fishing in the smaller area that is relevant to the Proposal.

Mr Boyd advises that the shallow and sheltered water of Whangarei Harbour and the semi-sheltered waters of Bream Bay support a range of demersal and pelagic fish species (all of which are commonly found along the north east coast). Overall, Mr Boyd advises that snapper is most commonly caught using the longline, trawl and Danish seine methods on the open coast. Further, he records that Gurnard and John dory are the second and third most important finfish species.

In Whangarei Harbour, the set net fishery targets (which we come to) principally target flounders and grey mullet. Parore, garfish and yellow-eyed mullet are also considered to be important commercial fish species. Mr Boyd notes that some set netting occurs in the outer Whangarei Harbour and its approaches, predominantly for sharks, snapper, kahawai and trevally. In addition, Mr Boyd advises that scallops and paddle crabs support the commercial shellfisheries in Bream Bay.

2.6.4 Trawl and Danish Seine Fishery

Mr Boyd advises that bottom trawl and Danish seine fisheries are mixed species fisheries that (in waters less than 50m depth) target snapper, but also catch smaller quantities of a range of other mobile fish species, such as John dory and gurnard. Both bottom trawl and Danish seine methods use fishing gear that makes contact with the seabed as it is being fished (such as nets and chains). As a consequence, Mr Boyd advises that these methods only operate in areas with soft seabed (such as Bream Bay and wider areas of the northeast coast). Overall, Mr Boyd advises that Bream Bay receives an average of five or fewer trawls per 1.85km per year[164].

We understand Mr Boyd's advice to be that Whangarei based trawl and Danish seine fishers operate throughout Bream Bay and east of the Three Mile Reef.

[163] New Zealand's National Aquatic Biodiversity Information System, http://www.nabis.govt.nz/.
[164] Boyd, R, page 14, section 3.4 "Commercial Fisheries in Whangarei Harbour and Bream Bay". Dated 11 August 2017.

2.6.5 Bottom Longline Fishery

From Mr Boyd's report we understand that the bottom longline fishing method uses a line that is several km long and is anchored on the seafloor (with buoys on either side) to target snapper. Mr Boyd advises that this method can occur over both soft and hard seabeds, thus, is more common along the coast than trawling or Danish seining. He goes on to advise that bottom longline fishery occurs in Bream Bay and in the shallow north of Ruakaka, but that it is not intensive.

2.6.6 Set Net Fishery

The set net method involves, we understand, setting a net in the coastal waters, and waiting for fish to become entangled with it. The net is held in place by weights and buoys. Mr Boyd advises that this method can also be used over both soft and rocky seabeds. He records that there are two distinct fisheries of the upper Whangarei Harbour and the inner Whangarei Harbour. The set net fisheries in the upper Whangarei Harbour target flatfish and grey mullet. The nets used in the fishery in the inner harbour (extending into and up the upper harbour channels and intertidal flats) are generally a few hundred metres in length. Mr Boyd advises that in the Whangarei Harbour mouth, outside the Whangarei Harbour entrance and throughout the shallow water of Bream Bay, nets (around 1000m in length) are used to catch species such as sharks, snapper, trevally and kahawai.

We understand Mr Boyd's advice to be that the majority of the set net fishing occurs in the Whangarei Harbour, with some light fishing areas including the outer entrance to the Whangarei Harbour, Mair Bank, and along the coast from Smugglers Cove to Peach Cove. Mr Boyd also advises that up to two set net fishers operate in Whangarei Harbour and Bream Bay[165].

2.6.7 Paddle Crab Fishery

Mr Boyd advises that the paddle crab, found off sandy beaches and in harbours and estuaries throughout New Zealand, are most common in lower intertidal zones (at least 10m depth). He notes that the crabs diet varies and adapts to the available prey. Mating occurs from May to November in sheltered inshore waters, with female crabs moving to deeper water to spawn from September to March[166]. Further, Mr Boyd advises that larvae are thought to live offshore before migrating inshore.

Mr Boyd advises that the Bream Bay paddle crab fishery is regionally significant, generating between two thirds and 100% of all commercial catches of this species throughout New Zealand[167]. He notes that crabs are caught throughout the year with no seasonal peak. Paddle crabs are caught using baited crab traps on the bottom of the seafloor. Mr Boyd records that paddle crab fishers focus their activities in Bream Bay, Calliope Bank, Urquharts Bay, Lort Point to Home Point, southeast of Mair Bank, and south to Bream Tail. Whelks are also caught as a saleable minor bycatch, and are targeted when crabs are not present[168].

2.6.8 Scallop Fishery

Mr Boyd advises that scallops are common in depths from 10m to 60m on sand, shell and gravel substrates around New Zealand. He describes scallops as being distributed in patches, some in small and some in large beds, and generally immobile (however they are capable of quick short

[165] Boyd, R, pages 24 to 29, section 3.6 "Commercial Fisheries in Whangarei Harbour and Bream Bay". Dated 11 August 2017.
[166] Boyd, R, page 29, section 3.7.1 "Commercial Fisheries in Whangarei Harbour and Bream Bay". Dated 11 August 2017.
[167] Boyd, R, page 30, section 3.7.3 "Commercial Fisheries in Whangarei Harbour and Bream Bay". Dated 11 August 2017.
[168] Boyd, R, pages 30 to 31, section 3.7.3 "Commercial Fisheries in Whangarei Harbour and Bream Bay". Dated 11 August 2017.

distance movements). He also records that scallops are found in enclosed and semi-enclosed harbours and bays.

Mr Boyd also advises that all commercial scallop fishing is undertaken (using small dredges) from the 15th of July to the 14th of February each year. He notes that scallops need to be a minimum size of 100mm, and the total allowable catch for the entire Northland fishery is 40 tonnes of meatweight (weight excluding the shells). When abundance can support larger catches, data is collected to support an increase in the annual catch limit for Northland fishery. Mr Boyd advises that historically (being up until the early 90's) there were high catches in Northland fishery. Since then, scallop catches have decreased[169]. Mr Boyd advises that scallops are found throughout Bream Bay but in low densities, as such, in recent years, scallop fishery has only occurred in an area south of the Ruakaka River mouth. **Table 2.6.8.1** shows the annual catches of scallops in Bream Bay from 2002 to 2017.

Fishing year	Area 1R reported scallop catch (kg meatweight)
2002-03	9,013
2003-04	0
2004-05	99,362
2005-06	174,421
2006-07	72,433
2007-08	<1
2008-09	0
2009-10	0
2010-11	0
2011-12	0
2012-13	0
2013-14	<1
2014-15	68,585
2015-16	46,459
2016-17	1,480

Table 2.6.8.1: Annual catches of scallops from Ministry for Primary Industries Scallop Statistical Area 1R (Bream Bay)[170]

We understand Mr Boyd's advice to be that over the past 15 years, the Bream Bay scallop fishery has generally only supported small commercial catches, as shown in **Table 2.6.8.1**. Mr Boyd advises that this is due to scallops in Bream Bay growing slower (generally speaking) than those in other areas. He expects this difference to be due to unknown environmental factors resulting in poor condition scallops. While noting that scallops are a high value product, Mr Boyd advises that operational costs are high, and due to the low numbers and the poor condition of scallops, returns from fishery tend to be modest. Mr Boyd advises that up to six commercial fishers have fished for scallops throughout Northland in recent years[171].

[169] Boyd, R, page 32, section 3.8.2 "Commercial Fisheries in Whangarei Harbour and Bream Bay". Dated 11 August 2017.
[170] New Zealand's National Aquatic Biodiversity Information System, http://www.nabis.govt.nz/
[171] Boyd, R, page 33, section 3.8.2 "Commercial Fisheries in Whangarei Harbour and Bream Bay". Dated 11 August 2017.

2.6.9 Commercial Cockle and Pipi Fisheries

Mr Boyd records that Snake Bank supported a commercial cockle fishery from 1980 until 2012, but closed due to the decrease in cockle biomass. Similarly, he also notes that a fishery for pipi existed on Mair Bank for approximately 50 years, but that it closed in 2012 due to low biomass levels[172]. Mr Boyd advises that these fisheries may open in the future if biomass increases.

2.6.10 Rock Lobster Fishery

We understand Mr Boyd's advice to be that rock lobsters are taken by potting (being baited pots anchored to the ground) on or near rocky shores, rocky reefs and seabed from the shallows (out to at least 100m in depth). He advises that lobsters are found along the northern shores of Bream Bay from the Whangarei Harbour entrance to Bream Head. He opines that small commercial catches of rock lobsters occur on the northern shores of Bream Bay.

2.7 Landscape, Visual and Natural Character

Mr Brown (of Brown New Zealand Limited) has describes the landscape, visual amenity and natural character existing within and adjacent to the Site[173]. We now summarise his description, using the following sub-sections:

1. Landscape Context
2. Identified Values
3. Bream Head/Mania Sequence
4. Bream Bay Ocean Bay
5. Natural Character
6. Whangarei Head Amenity Values
7. Amenity Values at and Around Refining NZ

2.7.1 Landscape Context

Mr Brown states that the natural landscape at, and in close proximity to the Site, is variable with a combination of a coastline, shallow dune corridors, industrial premises, and residential development areas which look out across Bream Bay. Refining NZ is, he advises, a part of this landscape context. Mr Brown states that the residential development to the west of Blacksmiths Creek generally consists of traditional bungalows. He records that the view from these residential dwellings include the Northport, vessels berthed at both the Port and the Refinery, and hills on the northern horizon.

Mr Brown also reports that Mount Lion and Home Point mark the outer limits of the Harbour, while a broad area of bush extending from Home Point to Busby Head and from the northern side of Smugglers Bay to Bream Head, provides natural qualities to this area.

Brown notes that most of the settlements between Reotahi and Urquharts Bay lie within the visual catchment of the Refinery and the entrance channel. As a result, we understand his advice to be

[172] Boyd, R, page 34, section 3.9.1 "Commercial Fisheries in Whangarei Harbour and Bream Bay". Dated 11 August 2017.
[173] Brown, S, "Marsden Point Crude Shipping Project Landscape Assessment", Dated August 2017

that the Refinery and the entrance to the Harbour are the visual focal points for these communities. He does record his opinion, however, that Mount Lion and Home Point provide natural aesthetic values which balance the views of the Refinery[174].

Mr Brown also records that a DoC reserve faces out into Bream Bay, which is a visual contrast to the pasture extending from Smugglers Bay to the Western end of Urquharts.

2.7.2 Identified Values

Mr Brown records that both the Operative WDP and Operative RPS identify Outstanding Natural Landscapes ('**ONLs**') in close proximity to the Site. He also notes that the RPS also identifies areas of High and Outstanding Natural Character in close proximity to the Site. These features are depicted in **Figures 2.7.2.1 and 2.7.2.2**[175] and summarised as follows:

a. Areas of High Natural Character within the Harbour exist on either side of the entrance channel, in and out of Marsden Point. Part of the High Natural Character area covering Calliope Bank extends down past Home Point and appears to include an area north to east of the proposed alignment for the dredged channel, and an area south of the proposed channel.

b. A strip of Notable Landscape and ONL, and an area of High Natural Character runs along Bream Bay's beachfront and dune corridor, to the south of the Refinery.

c. An area of Outstanding Natural Character exists covering the bush-clad above Home Point's historic, WWII gun emplacements.

d. An area of High level of Natural Character extends across most of the rest of the coastal ridge and promontories that culminate in Busby Head.

e. An area of Outstanding Natural Character covers the seaward slopes and bluffs from Smugglers Bay to Bream Head.

[174] Brown, S, pages 8 to 10, section 3.0, "Marsden Point Crude Shipping Project Landscape Assessment", Dated August 2017
[175] Brown, S, pages 10 to 12, section 3.1, "Marsden Point Crude Shipping Project Landscape Assessment", Dated August 2017

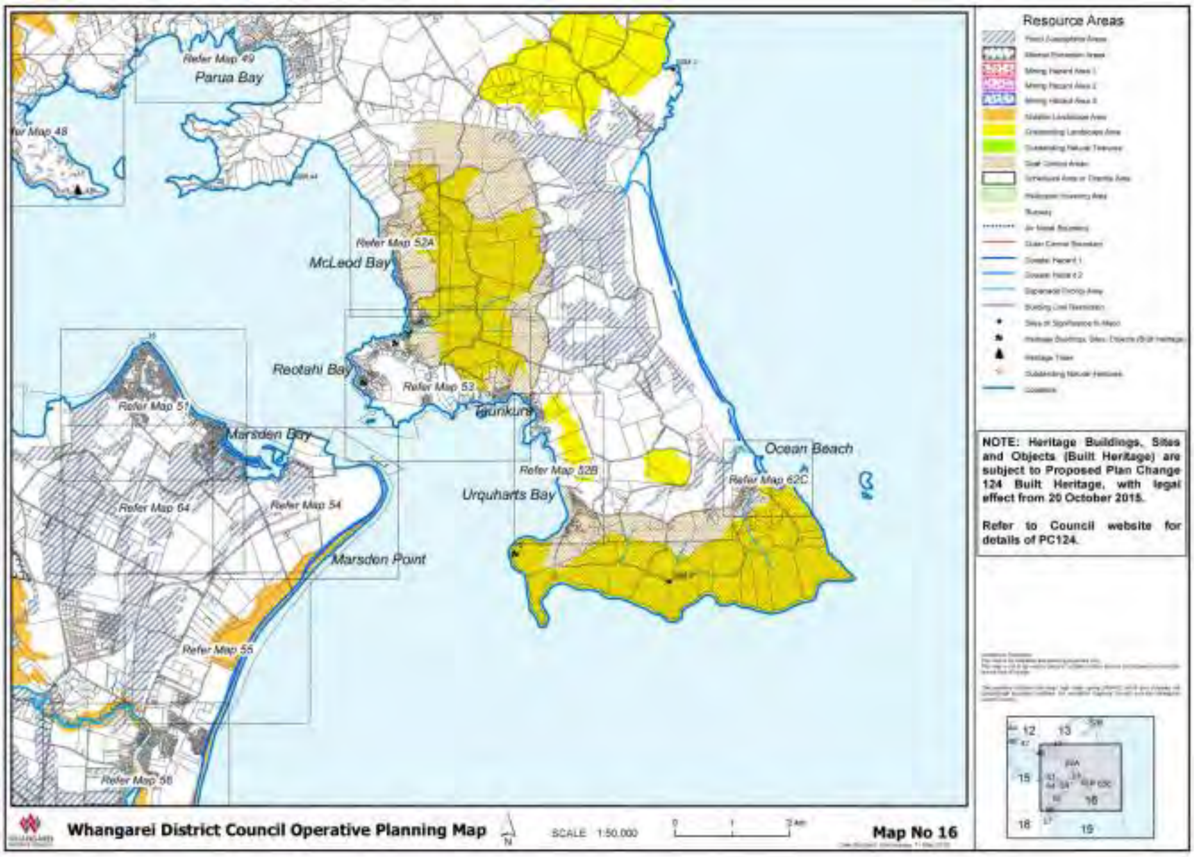


Figure 2.7.2.1: Operative Whangarei District Plan (Map 16) Showing ONLs (yellow) and Notable Landscapes (Orange)[176]

[176] Operative Whangarei District Plan, Map 16, Dated 03 May 2007

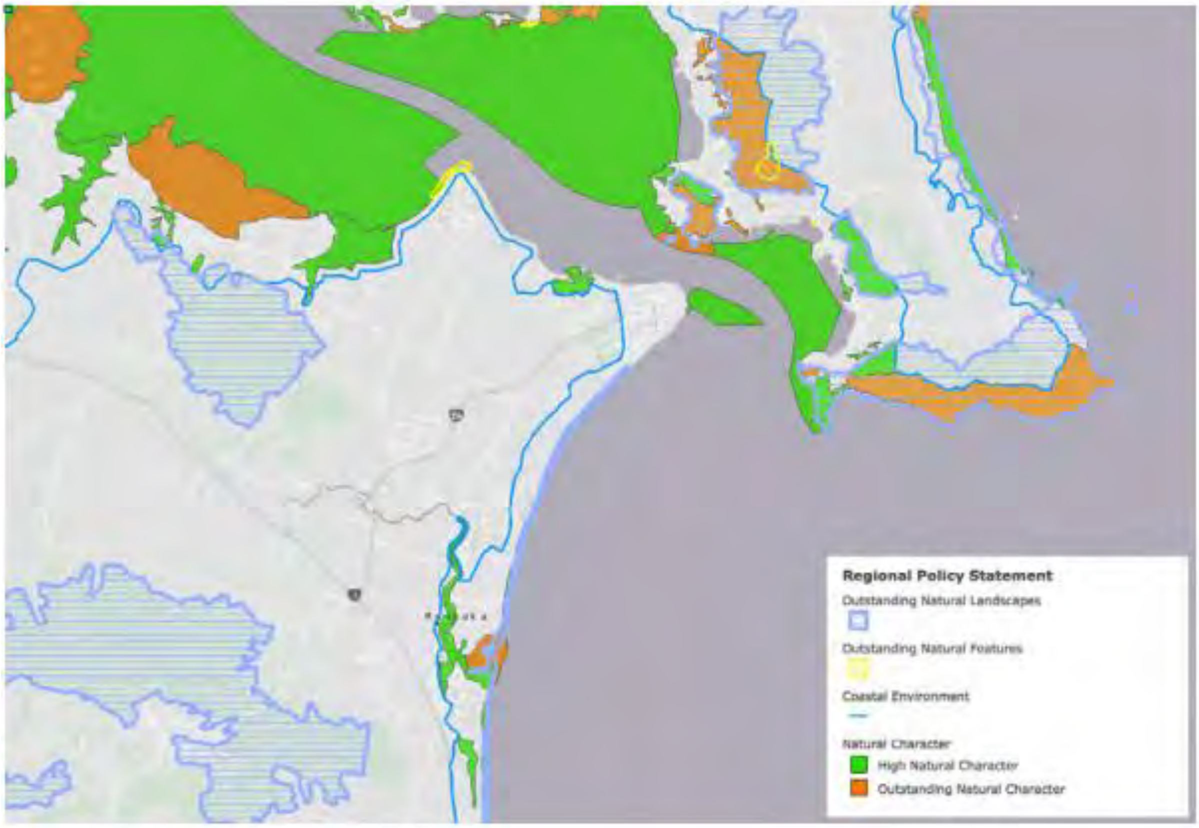


Figure 2.7.2.2: RPS Plan Showing areas of Outstanding Natural Character (orange), High Natural Character (green) and ONLs (horizontal green stripes formed by a mauve border)[177]

Further, Mr Brown advises that Appendix 3 of the RCP lists a number of outstanding geological features and landforms are said to be of international, national or regional significance within and around Marsden Point. This includes, he advises, the Reserve Point nephelenite flow, garnet andesite and sedimentary rock, McLeoad Bay unconformity, Taurikura natural jetty, Port Whangarei fossil beds, One Tree Point dunes and Bream Head stratovolcano[178]. The variable geology which underlies the Site is discussed in section 2.1.1.

We now provide concise summarises of Mr Brown's discussion of the key characteristics and qualities associated with the identified ONLs and the areas of high natural character that are in close proximity to the Site.

2.7.3 Bream Head / Mania Sequence

Mr Brown reports that the RPS describes the Bream Head area as a highly distinctive and 'iconic' landscape sequence that defines the outer harbour[179]. He goes on to state that this area is characterised by steep landforms, rocky pinnacles, forest/shrub land cover, and views of Whangarei Harbour. Mr Brown then advises that this area is considered to be distinct due to each small area typically being isolated from the next.

177 Northland Regional Policy Statement Plan, Dated 09 May 2016.
178 Brown, S, page 57, section 5.0, "Marsden Point Crude Shipping Landscape Assessment", Dated August 2017
179 Brown, S, pages 13 to 14, section 3.2, "Marsden Point Crude Shipping Project Landscape Assessment", Dated August 2017

2.7.4 Bream Bay Ocean Beach

Mr Brown also reports that the RPS states that Bream Bay Ocean Beach extends between Marsden Point and the Waipu River, and represents the largest example of this land type on the east coast of the Region[180]. He also notes that the beach is backed by low dunes, which forms extensive dune fields, but observes that only the seaward margin of the foredunes are included within the landscape given the modification of the remainder of the area.

2.7.5 Natural Character

Mr Brown reiterates that the RPS has established areas of High and Outstanding Natural Character in close proximity to the Site. Mr Brown advises that the RPS does not provide the same level of detail for the natural character values that these areas support. He goes onto, however, state that the areas of High Natural Character of relevance to the Proposal includes Mt Aubrey and the sides of Lort Point, shown in **Figure 2.7.2.1** and **Figure 2.7.2.2** above.

Further, these figures show that Mounts Manaia, Aubrey and Taurikura, which face Whangarei Harbour and Marsden Point, are each subject to an ONL overlay. Mr Brown advises that these areas highlight the contrast of elements within and around the outer Whangarei Harbour, and in his opinion have a moderate to high landscape and natural character value.

Mr Brown places these areas in context by recording that the outer waters of the Harbour are enclosed and bordered by forests and volcanic landforms, and that the natural character of the margins of Whangarei Harbour incorporate areas of settlements, pasture slopes, industrial development and port related activities. Mr Brown advises that Bream Bay contains traces of natural character down the coastal edge, which is incorporated with the housing development around Ruakaka, industrial premises lining Marsden Point Road, and the remains of the old Marsden B thermal power station and the local sewerage works.

2.7.6 Whangarei Heads Amenity Values

Mr Brown advises that Whangarei Heads area supports a wide range of local visual amenity values that contribute to the areas identity and visual amenity. His advice is that those values include:

a. The myriad views to, and from, the Harbour and its varied coastal margins.
b. The recreational resources provided by local beaches and beachfronts.
c. The DoC reserve located on the northern side of the Whangarei Harbour mouth, from Home Point to Bream Head.
d. The waters of the Whangarei Harbour and Bream Bay, used by fishermen, boaties and visitors.[181]

Mr Brown advises that the views (from the residential areas on both sides of the Whangarei Harbour) to Whangarei Harbour and Bream Bay underpins much of the locality's residential appeal. Further, he notes that the contrast between land and sea is a key part of the northern coastline's identity.

2.7.7 Amenity Values at and Around Refining NZ

Mr Brown describes the amenity values at and around the Refinery, including Blacksmith Creek, Ruakaka, and the northern harbour coastline.

[180] Brown, S, pages 14 to 15, section 3.2, "Marsden Point Crude Shipping Project Landscape Assessment", Dated August 2017
[181] Brown, S, pages 18 to 19, section 3.2, "Marsden Point Crude Shipping Project Landscape Assessment", Dated August 2017

Mr Brown advises that like the Whangarei Heads amenity values, those areas in close proximity to the Refinery have contrasting views of both the natural context and the industrial and residential values. He then states that the interaction of land and sea underlines the northern coastlines identity and character. The areas around Ruakaka are described by Mr Brown as being a combination of sea, volcanic peaks and dune plains.

Mr Brown advises that west of the Refinery, Marsden Bay and One Tree Point enclose the shoreline west of Blacksmiths Creek. Further, he notes that headlands and indented bays and coves (including McLeod Bay, Munroe Bay, Reserve Point and Manganese Point) line the harbour's northern coastline.

2.8 Archaeological Historical Heritage

Dr Clough and his colleagues at Clough and Associates Limited have considered the existing historic environment that exists both in, and in close proximity to the Site. We now summarise our understanding of Dr Clough's description of the existing environment.

Dr Clough advises that extensive archaeological excavations have been carried out around Whangarei Harbour since the 1960's. He also records that those investigations have revealed a number of archaeological sites related to Maori occupation that are situated in a relatively close proximity to the Site. This includes middens, hangi stones, fishing equipment, Pa sites with pits and terraces and gum-digging activities throughout the area, including at One Tree Point and Whangarei Heads. We understand his advice to be that the archaeologists that investigated the Site have concluded that this collection of sites points to a summer occupation of the One Tree Point area for large scale processing of shellfish, from 1500 AD onwards. Notably, Dr Clough records that there are no known archaeological sites at Marsden Point itself, although he advises that it is likely that the occupation in this area would likely have been similar to the surrounding sites[182]. In this regard, we understand his advice to be that the earthworks associated with the development of the Refinery are likely to have destroyed most of the archaeological sites that may have been present. We also understand him to advise that some intact evidence could be discovered in the future given the prograding (which means extending outward) shoreline and possible burial of some sites.

Relevantly, Mr Clough concludes that there are no known archaeological sites directly affected by the dredging or proposed marine disposal sites[183].

The current distribution of archaeological sites in the New Zealand Archaeological Association database is shown in **Figure 2.8.1** below:

[182] Clough, Dr R, page 13, "Marsden Refinery, Whangarei harbour Dredging: Archaeological Assessment". Dated July 2017
[183] Clough, Dr R, page 18, "Marsden Refinery, Whangarei harbour Dredging: Archaeological Assessment". Dated July 2017

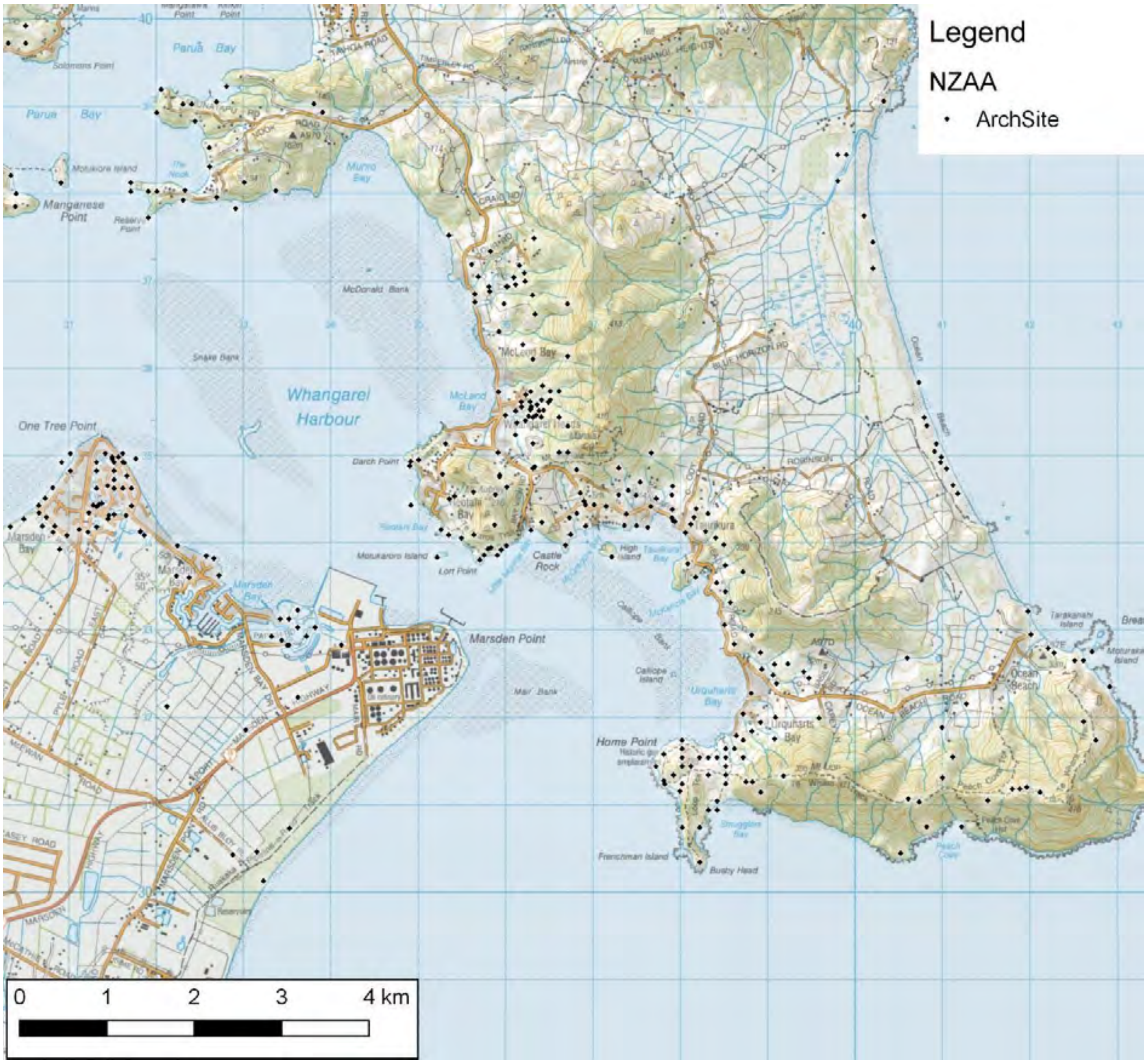


Figure 2.8.1: Distribution of Archaeological Sites[184]

Figure 2.8.1 shows, in our opinion, that the archaeological sites are generally clustered along the coastlines around One Tree Point, Marsden Bay, and McLeod Bay to Smugglers Bay.

2.8.1 Archaeological Significance of the Site and Its Surroundings

Dr Clough advises that the archaeological value of sites relates mainly to their information potential, that is, the extent to which they provide evidence relating to local, regional and national history through the use of archaeological investigation techniques, and the research questions to which the Site could contribute. The surviving extent, complexity and condition of archaeological sites are the main factors in their ability to provide information through archaeological investigation. Dr Clough notes that sites such as pa, are more complex and have higher information potential than most small midden. Further, he advises that archaeological values includes the context of the area, and concepts such as the heritage landscape values. Overall, Mr Clough advises that the broader area is relatively significant, but the areas of proposed dredging and disposal are not.

[184] New Zealand Archaeological Association's Archaeological Site Recording Scheme website, http://www.archsite.org.nz/, Dated 2009.

2.9 Cultural Values

A CVA has been prepared by Patuharakeke, on behalf of Nga Kaitiaki / Tangata Whenua o Whangarei Te Rerenga Paraoa[185]. The CVA identifies Tangata Whenua values within and surrounds of the Site. We note, at this juncture, that Patuharakeke assert mana whenua status over Poupouwhenua (Marsden Point) – although as we discuss below, a number of iwi and hapu have an interest in the Whangarei Harbour and Bream Bay area. We summarise our understanding of the key findings from the CVA below. We have reviewed the Statutory Acknowledgements and applicable iwi management plans[186] identified by the Regional Council[187] that apply to, or within the broader Whangarei harbour / Bream Bay area.

2.9.1 Interested Hapu and Iwi

Ms Chetham advises that Patuharakeke 's relationship with the Harbour and their status as Tangata Whenua is not held in isolation to other Tangata Whenua. In that regard, she advises that not only the Hau Kainga[188] in the direct vicinity of the Site, but all those whanau, hapu and iwi linked both by whakapapa, and physically and spiritually by the Harbour, have the potential to be effected by the Proposal. She goes on to advise that the relationships between the listed hapu and iwi and the Site are varied.

The hapu and iwi that have been identified by Patuharakeke as having an interest in and around the Site include:

a. Patuharakeke
b. Te Parawhau
c. Te Parawhau / Toetoe
d. Ngati Kahu o Torongare me Te Parawhau
e. Te Waiariki
f. Ngati Korora
g. Ngati Tu
h. Te Uriroroi
i. Ngatiwai
j. Ngapuhi
k. Ngati Whatua
l. Ngati Tahuhu
m. Ngati Manaia
n. Manuhiri (such as families at Marsden Village)

[185] Chetham, J, Patuharakeke Te Iwi Trust Board Incorporation, "Cultural Values Assessment Report, Refining NZ LTD, Crude Freight Proposal". Dated January 2015
[186] An iwi management plan (IMP) is a term commonly applied to a resource management plan prepared by an iwi, iwi authority, rūnanga or hapū. Definition sourced from "Quality Planning website", http://www.qualityplanning.org.nz/index.php.
[187] Northland Regional Council, Iwi/Hapu Management Plans, sourced from http://www.nrc.govt.nz/Your-Council/Working-with-Maori/Iwi-Hapu-Management-Plans/.
[188] The local people of a marae. Definition sourced from Moorfield, J, C, "Te Aka Online Maori Dictionary" Dated 2003-2017, http://maoridictionary.co.nz

Ms Chetham advises that Tangata Whenua of the Whangarei Harbour consider themselves to be the owners of the foreshore and seabed with respect to the Site.

2.9.2 Significance of Whales

Ms Chetham records that the name given to the Whangarei Harbour is 'Whangarei Te Rerenga Paraoa'. She goes on to advise that this name has different meanings, that vary according to various tribal traditions. We understand her advice to be that for Patuharakeke, the name signifies it was a gathering place of chiefs of Ngapuhi[189]. In addition, she records that 'paraoa' also means 'whale' to Patuharakeke[190].

Ms Chetham also notes that according to Ngatiwai tradition, the Whangarei harbour was a passing or gathering place for whales. She then advises that whales have a special place in Patuharakeke tradition, they are seen as a kaitiaki or guardians, as well as an indicator of cultural health.

2.9.3 Cultural Landscapes and Seascapes

Ms Chetham advises that the important areas that form the cultural landscape and seascape for the Site include maunga such as Manaia, Matariki (Mt Lion), Te Whara (Bream Head) and the Takahiwai and Pukekauri ranges. Furthermore, she reports that Taranga and Marotiri (Hen and Chickens), Motukaroro, while Taurikura and Pou Ewe Island are of traditional spiritual and cultural importance.

Ms Chetham advises that several of the hapu and iwi have a relationship to the Site and its surrounds can trace their lineage back to the ancestor Manaia, who was the captain of the Māhuhu-ki-te-rangi canoe. Manaia, she advises, resided along the coast from Rawhiti, to the south to Whangarei Heads, and Taranga Islands. Patuharakeke also notes that Mania has a connection to Taurikura Reef and stones at the top of Mount Manaia.

Ms Chetham records that there are also linkages through whakapapa and land ownership to the ancestor Torongare and the 19th century chiefs Pohe and Tirarau. As such, the sites discussed above are considered to be of cultural significance to Ngatiwai, Ngati Kahu o Torongare, Te Waiariki and Parawhau, Patuharakeke and others. In addition, she reports that there are approximately 50 registered archaeological sites in the Bream Head and Busby Head Scenic Reserves between Urquharts Bay and Ocean Beach, which she advises is evidence of the significant historical use and occupation of the area[191]. For completeness, Mr Clough who has assessed the archaeological sites in and around the Site, supports this statement. Ms Chetham also reports that there are unrecorded waahi tapu (such as Waiana koiwi[192]) in locations that cannot be disclosed, but which, we understand, could be relevant to the Proposal.

In conclusion, we understand the advice of Ms Chetham to be that the cultural landscape values within, and in close proximity to the Site are:

[189] Chetham, J, Patuharakeke Te Iwi Trust Board Incorporation, section 5.2, "Cultural Values Assessment Report, Refining NZ Limited, Crude Freight Proposal". Dated January 2015

[190] Chetham, J, Patuharakeke Te Iwi Trust Board Incorporation, Glossary, "Cultural Values Assessment Report, Refining NZ Limited, Crude Freight Proposal". Dated January 2015

[191] Chetham, J, Patuharakeke Te Iwi Trust Board Incorporation, page 13, section 5.2.2, "Cultural Values Assessment Report, Refining NZ LTD, Crude Freight Proposal". Dated January 2015

[192] Underwater burial caves and ledges. Definition sourced from Moorfield, J, C, "Te Aka Online Maori Dictionary" Dated 2003-2017, http://maoridictionary.co.nz

a. Whangarei Harbour, a gathering place of chiefs;

b. Maunga, including Manaia, Matariki (Mt Lion), Te Whara (Hen and Chickens), Motukaroro, Taurikura and Pou Ewe (rocks and reefs of traditions spiritual and cultural significance);

c. Pa sites, terraces, middens and ditches in the Bream Head and Busby Head Scenic Reserves between Urquharts Bay and Ocean Beach;

d. Blacksmith Creek used for baptisms

2.9.4 Waahi Tapu

Ms Chetham advises that there are a number of waahi tapu sites around Te Wahapu o Whangarei Te Rerenga Paraoa but notes that their specific locations cannot be revealed due to their cultural sensitivity. In general terms, however, she notes that the Harbour and its tributaries supported the spiritual and cultural practices of various hapu. Parts of creeks or rivers were, for example, set aside for baptisms, while others were used for teaching children to swim. Other places were renowned for their curative powers. Furthermore, Ms Chetham advises that lakes and wetlands in the dune systems were harvest sites for tuna (eels) and waterfowl. Harakeke and muka[193] and other plants used for weaving, and rongoa were also sourced there. Ms Chetham advises that sites such as these were often used as a repository for taonga. She also notes that the foredune at Poupouwhenua (Marsden Bay) was formerly a significant source of pingao[194] which was used to weave nets used to catch seafood (especially Finfish) such as Piper.

2.9.5 Mahinga Mataitai[195]

Ms Chetham reports that Tangata Whenua identify Bream Bay as a bountiful and rich food basket or 'Pataka'. She notes that the land on both sides of the harbour entrance hosted seasonal migrations of descendants from in and around the Harbour and related inland hapu to harvest kaimoana[196]. She records that prior to the construction of the Refinery, a mussel bed covered the foreshore from the edge of the shallow water near the entrance channel, and from Mair Bank along to the Port Jetty. This bed was, we understand, used for customary and recreational harvesting. Ms Chetham also advises that the area along the foreshore and dunes, between the Northport and the Refinery's jetty, was used as a nohoanga[197] regularly by Patuharakeke and their relations from the Whangarei area up until the development of the Refinery restricted this practice in the 1960's.

Ms Chetham states that other key traditional mahinga mataitai and fishing grounds include Patangarahi (Snake Bank) which supported pipi and cockle beds. Another significant traditional site was known as Patupo (sandbank). Ms Chetham advises that this sandbank may be known as Calliope Bank now. There were a number of sandbanks where Godwits fed and rested on their migratory journey, such as one at Marsden Point. She notes that Godwits are considered to be a kaitiaki and an indicator of cultural health in this area. We understand Ms Chetham's advice to be

[193] Prepared flax fibres. Definition sourced from Moorfield, J, C, "Te Aka Online Maori Dictionary" Dated 2003-2017, http://maoridictionary.co.nz
[194] Golden sand sedge. Definition sourced from Moorfield, J, C, "Te Aka Online Maori Dictionary" Dated 2003-2017, http://maoridictionary.co.nz
[195] Customary seafood gathering site, shellfish bed. Definition sourced from Moorfield, J, C, "Te Aka Online Maori Dictionary" Dated 2003-2017, http://maoridictionary.co.nz
[196] Seafood. Definition sourced from Moorfield, J, C, "Te Aka Online Maori Dictionary" Dated 2003-2017, http://maoridictionary.co.nz
[197] Seasonal occupation sites, places where food is gathered. Definition sourced from Moorfield, J, C, "Te Aka Online Maori Dictionary" Dated 2003-2017, http://maoridictionary.co.nz

that various hapu shared seasonal rights over these resources as well as ducks, shearwaters / mutton birds and sharks.

Ms Chetham also reports that Blacksmiths Creek was the site of the seasonal eel weir and planting and cultivating flax. She also states that important Mahinga Mataitai were located at Marsden Bay, McDonald Bank, Mair Bank, Marsden Bank, Calliope Bank and Urquharts Bay, the coastline from Reotahi to Taurikura (including well as Smugglers Bay), Peach Cove and Bream Bay. We understand her advice to be that species harvested at these locations and habitats included pipi tio, koura, kina, paua, tuatua and kutai. Hapuku were also traditionally fished at Three Mile Reef.

Lastly, on this point, Ms Chetham advises that the waters of the Harbour and Bream Bay are a taonga gifted by the tupuna of these tribes, which todays' kaitiaki have a duty to conserve and protect for their grandchildren. She records that in recent years, there has been a decline of kaimoana species, accompanied by a decline in traditional knowledge in regard to those species, their uses and management practices. Ms Chetham notes that this impacts on the duty of Tangata Whenua as kaitiaki, and displaces an important role and function for their children and grandchildren. She records that it also further diminishes their mana as due to an inability of Tangata Whenua to practise manaakitanga, which is to gather kai moana for both their families and manuhiri[198].

2.9.6 Statutory Acknowledgements

The RPS records that there are no Statutory Acknowledgements in close proximity to the Site[199]. As is shown by **Figure 2.9.6.1**, the nearest Statutory Acknowledgements to the Site lie to the South (Ngati Manuhiri's Coastal Statutory Acknowledgment) and to the West (Te Uri o Hau's Statutory Acknowledgment for the Mangawhai Harbour). We record, for completeness, that the Regional Council's Matauranga Maori Officer also confirmed there are no relevant Statutory Acknowledgements for the Proposal[200]. As noted in section 5.8.1 however, there have been a number of applications for customary marine title and protected customary rights with respect to the Site.

[198] Visitor or guest. Definition sourced from Moorfield, J, C, "Te Aka Online Maori Dictionary" Dated 2003-2017, http://maoridictionary.co.nz
[199] Northland Regional Council, "Te Ture Whakamana nga Iwi o Taitokerau, Statutory acknowledgements in Northland". Dated May 2016.
[200] Abraham Witana, Matauranga Maori Officer at Northland Regional Council, email correspondence dated 3rd March 2017.

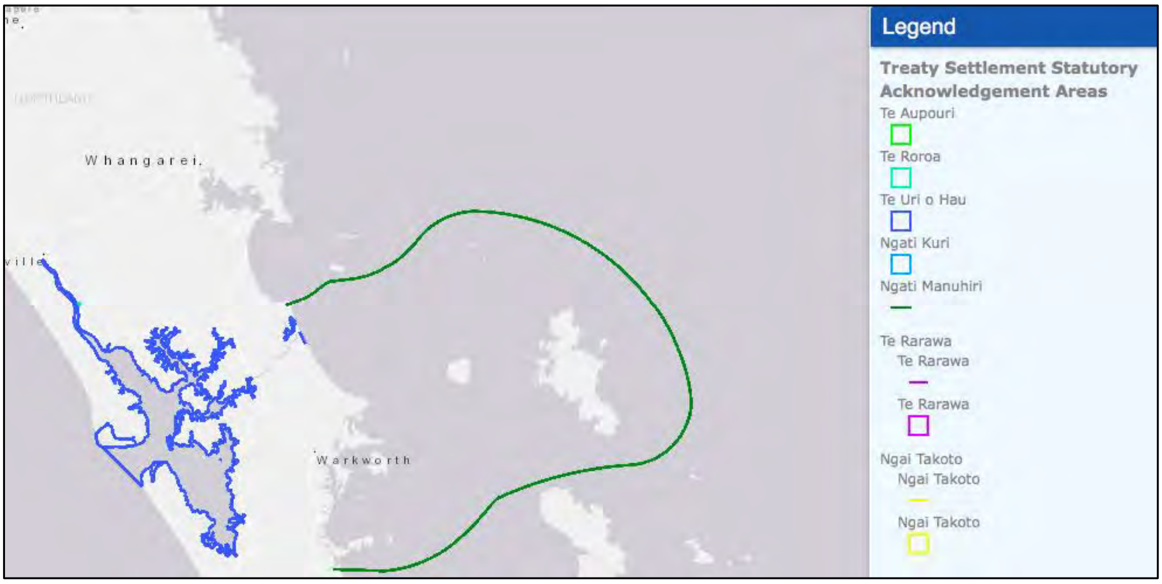


Figure 2.9.6.1: Statutory Acknowledgements in the Northland Region Area[201]

2.9.7 Applicable Iwi Management Plans

The Regional Council's website lists those iwi and hapu who have developed Environmental Management Plans that are recognised by an iwi authority[202]. We have reviewed two Environmental Management Plans (which we list below and are attached as **Annexure Four** to this AEE) which cover the Proposed Site and surrounding area. We have summarised the key values and issues that are of relevance to the Proposal in the sub-sections that follow.

a. Ngātiwai Trust Board, Ngātiwai Iwi Environmental Policy Document 2015

b. Patuharakeke Te Iwi Trust Board, Hapū Environmental Management Plan 2015

2.9.7.1 Ngātiwai Iwi Environmental Policy Document 2015

Those core values and main issues expressed within Te Iwi o Ngatiwai related to six broad headings which we list and then, concisely summarise:

a. Water Issues

b. Indigenous Fauna

c. Engagement

d. Wahi Tapu

e. Rahui

f. Landscape[203]

<u>Water Issues</u>

[201] Northland Regional Policy Statement maps viewer, "Treaty Settlement Statutory Acknowledgement Areas"
[202] Northland Regional Council, Nga Whakamahere o Te Taiao – Iwi / Hapu Management Plans.
[203] Ngatiwai Trust Board, pages 1 to 77, "Ngatiwai Iwi Environmental Policy Document'. Dated 2015.

The Ngatiwai Trust Board ('**NTB**') state that the mauri (life force) of water and their soil, and their associated ecosystems is being destroyed within their rohe (which includes the Whangarei Harbour and the surrounding area). NTB record that prior to European contact, the Harbour boasted numerous annual visits of marine mammals, but go on to advise that the Harbour's water quality has decreased (from activities such as farming operations). While not directly related to the Proposal it is notable that NTB makes reference to the dredging at the Whangarei Town Basin, and notes that this area requires regular dredging, and the dredged spoil then requires disposal. Lastly, the NTB records that the ability to put kaimoana on the table for visitors and family at tangi, hui and other events on Ngatiwai marae, and to feed Ngatiwai whanau and hapu on a regular, sustained basis, is being increasingly compromised by damage to the mauri of the Harbour's water.

Indigenous Fauna
NTB states that high percentages of species in Te Tai Tokerau (Far North, Whangarei and Kaipara regions) are endemic and are considered to be both family and taonga (treasures). NTB also note that indigenous fauna has a role to play in recreational and tourism, and has customary, historic, landscape and visual amenity values. NTB has not provided the names of specific species or specific areas of indigenous fauna that they wish to be protected.

Engagement
NTB state that there is a lack of direct and effective Ngatiwai involvement, as the kaitiaki guardian, in the sustainable management of their ancestral taonga, mineral and geothermal resources. NTB seek increased involvement for Tangata Whenua in the management and monitoring of environmental resources.

Wāhi Tapu
NTB define wāhi tapu as a place that is sacred, significant or important; and seek that wāhi tapu and the role of Ngatiwai are correctly understood and managed by all. NTB state that some wāhi tapu are places other than where a human burial has occurred, including both tangible and intangible values and dimensions. No wāhi tapu were identified by NTB.

Rahui
NTB define rāhui as both a traditional and contemporary form of managing a resource. We understand NTB to state that rāhui is the temporary prohibition of any natural resource for rejuvenation purposes or the temporary prohibition of access to a place for health and safety purposes. This system recognises the need to balance human requirements with the survival of a species or resource. NTB ask that the use of rāhui is recognised, respected and practiced, however, they do not specifically identify any current rāhui in place.

Landscape
NTB is concerned with the destruction of areas or sites of customary value, which contribute to or part of Ngatiwai cultural landscape. NTB use the example of middens and describe a large midden site at Pataua South, near Whangarei. NTB also advise that there are large numbers of pā around the coast of Ngatiwai which are surrounded by a high occurrence of other features, such as tracks, disposal sites, and wāhi tapu, including burial sites. NTB does not provide any additional specific areas or sites of customary value.

2.9.7.2 Hapū Environmental Management Plan 2015 (Patuharakeke)

Those key values and main issues addressed by Patuharakeke, which are relevant to the Proposal are:

a. Coastal Water Quality
b. Waahi Tapu
c. Foreshore and Seabed
d. Oil Spill Risk
e. Industrial Activities
f. Marine Mammals[204]

We now summarise (concisely) our understanding of these values and issues.

Coastal Water Quality
Patuharakeke are concerned about the water quality of the coastal water, as it impacts on the kaimoana (seafood) and mahinga kai in the Harbour and Bream Bay areas. Specifically, Patuharakeke advise that cumulative impacts of discharges from industries such as Northport and the Refinery have not been adequately quantified. They seek to be included in decision making over the management of coastal waters. In addition, Patuharakeke advise that the Whangarei Harbour Catchment Group is a positive step forward to managing coastal water quality.

Waahi Tapu
Patuharakeke record that wāhi tapu and sites of significance are their most precious taonga. Patuharakeke ask that wāhi tapu is managed appropriately and is considered as part of the cultural landscape and seascape. **Figure 2.9.7.2.1** below identifies sites considered to be wāhi tapu to Putuharekeke. **Figure 2.9.7.2.1** highlights the existence of a number of notable significant cultural values in and in close proximity to the Site. This reinforces our understanding that large areas of Whangarei Harbour and Bream Bay are culturally significant.

[204] Patuharakeke Te Iwi Trust Board Incorporation, "Patuharakeke Hapu Environmental Management Plan". Dated 2014

Figure 2.9.7.2.1: Patuharakeke Sites of Significance Overlay[205]

Foreshore and Seabed

Patuharakeke assert manawhenua, manamoana[206] and mana takutaimoana[207] over the foreshore and seabed in the south of Whangarei harbour and through Bream Bay. Patuharakeke state that this inalienable right has been ignored by successive local governments and record that their loss of control over these sites has allowed some of their most significant kaimoana beds, bird roosting sites, tauranga waka, waahi tapu, and nohoanga sites to be lost forever to industrialisation and reclamations. Patuharakeke list a number of specific Port and reclamation activities that require addressing.

Oil Spill Risk

[205] Patuharakeke Te Iwi Trust Board Incorporation, page 64, section 8.2, "Patuharakeke Hapu Environmental Management Plan". Dated 2014
[206] Authority over the sea. Definition sourced from Moorfield, J, C, "Te Aka Online Maori Dictionary" Dated 2003-2017
[207] Authority over the foreshore and seabed. Definition sourced from Moorfield, J, C, "Te Aka Online Maori Dictionary" Dated 2003-2017

Patuharakeke use the oil spill from the MV Rena incident in the Bay of Plenty as an example to express their concern over a potential oil spill from the Refinery. They state that the location of the Refinery, Northport and busy shipping routes within their rohe moana[208] and coastal waters places the marine environment at risk of oil spill. They also record that a significant oil spill would have devastating consequences for the kaimoana, taonga species, amenity and recreational values and the cultural health of their rohe moana.

Industrial Activities
Patuharakeke assert that construction activities associated with the original development of the Refinery "wiped out" extensive mussel beds and "flattened" the dune systems. They note that previous dredging to deepen the channel and reclamation of seabed for the construction of the log-handling facility at Northport has resulted in the destruction of arguably the largest remaining (and readily accessible by foot) pipi bed and shorebird roosting sites. Overall, Patuharakeke assert that industrial activities have had adverse impacts on the mauri and cultural health of the Harbour and the associated cultural landscapes / seascapes. Notwithstanding, Patuharakeke advise that they have developed a robust working relationship with Refining NZ, to work on improving the cultural and environmental health of the Harbour. Patuharakeke seek that major dredging programmes be avoided and that Cultural Impact Assessments be mandatory for any dredging proposals in their rohe or coastal waters. In addition, they seek that Refining NZ, Northport and the Regional Council work collaboratively with them to develop a research program to investigate and address how dredging, reclamation, sedimentation and discharges in the harbour are affecting mahinga kai.

Marine Mammals
Patuharakeke state that marine mammals, and whales in particular, are at risk from marine pollution (heavy metals, toxins, plastics), noise pollution, boat strike, harassment from some tourist operators and boat operators, set nets and other commercial fishing practices, plummeting food resources, and the effects of sonar. Patuharakeke advise that they have a spiritual connection to whales and dolphins, and therefore have a responsibility to protect these mammals. Overall, Patuharakeke advise that they will continue to advocate for a clean and healthy marine environment for marine mammals to increase the number of healthy whales and dolphins inhabiting and migrating through the coastal waters and harbour.

2.9.8 Summary of Iwi Management Plans

There are two iwi management planning instruments that are of relevance to the Proposal. Having read the instruments, we are of the opinion that they highlight a number of areas are of significance. In particular, the following values are universally highlighted as being of importance:

a. Water, in particular the quality of water in the Harbour and its effects on marine species.

b. Wahi Tapu, the significance of sites and the need to protect them.

c. Flora and fauna, protecting the land, but in particular flora and fauna which is endangered and used for cultural activities and traditions.

[208] Authority over the sea. Definition sourced from Moorfield, J, C, "Te Aka Online Maori Dictionary" Dated 2003-2017.

d. Engagement, including ensuring iwi are included in proposals, including those relating to dredging and disposal of marine sediments, and that cultural impact (or 'effects') assessments are prepared.

2.10 Recreation & Tourism

Rob Greenaway has prepared a report that details the recreation and tourism values that exists in and around the Site[209]. We summarise our understanding of this description of the existing environment as follows.

Having considered all of the available information, Mr Greenaway advises that the Site, in particular Whangarei Harbour, the Harbour entrance, and the marine and coastal marine settings between Marsden Point and Bream Head, are intensely-used recreation settings[210]. He goes on to advise that the scale and variety of activities suggests the area is at least of regional significance for recreation and tourism. More specifically, he records that the recreation and tourism activities undertaken include swimming/beach activities, surfing activities, fishing activities, shell fishing areas, diving and snorkelling sites, and boating. We understand Mr Greenaway's advice to be that the reason for the number of recreation activities is due to the quality of the environment (which is high). Mr Greenaway also notes that whilst these attractions and activities are primarily used by locals, domestic and international tourism is increasing.

Mr Greenaway has prepared a series of maps to show the location of these individual recreational activities. Drawing on these plans, Mr Greenaway has provided two maps (**Figure 2.10.1** and **Figure 2.10.2** which follow) to show the areas of high use and areas of moderate use.

[209] Greenaway, R, "Refining NZ Crude Shipping Project Recreation and Tourism Effects Assessment". Dated August 2017
[210] Greenaway, R, pages 6 to 14, section 1.2, "Refining NZ Crude Shipping Project Recreation and Tourism Effects Assessment". Dated August 2017

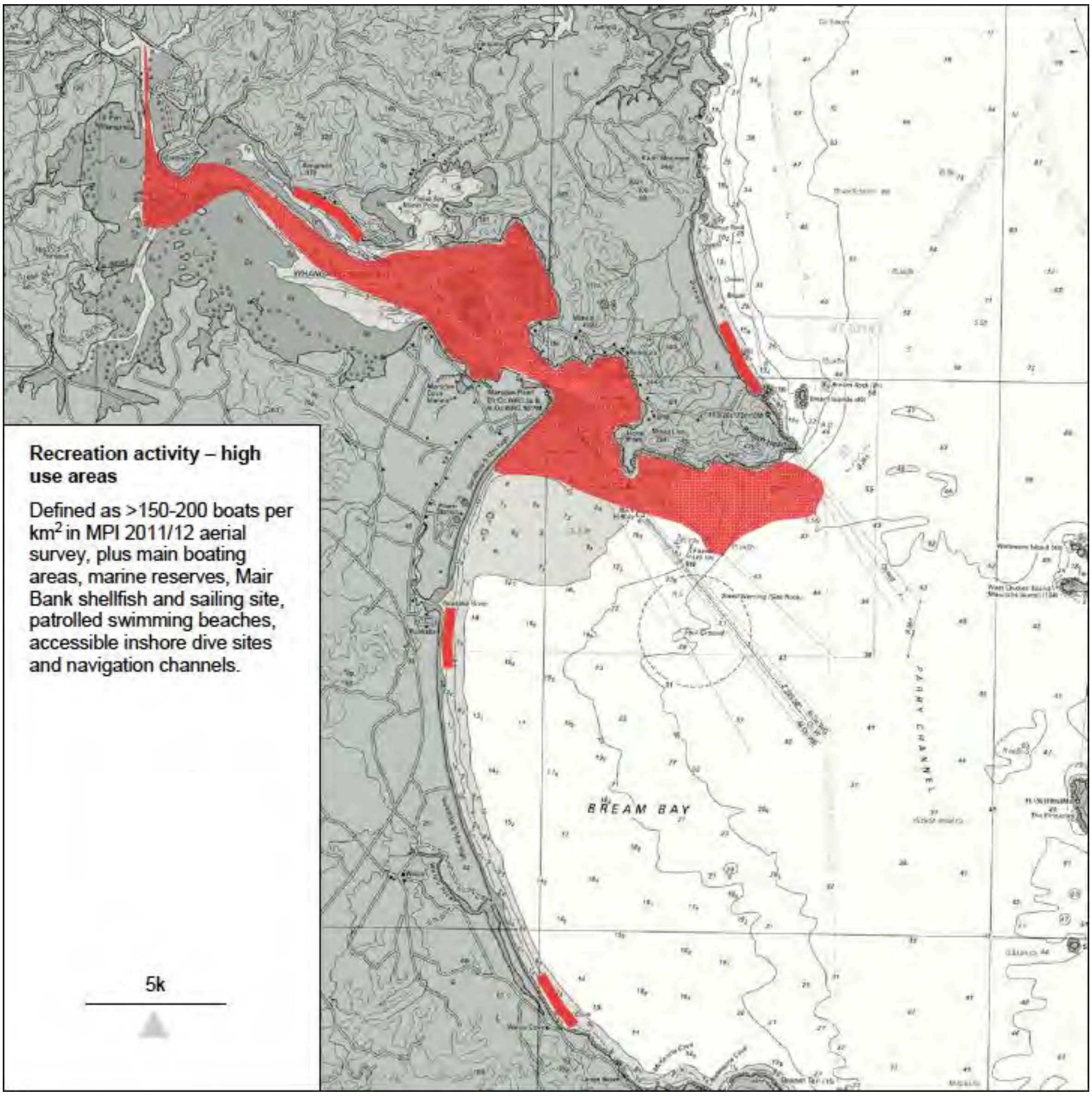


Figure 2.10.1: Recreation Activity – High Use Areas[211]

[211]Greenaway, R, page 12, section 1.2, “Refining NZ Crude Shipping Project Recreation and Tourism Effects Assessment”. Dated August 2017

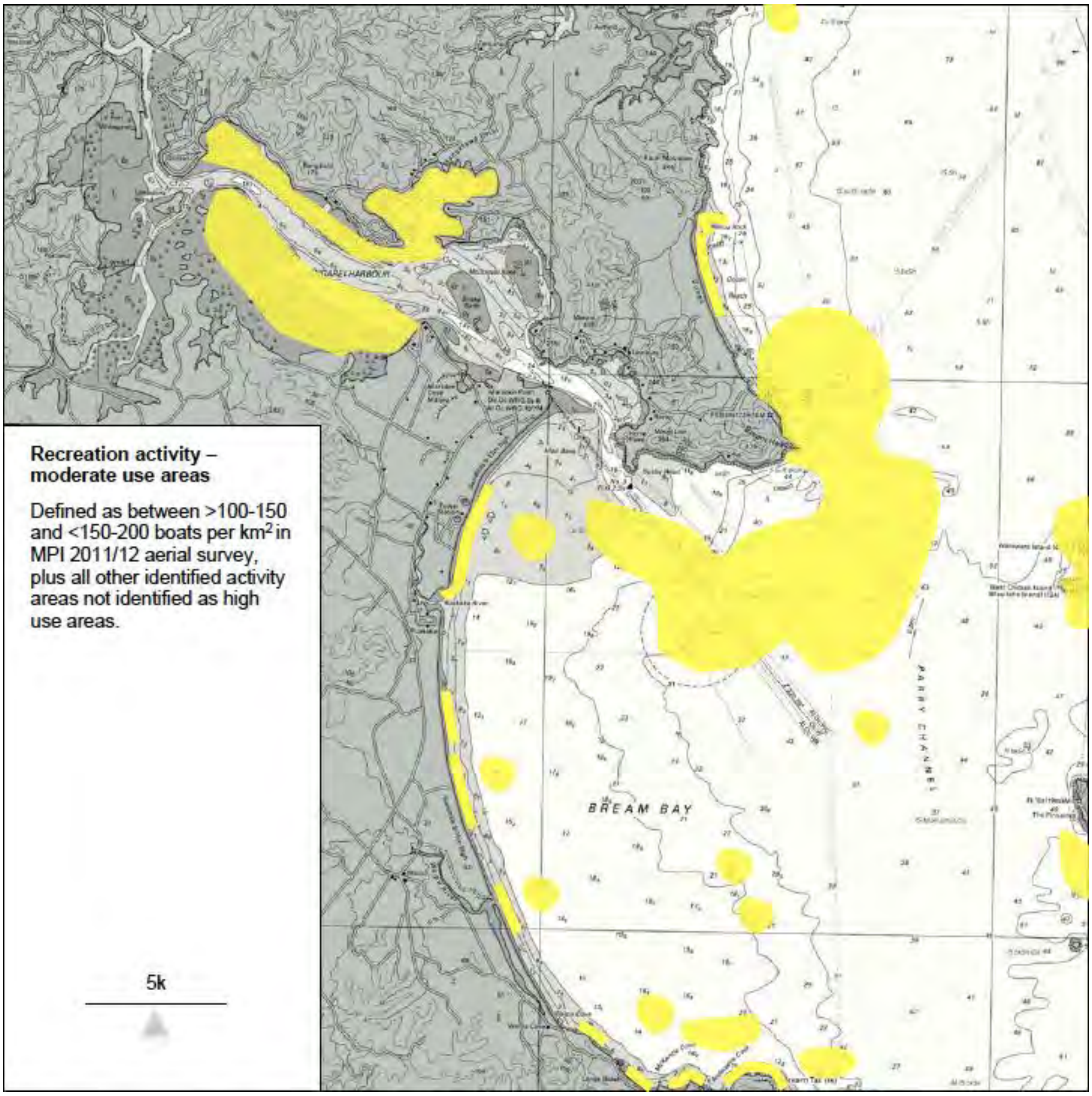


Figure 2.10.2: Recreation Activity – Moderate Use Areas[212]

Collectively, these plans show that the Site is generally either a site of high or medium recreation use, with the exception of the deeper Bream Bay ocean area.

We now summarise the key conclusions that are drawn by Mr Greenaway in relation to the specific recreation values that are present within and adjacent to the Site.

2.10.1 Public Conservation Land

Drawing on the Northland Conservation Management Strategy ('**the CMS**'), Mr Greenaway advises that there are a number of public conservation areas within the study area. These include the Bream Head tracks, which are identified as a 'gateway destination', promoted by DoC as being suitable, amongst other things for people's first 'adventures in the outdoors'[213].

[212] Greenaway, R, page 13, section 1.2, "Refining NZ Crude Shipping Project Recreation and Tourism Effects Assessment". Dated August 2017
[213] Greenaway, R, pages 19 to 23, section 3.0, "Refining NZ Crude Shipping Project Recreation and Tourism Effects Assessment". Dated August 2017

Mr Greenaway records that Whangarei Harbour and Bream Bay are identified within the DoC CMS as marine habitats with recreation values (fisheries, high natural character and marine and avian wildlife). This, he notes, is further recognised by the existence of the Marine Reserve. He goes on to note that the Marine Reserve is said to sustain diverse populations of native plants and animals. Mr Greenaway then also notes that the establishment of a marine recreational park between Cape Brett, the Poor Knights Islands Marine Reserve and Bream Head has been proposed by some elements of the community (and a report has been commissioned by NRC) as a means of 'making the most of a spectacular coastline to provide multiple sustainable economic benefits for Northland'. The proposed marine recreational park is also, he advises, proposed to align Maori values of long term sustainability and kaitiakitanga with enhanced conservation outcomes and recreation opportunities. Discussions around the potential for a new marine reserve have not advanced to the point that there is a firm proposal which we can further consider: however, we note that the area roughly outlined above does not include the area of proposed dredging or disposal.

Mr Greenaway notes that visitor use at the Site and in the surrounding areas is moderate to high, especially in summer when camping and boating are very popular, along with the active use of the many sandy beaches for fishing, swimming and surfing. He records that tracks and walkways through many of the DoC reserves supplement those provided by WDC. Mr Greenaway records that the attractions and activities are primarily used by locals, but domestic and international tourism is increasing.

2.10.2 Marine Protected Areas

Mr Greenaway advises that the ecosystems at the Marine Reserve are a popular recreational site, providing visitors with the opportunity to experience a diverse population of native plants and animals[214]. He goes on to note that the CMS recognises that these areas valued for their contribution to the biodiversity of the wider marine environment. Further, the CMS makes reference to the Poor Knights Islands Marine Reserve and the Whangarei Harbour Marine Reserve as being an internationally ranked diving destination.

2.10.3 Fishing

Mr Greenaway records that the Harbour, Tutukaka and the surrounding districts are extraordinary fishing destinations and that are relatively heavily fished. The main areas of concentration of fishing activity are around Peach Cove, Bream Head and within Whangarei Harbour (at the likes of the 'Snake Bank Channel'). Mr Greenaway notes surf casting opportunities exist along the shoreline, along with a number of fishing competitions said to occur within and around the Site.

2.10.4 Shell-Fishing

Mr Greenaway advises that there are many shellfish gathering sites in the areas surrounding the Site, including pipi and scallops around Snake Bank, pipi at Marsden Point and at Mair Bank, and scallops to the north of Urquharts Bay, south of Home Point, in Smugglers Bay and offshore from Langs Beach. He notes, however, that both the total abundance and biomass of pipis around Whangarei Harbour have reduced significantly since 2010, while, in recent years, an expanding bed of green-lipped mussels has established on Mair Bank.

[214] Greenaway, R, pages 22 to 23, section 3.0, "Refining NZ Crude Shipping Project Recreation and Tourism Effects Assessment". Dated August 2017

2.10.5 Diving

We understand Mr Greenaway's advice to be that the most popular areas for recreational diving in the Whangarei Harbour are along the northern shores near the Harbour's entrance, such as at Busby Head[215]. The CMS reports that Snorkelling and scuba diving are also popular along the coast, particularly at the Poor Knights Islands Marine Reserve. Mr Greenaway identifies diving sites for scallops which include Bream Head Boulder Bank, Peach Cove, Smugglers Cove within Whangarei Harbour, and Bream Bay. He goes on to advise that due to the swift tidal currents, most diving at these locations takes place around the turn of the tide. Mr Greenaway advises that the Harbour is an important a base from which excursions to dive spots (such as the Hen and Chicken Islands) commence from.

In terms of Bream Bay, Mr Greenaway notes that the coast between Smugglers Bay and Bream Head is an important diving area for local divers. This area provides, he advises, underwater scenery, scallops, crayfish and pelagic fish, thus appeals to divers, photographers, crayfish hunters and spear fishermen.

2.10.6 Boating

We understand Mr Greenaway's advice to be that two marinas are located within the Harbour. One is distant from the Site, being the marina situated in the Harbour Basin (Whangarei Marina and Riverside Drive Marina). The other is much closer, being the marina at Marsden Bay (Marsden Cove Marina)[216]. Mr Greenaway also records that the Draft Northland Regional Plan proposes two regionally significant anchorages in Taurikura and Urquharts Bay, and one regionally significant 'storm anchorage' in Parua Bay. He goes on to advise that clubs (such as the Northland Canoe Club and the Sea Scouts) use the Whangarei Harbour for training, and that Windsurfing New Zealand has identified One Tree Point, Onerahi and Bream Bay as sailing sites. **Figure 2.10.6.1**, and **Figure 2.10.6.2** which follows, shows the main fishing areas (determined by the number of boats) and the anchorages, boat clubs and boat launching sites that are located in and around the Harbour. This includes three water ski lanes at Limestone Island, Marsden Bay and Urquharts Bay. As is shown in **Figure 2.10.1** and **Figure 2.10.2** (please refer to section 2.10 of this AEE), there is little recreational activities, including boating, occurring in the Bream Bay area.

[215] Greenaway, R, pages 41 to 42, section 4.4, "Refining NZ Crude Shipping Project Recreation and Tourism Effects Assessment". Dated August 2017
[216] Greenaway, R, pages 43 to 45, section 4.5, "Refining NZ Crude Shipping Project Recreation and Tourism Effects Assessment". Dated August 2017

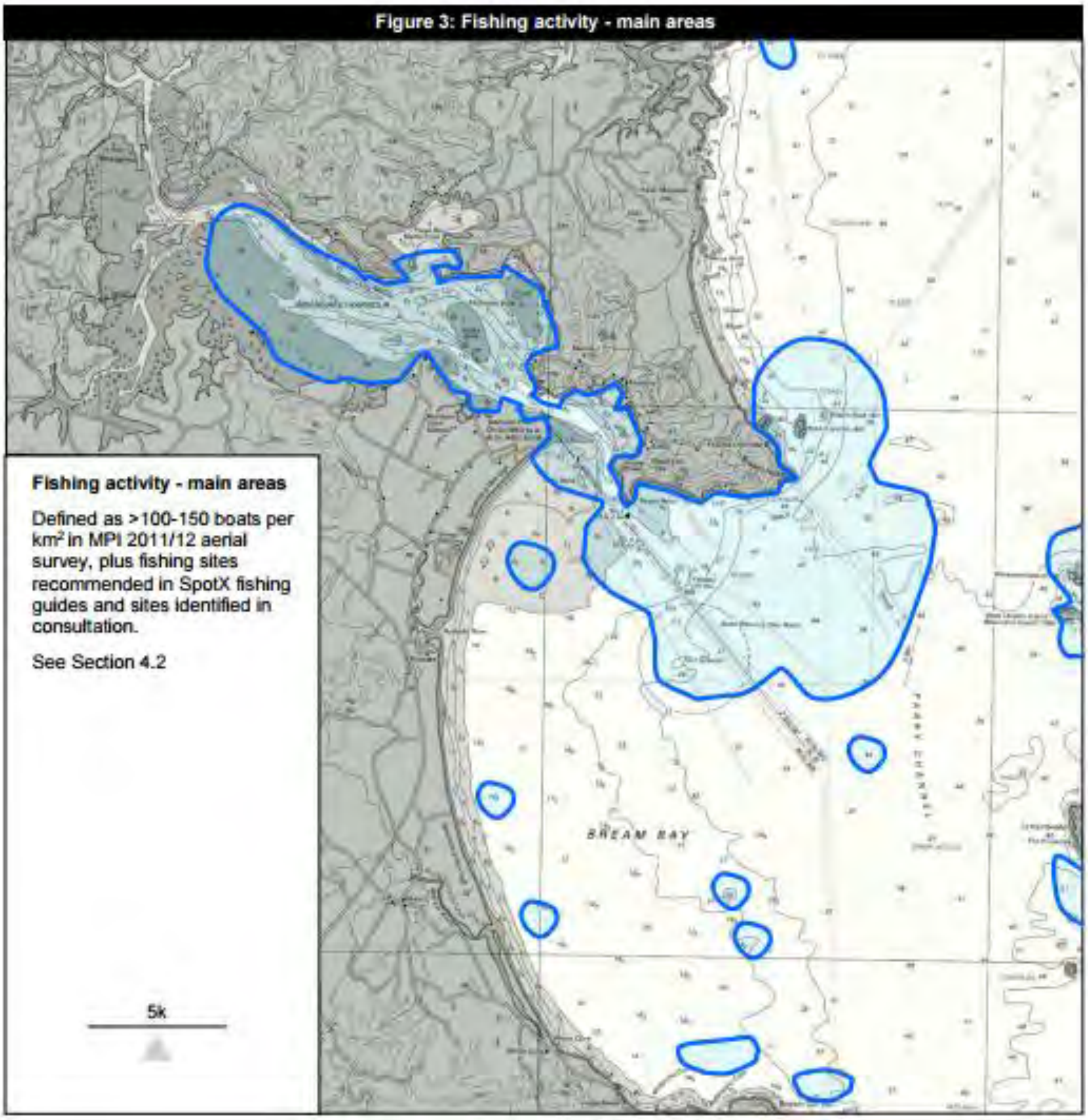


Figure 2.10.6.1: Fishing in and around Whangarei Harbour (determined by the number of boats in an area)[217]

[217] Greenaway, R, page 8, section 1.2, "Refining NZ Crude Shipping Project Recreation and Tourism Effects Assessment". Dated August 2017

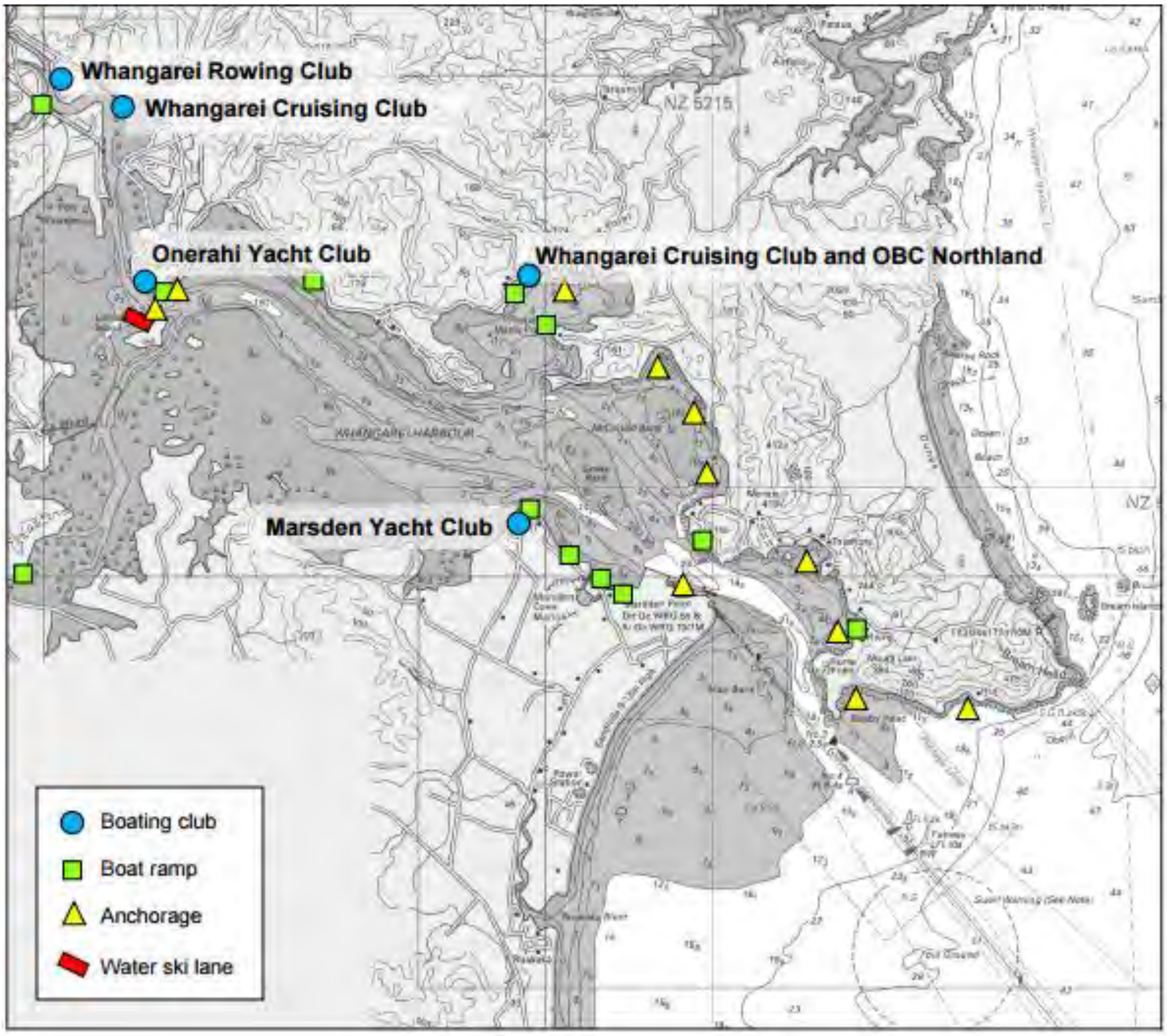


Figure 2.10.6.2: Anchorages, Boat Clubs and Boat Launching in and around Whangarei Harbour[218]

2.10.7 Surfing

Mr Greenaway highlights that the NZCPS does not identify any surf breaks of national significance within or adjacent to the Site[219]. He notes, however, that the *Wavetrack New Zealand Surfing Guide* does, identifies a number of surfing sites between Ocean Beach (which is located north of Bream Head) and Langs Beach. He advises that another source ('surf-forecast.com') describes the Ocean Beach (near Moturaka Island) break's reliability as fairly consistent, and Marsden Point as inconsistent. He then notes, for completeness, that the Draft Northland Regional Plan advances seven regionally significant surf breaks. Those breaks are shown in **Figure 2.10.7.1** below, which also follows.

[218] Greenaway, R, page 11, section 1.2, "Refining NZ Crude Shipping Project Recreation and Tourism Effects Assessment". Dated August 2017
[219] Greenaway, R, pages 46 to 49, section 4.6, "Refining NZ Crude Shipping Project Recreation and Tourism Effects Assessment". Dated August 2017

Figure 2.10.7.1: Regionally Significant Surf Breaks - Draft Northland Regional Plan[220]

2.10.8 Swimming & Beach Use

Mr Greenaway reports that the Regional Council monitors water quality at nine popular swimming sites, some of which are in reasonably close proximity to the Site[221]. He advises that the data for the 2013/14 and 2015/16 summer 'seasons' showed bathing water quality to be generally good or very good. The water quality monitoring sites and the associated water quality values are shown in **Figure 2.10.8.1**.

[220] Greenaway, R, page 49, section 4.6, "Refining NZ Crude Shipping Project Recreation and Tourism Effects Assessment". Dated August 2017
[221] Greenaway, R, pages 30 to 33, section 4.1, "Refining NZ Crude Shipping Project Recreation and Tourism Effects Assessment". Dated August 2017

Figure 2.10.8.1: Marine Bathing Monitoring Sites[222]

Mr Greenaway records that the WDC states that Whangarei has a reputation for their plentiful beaches that are said to offer a wide range of picturesque and safe places to swim, from the grand scale ocean beaches to the small sandy bays along both edges of the harbour. He also notes that Surf Lifesaving NZ patrols four beaches in relatively close proximity to the Site. The patrolled beaches are recorded on **Figure 2.10.8.2**. In addition, he reports that those beaches that are considered to be main swimming and or beach activity areas by the Regional include beaches on the

[222] Greenaway, R, page 30, section 4.1, "Refining NZ Crude Shipping Project Recreation and Tourism Effects Assessment". Dated August 2017

Coast of Whangarei Heads (from Urquharts Bay to Mcgregors Bay), beaches on the coast of One Tree Point, beaches around Munro Bay and beaches on either side of Ruakaka River.

Figure 2.10.8.2: Surf Lifesaving NZ Patrolled Beaches[223]

2.10.9 Hunting

Mr Greenaway advises that approximately 80% of the Whangarei Harbour area is designated as a Wildlife Refuge, which prohibits hunting and deliberate disturbance to wildlife, but does not restrict public access[224]. We understand this to mean that hunting is not a significant activity within or adjacent to the Site.

2.10.10 Tourism and Commercial Marine Recreation

Mr Greenway reports that international tourists undertake more recreation based activities than domestic tourists. He also notes that at a national level, water-based activities are the most popular past time activities[225]. More specifically, Mr Greenaway advises that 4% of domestic tourism trips included swimming in 2012, including swimming in pools, rivers, lakes and the sea. Further, he

[223] Greenaway, R, page 31, section 4.1, “Refining NZ Crude Shipping Project Recreation and Tourism Effects Assessment”. Dated August 2017
[224] Greenaway, R, page 51, section 4.8, “Refining NZ Crude Shipping Project Recreation and Tourism Effects Assessment”. Dated August 2017
[225] Greenaway, R, pages 49 to 50, section 4.7, “Refining NZ Crude Shipping Project Recreation and Tourism Effects Assessment”. Dated August 2017

reports that 3% of domestic tourism trips included fishing. Boating was reported to be carried out on 517,000 trips (1.1% of all trips) which included dolphin watching. The largest activities undertaken by tourists however were dining (31%), visiting friends (21%) and shopping (21%).

With respect to international tourists, boating activities were undertaken by 23%, swimming by 12%, bird watching by 7%, and fishing and dolphin watching by 5%.

Overall, Mr Greenaway advises that international tourists undertake more activities than domestic tourists.

2.11 Economic Considerations

Mr Clough and his colleagues at the New Zealand Institute of Economic Research ('**NZIER**') have prepared a report that sets out the framework for economic assessment for the Proposal[226]. In doing so, Mr Clough has provided considerable insight into elements of the economy. We now summarise our understanding of his advice.

Mr Clough states that the Refinery makes a significant contribution to the local (Whangarei), regional (Northland) and national economy.

Mr Clough also advises that the Refinery faces increasing competition from larger refineries in Asia, which has attributed with the closure of several Australian refineries of similar scale to Marsden Point. As such, he states that if Refining NZ were to retain the current channel, it will be increasingly difficult to remain competitive and to continue to operate at its current level.

Mr Clough then goes on to discuss three aspects of the economy, which we now summarise.

2.11.1 Regional Implications of RNZ's Operation

Mr Cough advises that in relation to New Zealand's demand, the Refinery currently supplies:

a. Approximately 86% of New Zealand's jet fuel;
b. Approximately 67% of all diesel;
c. Approximately 63% of all petrol;
d. Between 60 to 75% of all bitumen for roading;
e. All fuel oil for ships;
f. Sulphur for farm fertiliser; and
g. Carbon dioxide to the beverage industry.

Mr Clough states that Northland is a region that has been struggling in comparison to its resource base and other regions for several decades. To substantiate and support this comment he notes that Northland has a higher share of employment in the primary sector, a sector in which employment has been falling. He also advises that the Region has the highest age dependence ratio (proportion

[226] Clough, P, "Crude Shipping project, Economic assessment of channel deepening at the Marsden Point Refinery". Dated 02 August 2017

of people under 15 and over 65) of any New Zealand region, and this is forecast to significantly increase as the able-bodied move to other regions in search of jobs. Northland also has the second-lowest labour force participation and second-lowest-employment rate of all New Zealand regions. Mr Clough states that median household income in the region is approximately 20% lower than median household income in New Zealand.

Mr Clough records that Refining NZ is a substantial employer in the Whangarei District, offering relatively highly–skilled and highly paid job opportunities. In 2015, Mr Clough advises that the Company employed a total of 504 staff, with 355 of those being employees and the remaining 149 being contractors to RNZ. Further, Mr Clough estimates that, as a whole, the Refining NZ operations contributed 9.1% of the total Gross Domestic Product[227] to the Northland Region in 2015. Given the foregoing, we understand Mr Clough's advice to be that the continued operation of the Refinery is a significant driver of economic activity for the region[228].

Mr Clough also advises that Refining NZ's contribution to economic activity has increased faster than the growth in the Northland economy over the past five years, which we understand to be that the Refinery's economic importance has increased in recent years. Further, Mr Clough notes that employment growth at the Refinery has kept pace with growth in employment in Northland.

Mr Clough reports that Refining NZ currently pays approximately $68 million per year to people working for the Refinery, which he estimates consists of wage and salary payments to employees in the order of $48 million, with a further of $20 million being paid to contractors. He advises that approximately 94% of these payments are to employees and businesses residing in Northland.

In addition, Mr Clough records that Refining NZ also employs staff for its annual maintenance shutdowns. He advises that these shutdowns vary in size and duration each year but can offer work for around 500 additional people for a period of three to four weeks.

Mr Clough states that refining is a capital-intensive business, and that the Refinery has a long history of periodic investment in capital renewal and upgrading projects which inject substantial funds into the regional economy. He then notes that the Refinery's substantial links to other industries and contractors in the region were illustrated in the recent economic assessment of the Continuous Catalyst Regeneration Platformer project. He goes on to advise that, that this project involved total expenditure of $365m, of which $147m was spent in Northland, $27m in the rest of New Zealand and $191m overseas. This resulted in an estimated employment of up to 350 people in construction and a further 657 jobs stimulated in industries supplying the project.

Lastly, Mr Clough advises that the incomes earned by Refining NZ staff (both yearly and periodic shutdown staff) and contractors help retain 500 households in the region and their consumption of goods and services generates income and employment for local businesses in Whangarei.

[227] The total value of goods produced and services provided in a country during one year. Definition provided by Clough, P.
[228] Clough, P, pages 8 to 11, section 2.4, "Crude Shipping project, Economic assessment of channel deepening at the Marsden Point Refinery". Dated 02 August 2017

2.11.2 Current Oil Demand and Supply Security

Mr Clough's reports that oil was the source of 31% of the primary energy used in New Zealand in 2015[229]. Since that date, that percentage contribution from oil has fluctuated. Mr Clough advises, however, that oil accounted for 44% of total consumer energy in 2015, and 99% of all energy used in transport.

Not surprisingly, given the foregoing, Mr Clough advises that oil and oil products remain of critical importance to New Zealand, and that for many of the uses (particularly transport) there are currently no short or medium term practical or cost effective substitutes available.

2.11.3 Future Oil Demand

Mr Clough advises that New Zealand's primary energy consumption is growing at 1% per annum on average, with oil consumption growing at 0.6% per annum. Mr Clough also advises that oil is forecast to remain at 44% of New Zealand's primary energy demand for 2011 to 2040. Oil as a share of total consumer energy, is growing at an annual average growth rate of 0.8% over that period.

Mr Clough notes that at an international scale, oil production increased beyond demand in recent years, which has reduced oil prices. Further, Mr Clough advises that this is expected to continue.

Given the foregoing, we understand Mr Clough's advice to be that oil's predominant share of transport fuels market will, in all likelihood, continue into the foreseeable future, with only marginal shifts into new technologies. In this respect, we understand his advice to be that while oil remains cheap there is less incentive to bring alternative energy into use.

[229] Clough, P, pages 7, section 2.2.2, "Crude Shipping project, Economic assessment of channel deepening at the Marsden Point Refinery". Dated 02 August 2017

3.0 ASSESSMENT OF ACTUAL AND POTENTIAL ENVIRONMENTAL EFFECTS

3.1 Introduction

As we have already highlighted, when assessing this resource consent application, the Regional Council is required to have regard to any actual and potential effects on the environment that may result from allowing the Proposal to proceed. In undertaking this assessment, the Regional Council may disregard an adverse effect of the Proposal on the environment if a non-fanciful permitted baseline exists. For the reasons we discussed in section 1.7 of this AEE, we have not applied the permitted baseline in this instance. Further, and as we discussed in section 2.0 of this AEE, we have undertaken our assessment of environmental effects on the environment as it exists now, with the unimplemented component of Northport's reclamation consent and the District Council's Ruakaka wastewater outfall consent overlaid. On the basis of the advice received from the Regional Council, and as previously set out in section 2.0 of this AEE, we understand that there are no other relevant granted, but as yet implemented resource consents.

The key environmental effects associated with the Proposal are outlined in this section of the AEE. The effects have been classified into the following groups:

a. Geomorphology and Coastal Processes;

b. Channel and Navigational Safety;

c. Environmental Risk;

d. Terrestrial Noise;

e. Marine Ecology;

f. Avifauna Ecology;

g. Marine Mammals;

h. Commercial Fishing;

I. Landscape, Visual and Natural Character;

j. Archaeological and Historic Heritage;

k. Cultural Values;

l. Recreation and Tourism;

m. Economics; and

n. Positive Effects.

We now discuss each of these actual and potential effects in turn.

3.2 Geomorphology and Coastal Processes

Mr Reinen-Hamill has produced a report titled, Coastal Processes Assessment[230], which assesses the potential effects of the proposed activities on coastal processes in the Site. A full copy of Mr Reinen-Hamill's findings is contained within **Annexure Two** of this Report. Furthermore, Dr McComb undertook an evaluation of effects of the channel once it has been dredged on the wave climate, hydrodynamics, and sediment dynamics of the Site[231]. A full copy of Dr McComb's findings are also contained within **Annexure Two** of this Report. Together these two assessments define the coastal processes that exist within and adjacent to the Site. We now summarise what we understand to be the advice of Mr Reinen-Hamill and Dr McComb.

3.2.1 Wave Climate

Dr McComb advises that a 'SWAN model[232]' was used to understand and describe the wave climate and wave transformation across the ETD, based on the measurement of the wave climate throughout Bream Bay, including at the Wave Rider Buoy and nearshore along Ruakaka Beach. This allowed MetOcean to predict the effects of the proposed channel deepening.

As a result of the modelling, Dr McComb predicts the Proposal will result in a very subtle change of mean significant wave height (being the mean wave height from trough to crest) of generally no more than 2 centimetres ('**cm**'). During storm events, when offshore waves heights exceed 5.0m, Dr McComb advises that changes in the significant wave height fields should not exceed 10cm, except over a limited area to the west of Busby Head, where the significant wave height may increase by 20cm.

Dr McComb also advises that greater refraction of waves is predicted to occur and will increase wave height at Busby Head and offshore of Smugglers Bay up to a maximum of 10cm and 15cm during storm conditions, respectively. We understand Dr McComb's advise to be that a minor increase of wave height (1.0cm to 2.0cm on average) is expected along sections of Ruakaka Beach, while changes in wave height over Mair Bank are not expected to exceed 1cm on average and 5cm during extreme wave events[233].

In his assessment, Mr Reinen-Hamill notes that the Capital Dredging, Maintenance Dredging (over the course of 35 years) and the disposal of the dredged material, is expected to result in negligible changes to the average and moderate wave climate conditions. Notably, Mr Reinen-Hamill also records that average change in wave height is expected to an order of magnitude that is less than the annual variability[234].

Mr Reinen-Hamill also advises that during storm events (storms with significant wave heights offshore of 5.0m or more), there may be some channel refraction effects, as a result of the Proposal. Mr Reinen-Hamill records that this could result in higher waves, in the order of between 0.1m and 0.3m for storms with 5.0m high waves, breaking on the edge of Mair Bank and towards Busby Head[235]. While there is a broader change over the majority of the ETD that can be characterised as a general

[230] Reinen-Hamill, R, "Crude Shipping Project, Coastal Processes Assessment", Dated July 2017
[231] MetOcean Solutions Limited, "Predicted physical environmental effects from channel deepening and offshore disposal", Dated 25th of July 2017
[232] Simulating Waves Nearshore.
[233] MetOcean Solutions Limited, page 28, section 4.2, "Predicted physical environmental effects from channel deepening and offshore disposal", Dated 25th of July 2017
[234] Reinen-Hamill, R, page 54, section 5.1, "Crude Shipping Project, Coastal Processes Assessment", Dated July 2017
[235] Reinen-Hamill, R, page 54, section 5.1, "Crude Shipping Project, Coastal Processes Assessment", Dated July 2017

reduction in wave height, there is a slight focusing of waves along the southern flank of the ETD (less than 2.0cm change). When, however, Mr Reinen-Hamill compared the inter-annual variability on wave heights, he advised that the relative change as a result of the dredging during high energy wave events is an order of magnitude less than the annual variability of 1.36m for the 99% wave height[236].

Mr Reinen-Hamill concludes, with regard to wave processes, that:

"Based on the existing observed variability of the upper parts of the ebb tide shoal, which occurs due to the existing hydrodynamic variability on the upper parts of the shoal (±100,000 m^3/yr), these relatively small scale changes in wave heights during high energy events are unlikely to create a noticeable or measurable effect on sediment transport patterns and coastal process effects and therefore even for larger wave events will have negligible effects."[237]

3.2.2 Tidal Currents

Dr McComb advises that a 'SELFE' model was used to simulate the tidal flows within the Whangarei Harbour.

We understand the advice of Dr McComb to be that the SELFE model was applied to simulate the effects of the proposed channel deepening on the tidal hydrodynamics. As a result of the modelling, Dr McComb states that the Proposal is not expected to change the overall tidal hydrodynamics of the harbour entrance however, the proposed channel modifications will result in both reductions and accelerations to the tidal current speeds, depending on the location of measurement within the Harbour and channel[238]. Further, Dr McComb notes that while deepening the channel is not expected to fundamentally modify the bed shear stress fields over the Whangarei Harbour entrance, it may locally cause some adjustments[239]. Such changes in the bed shear stress fields can, we understand, generate some subtle adjustments of the local morphodynamics without causing an overall transformation of the sediment transport dynamics between the Whangarei Harbour and the Bream Bay[240]. However, we understand the advice of Dr McComb to be that these anticipated adjustments should be of relative 'low importance' compared to the effect of the waves on the morphodynamics outside of the entrance to Whangarei Harbour. Notably, Dr McComb predicts that there will be a very slight adjustment of the timing of the tidal phase[241]. Put another way, we understand that the existing times of the tides will need to be adjusted by approximately seven minutes.

Mr Reinen-Hamill again considers Dr McComb's advice, and notes that as a result of the Proposal, there is no change to the regional scale hydrodynamics or hydrodynamics within Bream Bay, and no changes to tidal flows within Whangarei Harbour[242]. Put another way, we understand his advice to be that the effects of the Proposal are limited to the Whangarei Harbour entrance and the ETD. Mr Reinen-Hamill advises that the difference in peak flood and ebb tidal velocities for the spring tide will be a small reduction (generally less than 0.02m/s), except along the edges of the channel adjacent

[236] Reinen-Hamill, R, page 54, section 5.1, "Crude Shipping Project, Coastal Processes Assessment", Dated July 2017
[237] Reinen-Hamill, R, page 54, section 5.1, "Crude Shipping Project, Coastal Processes Assessment", Dated July 2017
[238] MetOcean Solutions Limited, page 43, section 6.2, "Predicted physical environmental effects from channel deepening and offshore disposal", Dated 25th of July 2017
[239] MetOcean Solutions Limited, page 44, section 6.2, "Predicted physical environmental effects from channel deepening and offshore disposal", Dated 25th of July 2017
[240] MetOcean Solutions Limited, page 42, section 6.3, "Predicted physical environmental effects from channel deepening and offshore disposal", Dated 25th of July 2017
[241] MetOcean Solutions Limited, page 52, section 6.3, "Predicted physical environmental effects from channel deepening and offshore disposal", Dated 25th of July 2017
[242] Reinen-Hamill, R, page 55, section 5.2, "Crude Shipping Project, Coastal Processes Assessment", Dated July 2017

to Mair Bank, within the channel between Mair Bank and Home Point and between Home Point and Busby Head where changes could reach 0.1m/s[243].

Mr Reinen-Hamill evaluated the impact of these small changes in tidal velocity in relation to their potential to increase or decrease the existing erosion potential. Having completed this analysis, Mr Reinen-Hamill advises that there will be very little change in sediment transport patterns for fine sand (being a grain size of less than 200 micrometres ('**µm**')), which is the typical size of particles within the works area. He notes that any sediment movement is likely to be transported from the south-east of Busby Head, before potentially settling in the lower energy environment of the outer channel. Mr Reinen-Hamill considers these changes will have no effect on the adjacent shoreline stability but may locally affect the seabed, principally resulting in sedimentation potential within the dredged channel and the side slopes. However, he concludes that these effects are negligible[244].

Notably, Mr Reinen-Hamill advises that there will be no measurable change to the water levels within the Harbour, although he reiterates the advice from Dr McComb, being that there may be some slight change to the phase of the tidal wave, with mean changes in the order of ±7 minutes. As such, Mr Reinen-Hamill considers the effect of changes to water level are negligible[245].

Overall, we understand the advice of both Dr McComb and Mr Reinen-Hamill to be that the proposed channel modifications are not expected to significantly change the tidal hydrodynamics of the Whangarei Harbour entrance, and the existing coastal processes that apply to the ebb and flood tidal flows will be maintained after deepening.

3.2.3 Tidal Flux

Mr Reinen-Hamill has assessed the effects of the Proposal on tidal flux, which is the rate of flow of water through a defined area. In this regard, as a result of the proposed channel deepening, Mr Reinen-Hamill states that only a very small difference in tidal flux, particularly velocity and water level, within the inner harbour would be expected. Overall, he considers this would result in some small localised changes with increases and decreases in flow, that any effect of these tidal flux changes on coastal processes would be negligible[246].

3.2.4 Sediment Transport

Dr McComb advises that three techniques were used to investigate the potential changes to the Harbour entrance as a result of the Proposal. The first technique was to use a sediment transport pathway approach to determine grain size movements over a 6-month period. The second was to estimate the effect of a deeper channel on the potential sediment changes for a single representative sediment grain size. The third consisted of running a sequence of storm and fair-weather conditions over a 21-day historical period to simulate the cumulative morphological changes with a realistic seabed composition.

Having applied these techniques, Dr McComb and his colleagues found that the sediment dynamics of the Whangarei Harbour entrance, are not expected to be significantly modified by the channel

[243] Reinen-Hamill, R, page 55, section 5.2, "Crude Shipping Project, Coastal Processes Assessment", Dated July 2017
[244] Reinen-Hamill, R, page 55, section 5.2, "Crude Shipping Project, Coastal Processes Assessment", Dated July 2017
[245] Reinen-Hamill, R, page 56, section 5.3, "Crude Shipping Project, Coastal Processes Assessment", Dated July 2017
[246] Reinen-Hamill, R, page 59, section 5.4, "Crude Shipping Project, Coastal Processes Assessment", Dated July 2017

deepening project[247]. In that regard, the anticipated changes in the sediment transport fluxes are predicted to occur in spatially discrete zones and appear negligible compared to the total net sediment transport fluxes occurring through the main channel between the harbour and the open-ocean region[248].

We understand that having completed the assessment using the three techniques, Dr McComb is of the opinion that the morphodynamics of Mair Bank are largely influenced by the armouring provided by live shellfish, such as dense areas of live pipis that provide biological armouring, and their residual shell fragments. This leads him to advise that the proposed deepening within the channel will not significantly change the sedimentary outcomes on Mair Bank[249]. Furthermore, we understand Dr McComb to also conclude that the stability of Ruakaka Beach is not expected to be influenced by the variation in the wave conditions caused by channel deepening and that while enhanced wave refraction may increase the potential 'erodibility' of the seabed around Busby Head, the existing sandy shelly-gravel top layer of the seabed in this area will do much to mitigate this potential impact[250].

Having considered the advice of Dr McComb, Mr Reinen-Hamill recognises that both the Capital Dredging and Maintenance Dredging activities may result in a net loss of sediment from the ETD over time, which may not be replenished from natural sources. This, Mr Reinen-Hamill advises, could result in a reduction in the footprint of the ETD, as well as a general lowering in elevation of the same. Mr Reinen-Hamill estimates an average change in elevation of between 0.16m to 0.23m (over an area of $35km^2$), although there might be localised change of around 1.0m[251].

As we discussed in section 1.5.2 of this AEE, sedimentation is expected to occur at a relatively constant rate following the Capital Dredging works. Sediment is expected to settle immediately adjacent to the Marsden Point jetty and along the toe of Mair Bank. This will generate some need for periodic Maintenance Dredging[252].

Mr Reinen-Hamill notes that because of existing natural processes, Mair Bank and the coastline extending southward from Marsden Point are currently experiencing change and a net loss of sand. He also advises that future sea level rise may also result in a loss of sediment from the ETD. When the natural processes are combined with the Proposal, Mr Reinen-Hamill considers that this may result in increased erosion pressure on Mair Bank as well as, ongoing shoreline erosion along the open coast beaches adjacent to the ETD[253]. Given this potential outcome, Mr Reinen-Hamill recommends placing suitable dredged sediment within Disposal Area 1.2. For the Capital Dredging campaign, this is at least 2.5% of the dredged sediment, and may be up to a total of 5.0%[254]. We understand his advice to be that this disposal strategy will address any adverse erosive effect of the Proposal, and will improve the resilience of Mair Bank to the impacts of climate change. Mr Reinen-Hamill also recommends that ongoing monitoring (following completion of the Capital Dredging

[247] MetOcean Solutions Limited, page 76, section 7.4, "Predicted physical environmental effects from channel deepening and offshore disposal", Dated 25th of July 2017
[248] MetOcean Solutions Limited, page 84, section 7.6, "Predicted physical environmental effects from channel deepening and offshore disposal", Dated 25th of July 2017
[249] MetOcean Solutions Limited, page 85, section 7.6, "Predicted physical environmental effects from channel deepening and offshore disposal", Dated 25th of July 2017
[250] MetOcean Solutions Limited, page 85, section 7.6, "Predicted physical environmental effects from channel deepening and offshore disposal", Dated 25th of July 2017
[251] Reinen-Hamill, R, page 59, section 5.6.3, "Crude Shipping Project, Coastal Processes Assessment", Dated July 2017
[252] Reinen-Hamill, R, page 57, section 5.5.2, "Crude Shipping Project, Coastal Processes Assessment", Dated July 2017
[253] Reinen-Hamill, R, page 63, section 6, "Crude Shipping Project, Coastal Processes Assessment", Dated July 2017
[254] Reinen-Hamill, R, page 63, section 6.1, "Crude Shipping Project, Coastal Processes Assessment", Dated July 2017

campaign) is undertaken to determine the amount of disposal that occurs to Disposal Area 1.2 during the Maintenance Dredging campaigns[255]. Refining NZ has accepted this recommendation, and the Proposal has been modified accordingly.

Mr Reinen-Hamill recommends the following regime of monitoring, which has been accepted by Refining NZ[256]:

1. Ongoing measurement of waves and water level at the Wave Rider Buoy;
2. Prior to any Maintenance Dredging campaigns, surveying of Mair Bank, the upper portion of the ebb tide shoal (above the 5.0m depth contour), and Disposal Area 1.2 shall be completed to determine the amount of dredged material, if any, shall be place in Disposal Area 1.2; and
3. Annual monitoring of bathymetry of the upper part of the ebb tide shoal (above the 5.0m depth contour), Disposal Area 1.2, and the dredged channel, be continued for a period of up to 5 years after Capital Dredging has been completed. Following this initial monitoring period, Mr Reinen-Hamill records that an evaluation of the survey data should be carried out to confirm effects are within the range assessed by the studies carried out for this application and to determine the requirements (if any) of ongoing consent related monitoring.

3.2.5 Dredging Plumes

Dr McComb advises that the potential plume caused by the proposed dredging activities was simulated by using the 'ERCore lagrangian particle' modelling technique, in addition to the SELFE tidal modelling previously described. The model considered the typical type and size range of dredging vessels that might be used for the Proposal, being a TSHD, CSD and BHD. Notably, as the TSHD is the preferred option for the majority of the dredging operations, the modelling only investigated the use of a CSD and BHD within the jetty pocket, and a CSD for the inner portion of the channel. Dr McComb advises that the use of a large TSHD represents the worst-case scenario[257], as it disturbs the largest amount of sediment during each dredging cycle when compared to the operations of the CSD and BHD.

The analysis completed by Dr McComb and his colleagues identified that the plumes arising from the proposed dredging are predicted to follow the general channel alignment, consistent with the tidal currents, and extend for up to 1200m near the seafloor (at a minimum threshold of 12 milligrams per litre ('**mg/L**')[258]). Importantly, we understand the advice of Dr McComb to be that the plumes will not spread to the adjacent beaches, sand banks, the areas zoned Marine 1 (Protection) Management Areas in the RCP, or into the Marine Reserve[259].

3.2.6 Disposal Ground Dynamics

Dr McComb advises that an integrated assessment of the dynamics of the disposal grounds were made utilising the DELFT3D-WAVE model.

[255] Reinen-Hamill, R, page 65, section 7.2, "Crude Shipping Project, Coastal Processes Assessment", Dated July 2017
[256] Reinen-Hamill, R, page 65, section 7.2, "Crude Shipping Project, Coastal Processes Assessment", Dated July 2017
[257] MetOcean Solutions Limited, page 86, section 8.0, "Predicted physical environmental effects from channel deepening and offshore disposal", Dated 25th of July 2017
[258] A minimum 12 mg/L Suspended Sediment Concentration threshold of 12 Nephelometric Turbidity Units ('NTU') was applied to delimit the plume dispersion. Such threshold corresponds to the difference between the existing background levels of 3 NTU, and the 15 NTU level 2 Response Limit (based on a one-hour average) indicated in Dr Coffey, B, page 45, section 4.1.2e, "Crude Shipping Project. Proposal to Deepen and Partially Realign the Approaches to Marsden Point. Assessment of Marine Ecological Effects Excluding Seabirds and Marine Mammals". Dated 10 August 2017
[259] MetOcean Solutions Limited, page 88, section 8.1, "Predicted physical environmental effects from channel deepening and offshore disposal", Dated 25th of July 2017

Having done the modelling, we understand Dr McComb to advise that the predicted rate of movement of sediment from Disposal Area 3.2 is very low and essentially omnidirectional, although results suggest a slight bias to the south[260]. That is, once placed, the seabed of the area is not predicted to be significantly influenced by the effect of waves and currents, meaning the sediment is not expected to move by more than a few cm. Importantly, we understand Dr McComb's advice to be that there will be no material change to the sedimentary character of the adjacent Three Mile Reef[261].

Sediment discharged to Disposal Area 1.2 is predicted to be transported in the south-western and north-western directions over the adjacent beach and sand bank areas by waves. The circulation caused by tidal and wave forcing in this region is not predicted to connect the disposal mound system with the channel system, thus the risk of channel infilling by the dredged material after disposal is limited[262].

Overall, we understand the advice of Dr McComb to be that the predicted maximum changes to the nearshore wave climate by the presence of both Disposal Area 1.2 and Disposal Area 3.2 are very minor and not expected to exceed +/- 0.05m along the shoreline under energetic wave conditions[263]. We take this to mean that no consequences on the beach or nearshore processes are expected.

3.2.7 Disposal Plumes

The 'ERCore lagrangian' particle modelling technique was also used by Dr McComb and his colleagues to simulate the dispersion of a plume caused by disposal operations.

Dr McComb advises that the plumes caused by disposal of sediment at Disposal Areas 1.2 and 3.2 are expected to be short lived and will not travel significant distances. In that regard, we understand his evidence to be that the plumes are likely to extend along a northeast to southwest axis, and will not encroach into the ecologically sensitive Three Mile Reef complex. In particular, surface plumes will be constrained to the mixing zone around the disposal vessel, and will not extend more than 50m from the release location. Further, we understand his advice to be that 99% of the plume material is expected to settle to the seabed within 14 hours[264].

3.2.8 Expected Changes to Recreational Surfing

Wave modelling carried out by Dr McComb has concluded that areas where surfing is recognised within Bream Bay (being at the Ruakaka River mouth and at the Marsden Point Power Station breaks) currently experience a slight concentration of wave energy, which supports the contention that they are favourable locations for surfing.

Drawing on the advice of Dr McComb, Mr Reinen-Hamill states that the wave modelling shows no fundamental changes to the mean wave height and negligible changes to the maximum wave climate

[260] MetOcean Solutions Limited, page 120, section 9.6, "Predicted physical environmental effects from channel deepening and offshore disposal", Dated 25th of July 2017
[261] MetOcean Solutions Limited, page 120, section 9.6, "Predicted physical environmental effects from channel deepening and offshore disposal", Dated 25th of July 2017
[262] MetOcean Solutions Limited, page 120, section 9.6, "Predicted physical environmental effects from channel deepening and offshore disposal", Dated 25th of July 2017
[263] MetOcean Solutions Limited, page 120, section 9.6, "Predicted physical environmental effects from channel deepening and offshore disposal", Dated 25th of July 2017
[264] MetOcean Solutions Limited, page 122, section 10.2, "Predicted physical environmental effects from channel deepening and offshore disposal", Dated 25th of July 2017

along the Ruakaka shoreline. As such, he concludes that changes to recreational surfing would be negligible[265].

3.2.9 Effects of Climate Change

Mr Reinen-Hamill has identified that climate change effects, including changes to sea level and potential effects on storms, wind and storm-tide will occur within the Site and could have an impact on coastal processes, when combined with the Proposal[266]. He advises that climate change is predicted to accelerate the rate of sea level rise into the future, which has historically been 2.2 ± 0.6 mm/year in Northland. In addition, based on investigations undertaken by NIWA, Mr Reinen-Hamill notes that the mean annual wave height will increase slightly (generally less than 2 to 3%) on the western and southern coasts of New Zealand, with small decreases in mean wave height elsewhere, such as Northland. In this regard, we understand his advice to be that extreme wave heights are expected to increase between 0 to 5%, with a lower likelihood of increases up to 15%.

Mr Reinen-Hamill records that the sandy shoreline along the northern part of Bream Bay and within Whangarei Harbour are currently susceptible to coastal erosion and are likely to experience greater erosion pressure as a result of sea level rise and climate change effects over the next 100 years. With an increase in sea levels Mr Reinen-Hamill states that this could allow higher waves to reach the nearshore environment for all wave conditions. Although he has acknowledged that the increase in average conditions is negligible.[267]

Overall, Mr Reinen-Hamill records that the increased sea level will reduce the effect of the proposed dredging on wave processes, as the greater water depth will reduce nearshore processes. He advises that the potential for increased tidal flow from the Harbour will not be affected by the Proposal (as the 'throat' of the Harbour will not be modified, and it is this area that controls the tidal flows). Given this, Mr Reinen-Hamill records that the Proposal has less than minor effects on coastal processes in the present day, and the effect will reduce as a result of expected climate change effects. He adds that by adding sand volume in the active part of the ETD, the Proposal may provide a beneficial effect to assist in offsetting some of the future coastal hazard effects[268].

3.2.10 Expected Effects Resulting from Relocation of Navaids

Mr Reinen-Hamill considers that the relocation and installation of Navaids will have no effect on coastal processes, and will not be affected by climate change processes[269].

3.2.11 Summary

By way of an overall conclusion, we understand the advice of Dr McComb to be that the Proposal will not adversely affect the wave climate, tidal hydrodynamics or sediment dynamics to more than a minor degree.

For his part, Mr Reinen-Hamill advises that:

[265] Reinen-Hamill, R, page 32, section 3.10.1, "Crude Shipping Project, Coastal Processes Assessment", Dated July 2017
[266] Reinen-Hamill, R, page 65, section 5.15, "Crude Shipping Project, Coastal Processes Assessment", Dated July 2017
[267] Reinen-Hamill, R, page 65, section 5.15, "Crude Shipping Project, Coastal Processes Assessment", Dated July 2017
[268] Reinen-Hamill, R, page 65, section 5.15, "Crude Shipping Project, Coastal Processes Assessment", Dated July 2017
[269] Reinen-Hamill, R, page 65, section 5.13, "Crude Shipping Project, Coastal Processes Assessment", Dated July 2017

"Overall the changes to tidal flows and wave conditions resulting from the channel dredging and marine disposal are small and typically within the existing variability of tidal currents and wave energy. Changes to existing coastal processes are anticipated to be negligible on the open coast from Marsden Point to Ruakaka River or along the rocky coast from Home Point to Smugglers Bay, on the ebb tide shoal and Mair Bank or within the inner harbour area[270]*.*

The proposal is to provide a volume of sand to be added to the ebb tide shoal system during both the capital and maintenance dredging operation. The volume of sand to be placed is similar to, or slightly in excess of the volume being dredged on the northern edge of the shoal. As the volume returned to the system is of the same order of magnitude, the residual effects on coastal processes of the proposed channel dredging and disposal regime is expected to be within the observed fluctuations currently observed. Therefore the effects on the coastal environment with treatment are expected to be less than minor (i.e. negligible)"[271].

3.3 Channel and Navigational Safety

Mr Bermingham has considered the actual and potential navigation risks associated with the Proposal. A full copy of his Navigational Risk Assessment Report is contained within **Annexure Two** of this AEE.

3.3.1 Assumptions and Context

Mr Bermingham records that while undertaking his navigation risk assessment he highlighted a number of operational measures which are, in his opinion, required to support the use of the realigned and deepened entrance channel. These operational measures include:

- A towage study to identify and implement a capability that can fully mitigate ship failure scenarios alongside incorporating additional performance monitoring and reserve capacity into normal operations;
- Applying standard pilotage procedures, such as the use of tugs as risk mitigation measures;
- Issuing Standard Pilotage Plans to ships in advance that define the preferred track and waypoints into the Harbour;
- Mandatory use of a standard Personal Pilotage Unit, alongside associated training of the same;
- Requiring a second pilot to be on board, at least for the initial fully laden Suezmax tanker operations, to allow for redundancy, Personal Pilotage Unit monitoring and to ensure currency requirements are achieved[272]. This includes the adoption of standard procedures to utilise two pilots defining the roles of each;
- Defined pilot/tugmaster training and currency requirements; and
- Pilots board ships early enough to allow a full and comprehensive briefing.

Mr Bermingham goes on to note that these measures, which are outside of the control of Refining NZ, will be required (in his view) to achieve the internationally accepted 'As Low As Reasonably Practicable' ('**ALARP**') risk criterion that aligns with Health and Safety regulation[273]. As such, Mr

[270] Reinen-Hamill, R, "Crude Shipping Project, Coastal Processes Assessment", Dated July 2017
[271] Reinen-Hamill, R, page 68, section 6.1, "Crude Shipping Project, Coastal Processes Assessment", Dated July 2017
[272] Achieving currency means that a pilot has met the requirements to act as a pilot in command of vessel within a certain time period.
[273] Bermingham, G, page 15, section 5.2, "Report in Support of an Assessment of Effects on the Environment, Navigational Risk Assessment of Engineered Channel Designs". Dated 15 August 2017.

Bermingham has advanced the navigation risk assessment on the basis that the operational measures will be implemented as a pre-requisite to use of the realigned and modified channel. Refining NZ advise us that the third parties needed to implement these measures have been made aware of this advice and undertaking an 'operational review' (Martin, D, pers. com). We understand Mr Martin's advice to be that the third parties are looking favourably at the operational matters that have been raised. As the operational matters are not within the remit of Refining NZ, all the Company can do in this instance is to track the progress that is being made in the operational review, and to support the adoption of the changes that have been recommended. Refining NZ advise, however, that no issue has been raised regarding the use of the revised channel by either Northport or the harbourmaster.

The navigation risk assessment also took into account the discussions and outcomes reached from the two-day Maritime Risk Assessment workshops with key stakeholders[274], which was previously discussed in section 1.4 of this Report. The workshops identified, described and considered the hazards and threats associated with navigating large vessels given each of two channel design options, being Option 2 and Option 4.2, as well as the existing and potential mitigations to these hazards. The workshop then considered the changes inherent in the two channel options. The workshops were informed by a series of computer modelling simulations of the approaches and departures, with the outcomes of the workshops tested by a further series of simulation runs[275].

Mr Bermingham notes that the Navigation Risk Assessment Report was prepared in accordance with the international risk management process set out in AS/NZS ISO 31000:2009 *Risk Management – Principles and Guidelines*[276]. We understand that this international standard can be used by any public, private or community enterprise, association, group or individual and is not specific to any industry or sector.

3.3.2 Characteristics of the Tankers Assessed

The Navigation Risk Assessment Report goes into reasonable detail as to how the navigation effect of the Proposal was assessed. The focus of the report is on, in our opinion, the effect that the deepened and realigned entrance channel will have on existing tanker types and loadings, as well as fully laden Suezmax tankers, with a draught of 16.6m and a greater displacement (between 160,000 tonnes and 180,000 tonnes[277]) to entering the Whangarei Harbour on any given high tide. We understand the rationale for this choice to be that all large tankers, including fully laden Suezmax tankers, must be able to safely navigate the dredged channel[278]. Mr Bermingham notes that he has assumed, in his risk assessment, that tankers will arrive and discharge most, if not all, of their cargo at the Refinery, and that they will not take on petroleum product for onward transit. As a consequence, he considers both full and part full Suezmax tankers arriving at the Refinery, and large tankers, including Suezmax, leaving part loaded and in ballast. This means the risk assessment has also assumed that the Suezmax tankers leaving the Refinery will have less draught when compared

[274] The Maritime Risk Assessment was facilitated by Navigatus on the 17th of April 2015 and attended by representatives from RHDHV, Refining NZ, NorthTugz Limited, Northport, and the Harbour Master. Specialists from Be Software, Brisbane Marine Pilots, DNV GL and Royal HaskoningDHV also provided external expertise and viewpoints on subjects during the workshop.
[275] Bermingham, G, page 5, section 3, "Report in Support of an Assessment of Effects on the Environment, Navigational Risk Assessment of Engineered Channel Designs". Dated 15 August 2017.
[276] Bermingham, G, page 5, section 3, "Report in Support of an Assessment of Effects on the Environment, Navigational Risk Assessment of Engineered Channel Designs". Dated 15 August 2017.
[277] The actual displacement of a laden Suezmax tanker varies dependent on such factors as cargo size, crude oil density, and ship empty displacement.
[278] Bermingham, G, page 11, section 4.4, "Report in Support of an Assessment of Effects on the Environment, Navigational Risk Assessment of Engineered Channel Designs". Dated 15 August 2017.

to the tankers entering the Harbour. Whilst tankers laden with crude oil tend to have a near constant draught along their length, ballasted tankers tend to ride deeper by the stern. It is noted that a ballasted ship will present more windage (being the exposure of the vessel above the waterline to wind) than a laden one, due to greater freeboard[279].

3.3.3 Effects Assessment

The navigation risk assessment undertaken by Mr Bermingham and his colleague is, in essence, focussed on identifying and analysing hazards and threats to safe navigation that could lead to an undesirable event. Aside from the threats, the assessment included the effectiveness of measures and factors that could help prevent an undesirable event, or if the event occurred, the responses that could stop the event developing to a full consequence. The six potentially significant consequences from an undesirable event, as identified by in the assessment, were[280]:

a. Contact with buoy;
b. Heavy contact with jetty (Reach 6 only);
c. Grounding on sand;
d. Contact with sand;
e. Grounding on rock (Reaches 3 and 4 only); and
f. Contact with rock (Reaches 3 and 4 only).

We now summarise the Mr Bermingham's assessment of the relative risk of each of the undesirable event occurring below.

3.3.4 Contact with Buoy

Mr Bermingham notes that if contact of a vessel occurred with a buoy then it is likely to be a glancing blow. Aside from being considerably smaller than a large tanker, as the buoys are secured by a chain and bottom tackle, they are able to move, which, in turn, lessens the force transmitted between the ship and buoy. Mr Bermingham states that at worst, no more than some minor denting of the plating of the outer hull will occur, with scrapes being the likely outcome. Overall, Mr Bermingham considers the consequence would be very minor[281].

3.3.5 Heavy Contact with Jetty

Mr Bermingham records that the limiting lateral speed for berthing is 0.15m/s. Put another way, we understand that the maximum acceptable closing rate that a vessel should berth at the Refinery, is 0.15m/s. Mr Bermingham advises that if a vessel berthed at a higher speed, it would likely result in overly heavy contact with the jetty infrastructure. Mr Bermingham also advises that in the past, some vessels have made heavy contact with the breasting dolphin, however, buffers on the dolphins limited any damage to the ships to cosmetic marks only. In one case a dolphin, was knocked out of

[279] Bermingham, G, page 11, section 4.4, "Report in Support of an Assessment of Effects on the Environment, Navigational Risk Assessment of Engineered Channel Designs". Dated 15 August 2017
[280] Bermingham, G, page 26, section 5.6, "Report in Support of an Assessment of Effects on the Environment, Navigational Risk Assessment of Engineered Channel Designs". Dated 15 August 2017
[281] Bermingham, G, page 26, section 5.6.1, "Report in Support of an Assessment of Effects on the Environment, Navigational Risk Assessment of Engineered Channel Designs". Dated 15 August 2017.

alignment while the ship remained undamaged. When all things are considered, Mr Bermingham advises that, as is the design intent, even heavy contact with a fully laden Suezmax tanker, the outer hull plating is unlikely to be breached[282].

3.3.6 Grounding on Sand

Mr Bermingham notes that a vessel that was well off-track could contact the edge of the channel and could ground. He records that if a vessel impacted at a shallow angle, a firm ground is unlikely. While a steeper front impact onto the sand is almost certain to not affect the propulsion and steering systems, although plates at the bow (front of the vessel) may buckle. Mr Bermingham goes on to advise that only limited damage to the inner hull and tanks is likely to occur as a result of the collision bulkhead design, as all tankers are designed to protect the watertight integrity of the main hull. However, a minor oil leak from the bilges of the void spaces between any buckled plates is a possibility. Mr Bermingham concludes that after grounding, the greatest risk factor would be the subsequent sea state and weather, which could contribute to the damage sustained by the ship over time[283].

3.3.7 Contact with Sand

Mr Bermingham advises that a glancing blow with the side of the channel, not resulting in grounding, would likely only result in some deformation and buckling of the outer hull plates. While there may be some damage to the structure between the outer and inner hulls, it is Mr Bermingham's view that damage to the inner hull and oil tanks is highly unlikely. Further, the glancing or sliding nature of this type of blow means that it is likely that the propulsion and steering systems would be unaffected. Cracking associated with heavy buckling of the outer plates could lead to slow flooding of the void sections of the hull and an increase in the ship's draught. Taking these considerations into account, we understand Mr Bermingham to be of the opinion that the ship is likely to be able to berth safely[284].

3.3.8 Grounding on Rock

Mr Bermingham states that any grounding on rock would be expected to cause considerably more damage than grounding on sand. In that regard, we understand Mr Bermingham to advise that such grounding, if on the forepart, is likely to cause major damage to the forward hull plates and structure leading to flooding of the ship's forepeak. The extent of the damage would depend on the impact speed and extent of collision, and time in contact. Mr Bermingham considers that given the size of a fully laden Suezmax ship, and size and depth of the rocks in the channel, it is highly unlikely the ship would ride up over the rock and would instead sustain damage to the hull side plating and associated structure as it was being deflected laterally. As a result, he considers it extremely unlikely that the ship would become 'stuck fast' on the rock, which could rapidly damage a ship beyond recovery. As with grounding on sand, the full extent of the damage would depend on the speed and angle of the grounding. Mr Bermingham considers that the consequences of grounding on a rock

[282] Bermingham, G, page 26, section 5.6.2, "Report in Support of an Assessment of Effects on the Environment, Navigational Risk Assessment of Engineered Channel Designs". Dated 15 August 2017.
[283] Bermingham, G, page 26, section 5.6.3, "Report in Support of an Assessment of Effects on the Environment, Navigational Risk Assessment of Engineered Channel Designs". Dated 15 August 2017
[284] Bermingham, G, page 27, section 5.6.4, "Report in Support of an Assessment of Effects on the Environment, Navigational Risk Assessment of Engineered Channel Designs". Dated 15 August 2017.

will almost certainly be severe, and in the event, that any oil tanks were ruptured, considerable oil leakage would be expected[285].

3.3.9 Contact with Rock

Mr Bermingham also advises that a glancing or passing contact with a rock would have notably greater consequences than a similar contact with sand. In this regard, he advises that that hull plates are highly likely to be buckled and/or torn, which would lead to relatively fast flooding of the void spaces between the outer hull and the oil tanks. He records that it is quite possible that the inner hull and tanks would be breached, which would lead to significant oil spillage, although the extent of the damage would depend on the speed and angle of the ship at contact. Mr Bermingham records that a particular consequence would be if the glancing contact included the stern (rear of the vessel) as it could damage steering. Given the double hull, the void spaces may also have taken on water (with an associated increase in the vessel's displacement of water), which would be a significant effect on the draught. It is clear to us that Mr Bermingham is of the opinion that the consequences of a glancing contact with a rock would be severe[286].

We understand the advice of Mr Bermingham to be that while there will always be a navigation risk associated with large vessels visiting the Whangarei Harbour, the Proposal enables a reduction in that risk. Further, we understand his advice to be that the implementation of channel alignment Option 4.2 (which is proposed by Refining NZ within this application) will, when coupled with the implementation of the operational measures[287] proposed by Mr Bermingham, avoid and mitigate the navigation risk to a level that has been deemed acceptable. We also understand his advice to be that the proposed channel alignment is a notable improvement over the status quo, in terms of navigation risk.

Overall, Mr Bermingham concludes that:

"Having a deeper engineered channel (either design Option [being channel alignment options 2 and 4.2]) within the natural channel in the outer reaches creates a requirement to navigate vessels within a narrower outer channel than is currently the case. However, the associated risk with this design is not unique and can be adequately managed provided the range of operational measures identified are implemented.

Channel design Option 2 offers significant risk reduction for the operations involving vessel types currently handled and enables adequate risk management for operations for the proposed fully laden Suezmax tankers.

Channel design Option 4.2 offers further risk reduction over Option 2 for the operations involving vessel types currently handled. Option 4.2 design is closest to full compliance with the applicable international design guidelines – a feature that contributes to this design enabling the lowest navigational risk. Channel Option 4.2 would, if implemented, enable operations for the proposed fully laden Suezmax tankers that can be considered to meet the ALARP criterion.

[285] Bermingham, G, page 27, section 5.6.5, "Report in Support of an Assessment of Effects on the Environment, Navigational Risk Assessment of Engineered Channel Designs". Dated 15 August 2017.
[286] Bermingham, G, page 27, section 5.6.6, "Report in Support of an Assessment of Effects on the Environment, Navigational Risk Assessment of Engineered Channel Designs". Dated 15 August 2017.
[287] Bermingham, G, page 14, section 5.2, "Report in Support of an Assessment of Effects on the Environment, Navigational Risk Assessment of Engineered Channel Designs". Dated 15 August 2017.

The risk-advantages of Option 4.2 are due to the notably simplified navigational path with fewer turns as well as fewer and longer periods of fixed-bearing-paths for the pilots, with each aided by leading marks. This greatly simplifies the task of navigating large ships through the point of highest hazard, namely Home Point." [288]

3.4 Environmental Risk Assessment (Oil Spill)

Mr Oldham and his colleagues at Navigatus have considered the potential environmental risks, as a result of the operation of the Refinery following completion of the Proposal. As with all of the technical assessments, a full copy of Mr Oldham's Risk Assessment[289] is contained within **Annexure Two** of this AEE.

3.4.1 Prior Findings of Relevance and Assessment Approach

We have already recorded (in section 1.4 of this AEE) our understanding that the proposed channel alignment would offer a significant reduction in navigation risk compared to the current channel, and a notable improvement in navigational risk over the other channel options that were assessed. Mr Oldham also reiterates that facilitating access by fully laden Suezmax tankers to the Refinery will result in fewer tanker visits per year to Marsden Point. These findings are, we understand, directly relevant to Mr Oldham's assessment of the environmental risk associated with the unintentional discharge of oil into the environs within and surrounding the Site.

Mr Oldham advises that a series of discussions were held with a range of expert consultants engaged by RNZ[290] to aid in his assessment of the environmental risk that exists, and that could arise should the Proposal proceed. We understand that these discussions traversed the nature of the surrounding environment, effects of spilled oil on these features and, in particular, discussion of the marginal effects of larger volumes of oil spilled in the environment (including potential tipping points). Mr Oldham advises that the information obtained during these discussions was combined with research on oil spill case studies to inform the analysis of the difference in environmental consequence and the evaluation of the expected net difference in the environmental risk profile[291]. We understand that the environmental risk completed by Mr Oldham was also informed by an assessment of the Proposal against the continued use of the existing channel.

Mr Oldham states that the environmental risk of the Proposal has four main components, being:

a. Difference in event likelihood per transit;

b. Difference in number of transits;

c. Difference in amount spilled per event; and

d. Resulting difference in environmental consequences.

[288] Bermingham, G, page 35, section 7.1, "Report in Support of an Assessment of Effects on the Environment, Navigational Risk Assessment of Engineered Channel Designs". Dated 15 August 2017.
[289] Oldham, K, Navigatus, "Environmental Spill Risk Assessment for Proposed Tanker Operations Associated with Engineered Channel", Dated 14 August 2017
[290] Discussions were held with Mr Don (avian ecology), Mr Greenaway (recreation), Dr Elvines (marine mammals), Ms Chetham (cultural values) and Dr Coffey, B, (marine ecology), as found in Oldham, K, pages 16 and 17, section 5, "Environmental Spill Risk Assessment for Proposed Tanker Operations Associated with Engineered Channel", Dated 14 August 2017.
[291] Oldham, K, page 6, section 3, "Environmental Spill Risk Assessment for Proposed Tanker Operations Associated with Engineered Channel", Dated 14 August 2017

We now discuss each of these matters in turn.

3.4.2 Difference in Event Likelihood per Transit

Mr Oldham advises that Option 4.2 enables a significant reduction in the likelihood of an adverse event over the current channel for operations involving vessel types and cargo sizes currently handled. When combined with the associated package of operational measures to be implemented (as is proposed), then Mr Oldham considers that Option 4.2 would also enable operations for the proposed fully laden Suezmax tankers that can be considered to meet the ALARP criterion.

We understand this to be based on the assumption that the proposed channel will be substantially safer, from a navigational perspective, than the existing situation, and thus there is less chance of oil being released from a vessel while it is in transit into the Refinery[292].

3.4.3 Difference in Number of Vessel Transits

Mr Oldham advises that based on historical averages from 2006 to 2015, the number of oil tankers is expected to change following the Capital Dredging works proposed (referenced as 'Use Case B' in Mr Oldham's report and described as the case where there are maximum benefits that could be incurred if other Companies such as NorthPort are involved). In that regard, he expects the Proposal would see an average increase in the number of Suezmax tanker visits (25 proposed versus four existing) and a reduction in Aframax tanker visits (23 proposed versus 55 existing). Overall, he advises that there would be approximately 19% fewer tanker visits to Marsden Point should the Proposal proceed (48 visits (proposed) versus 59 visits (existing)).

He does note, for completeness, that while the proposed changes to the channel are likely to result in fewer overall tanker visits, existing tanker operations may continue. That is, the mix of tankers and cargo sizes operating with channel design Option 4.2 implemented may remain the same (referenced as 'Use Case A' in Mr Oldham's report and described as the case that is aligned with the area Refining can control). Although he goes on to specify that the net result is a significant reduction in environmental risk compared to the baseline of existing tanker operations in the existing channel.

Mr Oldham then advises that as the overall chance of an oil spill event is a function of the event likelihood per transit and the number of transits, a 19% reduction in transits would equate to a 19% reduction in the overall chance of an event in any given year. Mr Oldham also notes that fewer transits would also result in a lower overall likelihood of smaller transfer spills, such as during cargo transfers at the refinery jetty[293].

3.4.4 Difference in Amount Spilled per Event

Mr Oldham advises that there are several factors that influence the volume of oil spilled should an oil tank rupture. These include the event type, event response, cargo size and spill release rate.

292 Oldham, K, page 21, section 7.2, "Environmental Spill Risk Assessment for Proposed Tanker Operations Associated with Engineered Channel", Dated 14 August 2017.

293 Oldham, K, page 21, section 7.3, "Environmental Spill Risk Assessment for Proposed Tanker Operations Associated with Engineered Channel", Dated 14 August 2017

Mr Oldham advises that the expected volume of oil spilled for a given event at Marsden Point increases in an approximately linear relationship with the volume of oil carried in a given vessel. That is to say, an overall cargo increase of 25% roughly equates to a 25% (+/-5%) increase in the likely volume of oil spilled for a given event[294]. Mr Oldham does note that a fully laden Suezmax tanker may spill less oil in the event of a rupture due to hydrostatic pressure[295]. Put another way, we understand that a heavy vessel sits lower in the water, and therefore, less oil would likely be spilled due to the opposing forces of seawater. However, Mr Oldham records that any actions to stop the leak or reduce the effect, such as pumping oil from the holds, could counteract the hydrostatic pressure as the vessel becomes lighter[296]. Mr Oldham also advises that all tanks using Marsden Point are double-hulled, therefore, there is a void space between the vessel's hull in contact with the sea and the tanks that contain the cargo oil[297]. Further, Mr Oldham notes that Suezmax tankers are compartmented, typically having 12 main oil cargo tanks[298]. Overall, we understand Mr Oldham's advice to be that there are a number of uncertainties associated with such events, which means that it is not possible to predict the exact nature of an event or the responses needed to the same.

3.4.5 Difference in Environmental Consequences

The Proposal is likely, in Mr Oldham's opinion, to result in fewer oil tanker visits that carry a larger volume of oil. To aid in his assessment of whether this generates an increase or reduction in the level of environmental risk faced, Mr Oldham has considered the environmental consequences of a spill of oil from a fully laden Suezmax, as well as the potential effects of the existing operations continuing with an improved channel.

Mr Oldham notes that the impact of an oil spill depends on a range of factors[299], including:

a. Event type. For example, collision, grounding or contact with rock, impact force and extent of hull and tank damage. This will significantly affect the spill amount, event response and spill release rate.

b. Event response. For example, actions taken to save human life, the vessel and to reduce the volume spilled. Responses could have a positive or negative effect on the spill volume and spill release rate.

c. Cargo size. Larger crude oil cargoes mean there is potential for a larger spill (although this does not mean a larger spill will necessarily result). Cargo size may also affect spill size indirectly through hydrostatic forces.

d. Release rate. The rate of oil release from the vessel into the sea depends on the above factors as well as the sea conditions. Oil release over a longer period of time means tides will change and there is potential for wind and sea conditions to change thus affecting the spill extent.

---

[294] Oldham, K, page 22 to 26, section 7.4, "Environmental Spill Risk Assessment for Proposed Tanker Operations Associated with Engineered Channel", Dated 14 August 2017

[295] Hydrostatic pressure is the driving force that would act to push oil out of any ruptured tank due to the height of oil in the tank above sea level. In essence, the higher the oil level, the greater the outward flow rate for a given size of hole.

[296] Oldham, K, pages 22 to 26, section 7.4, "Environmental Spill Risk Assessment for Proposed Tanker Operations Associated with Engineered Channel", Dated 14 August 2017.

[297] Oldham, K, page 7, section 4.1, "Environmental Spill Risk Assessment for Proposed Tanker Operations Associated with Engineered Channel", Dated 14 August 2017

[298] Oldham, K, page 21, section 7.4 Environmental Spill Risk Assessment for Proposed Tanker Operations Associated with Engineered Channel", Dated 14 August 2017

[299] Oldham, K, pages 26 to 32, section 7.5, "Environmental Spill Risk Assessment for Proposed Tanker Operations Associated with Engineered Channel", Dated 14 August 2017

e. Amount of oil spilled. This depends on the above factors and influences the spill extent.

f. Sea conditions, wind conditions and oil degradation. These factors all directly affect the spill extent.

g. Spill extent. This depends on the all of the preceding factors. Ultimately, it determines what ecological and social features will be impacted.

h. Ecological features affected by the spill. This depends on the location of this spill and the tide and weather conditions affecting spill extent. Consequences include direct mortality and reduction in species diversity.

i. Social features affected by the spill. Many social features are ecologically based. Resulting social damages include cultural, amenity and economic impacts.

j. Spill response. This is primarily by the ecological and social features exposed and will aim to reduce the impacts on these.

k. Recovery dynamics. For example, post spill recolonisation of damaged area and restoration to pre-spill conditions. Includes potential imbalances between species which could be short or long lasting.

Mr Oldham also notes that a larger spill volume would result in oil spreading further, and longer persistence in the environment. He advises, however, that these factors would most likely increase to a lesser degree than the increase in cargo carried. Put another way, we understand his advice to be that, as an example, a 25% increase in spill volume would likely result in less than a 25% increase in area covered[300].

Mr Oldham also notes that there are many variables that determine the effect on a particular site, due to the existing ecological or social features.

3.4.6 Summary

In conclusion, Mr Oldham states that:

"For Use Case A (existing mix of tankers and cargo sizes operating with channel design Option 4.2 implemented) the net result is a significant reduction in environmental risk compared to the Baseline of existing tanker operations in the existing channel. This is self-evident, once the navigational effects of the improved channel on existing tanker operations are known (being a significant reduction in navigational risk) as all else is unchanged from Baseline.

Whilst any large-scale spill would have profound effects on the environment over the short to medium term, the proposed crude oil cargo size increase would not make environmental consequences disproportionately worse. When balanced against reduced event likelihood this results in a net reduction in risk.

We conclude that, for Use Case B, the benefits of improved navigational safety and fewer tanker visits would significantly outweigh the countervailing risks due to larger crude oil cargo sizes. The

[300] Oldham, K, page 32, section 7.5, "Environmental Spill Risk Assessment for Proposed Tanker Operations Associated with Engineered Channel", Dated 14 August 2017

overall environmental risk for Use Case B will be significantly lower than the Baseline of existing tanker operations in the existing channel." [301]

3.5 Terrestrial Noise

Jon Styles of Styles Group Limited has considered the actual and potential airborne noise levels, which could arise as a consequence of the Proposal. A full copy of the Acoustic Report is contained within **Annexure Two** of this AEE. We now summarise what we understand to be his advice.

3.5.1 Approach to Modelling

Mr Styles notes that dredging and disposal activities in Bream Bay (i.e. outside the Harbour) have not been modelled due to the noise emissions being so low at what he considers to be the receivers that they are expected to be inaudible and not measureable for all, or most of the time[302].

Mr Styles advises that the potential receivers of noise from the Proposal should be limited to the Northport industrial site and residential properties along the coastline of the Whangarei Heads (from Reotahi Bay to Urquharts Bay). He notes that the residential properties at Marsden Bay are not expected to be potentially affected, as the nearest dwelling is approximately 1,700m from the Site. Those coastal residential dwellings on Whangarei Heads are the parties that Mr Styles expects to be most affected by the Proposal[303].

As a contract has not been awarded for the Proposal, it is not possible for Mr Styles to model the dredge(s) that would be utilised. Therefore, he has based his assessment on published data for the types of dredging methods and vessels that are likely to be used, adopting a conservative approach[304]. As we note below, Mr Styles also recommends that noise measurements of the actual dredges commissioned be undertaken prior to works commencing in order to confirm this assessment.

In addition, a number of possible wind conditions were utilised in the acoustic model. The wind direction and strength variables were based on the wind rose from the Marsden Point. This enabled the model to demonstrate how wind from different directions will influence the propagation of noise from the Proposal[305].

3.5.2 Results, Mitigation & Monitoring

Given the results of the noise modelling Mr Styles expects that the dredging proposed will comply with the relevant permitted activity noise limits (as are set out in Rules 31.4.13(a) and 31.7.12(a) of the RCP[306]) for the vast majority of the time, and in most cases, by a large margin. However, Mr Styles advises that when dredging is undertaken generally north of the number 18 navigation buoy,

[301] Oldham, K, page 36, section 9, "Environmental Spill Risk Assessment for Proposed Tanker Operations Associated with Engineered Channel", Dated 14 August 2017
[302] Styles, J, page 11, section 5.2, "Whangarei Harbour Entrance and Marsden Point Channel Realignment and Deepening: Assessment of Environmental (Airborne) Noise Effects", Dated 31 July 2017
[303] Styles, J, page 2, section 2, "Whangarei Harbour Entrance and Marsden Point Channel Realignment and Deepening: Assessment of Environmental (Airborne) Noise Effects", Dated 31 July 2017
[304] Styles, J, page 10, section 5.1, "Whangarei Harbour Entrance and Marsden Point Channel Realignment and Deepening: Assessment of Environmental (Airborne) Noise Effects", Dated 31 July 2017
[305] Styles, J, pages 12 to 13, section 5.3, "Whangarei Harbour Entrance and Marsden Point Channel Realignment and Deepening: Assessment of Environmental (Airborne) Noise Effects", Dated 31 July 2017
[306] Northland Regional Coastal Plan, pages 295 and 342 (respectively)

and when the wind is blowing from any direction other than the northern quarter, the permitted limits will be exceeded when the 45dB L_{Aeq}[307] noise limit applies (being between the hours of 2000 and 0630 on weeknights and from 1800 to 0730 on Saturdays, Sundays and Public Holidays)[308]. In order to ensure that the Proposal does not exceed the permitted levels, Mr Styles has recommended:

1. That dredging ceases to the north of navigation buoy 18 at times when the 45dB L_{Aeq} noise limit applies, unless the wind is blowing from the northern quarter or the noise limits (at any time) are not exceeded. It is noted that point (2) below may remove or modify such a restriction[309]; and/or
2. Noise measurements of the dredge(s) commissioned to undertake the work shall be undertaken to determine if they can comply with the permitted activity noise emission rule, even when wind is blowing from the western, eastern and southern quarters. If it can, the operational restriction set out in bullet point (1) of this section need not be implemented[310].

In addition, Mr Styles records that noise effects associated with the installation of the Navaids will be temporary and relatively low. The most adverse effects, in Mr Styles opinion, will result from any required piling activities. Overall, Mr Styles notes that the works associated with the Navaids is expected to be very low, and likely inaudible and not measureable (with any reasonable degree of certainty) from shore. In order, however, to ensure that the Proposal does not exceed the permitted levels, Mr Styles has recommended that the installation of the proposed Navaids only occur between Monday to Saturday 0730 (7.30am) to 1800 (6pm)[311].

These recommendations have been adopted by the Company and it is expected that a condition of consent will formalise its application in this instance.

More generally, Mr Styles considers that the noise effects of the dredging project will be unnoticeable for a large proportion of the project for the receivers on the northern side of the harbour. Further, he notes that dredging and disposal activities will be inaudible and not measureable when the dredges are operating outside of the Harbour or generally east of Busby Head. Mr Styles also notes that for all other locations within the Harbour, the dredging activity will be audible to some receivers, but generally at noise levels less than the permitted activity limits. Of note, we understand Mr Styles to advise that the existing ambient noise level during the day is generally considerably higher than the noise level that applies to permitted activities. When this occurs, the dredging will likely be inaudible over other sources in the environment such as traffic, birds, insects, wind in the trees or waves on the shore[312].

In terms of cumulative effects, Mr Styles view is that any cumulative effects, which will be limited are only a potential issue at night when the noise emissions from the CSP are permitted to be similar to

307 Defined as the equivalent continuous level. When a noise varies over time, the Leq is the equivalent continuous sound which would contain the same sound energy as the time varying sound.
308 Styles, J, page 14, section 5.5, "Whangarei Harbour Entrance and Marsden Point Channel Realignment and Deepening: Assessment of Environmental (Airborne) Noise Effects", Dated 31 July 2017
309 Styles, J, page 16, section 6, "Whangarei Harbour Entrance and Marsden Point Channel Realignment and Deepening: Assessment of Environmental (Airborne) Noise Effects", Dated 31 July 2017
310 Styles, J, page 16, section 6, "Whangarei Harbour Entrance and Marsden Point Channel Realignment and Deepening: Assessment of Environmental (Airborne) Noise Effects", Dated 31 July 2017
311 Styles, J, page 14, section 5.6, "Whangarei Harbour Entrance and Marsden Point Channel Realignment and Deepening: Assessment of Environmental (Airborne) Noise Effects", Dated 31 July 2017
312 Styles, J, page 14, section 5.5, "Whangarei Harbour Entrance and Marsden Point Channel Realignment and Deepening: Assessment of Environmental (Airborne) Noise Effects", Dated 31 July 2017

that generated by the operation of the Refinery generally. In this regard, Mr Styles notes that even if the Refinery and dredging activities proposed were generating noise levels at their maximum respective limits at the same receiver, being a maximum level of 45dB LAeq between the hours of 10pm to 7am, the combined noise level would be 48dB LAeq. This is only 3dB more than the respective noise limits. Mr Styles comments that a difference of 3dB in this context would be just perceptible to the receiver. Given the very temporary nature of the proposed activities that may approach the night time noise limit, the low probability that both the Refinery and the CSP will be generating noise levels very close to their respective noise limits at the same time, and the very small potential increase in noise level, Mr Styles concludes that the potential cumulative effects are negligible and no mitigation is required to address this issue[313].

As we have already noted in section 1.5.17.4 of this AEE, Mr Styles has also recommended that the dredging operations be subject to a NMP, a draft of which is attached in Annexure H of Mr Styles Report (attached in **Annexure Two** of this AEE). The NMP includes detail of the proposed noise monitoring, as follows:

1. At the commencement of dredging activity, noise monitoring shall be completed to determine actual noise emissions for the dredge(s). Once these measurements are secured, the acoustic model for each dredge will be recalibrated to determine whether any change or refinement of the restrictions on dredging being required;
2. Ongoing noise monitoring should be undertaken to ensure compliance and in response to reasonable complaints; and
3. A noise-related complaints register is adopted to record, respond and manage any noise complaints that Refining NZ may receive.

These recommendations have also been adopted by Refining NZ. Conditions of consent, to formalise the same, are expected.

3.5.3 Summary

Overall, Mr Styles states:

"*In our opinion, and if the recommendations in this report are adhered to, we consider that the noise effects arising from the Crude Shipping Project will be reasonable in terms of s16 of the Act and less than minor*."

3.6 Marine Ecology

Dr Coffey has considered the actual and potential effects of the Proposal on marine ecology. A full copy of Dr Coffey's Marine Ecology Assessment[314] is contained within **Annexure Two** of this AEE. We summarise Dr Coffey's advice in the following sub-sections of this AEE.

[313] Styles, J, page 15, section 5.7, "Whangarei Harbour Entrance and Marsden Point Channel Realignment and Deepening: Assessment of Environmental (Airborne) Noise Effects", Dated 31 July 2017

[314] Dr Coffey, B, page 13, section 2.4, "Crude Shipping Project, Proposal to Deepen and Partially Realign the Approaches to Marsden Point, Assessment of Marine Ecological Effects, Excluding Seabirds and marine Mammals". Dated 10 August 2017

3.6.1 Water Quality

Relying on the advice of Dr McComb's and Mr Reinen-Hamill's reports on Coastal Processes, Dr Coffey records that the sediment plumes are likely to affect water quality within the CMA.

He goes on to note, however, that any sediment plumes resulting from the dredging activities will largely be confined to the deepest parts of the channel, with limited dispersion to the surrounding areas due to currents and the composition of the substrate to be dredged, being predominantly medium and fine sands[315]. Dr Coffey also advises that effects on water quality are likely to be limited to a reasonable mixing zone in the water column. While the RCP or Act does not specify a reasonable mixing zone, Dr Coffey suggests that based on the attributes of the Site (such as currents, tides, bathymetry, and sediments) a reasonable mixing zone is 300m, except in proximity to sensitive hard-bottom reef habitats between Home Point and the Marine Reserve, when the reasonable mixing zone should be reduced to 100m[316].

In addition, Dr Coffey states that given the low organic matter content of the material within the Site, no notable reductions in dissolved oxygen levels are expected to be associated with sediment plumes associated with the Proposal[317].

To manage suspended solids in the water column, Dr Coffey recommends that water quality shall be monitored throughout the proposed dredging and disposal works. In summary, we understand him to recommend the following:

1. Installing and monitoring real time turbidity recorders on the boundaries of adjacent sensitive rocky reef communities during dredging activities adjacent to Motukaroro Island Whangarei Marine Reserve Marine 1 Management Area and Home Point Marine 1 Management Area; and
2. Automatic monitoring using hand-held turbidity meter measurements when dredging and disposal activities are undertaken in proximity to the Calliope Bank M1MA, the Mair Bank M1MA, and Bream Bay including at Three Mile Reef.

The monitoring regime recommended by Dr Coffey is proposed to enable a response should a series of turbidity thresholds be exceeded during the proposed dredging and disposal activities. The various thresholds are summarised in **Table 3.6.1.1,** which follows. We note, for completeness, that Dr Coffey's recommended turbidity thresholds are to be measured by NTU over a six-hour monitoring period (being the average of 60, one-minute real time records). Notably, Dr Coffey advises that there are three 'levels' of turbidity controls, which require responses from the dredging vessel operators. Those responses are as follows:[318]

1. Level 1: below which there is no effect; above this suspended solids concentrations down-current of the operational dredge need to be investigated;

[315] Dr Coffey, B, page 41, section 4.1.2a, "Crude Shipping Project, Proposal to Deepen and Partially Realign the Approaches to Marsden Point, Assessment of Marine Ecological Effects, Excluding Seabirds and marine Mammals". Dated 10 August 2017
[316] Dr Coffey, B, page 43, section 4.1.2d, "Crude Shipping Project, Proposal to Deepen and Partially Realign the Approaches to Marsden Point, Assessment of Marine Ecological Effects, Excluding Seabirds and marine Mammals". Dated 10 August 2017
[317] Dr Coffey, B, page 41, section 4.1.2a, "Crude Shipping Project, Proposal to Deepen and Partially Realign the Approaches to Marsden Point, Assessment of Marine Ecological Effects, Excluding Seabirds and marine Mammals". Dated 10 August 2017
[318] Dr Coffey, B, page 44, section 4.1.2e, "Crude Shipping Project, Proposal to Deepen and Partially Realign the Approaches to Marsden Point, Assessment of Marine Ecological Effects, Excluding Seabirds and marine Mammals". Dated 10 August 2017

2. Level 2: operational changes are required by the dredge to reduce down-current suspended solids concentrations; and
3. Level 3: suspended solids concentrations down-current of the operational dredge result in dredge activities being stopped.

Dr Coffey advises that Refining (pers, comm, Riaan Elliot) have been trialling the deployment of continuous recording, data transmission, turbidity meters on the Motukaroro Island, Whangarei Marine Reserve Marine 1 Management Area boundary, since May 2017. Refining have reported background turbidity records greater than 10 grams per m^3, as shown in **Table 3.6.1.1** below.

Location	Concern	Level 1 Threshold	Level 2 Threshold	Level 3 Threshold
A – Motukaroro Island Whangarei Marine Reserve Marine 1 Management Area	Rocky Reef Taxa	15*	20*	25 *
B – Calliope Bank Marine 1 Management Area	Shellfish benthic invertebrates	15	20	35
C – Mair Bank Marine 1 Management Area	Shellfish benthic invertebrates	15	20	35
D – Home Point Marine 1 Management Area	Rocky Reef Taxa	15 *	20*	25 *
E – Bream Bay including Three Mile Reef	Shellfish benthic invertebrates	20	25	40 (100 for Disposal Area 1.2)

Table 3.6.1.1: Recommended turbidity thresholds (NTU) for the Proposal. A and D relate to a six-hour average of one minute interval records from fixed turbidity metres. B, C and E relate to hand-held turbidity meter readings (* symbol identifies those thresholds which are provisional based on Refining's data base (Elliot, 2017) for Location A between May and July 2017).[319]

In addition to the monitoring, Dr Coffey recommends that, provided there is no discharge from the THSD when it is in transit between dredging and disposal sites, no ecological effects are expected to be associated with the transport of material between dredging and disposal areas. He advises that this will reduce the potential for turbidity and to increase the speed of settlement of discharged material.[320] Refining NZ has accepted and adopted this recommendation, and indeed all of the recommendations that have been made by Dr Coffey.

Given the foregoing, Dr Coffey advises that the coastal water quality standards of the RCP will be met after reasonable mixing and water column effects are expected to be less than minor[321]. Further, we understand him to advise that the sediment plumes will not adversely affect the significant habitats of indigenous fauna or significant indigenous flora. We come back to this matter shortly.

[319] Dr Coffey, B, page 45, section 4.1.2e, "Crude Shipping Project, Proposal to Deepen and Partially Realign the Approaches to Marsden Point, Assessment of Marine Ecological Effects, Excluding Seabirds and marine Mammals". Dated 10 August 2017
[320] Dr Coffey, B, page 43, section 4.1.2c, "Crude Shipping Project, Proposal to Deepen and Partially Realign the Approaches to Marsden Point, Assessment of Marine Ecological Effects, Excluding Seabirds and marine Mammals". Dated 10 August 2017
[321] Dr Coffey, B, page 44, section 4.1.2e, "Crude Shipping Project, Proposal to Deepen and Partially Realign the Approaches to Marsden Point, Assessment of Marine Ecological Effects, Excluding Seabirds and marine Mammals". Dated 10 August 2017

3.6.2 Soft-bottom Benthic Communities

Dr Coffey records that the proposed dredging activities would physically remove existing benthic communities as a result of dredging material from the soft-bottom areas of the seabed. In addition, he notes that the placement of dredged material within Disposal Areas 1.2 and 3.2 would bury existing benthic communities within part or all of these two Disposal Areas. Within these areas, Dr Coffey has conservatively assumed complete mortality. Overall, Dr Coffey calculates that benthos will be displaced from a total area of 4.37km^2, as a result of the Capital Dredging programme[322].

In terms of potential effects, Dr Coffey considers that the dredging and disposal activities would result in a short-term displacement, in the order of six to 24 months, of benthic communities within disturbed areas, whereby they are expected to be recolonised by a similar assemblage of taxa that occur at a similar depth on the surrounding soft-bottom seabed[323]. While Dr Coffey considers that recolonisation is expected by similar species that are displaced, there is the potential that invasive taxa, such as marine pests, could also colonise the vacant niche that would be created by the Proposal. However, Dr Coffey records that this is considered to be a low risk, as any invasive taxa have not proved problematic at other comparable dredging programmes, such as those undertaken in association with the Ports of Auckland, Tauranga or Otago[324].

The same type of effects are predicted by Dr Coffey with regard to the Maintenance Dredging campaigns, which are each expected to remove up to 122,000m^3 of sediment per campaign (every two years) during the initial six year period. This sediment may be placed in any or all of Disposal Area 1.2, Disposal Area 3.2, or possibly on land (assuming any relevant consents or authorisations are separately obtained)[325].

Overall, in regard to soft-bottom benthic communities, Dr Coffey states that:

"Existing soft-bottomed communities are adapted to naturally occurring sediment transport and there are no ecological issues associated with proposed disturbance activities at these sites. However, when these soft-bottom communities are instantaneously buried by a layer of sediment that is too deep for them to migrate up through to reach the new seabed surface, they are smothered and a conservative approach is to assume complete mortality of pre-exiting benthos. It is expected that such areas will be recolonised by like communities within a relatively short time-frame (i.e. 6 to 24 months after disposal is complete).

The habitat of indigenous fauna that would be disturbed by proposed dredging activities and buried by the placement of dredged material in proposed Disposal Areas 1.2 and 3.2 is not of national or regional significance. No benthic taxa in these predominantly sandy sites are considered to be endangered or at risk."

In summary, we understand that Dr Coffey considers that the Proposal will result in short-term and localised minor to moderate effects on soft-bottom benthic communities within the dredging

[322] Dr Coffey, B, page 38, section 4.1, "Crude Shipping Project, Proposal to Deepen and Partially Realign the Approaches to Marsden Point, Assessment of Marine Ecological Effects, Excluding Seabirds and marine Mammals". Dated 10 August 2017

[323] Dr Coffey, B, page 46, section 4.1.3b, "Crude Shipping Project, Proposal to Deepen and Partially Realign the Approaches to Marsden Point, Assessment of Marine Ecological Effects, Excluding Seabirds and marine Mammals". Dated 10 August 2017

[324] Dr Coffey, B, page 46, section 4.1.3b, "Crude Shipping Project, Proposal to Deepen and Partially Realign the Approaches to Marsden Point, Assessment of Marine Ecological Effects, Excluding Seabirds and marine Mammals". Dated 10 August 2017

[325] Dr Coffey, B, page 48, section 4.2, "Crude Shipping Project, Proposal to Deepen and Partially Realign the Approaches to Marsden Point, Assessment of Marine Ecological Effects, Excluding Seabirds and marine Mammals". Dated 10 August 2017

footprint[326]. In order to compensate for the expected short-term effects on soft-bottom benthic productivity, Dr Coffey has recommended that Refining NZ support or undertake environmental restoration / rehabilitation activities in relatively close proximity to the Site. As is apparent from section 1.5.16.1.3 of this AEE, Refining NZ has adopted this recommendation.

In addition, should post dredging campaign monitoring of the dredged channel and disposal grounds show that their recolonisation is dominated by weed and /or pest species, Dr Coffey has recommended that a monitoring regime be established. This includes Refining NZ notifying and collaborating with the MPI to develop a response to this occurring[327].

Further, we note Dr Coffey's advice is that the relocation and installation of the proposed Navaids utilising anchors, blocks, poles or rock / boulder pins, will cause a temporary and localised disturbance to the marine environment. According to Dr Coffey, because of the Navaids limited footprint and the adoption of best industry practices, particularly in the case with the West Cardinal Beacon at Home Point, which would involve a tripod base utilising blocks that weigh two-Metric Tonnes attached to each leg, or, three separate mooring blocks and chain to position the structure, rather than drilling into the reef, he concludes that the installation, modification and removal of Navaids will have effects that will be less than minor[328].

3.6.3 Hard-bottomed Reef Communities

We understand Dr Coffey to advise that the various hard-bottom reef communities that exist adjacent to the Site, and which support habitats such as kelp beds and sponge gardens, will not be directly affected by the proposed dredging. However, Dr Coffey notes that these submerged reefs and rocky shorelines adjacent to the disturbed areas are potentially vulnerable to sediment plumes[329]. Given the advice from Dr McComb that the expected sediment plume from the dredging activity will largely be confined to the deepest part of the channel, Dr Coffey is confident that the sensitive (and ecologically significant) habitats will not be impacted by the plumes that do arise.

To ensure the potential effects as a result of sediment plumes are avoided, Dr Coffey has recommended turbidity monitoring (by the deployment of continuous recording, real time data transmitting meters) on the boundary of adjacent reef habitats when dredging is being undertaken. In the event that the turbidity encountered is, on average and over a six-hour period, equal to or more than of 20 NTU on the boundary of the Marine Reserve or Home Point, and is found to be due to dredging activities, then dredging activities shall to be modified to ensure the a six-hour average turbidity is reduced to less than 20 NTU[330]. If the six-hour average reading it over 25 NTU and again is caused by dredging, on the boundary of the Marine Reserve or Home Point due to dredging activities, then dredging activities shall stop[331].

---

[326] Dr Coffey, B, page 46, section 4.1.3b, "Crude Shipping Project, Proposal to Deepen and Partially Realign the Approaches to Marsden Point, Assessment of Marine Ecological Effects, Excluding Seabirds and marine Mammals". Dated 10 August 2017

[327] Dr Coffey, B, page 47, section 4.1.3b, "Crude Shipping Project, Proposal to Deepen and Partially Realign the Approaches to Marsden Point, Assessment of Marine Ecological Effects, Excluding Seabirds and marine Mammals". Dated 10 August 2017

[328] Dr Coffey, B, page 49, section 4.4, "Crude Shipping Project, Proposal to Deepen and Partially Realign the Approaches to Marsden Point, Assessment of Marine Ecological Effects, Excluding Seabirds and marine Mammals". Dated 10 August 2017

[329] Dr Coffey, B, page 6, section 1, "Crude Shipping Project, Proposal to Deepen and Partially Realign the Approaches to Marsden Point, Assessment of Marine Ecological Effects, Excluding Seabirds and marine Mammals". Dated 10 August 2017

[330] Dr Coffey, B, page 56, section 7.2, "Crude Shipping Project, Proposal to Deepen and Partially Realign the Approaches to Marsden Point, Assessment of Marine Ecological Effects, Excluding Seabirds and marine Mammals". Dated 10 August 2017

[331] Dr Coffey, B, page 56, section 7.2, "Crude Shipping Project, Proposal to Deepen and Partially Realign the Approaches to Marsden Point, Assessment of Marine Ecological Effects, Excluding Seabirds and marine Mammals". Dated 10 August 2017

Dr Coffey also records that any stable hard structures (such as a tripod base and / or anchor blocks) that are used at Home Point will have a positive benefit of providing further attachment sites for sessile benthos. Overall, Dr Coffey states that the potential effects, as a result of the installation and maintenance of the proposed lateral marker Navaid at Home Point, will be localised, temporary and less than minor[332].

Overall Dr Coffey advises that:

"However, surrounding some of these soft-bottom areas that will be disturbed are hard bottom reef communities of high intrinsic, conservation and recreational value. These communities are of regional and national significance and it is proposed that potential adverse effects on these areas are to be avoided by monitoring and responding to real time telemetering of turbidity meters on the boundary between disturbance activities and these sensitive habitats." [333]

3.6.4 Fish Species

Dr Coffey records that the Proposal is likely to result in an initial localised reduction of the population of species such as snapper, kahawai and kingfish within the Site footprint as fish species generally tend to avoid disturbed sites until their feeding grounds have recovered. However, Dr Coffey also advises that a progressive recovery of these populations would be expected within 6 to 24 months of the Capital Dredging campaign being completed[334].

More specifically, Dr Coffey considers that sharks are likely to avoid areas associated with the Proposal due to reduced benthic production and are unlikely to return to the disturbed areas until the benthic communities have re-established[335].

Furthermore, Dr Coffey notes that most migrating native fish (including eels and whitebait) will avoid obstacles, or wait until the environmental conditions are suitable to continue with their migration from the sea into the aquatic habitats. Consequently, Dr Coffey considers that the Proposal is not expected to adversely affect these species, either as individuals commencing or completing their migrations or as a population[336].

In conclusion, Dr Coffey states that:

"The effect of the proposed disturbance activities on fish feeding and fish migration is expected to be relatively minor with the most important effect being a temporary reduction in food availability for those taxa that feed on benthos in the entrance channel and disposal grounds for dredged material. In this regard, the fish species that feed in the disturbed areas are likely to avoid them in the short term, but will return as re-colonisation occurs. As such, the disturbance activities proposed are not considered likely to contravene Policy 11(b) of the Coastal Policy Statement (Department of

[332] Dr Coffey, B, page 49, section 4.4, "Crude Shipping Project, Proposal to Deepen and Partially Realign the Approaches to Marsden Point, Assessment of Marine Ecological Effects, Excluding Seabirds and marine Mammals". Dated 10 August 2017
[333] Dr Coffey, B, page 50, section 4.5, "Crude Shipping Project, Proposal to Deepen and Partially Realign the Approaches to Marsden Point, Assessment of Marine Ecological Effects, Excluding Seabirds and marine Mammals". Dated 10 August 2017
[334] Dr Coffey, B, page 47, section 4.1.3c, "Crude Shipping Project, Proposal to Deepen and Partially Realign the Approaches to Marsden Point, Assessment of Marine Ecological Effects, Excluding Seabirds and marine Mammals". Dated 10 August 2017
[335] Dr Coffey, B, page 47, section 4.1.3c, "Crude Shipping Project, Proposal to Deepen and Partially Realign the Approaches to Marsden Point, Assessment of Marine Ecological Effects, Excluding Seabirds and marine Mammals". Dated 10 August 2017
[336] Dr Coffey, B, page 47, section 4.1.3c, "Crude Shipping Project, Proposal to Deepen and Partially Realign the Approaches to Marsden Point, Assessment of Marine Ecological Effects, Excluding Seabirds and marine Mammals". Dated 10 August 2017

Conservation, 2010) or provisions of the Northland Regional Policy Statement relating to Indigenous Ecosystems and Biodiversity (Northland Regional Council, 2016)."[337]

3.6.5 Plankton

Plankton is said to be abundant along the north-east coast of the North Island and can on occasions bloom to nuisance proportions. Given that the Site is well flushed with open oceanic water, Dr Coffey considers that it is very unlikely that the large-scale drivers for plankton productivity and potential toxicity within Bream Bay or the Whangarei Harbour would be affected by the Proposal[338].

While Dr Coffey does note that localised and transient effects of reduced light levels and fine particles clogging the filter feeding mechanisms of zooplankton could occur within sediment plumes generated by disturbance activities, he does not consider that these short-term potential impacts would require any monitoring associated with plankton species[339].

In conclusion, Dr Coffey advises that:

"Overall, any adverse effects on plankton associated with the proposed disturbance activities are predicted to be negligible, and are not expected to adversely impact on significant ecological areas." [340]

3.6.6 Avoidance, Remediation or Compensation Measures

As we have previously set out, to mitigate and/or compensate for any actual or potential effects of the Proposal on marine species, Dr Coffey has recommended that Refining NZ adopt a number of compensation measures[341], which we now summarise as follows:

1. Refining NZ, in consultation with the Regional Council, Tangata Whenua, and other interested parties, provide support to enhance, for example, harbour water quality and / or seagrass communities within and adjacent to the Site. The collaboration with the aforementioned parties will enable Refining NZ to provide a reasonable and constructive contribution for enhancements of this nature.
2. Monitoring of the dredging and disposal areas should be undertaken to determine whether any adventive pests are dominating the re-colonisation of these disturbed areas.
3. Work with the Ministry of Primary Industries ('**MPI**') in their response to pest and weed species, in the event that the aforementioned monitoring identifies that adventive pests are found to have dominated the re-colonisation of the areas that are disturbed by the dredging and disposal activities.

[337] Dr Coffey, B, page 48, section 4.1.3c, "Crude Shipping Project, Proposal to Deepen and Partially Realign the Approaches to Marsden Point, Assessment of Marine Ecological Effects, Excluding Seabirds and marine Mammals". Dated 10 August 2017
[338] Dr Coffey, B, page 45, section 4.1.3, "Crude Shipping Project, Proposal to Deepen and Partially Realign the Approaches to Marsden Point, Assessment of Marine Ecological Effects, Excluding Seabirds and marine Mammals". Dated 10 August 2017
[339] Dr Coffey, B, page 45, section 4.1.3a, "Crude Shipping Project, Proposal to Deepen and Partially Realign the Approaches to Marsden Point, Assessment of Marine Ecological Effects, Excluding Seabirds and marine Mammals". Dated 10 August 2017
[340] Dr Coffey, B, page 46, section 4.1.3a, "Crude Shipping Project, Proposal to Deepen and Partially Realign the Approaches to Marsden Point, Assessment of Marine Ecological Effects, Excluding Seabirds and marine Mammals". Dated 10 August 2017
[341] Coffey, Dr, B, page 51, section 5.0, "Crude Shipping Project, Proposal to Deepen and Partially Realign the Approaches to Marsden Point, Assessment of Marine Ecological Effects, Excluding Seabirds and marine Mammals". Dated 10 August 2017

4. Adopt real time monitoring of turbidity levels at key locations within the Whangarei Harbour that are linked to a three tier response mechanism, the first response being to investigate the cause of the turbidity, the second response being to employ one of a number of mechanisms to reduce the turbidity being caused by the dredge, and the third triggering a cessation of dredging works in close proximity to the turbidity monitors until turbidity drops below the third level that Dr Coffey has proposed.
5. Respond to any adverse increases in turbidity levels by undertaking operational controls during dredging / disposal activities.
6. Undertake benthic ecological surveys following the Capital Dredging works have concluded. This should involve a repeat of the baseline surveys conducted for the AEE immediately prior and immediately after the disturbance events. These (post-dredging and disposal) surveys will assist in informing aspects of the Maintenance Dredging. Any additional monitoring practices, if required, will be determined after analysis of the Capital Dredging project data.

3.6.7 Summary

Dr Coffey summarises the potential ecological effects assessment of the Proposal in Table 1 of his report[342], which is copied below as **Table 3.6.7.1**.

	Actual Effects	Potential Effects	Avoidance Factors	Remediation / Compensation	Final Significance
Dredging Activities (see Figure 2)					
Disturbance and removal of bed material					
Seabed Effects					
Bathymetry	Increased water depth	Changed currents / sediment transport / wave climate	Not required (MetOcean Solutions, 2016B)	Not required (MetOcean Solutions, 2016B)	Less than minor (MetOcean Solutions, 2016B)
Exposure of new surficial sediments	Removal of benthic communities and some biological armouring	Change sediment type / texture / transport	Not required as vibrocores show similar sediment will be exposed	Contribution to enhancement of local harbour water quality / seagrass habitat for example	Minor to moderate, localised, short term loss of benthos within dredging footprint
Water Column Effects					
Sediment Plumes	Increased sedimentation and turbidity within dredging footprint	Dissolved Oxygen sags / toxicity / sedimentation issues outside	Dredged material is not contaminated and has a low silt content	Manage turbidity thresholds at boundary of adjacent habitats	Avoid effects on adjacent reef habitats, avoid / mitigate

[342] Dr Coffey, B, page 8, section 1, "Crude Shipping Project, Proposal to Deepen and Partially Realign the Approaches to Marsden Point, Assessment of Marine Ecological Effects, Excluding Seabirds and marine Mammals". Dated 10 August 2017

	Actual Effects	Potential Effects	Avoidance Factors	Remediation / Compensation	Final Significance
		of dredge footprint			effects on others
Suspended Solids	Increased concentration within dredging footprint	Increased concentration outside dredging footprint	Monitor and respond to turbidity limits in adjacent communities	Not applicable for adjacent reef habitats.	Avoid effects on adjacent reef communities, avoid / mitigate for effects on others
Turbidity	Increased value within dredging footprint	Increased value outside dredging footprint	Monitor and respond to turbidity limits in adjacent communities	Not applicable for adjacent reef habitats.	Avoid effects on adjacent reef communities, avoid / mitigate for effects on others
Light penetration	Decreased value within dredging footprint (but no attached macrophytes present)	Decreased value outside dredging footprint	Managed via response to turbidity limits in adjacent habitats	Not applicable for adjacent reef habitats.	Avoid effects on adjacent reef communities, less than minor effects on others.
Effects on Communities					
Plankton	Less than minor due to high replenishment rates	Less than minor due to high replenishment rates	Not required	Not required	Less than minor
Benthos	Removal & death of resident benthos from dredging footprint	Adventive pests may colonise vacant niche	Not applicable	Contribution to local enhancement of local harbour water quality / seagrass habitat for example	Minor to moderate, localised, short term loss of benthos within dredging footprint
Fish and Wildlife	Minor, localised, disturbance and avoidance during dredging activities	Minor, localised, and short term reduction in available food supplies	Not applicable	Not required	Less than minor outside of dredging footprint
Dredge in transit between dredging / disposal areas					
Water Column Effects	None if green valve closed	None if zero discharge from dredge	Not applicable	Not Applicable	none

	Actual Effects	Potential Effects	Avoidance Factors	Remediation / Compensation	Final Significance
Effects on Communities	None if green valve closed	None if zero discharge from dredge	Not applicable	Not Applicable	none
Disposal Sites for Dredged Material (see Figure 2)					
Disturbance and Deposition of bed material					
Water Column Effects					
Sediment Plumes	Increased sedimentation increased turbidity within disposal footprint	Dissolved Oxygen sags / toxicity / sedimentation issues outside of disposal area	Not required. Material not contaminated and with low silt content.	Not required if placement confined to disposal area	Less than minor outside of disposal footprint
Suspended Solids	Increased concentration within disposal footprint	Increased concentration outside disposal footprint	Monitor and respond to turbidity limits in adjacent habitats	Not required if placement confined to disposal area	Less than minor outside of disposal footprint
Turbidity	Increased value within disposal footprint	Increased value outside dredging footprint	Monitor and respond to turbidity limits in adjacent habitats	Not required if placement confined to disposal area	Less than minor outside of disposal footprint
Light penetration	Decreased value within disposal areas (but attached macrophytes not present)	Reduced value outside disposal footprint	Managed via response to turbidity levels in adjacent habitats	Not required due to lack of attached macrophytes within disposal areas	Less than minor outside of disposal footprint
Effects on Communities					
Plankton	Less than minor due to high replenishment rates	Less than minor due to high replenishment rates	Not required	Not required	Less than minor
Benthos	Burial & death within disposal footprint	adventive pests may colonise vacant niche	Not applicable	Contribution to local enhancement of local harbour water quality / seagrass habitat for example	Minor to moderate, localised, short term loss of benthos within disposal areas
Fish and Wildlife	Minor, localised, disturbance and	Minor, localised, and short term reduction in	Not applicable	Not required	Less than minor outside of

	Actual Effects	Potential Effects	Avoidance Factors	Remediation / Compensation	Final Significance
	avoidance during disposal activities	available food supplies			disposal footprint
Changes to Navigation Aids (see Figure 3)					
Water Column Effects	Less than minor because of limited footprint	Less than minor because of limited footprint	Not applicable	Adoption of Best Industry Practices	Less than minor
Effects on Communities	Less than minor because of limited footprint	Less than minor because of limited footprint	Not applicable	Adoption of Best Industry Practices	Less than minor

Table 3.6.7.1: Summary of Ecological Effects of Proposed Dredging Activities (excluding Marine Birds and Marine Mammals)

Overall, Dr Coffey states that:

"With proposed avoidance, remediation and compensation measures in place, any adverse ecological effects within the footprints of the dredging and disposal activities are expected to be localised and short term (6 -24 months) and further offset / compensated for by proposed contributions to projects such as enhancing the overall health of the harbour / seagrass habitats.

Similarly, given the very conservative approach that is proposed in close proximity of ecologically significant areas (Motukaroro Island Whangarei Marine Reserve and kelp beds and sponge communities at Home Point), any adverse effects on the adjacent communities and environs is expected to be avoided.

In terms of Policy 11 of the New Zealand Coastal Policy Statement, the proposed activities would be conducted in accordance with the direction it sets. Adverse effects on matters listed in 11(a) will be avoided; and significant effects on matters listed in 11(b) will be avoided, and other effects avoided, remedied or mitigated"[343].

3.7 Avifauna Ecology

Mr Don has considered the actual and potential effects of the Proposal on coastal birds. A full copy of Mr Don's Coastal Birds Assessment[344] is contained within **Annexure Two** of this AEE. We now summarise the key points to arise out of that assessment.

Mr Don records that the Proposal will not cause the following effects on coastal and pelagic birds:

[343] Dr Coffey, B, page 52, section 5.3, "Crude Shipping Project, Proposal to Deepen and Partially Realign the Approaches to Marsden Point, Assessment of Marine Ecological Effects, Excluding Seabirds and marine Mammals". Dated 10 August 2017

[344] Don, G, "Crude Shipping Project, AEE Report, Coastal Birds, Final", Dated 09 August 2017

a. There will be no permanent loss of feeding habitat.

b. There will be no loss of intertidal roosting for shorebirds or nesting habitat.

c. No sediment contamination, or any contaminant release that could affect marine habitats and organisms that are relied on for food. This includes the potential for bioaccumulation of contaminants.

d. That the Proposal will not exacerbate the effects on shorebirds and pelagic species, as a result of climate change.

In addition, Mr Don notes that there will be no effects as a result of the Maintenance Dredging campaigns or as a consequence of the relocation and installation of the Navaids[345].

Mr Don advises that there are five potential risks associated with the Proposal, namely:

a. Turbidity increases – Dredging and Disposal Areas;

b. Deposition of released sediment;

c. Vessel movements;

d. Vessel lighting;

e. Underwater noise; and

f. Cumulative effects.

3.7.1 Turbidity Increases – Capital Dredging

Mr Don states the Capital Dredging works will result in an increase in the turbidity in the immediate vicinity of the dredge for the duration of the dredging in the channel[346]. Mr Don notes that that the birds that will be affected by an increase in turbidity during the Capital Dredging works are visual fish feeders such as little penguin, australasian gannet, white-fronted tern, caspian tern, red-billed gull and the shag species. This is because an increase in turbidity may impair these species ability to see and capture fish and fish may avoid areas of higher turbidity reducing the available area of feeding habitat. However, Mr Don does recognise that in general, the effects of increased turbidity and suspended solids on foraging seabirds are not well known[347].

With respect to australasian gannet, white-fronted tern, caspian tern, red-billed gull and the shag species, Mr Don advises that they will be able to move away from visually unsuitable feeding conditions. Further, he comments that there will be sufficient areas of habitat containing typically high clarity water close to the dredging area to prevent a significant adverse effect being generated[348]. Mr Don does also note, however, that during the main breeding periods for shags (October to December), gulls (mid-September to January) and terns (September to January), feeding efficiency and energy conservation obtaining food can be critical to breeding success and juvenile survival. However, Mr Don does record that while greater effort may be required to secure food by these species, these instances, if any, cannot be defined precisely but are unlikely to be any greater

[345] Don, G, page 32, section 5.1, “Crude Shipping Project, AEE Report, Coastal Birds, Final”, Dated 09 August 2017
[346] Don, G, page 33, section 5.2.1.1, “Crude Shipping Project, AEE Report, Coastal Birds, Final”, Dated 09 August 2017
[347] Don, G, page 34, section 5.2.1.1, “Crude Shipping Project, AEE Report, Coastal Birds, Final”, Dated 09 August 2017
[348] Don, G, page 36, section 5.2.1.1, “Crude Shipping Project, AEE Report, Coastal Birds, Final”, Dated 09 August 2017

than the effects caused by natural, seasonal prey variation or poor weather conditions. As such, Mr Don concludes that such instances are unlikely to reduce either breeding success or juvenile survival during the six month period of Capital Dredging.

In the case of the little penguin species, we understand Mr Don's advice to be that the main concerns are disrupting their passage between shoreline nesting areas and the nearby open water, specifically between the inner Harbour and its entrance, as they forage for food[349]. Notably, Mr Don concludes that areas affected by a turbidity plume could be rendered unsuitable for foraging by little penguin resulting in temporary displacement from that feeding area and a lower foraging efficiency. Such a displacement would, we understand, have potentially adverse effects at a local population level, but not at a national level. Mr Don does, however, comment that any area of disruption is likely to be minor, relative to the wide feeding area available in Bream Bay out to the Hen and Chickens Islands[350].

Mr Don states that based on targeted surveys, a population that could represent at least twelve pairs of little penguin use the habitat in and around the Site for nesting and chick rearing. He advises that this suggests a relatively low breeding density. Given this advice, Mr Don notes that although the plume from the dredge has the potential to disrupt foraging trips during the breeding season, as discussed in the preceding paragraph, the risk for the population of little penguin present inside Busby Head is, in his opinion, low to moderate[351]. While the risk to the local population of little penguins between Busby Head to Bream Head, and around to Ocean Beach, is also low because of the remote nesting habitat. In terms of effects on little penguins nesting beyond Whangarei Harbour (such as along the Bream Head coastline), Mr Don considers this would be less than minor.

In summary, therefore, we understand Mr Don's advice to be that there is a possible short term change to the local little penguin population, both inside and outside Busby Head. However, given the characteristics of the sediment plumes associated with the dredging, Mr Don advises the main area of dredging disturbance will be beyond Whangarei Heads and would not affect the passage of little penguin to and from Whangarei Harbour. He also advises that, based on his understanding of Dr McComb's advice, the turbidity arising from the dredging activity will be temporary and confined to the existing channel. As such, Mr Don advises that a turbidity 'barrier' across the channel would not be created. This will permit little penguin to traverse the Channel's edges, especially along the northern side where nesting habitat is more likely. That would avoid a disruptive barrier being created between inner Harbour nesting habitats and open water within the Bream Bay foraging sites[352]. Furthermore, Mr Don notes that little penguins have adapted to intermittent, temporary turbidity increases that would be accommodated during storm events, rainfall events and river discharges[353].

Given the potential for the turbidity associated with dredging activity to temporarily affect little penguins, Mr Don recommends that Refining NZ should enhance the breeding opportunity and potential success of little penguin by providing 24 nesting boxes on Motukaroro Island. Mr Don has also recommended pest eradication on Motukaroro Island, and along its facing mainland foreshore. The control is to commence six months prior to the start of any capital dredging, to minimise pest incursions. He recommends the use of self-setting traps for stoats/rats and possums, with about 5

[349] Don, G, page 38, section 5.2.1.1, "Crude Shipping Project, AEE Report, Coastal Birds, Final", Dated 09 August 2017
[350] Don, G, page 38, section 5.2.1.1, "Crude Shipping Project, AEE Report, Coastal Birds, Final", Dated 09 August 2017
[351] Don, G, page 38, section 5.2.1.1, "Crude Shipping Project, AEE Report, Coastal Birds, Final", Dated 09 August 2017
[352] Don, G, page 39, section 5.2.1.1, "Crude Shipping Project, AEE Report, Coastal Birds, Final", Dated 09 August 2017
[353] Don, G, page 40, section 5.2.1.1, "Crude Shipping Project, AEE Report, Coastal Birds, Final", Dated 09 August 2017

stations on Motukaroro Island and 10 on the mainland edge. Further, Mr Don recommends that this pest eradication should ideally be completed prior to June (when penguins start to utilise their burrow, and continue for a minimum of 5 years. This recommendation has been adopted by the Company and this suggestion now forms part of the Proposal[354].

In conclusion, Mr Don states that:

""[T]he behaviour of birds is difficult to predict and it is equally difficult to discount all effects. For that reason, recommendations are presented below for predator control and the installation of little penguin nesting boxes inside the Harbour to mitigate any short term changes that might adversely affect the local breeding population. In the longer term the maintenance of nesting boxes, especially in a predator – controlled area, would be a positive benefit to the Harbour's population, and also to any nesting variable oystercatcher, reef heron and shags.

In summary, without any mitigation the effects on the local little penguin population are concluded to be less than minor; with the initiatives outlined in Section 7.1 the nett result is viewed as ecological enhancement"[355].

3.7.2 Turbidity Increases – Disposal Areas 1.2 and 3.2

Given the slow passage of the dredge to the Disposal Areas, Mr Don expects that any surface resting birds will be dispersed before the disposal operations comment. He notes that this reaction currently occurs as a result of the passage of existing tankers, freighters and other vessels in and out of the Harbour[356].

Mr Don goes on to advise that once the dredge vessel releases the sediment at the Disposal Areas, the dredged material will rapidly fall to the seafloor. As a consequence of this settling and due to the low silt content of the dredged material, Mr Don records that any adverse effect on water quality (and thus pelagic birds) is likely to be very localised[357].

During daylight hours, Mr Don notes that there is nothing to attract birds to the dredge vessel, when compared to, for example, a fishing vessel. However, he reiterates that the behaviour and presence of birds can be highly variable[358].

In summary, Mr Don states, with respect to the activities at the Disposal Areas, that:

"Therefore, while there would be disruption to any feeding pelagic birds by the dredge vessel's passage, the effect would be less than minor on a population level. Similarly, the probability of pelagic birds being attracted to the stationary vessel and diving to depths with localised elevated turbidity resulting in an adverse effect, is remote, and any effect would be very low and would not trigger NZCPS Policy 11 (a) (I) or 11 (b) (ii) and cut across Objective 3.4 and Policy 4.4.1 of the NRPS." [359]

[354] Don, G, page 52, section 7.1, "Crude Shipping Project, AEE Report, Coastal Birds, Final", Dated 09 August 2017
[355] Don, G, page 40, section 5.2.1.1, "Crude Shipping Project, AEE Report, Coastal Birds, Final", Dated 09 August 2017
[356] Don, G, page 45, section 5.2.1.2, "Crude Shipping Project, AEE Report, Coastal Birds, Final", Dated 09 August 2017
[357] Don, G, page 40, section 5.2.1.2, "Crude Shipping Project, AEE Report, Coastal Birds, Final", Dated 09 August 2017
[358] Don, G, page 41, section 5.2.1.2, "Crude Shipping Project, AEE Report, Coastal Birds, Final", Dated 09 August 2017
[359] Don, G, page 41, section 5.2.1.2, "Crude Shipping Project, AEE Report, Coastal Birds, Final", Dated 09 August 2017

3.7.3 Deposition of Released Sediment

Based on the advice from Dr McComb, Mr Don advises that the proposed sediment disposal at Disposal Areas 1.2 and 3.2 is unlikely to result in an adverse ecological effect on the feeding habitats of coastal birds from the deposition of sediment on adjacent intertidal and subtidal areas within Bream Bay[360].

3.7.4 Vessel Movements

Mr Don records that the vessels involved with the various works associated with the Proposal will not be significantly different from the range using inner Bream Bay and the Home Point to Busby Point area at present, in terms of sizes and speeds. Mr Don also records that on balance, the risk of additional vessel movements resulting in an adverse effect on the avifauna is very low[361].

While noting that the species most at risk from vessel movements is the little penguin, Mr Don advises that injuries and mortality from fast moving craft are more likely than from the proposed vessels used for the Proposal. Ultimately, Mr Don advises that any adverse effect of this nature would be less than minor and would therefore, be in accordance with the direction set by the NZCPS and the RPS[362].

3.7.5 Vessel Lighting

Mr Don states that lights are well known to attract a variety of marine birds. The adverse attraction to vessel lights by seabirds is, in his opinion, more likely in Bream Bay beyond Busby Head. This is because the ambient light levels within the Harbour are relatively high given the operations of Refining NZ, Northport, Marsden Cove, berthed vessels, residential areas and the existing Navaids[363].

Beyond Busby Head, Mr Don considers that the potential for the dredge to attract seabirds is high. Given the proposed operation is continuous, the potential for an adverse effect is also considered moderate-high but tempered, in his opinion, by the fact that large vessels are moored in Bream Bay on a continual basis, 12 months a year in all weather conditions[364].

We understand Mr Don's advice to be that susceptibility of light-attracted seabirds to collision and injury or death is higher on moonless nights or during the hours of darkness when the moon is below the horizon. Particularly during a week either side of the new moon each month, whereas clear starlit nights are less risky because the birds are able to navigate and orientate normally. Similarly, heavy fog and rain at night can increase the collision risk. Given this, Mr Don considers that collisions between seabirds and the dredging vessel, especially in the areas between Busby Head and Disposal Area 3.2, are likely[365]. He advises that the species at greatest risk are shearwaters and diving petrels nesting within Bream Bay Scenic Reserve, on the Hens and Chickens Islands, and on the Poor Knights Islands. Of these identified species, Mr Don advises that one is identified as a

[360] Don, G, page 41, section 5.2.2, "Crude Shipping Project, AEE Report, Coastal Birds, Final", Dated 09 August 2017
[361] Don, G, page 41, section 5.2.3, "Crude Shipping Project, AEE Report, Coastal Birds, Final", Dated 09 August 2017
[362] Don, G, page 42, section 5.2.3, "Crude Shipping Project, AEE Report, Coastal Birds, Final", Dated 09 August 2017
[363] Don, G, page 42, section 5.2.4, "Crude Shipping Project, AEE Report, Coastal Birds, Final", Dated 09 August 2017
[364] Don, G, page 42, section 5.2.4, "Crude Shipping Project, AEE Report, Coastal Birds, Final", Dated 09 August 2017
[365] Don, G, page 43, section 5.2.4, "Crude Shipping Project, AEE Report, Coastal Birds, Final", Dated 09 August 2017

nationally threatened pelagic species (flesh-footed shearwater) and twelve are nationally at risk species[366].

Mr Don then goes on to recommend several measures that could be initiated to reduce the attraction of seabirds to a vessel, if specific issues arose from vessels lighting. These measures are as follows:

a. Reduce all unnecessary deck and cabin lighting, and cover accommodation windows at night with blinds and curtains.
b. Where possible, orientate all deck lights so they shine only downwards and shield them to prevent upwards or horizontal light projection.
c. Use light dimmers and timers to minimise lighting in areas where people are not constantly active.
d. Trial different light colour options, such as green coloured lights in operational areas, to reduce overall light intensity levels on the vessel.
e. Investigate the use of LED floodlights with computer controlled light levels, colours and timers.

When summarising his advice on this matter, Mr Don states that:

"Clearly, but with the caveats on the existing use of the area by large vessels, the risk of an effect on species that are considered nationally threatened or at risk is notable and heightened by the proximity of breeding colonies at Bream Bay Scenic Reserve, the Hen and Chickens Islands and the Poor Knights Islands, and the use of Bream Bay by young, inexperienced birds.

It is understood that there has been no breeding activity by grey-faced petrel on Matakohe-Limestone Island in the inner Harbour in 2016 so that potential risk would not appear to be an issue. Any birds utilising the Island would anyway have acclimated to the ambient light levels of the Harbour environment.

On balance the general risk of light attraction and collision would be similar to that of any other large vessel and would not be significant on a population level but would increase during the post-fledging period. While NZCPS Policy 11(a)(i) would not be triggered, some management may be appropriate, particularly to achieve the direction set in Objective 3.4 and Policy 4.4.1 of the NRPS."[367]

Mr Don also recommends that any potential adverse effect on grey-faced petrel as a result of vessel lighting could also be offset by the provision of nesting boxes. This would be in addition to the support than Refining NZ already provides to the Bream Head Conservation Trust, with any grey-faced petrel nest box initiative to be specific and targeted, with the nest boxes enhancing existing earth burrows. This work should be undertaken in consultation with the Bream Head Conservation Trust and DOC[368].

All of these recommendations have been adopted by Refining NZ, and now form part of the Proposal.

[366] Don, G, page 43, section 5.2.4, "Crude Shipping Project, AEE Report, Coastal Birds, Final", Dated 09 August 2017
[367] Don, G, page 48, section 5.2.4, "Crude Shipping Project, AEE Report, Coastal Birds, Final", Dated 09 August 2017
[368] Don, G, page 40, section 5.2.1.1, "Crude Shipping Project, AEE Report, Coastal Birds, Final", Dated 09 August 2017

3.7.6 Underwater Noise

Mr Don advises that underwater noise could affect avifauna species that hunt prey underwater for longer periods, such as shags and little penguin[369]. We understand his advice to be that the short dives of birds, such as, white-fronted tern and australasian gannet and not expected to be adversely effected[370].

Drawing on the advice of Mr Cross[371], Mr Don considers that the noise generated by a TSHD will be similar to that of a large vessel, which are already common in the Site. He notes, however, that the key difference will be that the noise will be continuous during the works rather than intermittent[372].

Ultimately, Mr Don advises that Bream Bay and the Whangarei Harbour support a diverse and abundant avifauna, despite the passage of large ships and numerous smaller vessels within and around the Site. As such, Mr Don advises that the probability of a noise-induced adverse effect on swimming and diving birds is negligible and noise effects would not cut across the requirements set by either the NZCPS or by the NRPS[373].

3.7.7 Cumulative Effects

Mr Don states that none of the proposed activities associated the dredging and disposal will be new to the area. He also notes that at present, large vessels traverse the Whangarei Heads and Harbour area on a 24-hour basis and in a wide range of sea states, weather conditions, tidal stages and turbidity levels.

Mr Don concludes that on balance, the cumulative effects associated with all aspects of the dredging and disposal activities on coastal and pelagic birds, and their habitats, will be less than minor, particularly when taking into account the proposed mitigation[374].

Further, while recognising that at a national level, little penguin are subject to external pressures, Mr Don highlights that there is no information that the current proposal will have effects, including cumulative effects, on little penguin beyond intermittent, temporary turbidity increases confined to the existing channel. When considered together with the proposed environmental enhancement measures, which includes the provision of nesting boxes and predator eradication and control, the effect on little penguin is considered negligible.[375]

3.7.8 Mitigation and Monitoring

As we have previously set out, to mitigate any actual or potential effects of the Proposal on coastal birds, Mr Don has recommended that Refining NZ adopt a number of mitigation options[376], which we now summarise as follows:

[369] Don, G, page 45, section 5.2.5, "Crude Shipping Project, AEE Report, Coastal Birds, Final", Dated 09 August 2017
[370] Don, G, page 45, section 5.2.5, "Crude Shipping Project, AEE Report, Coastal Birds, Final", Dated 09 August 2017
[371] Cross, J, page 29, section 9.5, "RHDHV Technical Memo – Dredging Methodology Assessment", Dated 11th August 2016, contained within Appendix A of the Reinen-Hamill, R, "Dredging and Disposal Options – Synthesis Report"; Dated July 2017
[372] Don, G, page 45, section 5.2.5, "Crude Shipping Project, AEE Report, Coastal Birds, Final", Dated 09 August 2017
[373] Don, G, page 45, section 5.2.5, "Crude Shipping Project, AEE Report, Coastal Birds, Final", Dated 09 August 2017
[374] Don, G, page 50, section 5.2.6, "Crude Shipping Project, AEE Report, Coastal Birds, Final", Dated 09 August 2017
[375] Don, G, page 50, section 5.2.6, "Crude Shipping Project, AEE Report, Coastal Birds, Final", Dated 09 August 2017
[376] Don, G, page 48, section 6, "Crude Shipping Project, AEE Report, Coastal Birds, Final", Dated 09 August 2017

- In consultation with DoC enhance the breeding opportunity for, and potential breeding success of, little penguin, should be enhanced via predator control and the provision of nesting boxes on Motukaroro Island. Predator eradication will commence six months prior to the start of any Capital Dredging campaign and will include traps on both Motukaroro Island (five traps), and along the mainland foreshore facing Motukaroro Island (ten traps) to minimise pest incursions. The pest eradication activities will occur in parallel with the establishment of tracking tunnels on Motukaroro Island to monitor pest presence. Following the period of pest eradication work, 24 little penguin nesting boxes are established prior to June, which is when little penguins start to utilise their burrows. The pest control measures will be continued for a minimum of 5 years.
- In consultation with the Bream Head Conservation Trust and DoC, enhance the breeding opportunity for, and potential breeding success of, grey-faced petrels, by installing nesting boxes and undertaking predator control. To achieve this, Refining NZ will install 20 nesting boxes, which will enhance existing earth burrows and be undertaken in accordance with a specific management plan that has been agreed with the Bream Head Conservation Trust and DoC. In terms of predator control, Refining NZ will continue to support the Bream Head Conservation Trust, which already operates a comprehensive predator control program.
- A lighting audit of all vessels used during the works will be undertaken. The purpose of the lighting audit is to identify where changes may be required to vessel lighting, such as orientating deck lighting downwards, to limit glare from the vessels at night. This mitigation is proposed to minimise the number of birds that are attracted to the vessels, which is expected to reduce the change of bird strike.

The Company has accepted all of these mitigation recommendations.

Given Mr Don's opinion that adverse effects are in the low risk category, he does not recommend monitoring during the campaign for coastal birds[377]. Rather, Mr Don recommends monitoring be undertaken following the completion of the Capital Dredging campaign[378].

The post Capital Dredging monitoring consists of a once-off state-of-environment survey, which is a repeat of the coastal bird surveys undertaken between November 2015 to March 2016. This includes the following:

- Marsden Point to Northport breeding season (November) habitat use.
- Darch Point to Home Point breeding season (November) habitat use.
- Mair Bank coastal bird surveys (2) in the February – March period.
- Refinery Jetty to Northport coastal bird survey (1) in the February – March period.
- Urquharts Bay coastal bird survey (1) in the February - March period.

Furthermore, one-off daylight and dusk counts for little penguins should be completed between Reotahi Bay to Urquharts Bay (inclusive) during November to January, and September to October. This is in addition to the previously noted regular, ongoing monitoring program that will last a minimum of 5 years, which will be to record nesting box success in parallel with pest control measures[379].

[377] Don, G, page 50, section 7, "Crude Shipping Project, AEE Report, Coastal Birds, Final", Dated 09 August 2017
[378] Don, G, page 50, section 8, "Crude Shipping Project, AEE Report, Coastal Birds, Final", Dated 09 August2017
[379] Don, G, page 50, section 8, "Crude Shipping Project, AEE Report, Coastal Birds, Final", Dated 09 August 2017

The Company has accepted all of these monitoring recommendations.

3.7.9 Summary

In summary, Mr Don advises:

"Overall the impact of the Project including cumulative effects on coastal and pelagic birds is considered to be low especially at a national population level; the NZCPS Policy 11 (a) (i), regarding adverse effects on threatened or at risk taxa, and Policy 11 (b) (ii), regarding adverse effects on vulnerable life stages would not be triggered at a population or regional level and, if triggered at a local level, can be mitigated. Furthermore, the other applicable (avifauna) policy from the NRPS will also be achieved if the Proposal is advanced in the manner that we have recommended.

The key initiative recommended is the provision of little penguin nesting boxes within the Harbour to offset any local effect on breeding success as a result of dredging and a turbidity increase.

In addition the provision of nest boxes for grey-faced petrel in Bream Head Scenic Reserve is recommended to offset any local effect of the dredger's lighting on fledged juveniles.

Post-capital dredging monitoring is recommended to provide before and after state-of-the-environment information on coastal birds and little penguin."[380]

3.8 Marine Mammals

Dr Clement has, with colleagues from Cawthron, considered the actual and potential effects of the Proposal on marine mammals. In doing so, she has relied on underwater noise investigations that were completed by Styles Group. A full copy of Dr Clements Marine Mammal Assessment[381] is contained within **Annexure Two** of this AEE.

Having considered the values that exist, and the detail of the Proposal, Dr Clement advises that the Proposal could generate both direct and indirect effects on marine mammals. The three direct effects identified by Dr Clement are:

a. Vessel strike.
b. Underwater noise.
c. Risk of entanglement.

We now summarise her advice in relation to all three of these potential effects.

3.8.1 Vessel Strike

Based on worldwide studies, Dr Clement advises that the risk of a collision between dredging vessels and marine mammals is minimal if the activity avoids critical habitats and seasons when the species

[380] Don, G, page 50, section 8, "Crude Shipping Project, AEE Report, Coastal Birds, Final", Dated 09 August 2017
[381] Clement, D, "Assessment of Effects on Marine Mammals from Proposed Deepening and Realignment of the Whangarei Harbour Entrance and Approaches". Dated August 2017

of concern may be more 'distracted' while feeding or resting, with particular species or age groups (such as calves and juveniles) being more susceptible to vessel strike than others. Given her understanding of the Site and the Proposal, Dr Clement considers the Bryde's, humpback, southern right whales and, to a lesser extent, bottlenose dolphins and orca (given their current endangered species status rather than proneness for vessel strike) are of greatest concern in terms of collisions[382]. For these species, the Dr Clement notes that there is a low probability of the dredge vessel encountering a migrating whale as currently only one to three individual whales are sighted within Whangarei Harbour and Bream Bay each year. With the majority of migrating whales passing by Hen (Taranga) and Chicken Islands over five nautical miles from the Site. Further, she records that if whales are sited in within Whangarei Harbour and Bream Bay, it is only for a limited period each year, usually in the winter months and some spring months, with most only remaining for a day up to a week (the exception being Bryde's whales).

Dr Clement notes that the likelihood of a vessel strike occurring depends on a number of operational factors, including vessel type, speed and location. She records that there has only been one recorded instance of a dredge striking a marine mammal out of 134 worldwide recorded cases (in which the vessel type was known) between 1975 and 2002[383].

To avoid / minimise the potential of a vessel strike, Dr Clement recommends that the following mitigation measures are implemented:

1. Adoption of best boating guidelines for marine mammals, including speed limits; and
2. Liaise with DoC throughout the works to obtain real-time/recent sighting information, in order to anticipate and mitigate potential interactions with any whale species sighted in and near the project area.
3. Establish a designated observer on the dredge vessel that maintains a watch for marine mammals during operations during daylight hours; and
4. Establish a designated 'precautionary' safety zone of 50m around dredging operations that will temporarily cease operations if a marine mammal is within the zone[384].

In addition, Dr Clement recommends reporting and monitoring throughout the Proposal. This includes recording any vessel strike incidents or 'close calls' of such incidents. In the event that a fatal marine mammal incident occurs, Dr Clement advises that the carcasses should be recovered by Refining NZ, if possible, and DoC and Tangata Whenua be notified[385].

Relying on the advice of Mr Bermingham[386], Dr Clement notes that while the number of trips for the dredge will result in a temporary increase in vessel traffic at the Site during the proposed works, harbour traffic will decrease over the long-term as more heavily-laden, tankers will result in fewer overall ship movements. Dr Clement also advises that the vessel traffic associated with the Proposal

[382] Clement, D, page 5, section 3.1.1, "Assessment of Effects on Marine Mammals from Proposed Deepening and Realignment of the Whangarei Harbour Entrance and Approaches". Dated August 2017
[383] Clement, D, page 5, section 3.1.1, "Assessment of Effects on Marine Mammals from Proposed Deepening and Realignment of the Whangarei Harbour Entrance and Approaches". Dated August 2017
[384] Clement, D, page 21, section 3.3, "Assessment of Effects on Marine Mammals from Proposed Deepening and Realignment of the Whangarei Harbour Entrance and Approaches". Dated August 2017
[385] Clement, D, page 21, section 3.3, "Assessment of Effects on Marine Mammals from Proposed Deepening and Realignment of the Whangarei Harbour Entrance and Approaches". Dated August 2017
[386] Bermingham, G, page 12, section 4.5, "Report in Support of an Assessment of Effects on the Environment, Navigational Risk Assessment of Engineered Channel Designs". Dated 15 August 2017.

will be localised, slow moving (less than 15 knots) or stationary. In addition, there will be few occasions when the dredge could be operating at the same time as commercial vessels are entering or leaving the harbour. As such, and given the narrow entrance channel and shallow depths associated with this particular section of the Site, Dr Clement considers that this will reduce any potential cumulative effects from multiple vessel presence (and any associated masking effects on noise) leading to possible vessel strike[387].

She goes on to state that given these factors, there is a low probability of dredge vessels encountering a migrating whale. As a result of the foregoing, Dr Clement records that:

"the likelihood of a vessel strike (injury or mortality) associated with the proposal is assessed as low for migrating baleen whales, odontocete[388] and pinniped[389] species and the significance of the effect is considered de minimis with proposed mitigation actions." [390]

3.8.2 Underwater Noise

Relying on the advice of Dr Pine[391], Dr Clement has assessed the effects of underwater noise on marine mammals. Marine mammals can, we understand, be affected by an increase in underwater noise as they rely on underwater sounds for communication, orientation, predator avoidance and foraging. Dr Clement also advises that underwater noise may also affect marine mammals through changes in behaviour (such as changes in swimming direction, speed, surface intervals, respiration rates, vocalisation behaviours), masking of important noise signals, temporary auditory shifts or permanent injury[392].

The Proposal will result in an increase in vessel traffic and mechanical activities that, in turn, will generally increase the amount of human-made underwater sound produced within the Site.

In regards to the dredging activities, Dr Clement, drawing on advice from literature she reviewed[393], records that the noises associated with the proposed dredging activities are continuous, broad-band sounds at frequencies mostly below 1.0 kilohertz, which is a similar noise frequency to other New Zealand harbours[394]. She also advises, again drawing on advice from Dr Pine, that the dredge types proposed are expected to result in sound levels that generally range between 164 and 185 dB *re*1 µPa rms @ 1.0m[395]. Lastly, Dr Clement advises that these are generally lower sound levels than that generated by a powerful ship, which is typically between 180 to 190 dB *re*1 µPa rms @ 1.0m.

---

[387] Clement, D, page 23, section 3.3, "Assessment of Effects on Marine Mammals from Proposed Deepening and Realignment of the Whangarei Harbour Entrance and Approaches". Dated August 2017

[388] The term 'odontocete' refers to whale species that have teeth, such as, orca, bottlenose and common dolphins.

[389] The term 'pinniped' refers to species commonly known as seals.

[390] Clement, D, page 5, section 3.1.1, "Assessment of Effects on Marine Mammals from Proposed Deepening and Realignment of the Whangarei Harbour Entrance and Approaches". Dated August 2017

[391] Pine, M, "Whangarei Harbour Entrance and Marsden Point Channel Realignment and Deepening: Underwater Acoustic Modelling for the Marine Mammal Impact Assessment". Dated 21 August 2017, contained within Appendix 2 of the Clement, D, "Assessment of Effects on Marine Mammals from proposed Deepening and Realignment of the Whangarei Harbour Entrance and Approaches", Dated August 2017.

[392] Clement, D, page 8, section 3.1.2, "Assessment of Effects on Marine Mammals from Proposed Deepening and Realignment of the Whangarei Harbour Entrance and Approaches". Dated August 2017

[393] Todd VL, Todd IB, Gardiner JC, Morrin EC, MacPherson NA, DiMarzio NA, Thomsen F 2015. A review of impacts of marine dredging activities on marine mammals. ICES Journal of Marine Science: Journal du Conseil 72(2): 328-340

[394] Clement, D, page 8, section 3.1.2, "Assessment of Effects on Marine Mammals from Proposed Deepening and Realignment of the Whangarei Harbour Entrance and Approaches". Dated August 2017

[395] As stated by Clement, D, the term 'dB *re*1 µPa rms @ 1 m' represents the sound pressure level that has been back calculated to a standardised distance of 1.0 metre distance from the source, and termed source level. RMS is the Root Mean Square or mean squared pressure, and rms levels are often used for the assessment of continuous noise sources. The averaged square pressure is measured across some defined time window that encompasses the signal.

Based on the species that are known to visit the Site and the modelling undertaken by Dr Pine[396], Dr Clement is of the opinion that the likelihood of any migrating baleen whales, odontocetes and fur seals being able to hear and behaviourally respond to underwater noise produced by the Proposal is low to moderate. In this regard, Dr Clement advises that the degree of effect depends on the location of both the animal and dredge vessel, and the size of the dredge vessel. As an example, the potential effect on baleen whales may occur as far away as 18.5km when using a medium-sized TSHD in the outer-channel, although this radius is significantly less for mid-frequency cetaceans (such as orca and bottlenose and common dolphins) and fur seals. Dr Clement then advances, as a worst-case scenario, a proposition that any short-term auditory masking of particular communication signals for orca, bottlenose and fur seals would be limited, respectively, to a 7.6km, 4.7km, and 14.7km radius from the dredge location when in the outer channel. While any potential for the onset of temporary auditory shifts are estimated to occur only when an animal is within 10m of the TSHD during dredging operations, and only within 1.0m for other dredge types. Dr Clement also does not expect permanent hearing injuries for any marine mammals, regardless of the dredge vessel used or its location. While also noting that noise generated from spoil disposal will be significantly lower than dredge noise, and will have a short duration lasting only several minutes, at most [397].

In regards to the installation of the Navaids, Dr Clement notes that the proposed pile driving activities will be of a very short duration lasting up to two days in total (approximately four hours per pile with a total of two steel piles to be installed). Dr Clement acknowledges that the works will involve the driving of steel tube piles at two different locations within Calliope Bay, just past the harbour entrance, by either a vibro hammer (producing continuous noise) or traditional hammer (producing impulsive noise). Dr Clement records that the soft sediments at a relatively shallow depth (approximately 10m) where the piles are to be driven will assist in attenuating some of the lower frequency sounds generated during the installation of the Navaids, which, in turn, will reduce the distance of any potential effects[398]. Based on advice from literature that Dr Clement reviewed[399], she notes that any potential hearing impairments or injuries to marine mammals as a result of pile driving, will only occur within 300m of the works, depends on the exposure duration and, as such, ensures that the likelihood of exposure effects will be low to not applicable with mitigation.

To avoid and minimise the potential of an unacceptable emission of underwater noise, Dr Clement recommends that the following mitigation measures are implemented:

1. Use Best Practicable Options for all dredging and pile driving activities to minimise underwater noise effects; and
2. Regularly maintain and service all dredging equipment, vessels, and pile driver, associated with the Proposal; and

[396] Pine, M, page 12, "Whangarei Harbour Entrance and Marsden Point Channel Realignment and Deepening: Underwater Acoustic Modelling for the Marine Mammal Impact Assessment". Dated 21 August 2017, contained within Appendix 2 of the Clement, D, "Assessment of Effects on Marine Mammals from proposed Deepening and Realignment of the Whangarei Harbour Entrance and Approaches", Dated August 2017.

[397] Clement, D, page 10, section 3.1.2, "Assessment of Effects on Marine Mammals from Proposed Deepening and Realignment of the Whangarei Harbour Entrance and Approaches". Dated August 2017

[398] Clement, D, page 15, section 3.1.2, "Assessment of Effects on Marine Mammals from Proposed Deepening and Realignment of the Whangarei Harbour Entrance and Approaches". Dated August 2017

[399] Clement, D, pages 16 and 17, section 3.1.2, "Assessment of Effects on Marine Mammals from Proposed Deepening and Realignment of the Whangarei Harbour Entrance and Approaches". Dated August 2017

3. Establish a designated observer on the dredge vessel that maintains a watch for marine mammals during operations during daylight hours; and
4. Establish a designated 'precautionary' safety zone that is a 50m from dredging activities. The safety zone and observation zone for pile driving activities will be based on the chosen driving technique, noise exposure thresholds and subsequent safety zone distances as provided by the *Underwater Piling Noise Guidelines*[400]. Operations will temporarily cease if a marine mammal is within the safety or observation zones[401].

In addition, Dr Clement proposes measuring actual underwater noise level generated by the dredging and adjusting any modelling (as necessary) to reflect the monitoring data and recording and reporting all marine mammal sightings (along with acoustic recordings, if possible) to DoC. Dr Clement also recommends passive acoustic monitoring near dredge and disposal activities[402].

Given the foregoing, Dr Clement advises that "*any effects from additional underwater noise generated from the dredging Proposal will likely be transitory and non-injurious. The overall levels and character of dredging noise will be generally comparable to existing vessel movements currently travelling to and from the harbour. Effects will be predominantly limited to the momentary masking of some noise signals (for example, members of the same species may find it more difficult to communicate across particular frequencies / levels while in proximity of the operating dredge), and a range of potential behavioural responses (for example, avoidance by mothers with calves but equally possible, attraction of lone males to areas in proximity of the operating dredge) depending on the species and individual animal. The likelihood of any TTS effects occurring is considered low and any hearing injury effects (PTS) are not applicable based on modelling results. Therefore, with the recommended mitigation actions, the significance of any acoustic effects are considered to be nil to de minimis for both local and visiting species"*[403].

Further, Dr Clement states that *"effects from piling noise are more likely to involve temporary acoustic masking or behavioural responses of marine mammals in the immediate vicinity (several kilometres) of the pile driving works, which may see animals moving to other regions of the proposal area (e.g. up into the inner harbour or other areas of the wider Bream Bay area) while piling is underway. The likelihood of TTS or PTS as a result of pile driving is considered low due to the short duration, expected small spatial envelope for the onset of any physical hearing effects and an extremely short exposure time for any individual marine mammal and with the recommended mitigation actions, the effects will be nil to de minimis."*

Of note is Dr Clement's advice that noise generated from spoil disposal will be significantly lower than dredge noise, and will have a shorter duration lasting only several minutes[404].

When all things are considered, Dr Clement states:

[400] Underwater Piling Noise Guidelines prepared by the Government of South Australia Department of Planning, Transport and Infrastructure, dated 21 November 2012.
[401] Clement, D, page 21, section 3.3, "Assessment of Effects on Marine Mammals from Proposed Deepening and Realignment of the Whangarei Harbour Entrance and Approaches". Dated August 2017
[402] Clement, D, page 21, section 3.3, "Assessment of Effects on Marine Mammals from Proposed Deepening and Realignment of the Whangarei Harbour Entrance and Approaches". Dated August 2017
[403] Clement, D, page 13, section 3.1.2, "Assessment of Effects on Marine Mammals from Proposed Deepening and Realignment of the Whangarei Harbour Entrance and Approaches". Dated August 2017
[404] Clement, D, page 10, section 3.1.2, "Assessment of Effects on Marine Mammals from Proposed Deepening and Realignment of the Whangarei Harbour Entrance and Approaches". Dated August 2017

"[T]he overall effects of the capital and maintenance dredging and the disposal and pile driving components on marine mammal species within Whangarei waters are assessed as de minimis when considered with the recommended avoidance / mitigation actions."[405]

3.8.3 Risk of entanglement

We understand that a major hazard from coastal development projects for marine mammals is the possibility of entanglement. In this regard, Dr Clement advises that whales, dolphins and pinnipeds are often attracted to floating debris and can get entangled in them. The greatest entanglement risk to marine mammals is from loose, thin lines or lost ropes and lines.

The only ropes required as part of this Proposal are to secure the barge to the BHD or CSD during dredging of the inner- or mid-channel.

Dr Clement recommends the following mitigation measures in response to the potential for marine mammals to become entangled:

1. Avoid loose ropes; and
2. Ensure that all dredging, support vessels and other project activities have Waste Management Plans in place before the commencement of works[406].

In addition, Dr Clement recommends recording and reporting all entanglement events or near misses of such incidents. In the event that a fatal marine mammal entanglement incident occurs, she advises that the carcasses should, if possible, be recovered by Refining NZ, and DoC and Tangata Whenua be notified[407].

Given the foregoing, Dr Clement advises that:

"[T]he nature of the Proposal and types of equipment involved means the likelihood of entanglement in marine debris from dredging and disposal is low. Any subsequent effects to marine mammals are expected to be de minimis in well-maintained coastal development projects with proper waste management programmes in place (e.g. secure on board storage of lines, ropes, and waste) in order to comply with the NZ Maritime Rules Part 180."[408]

3.8.4 Indirect effects

In addition to the three direct effects, Dr Clement highlights several indirect effects that may result from physical changes to the habitat itself, which, in turn, could affect the health of the local ecosystem and / or impinge on important prey resources of marine mammals[409].

[405] Clement, D, page 13, section 3.1.2, "Assessment of Effects on Marine Mammals from Proposed Deepening and Realignment of the Whangarei Harbour Entrance and Approaches". Dated August 2017
[406] Clement, D, page 21, section 3.3, "Assessment of Effects on Marine Mammals from Proposed Deepening and Realignment of the Whangarei Harbour Entrance and Approaches". Dated August 2017
[407] Clement, D, page 21, section 3.3, "Assessment of Effects on Marine Mammals from Proposed Deepening and Realignment of the Whangarei Harbour Entrance and Approaches". Dated August 2017
[408] Maritime New Zealand, Marine Protection Rules: Part 180 – Dumping of Waste and Other Matter. Dated 31st October 2015.
[409] Clement, D, page 14, section 3.2, "Assessment of Effects on Marine Mammals from Proposed Deepening and Realignment of the Whangarei Harbour Entrance and Approaches". Dated August 2017

Dr Clement advises that Whangarei Harbour and Bream Bay are not unique or important feeding habitats for any local or visiting marine mammals. Given this, she advises that potential indirect effects of the Proposal are limited to bioaccumulation of contaminants, and the loss or disturbance of prey species due to habitat loss, benthic disturbance, or turbidity plumes[410]. We now summarise Dr Clement's advice on those matters.

3.8.5 Bioaccumulation of Contaminants

Dr Clement notes that the level of exposure to contaminants in the dredged sediment (for any local marine mammals) will depend on the chemical characteristics of the dredge spoil, the subsequent uptake by relevant prey resources (such as plankton, fish, rays and cephalopods), and the feeding habits and range of those marine mammals.

Drawing on Dr Coffey's advice and analysis[411] (which did not identify any contaminants within the dredge spoil that represents a risk to marine ecology), Dr Clement concludes that the likelihood for contaminants in dredged sediments to adversely affect the marine mammals present within or adjacent to the Site is 'not applicable to low', with the overall effect assessed as nil to *de minimis*[412].

3.8.6 Loss or Distribution of Prey Species

Prior to providing her advice, with respect to the effect of the benthic disturbance and loss caused by the Proposal on marine mammals, Dr Clement considered the advice provided by Dr Coffey[413], and already summarised in section 3.6 of this AEE. Having undertaken that review, she advised that any consequential (short or long-term) flow-on effects to local marine mammals would be nil to *de minimis*[414].

In terms of the turbidity plumes caused by the dredging and disposal operations, Dr Clement advises that marine mammals are known to inhabit fairly turbid environments within New Zealand's nearshore environments. As a consequence, we understand her advice to be that turbidity plumes are more likely to only indirectly affect marine mammals via their prey resources. Again, however, having considered the advice of Dr Coffey, Dr Clement advises that any effects caused by the increased turbidity will be limited in their spatial extent and are expected to only temporarily displace individual fish from the works areas affected by the plume. As a consequence, Dr Clement is of the opinion that any indirect turbidity effects on marine mammals are not expected to have any detrimental or long-term flow-on effects to local marine mammals in the region, and therefore will be nil to *de minimis* in their magnitude[415].

---

[410] Clement, D, page 15, section 3.2, "Assessment of Effects on Marine Mammals from Proposed Deepening and Realignment of the Whangarei Harbour Entrance and Approaches". Dated August 2017

[411] Dr Coffey, "Crude Shipping Project. Proposal to Deepen and Partially Realign the Approaches to Marsden Point. Assessment of Marine Ecological Effects Excluding Seabirds and Marine Mammals". Dated 10 August 2017.

[412] Clement, D, page 15, section 3.2.1, "Assessment of Effects on Marine Mammals from Proposed Deepening and Realignment of the Whangarei Harbour Entrance and Approaches". Dated August 2017

[413] Dr Coffey, "Crude Shipping Project. Proposal to Deepen and Partially Realign the Approaches to Marsden Point. Assessment of Marine Ecological Effects Excluding Seabirds and Marine Mammals". Dated 10 August 2017.

[414] Clement, D, page 16, section 3.2.2, "Assessment of Effects on Marine Mammals from Proposed Deepening and Realignment of the Whangarei Harbour Entrance and Approaches". Dated August 2017

[415] Clement, D, page 17 and 18, section 3.2.2, "Assessment of Effects on Marine Mammals from Proposed Deepening and Realignment of the Whangarei Harbour Entrance and Approaches". Dated August 2017

3.8.7 Mitigation and Monitoring

As we have previously set out, to mitigate any actual or potential effects of underwater noise on marine mammals, Dr Clement has recommended that Refining adopt a number of best practicable options[416], which we now summarise as follows:

1. A MWMP (a draft of which is attached as a draft to her report in **Annexure Two**) has been prepared and is to be finalised in consultation with DoC prior to commencing works. It sets out the guidelines for best boating, debris management, minimisation of noise, liaison procedures with DoC and Tangata Whenua and incident reporting procedures.
2. To reduce vessel strike, all dredge vessel operators will adopt and use simple and common-sense boating behaviour guidelines around marine mammals by the vessel), particularly around baleen whales and any calves. These behaviours and guidelines are set out in the MWMP and include, but are not limited to, keep boat speed constant or slow the vessel within 500m of marine mammals, and avoid erratic changes in direction or speed of vessels.
3. Real-time / recent sighting information is to be obtained from DoC (or other project vessels) throughout the duration of the Proposal, in order to anticipate and mitigate potential interactions with any whale species sighted in and near the project area.
4. To minimise underwater noise, the Company will utilise the smallest practical dredge vessel that is regularly maintained to a high standard, where practicable.
5. To minimise underwater noise, the Company will utilise, where practicable, the least acoustically evasive pile-driving technique practically suited for the conditions, which is regularly maintained to a high standard.
6. During pile driving activities, the Company will implement the standard operational procedures and noise exposure thresholds from the *Underwater Piling Noise Guidelines*[417].
7. A marine mammal observer will be on Site during daylight dredging and pile driving activities so that they may notify the operator of the dredge or pile driver vessel if a marine mammal is sighted within or entering a precautionary safety zone (of 50m from dredging activities, 100m from vibro-driving piling, and 300m from impact pile driving). If the operator receives notice from a marine mammal observer, dredging or pile driving will cease until the marine mammal leaves the precautionary safety zone.
8. Passive acoustic recorders should be placed at approximately four locations near the Harbour entrance, disposal areas, and near the 120 dB underwater noise boundary to record marine mammal detections. This monitoring is not intended to assess species frequency or intensity of use but rather, determine whether any marine mammals are present within the Site during different cycles and noise levels during the Capital Dredging works. Only two separate monitoring periods of approximately 14 days each are necessary within the estimated six month project duration to sufficiently detect the potential presence of marine mammals across several dredging cycles.

Refining NZ has accepted all of these recommendations.

[416] Clement, D, page 21, section 3.3, "Assessment of Effects on Marine Mammals from Proposed Deepening and Realignment of the Whangarei Harbour Entrance and Approaches". Dated August 2017

[417] Underwater Piling Noise Guidelines prepared by the Government of South Australia Department of Planning, Transport and Infrastructure, dated 21 November 2012.

In addition, Dr Clement has recommended that Refining NZ undertake informative marine mammal surveys by recording actual behavioural responses of local and visiting marine mammals[418]. We note that the monitoring is not intended to statistically assess the impact of dredging and pile driving on local marine mammal populations in relation to predetermined indicators or thresholds. Rather, the monitoring programme has been designed to help validate any potential assumptions that underlie the Marine Mammal Report. It is expected that this data will be utilised by industry and DoC to further understand any actual effects of dredging activities on marine mammals and, if necessary, help reduce the risk of similar incidences with any future maintenance dredging.

We understand Dr Clement's advice to be that this monitoring will include the collection of opportunistic visual sightings and passive underwater acoustic monitoring before and then after Capital Dredging and pile driving activities has stopped. It would also include collecting general information on species presence within the project vicinity while assessing specific questions related to the actual versus potential responses of local and visiting marine mammal to dredging, disposal and pile driving activities.

Dr Clement confirms that the consideration of possible monitoring options for Capital Dredging and spoil disposal also applies to any ongoing Maintenance Dredging, but more so in relation to operational practices in proximity to sighted marine mammals. The assumed smaller scale aspects of Maintenance Dredging and disposal, along with smaller dredge vessel size, will likely require less extensive monitoring than that proposed for the Capital Dredging. As discussed above, and as a minimum, Dr Clement recommends that best-management practices should still be adopted and a designated marine mammal observer should also maintain a watch on the dredge vessel whenever dredging or disposal activities are underway (including transiting) over daylight hours only. The purpose of this marine mammal observer would be to record opportunistic sightings and observation data (e.g. behavioural information) on marine mammals in the general area, with an emphasis on those nearest to the dredging and disposal sites; and secondarily, to avoid vessel strike / marine mammal interactions. As with Capital Dredging activities, a central contact point should be established (such as with DoC and other project staff) to obtain up-to-date regional sighting information, so that the marine mammal observer on-board the dredge vessel can anticipate the presence of any marine mammals previously sighted in or near the area.

Dr Clement notes that the information compiled via direct observation and passive acoustic monitoring during the Capital Dredging project can be used to inform aspects of any program for Maintenance Dredging; especially regarding marine mammal response to dredging and spoil disposal operations and seasonal use of the area by individual species. Any additional monitoring practices, if required, will be determined after analysis of the Capital Dredging project data[419].

3.8.8 Summary

Having considered all matters she considers relevant, Dr Clement states:

[418] Clement, D, pages 28 to 32, section 3.4, "Assessment of Effects on Marine Mammals from Proposed Deepening and Realignment of the Whangarei Harbour Entrance and Approaches". Dated August 2017
[419] Clement, D, page 40, section 5, "Assessment of Effects on Marine Mammals from Proposed Deepening and Realignment of the Whangarei Harbour Entrance and Approaches". Dated August 2017

"Based on the direct and indirect potential effects highlighted in this report, the overall effects of the capital and maintenance dredging and the disposal and pile driving components on marine mammal species within Whangarei waters are assessed as de minimis when considered with the recommended avoidance / mitigation actions."[420]

3.9 Commercial Fishing

As we highlighted earlier, Rick Boyd has considered the actual and potential effects on commercial fishing, as a result of the Proposal. A full copy of Mr Boyd's Commercial Fishing Assessment[421] is attached as part of **Annexure Two** of this AEE. We summarise his advice below.

As previously discussed in section 2.6 of this report, Mr Boyd has highlighted that the commercial fishery in Whangarei Harbour and Bream Bay is comprised of several essentially discrete and unrelated fisheries, using different methods, or targeting different species, and each could be impacted differently, as a result of the Proposal. In particular, Mr Boyd notes that there are a number of project impacts that may potentially affect commercial fishing and need to be evaluated. These include the following:

i. Direct mortality of commercial fish and shellfish species.

ii. Loss of or ecological changes to habitats that fish use that may result in loss of commercial fishing opportunities.

iii. Physical changes to habitats that may affect the operation of fishing methods or gear and/or prevent fishing.

iv. The availability of alternative locations for commercial fishing.

v. Whether any of the impacts are permanent or temporary, and if temporary the duration of recovery of any ecological or physical changes to habitat.

3.9.1 Direct Mortality of Commercial Fish and Shellfish Species

Relying on the advice of Dr Coffey that finfish are highly mobile, Mr Boyd records that commercial species, such as snapper, gurnard and John dory, are able to move to undisturbed nearby areas. He also notes that paddle crabs are also very mobile. As such, Mr Boyd states that both finfish and paddle crabs may actually be attracted to disturbed areas to scavenge for benthic organisms that will be disturbed during the works. Therefore, Mr Boyd records that both the dredging activity and disposal of dredged material is highly unlikely to result in mortality of mobile fish species that naturally avoid physical disturbance[422].

Again, relying on the advice of Dr Coffey, Mr Boyd states that sessile bottom dwelling species, such as scallops, are unlikely to survive either dredging or being buried by dredged sediments at the disposal sites. However, Mr Boyd records that commercial densities of sessile bottom dwelling species, except for whelks, are not known to occur within the dredging and disposal footprints and therefore, there will be no effect on these commercial fishery species. Given that whelks are present at both the dredge and disposal sites, Mr Boyd notes that they are unlikely to survive burial, although

[420] Clement, D, page 26, section 4, "Assessment of Effects on Marine Mammals from Proposed Deepening and Realignment of the Whangarei Harbour Entrance and Approaches". Dated August 2017

[421] Boyd, R, "Commercial Fishing in Whangarei Harbour and Bream Bay", Dated 11 August 2017

[422] Boyd, R, page 35, section 4.2.1, "Commercial Fishing in Whangarei Harbour and Bream Bay", Dated 11 August 2017

any effect on the commercial whelk fishery in Bream Bay would be temporary and negligible. In addition, he notes that they would recovery in the areas within 6 to 12 months[423]. We are advised, for completeness, that Refining NZ expects to only disturb a portion of Disposal Site 1.2 during any single dredging programme. For instance, the advice to us is that approximately 10% could be disturbed.

3.9.2 Loss of or Ecological Changes to Fisheries Habitat

Although Mr Coffey advises that the combined capital dredging and disposal would impact the benthic communities for a period of 6 to 24 months, Mr Boyd indicates that there will be no permanent loss of fish feeding habitat within the combined Capital Dredging and disposal areas, as an ecologically constructive benthic community is expected to progressively re-establish within a period of not more than 12 months, as recorded by Dr Coffey. As such, Mr Boyd considers that any reduction in availability of benthic fauna that fish feed on will be temporary and confined to the dredging and disposal sites[424].

3.9.3 Physical Changes to Habitat

Mr Boyd records that bottom trawling and Danish seining could be affected by any long term or permanent changes to soft bottom seabeds, such as that proposed to occur at Disposal Site 3.2. However, on review of the surface elevation and contours by T&T, Mr Boyd acknowledges that once disposal at the Site finishes, the seabed form and density at Disposal Site 3.2 will have physical characteristics similar to its present state and like adjacent areas where trawling occurs. Therefore, he considers that the disposal is not expected to materially affect the continued use of Disposal Site 3.2 for trawling and Danish seining, while any effects on the future use of Disposal Site 3.2 for commercial fishing be negligible[425].

3.9.4 Availability of Alternative Sites for Commercial Fishing

Mr Boyd records that the total area impacted by dredging and disposal, as a result of the Proposal, is very small in comparison to the total area where commercial fishing activity takes place in Whangarei Harbour and Bream Bay. As such, he considers that individual fishers may operate anywhere throughout Bream Bay and the wider region [426].

3.9.5 Duration of Impacts – Permanent and Temporary

Mr Boyd notes that the proposed project will result in a number of permanent changes to the environment in which commercial fishing takes place. These include:

i. A deeper and re-aligned shipping channel into Marsden Point.

ii. Altered navigational aids.

iii. Shallower seabed depth within proposed Disposal Site 3.2.

iv. Areas of shallower depths where dredged material is deposited within proposed Disposal Site 1.2.

[423] Boyd, R, page 35, section 4.2.1, “Commercial Fishing in Whangarei Harbour and Bream Bay”, Dated 11 August 2017
[424] Boyd, R, page 36, section 4.2.3, “Commercial Fishing in Whangarei Harbour and Bream Bay”, Dated 11 August 2017
[425] Boyd, R, page 36, section 4.2.4, “Commercial Fishing in Whangarei Harbour and Bream Bay”, Dated 11 August 2017
[426] Boyd, R, page 36, section 4.2.4, “Commercial Fishing in Whangarei Harbour and Bream Bay”, Dated 11 August 2017

Mr Boyd specifies that neither the deeper and realigned shipping channel nor the altered Navaids are expected to have any adverse impacts on commercial fishing. In fact, he comments that such changes, as a result of the Proposal, are more likely to be beneficial, both in terms of reducing risk to the fisheries environment from oil tankers visiting the port and aiding fishing vessels entering and departing Whangarei Harbour.

Further, Mr Boyd indicates that a shallower seabed depth at proposed Disposal Site 3.2 is unlikely to adversely affect commercial fishing, as the reduction in depth by approximately 4.0m at this site is not significant in a commercial fishing context due to the range of depths that commercial fishing vessels, with a variety of methods, can operate within.

At Disposal Site 1.2, Mr Boyd considers that due to the small area impacted from disposal activities, the shallower depth is unlikely to result in measurable impacts to commercial fishing when compared to the very wide area where commercial vessels now operate in this part of Bream Bay[427].

3.9.6 Impacts on Commercial Trawl and Danish Seine Fishing

Mr Boyd records that there are two potential adverse impacts on bottom trawl and Danish seine fishing, the first being the loss of access to all or part of the area of proposed Disposal Site 3.2 during the period of active disposal from both Capital Dredging and Maintenance Dredging works, and periodic dredging work. The second potential adverse impact is the displacement of commercial fishes at Disposal Site 3.2 as a result of both physical disturbance and the loss of benthic fauna on which fishes feed. Both of these effects are considered by Mr Boyd to be temporary, lasting a period of 6 to 12 months. Overall, Mr Boyd considers that any adverse effect on trawling and Danish seining, as a result of the Proposal, can be expected to be negligible[428].

3.9.7 Impacts on Longline Fishing

In his assessment, Mr Boyd notes that commercial fish species that longliners target will be displaced as a result of both physical disturbance and the temporary loss of benthic fauna on which these species feed at both Disposal Sites 1.2 and 3.2. Mr Boyd also indicates that there is very little longline fishing that occurs around the dredge footprint. The adverse effects on longlining from displacement of fishes at both disposal sites can be expected to be very small, if any, for the same reasons as given above for trawling and Danish seining. In addition, Mr Boyd notes that although Disposal Site 1.2 lies within, or near the area of greatest longline activity, placement of dredged material there will be localised. As such, he considers that any adverse effects of dredging and disposal on commercial longline fishing can be expected to be negligible[429].

3.9.8 Impacts on Set Net Fishing

Mr Boyd also notes that any adverse effects on set net fishing at Disposal Site 1.2 are the same as for longline fishing (set out above) and are expected to be negligible for the same reasons[430].

[427] Boyd, R, page 37, section 4.2.5, "Commercial Fishing in Whangarei Harbour and Bream Bay", Dated 11 August 2017
[428] Boyd, R, page 38, section 4.3, "Commercial Fishing in Whangarei Harbour and Bream Bay", Dated 11 August 2017
[429] Boyd, R, page 38, section 4.4, "Commercial Fishing in Whangarei Harbour and Bream Bay", Dated 11 August 2017
[430] Boyd, R, page 38, section 4.5, "Commercial Fishing in Whangarei Harbour and Bream Bay", Dated 11 August 2017

3.9.9 Impacts on Paddle Crab and Whelk Fishing

While paddle crabs are mobile, Mr Boyd notes that they are not able to move as fast as fishes and may be unable to avoid dredged material when it is deposited and therefore, are likely to be buried by the disposal of dredged material. Mr Boyd records that while Disposal Site 1.2 is within the area most actively fished by commercial fishers, these commercial fishers have reported that the paddle crabs appear to regularly move or migrate to different areas in Bream Bay over the course of the year. As such, Mr Boyd considers that at other times, paddle crabs may not be very abundant at Disposal Site 1.2. Mr Boyd also records that Disposal Site 3.2 does not lie within the area where paddle crab fishers indicate they fish.

In addition, Mr Boyd specifies that as whelks move very slowly over the seabed, some will be buried by the disposal of dredged material at Disposal Site 1.2.

Given that both paddle crabs and whelks are predators and scavengers, Mr Boyd considers that both species may initially be attracted to the benthic fauna exposed in the dredge deposits and this may make them more vulnerable to repeated deposition. However, as material at Disposal Site 1.2 is proposed to be localised and of relatively small amounts, this attraction is unlikely to be significant.

Overall, Mr Boyd states that adverse effects resulting from the disposal of dredged material at Disposal Site 1.2 on paddle crab fishing is expected to be negligible as they are very mobile species and the impacted area at Disposal Site 1.2 is very small when compared with the area where paddle crab fishing takes place in Bream Bay. In addition, Mr Boyd records that there will be some loss of whelks within Disposal Site 1.2. However, the most important area within Bream Bay to whelk fishers is located more than 1.0 km from proposed disposal Site 1.2. As such, any effect at Disposal Site 1.2 on whelks, will be localised, of relatively small amounts, and is expected to be negligible.

3.9.10 Impacts on Scallop Fishing

Although low densities of scallops occur throughout Bream Bay, in recent years, commercial densities of scallops have only ever been present south of Ruakaka. As such, Mr Boyd considers that there are no adverse effects on commercial scallop fishing as a result of the Proposal.

3.9.11 Impacts on Other Commercial Fishing

As cockle and pipi fisheries do not occur within the Site, Mr Boyd considers that no adverse effects on commercial fishing for cockle or pipi are likely. Further, he records that due to the limited commercial rock lobster fishing occurring along the rocky northern shores of Bream Bay, and the distance between the proposed dredging footprint and Disposal Site 3.2, no adverse impacts on the rock lobster fishery are likely.

3.9.12 Summary

Given the foregoing, we understand that as a result of Mr Boyd's assessment of the Proposal, the effects on commercial fishing in the Whangarei Harbour and Bream Bay, are negligible.

3.10 Landscape, Visual and Natural Character

As we highlighted earlier, Stephen Brown has considered the actual and potential landscape, visual (amenity) and natural character effects of the Proposal. A full copy of Mr Brown's Landscape Assessment[431] is attached as part of **Annexure Two** of this AEE. We summarise his advice.

Mr Brown states that the Proposal will affect the outer harbour's underwater environment to a greater degree than its above-water landscape. Mr Brown[432] goes on to then discuss what he considers to be the six main issues that are associated with the Proposal, being:

1. Changes to the sea floor and biota, as a result of the dredging to form the proposed channel alignment.
2. Modifications associated with the disposal of sand within Bream Bay at the two Disposal Areas.
3. The permanent addition of the two new Lead Lights near Taurikura.
4. The introduction of a new 'lateral marker' to a rock outcrop adjacent to Home Point.
5. Sediment plumes / water turbidity as a result of the dredging and disposal activities proposed.
6. The dredging and sand disposal operations, mainly pertaining to the effects of vessel lighting and operational noises on local residents.

We now discuss each of those issues, drawing heavily on the advice of Mr Brown.

3.10.1 Channel Formation

Mr Brown records that the modified channel will have an impact on the surface of the water, due to the realigned buoys and additional Navaids. He notes, however, that for all intents and purposes, the channel will appear almost identical to that which exists at present[433]. In addition, Mr Brown states that those viewing the repositioned buoys from land will be doing so against the highly-modified coastline of Marsden Point and / or the landform of Home Point. He also notes that the Navaids have a visual presence that is currently quite limited and he expects this to remain the case following the Proposal. Consequently, Mr Brown considers that the Proposal would have a limited effect in relation to the ONL values of Home Point[434]. Mr Brown also advises that any direct modification of natural character values above the surface of the water would be very limited[435]. With regard to visual amenity effects, Mr Brown advises that there would be no appreciable change to the above water profile of the channel and the amenity associated with either the outer harbour or Bream Bay. Furthermore, he considers that changes to the configuration of the marker buoys would be insignificant once completed[436].

Drawing on the advice of Dr McComb and Mr Reinen-Hamill, Mr Brown notes that there will be changes to the natural character below the surface of the water. He notes his understanding of those two reports being, that while changes to the geomorphology and coastal processes are expected to be appreciable, the seabed will also be subject to changes generated by natural events (such as

[431] Brown, S, "Marsden Point Crude Shipping Project Landscape Assessment", Dated August 2017
[432] Brown, S, page 6, section 2.1, "Marsden Point Crude Shipping Project Landscape Assessment", Dated August 2017
[433] Brown, S, page 29, section 4.1, "Marsden Point Crude Shipping Project Landscape Assessment", Dated August 2017
[434] Brown, S, page 29, section 4.1, "Marsden Point Crude Shipping Project Landscape Assessment", Dated August 2017
[435] Brown, S, page 29, section 4.1, "Marsden Point Crude Shipping Project Landscape Assessment", Dated August 2017
[436] Brown, S, page 30, section 4.1, "Marsden Point Crude Shipping Project Landscape Assessment", Dated August 2017

storms and tidal processes) and will naturally stabilise between any Maintenance Dredging periods[437]. This understanding, when coupled with his understanding of Bioresearches advice (which is that moderate impacts will be felt on the areas of dredging, but that they will reduce over time) and mitigation proposed to by Refining NZ to manage turbidity, leads Mr Brown to the conclusion that the Proposal will have no appreciable effect in relation to areas that are regionally significant, and highly sensitive, habitats, like the rocky reefs and sponge gardens[438].

3.10.2 Sand Disposal

Mr Brown notes that the only landscape effect associated with the disposal of dredged material at the two Disposal Areas would be the presence of the dredging vessel itself as it discharges the sediment to the seabed in Bream Bay. Ultimately, Mr Brown advises that the dredging vessel and disposal process would have a quite limited impact on perceptions of the Bream Bay landscape due to the viewing distances and similar maritime activities taking place at the Site[439].

Mr Brown records his opinion that any natural character effects on the surface of the water would be largely limited to awareness of an additional vessel (the dredge) within Bream Bay. He advises that such effects would be small scale and incremental, particularly given the scale and expansive qualities of Bream Bay[440]. Drawing, we understand, on the advice of Dr Coffey, Dr Clement and Mr Don, Mr Brown also advises that any effects on Bream Bay's underwater natural character values, as a result of the disposal activities, would merge with the existing underwater environment such that any changes would be of a low order overall.

Lastly, Mr Brown's advice is that from the perspective of actual or potential effects, the disposal of sediment at both sites would scarcely affect perceptions of Bream Bay's character, identity and sense of place. He thus advises that any adverse amenity effects would be very low[441].

3.10.3 Installation of Front & Rear Lead Lights near Taurikura

Given the distance of the proposed Lead Lights at Taurikura from land, Mr Brown advises that the effects would be extremely limited, to inconsequential on the landscape, natural character and amenity values of Taurikura Bay, McKenzie Bay, the outer harbour and the Calliope Bank High Natural Character area[442].

3.10.4 Lateral Marker at Home Point

Given the size of the proposed lateral marker at Home Point, Mr Brown advises that there would be no appreciable impact on the landscape values of Home Point (and the associated DoC reserve), the wider harbour / Bream Bay coastline or Home Point ONL[443]. He goes on to note that the lateral marker would, in absolute terms, very slightly reduce the natural character content and values in the vicinity of Home Point, by incrementally adding to the array of structures both within and next to the Harbour's water area[444]. In saying that, Mr Brown advises that this change would be so slight that it

[437] Brown, S, page 30, section 4.1, "Marsden Point Crude Shipping Project Landscape Assessment", Dated August 2017
[438] Brown, S, page 30, section 4.1, "Marsden Point Crude Shipping Project Landscape Assessment", Dated August 2017
[439] Brown, S, page 33, section 4.2, "Marsden Point Crude Shipping Project Landscape Assessment", Dated August 2017
[440] Brown, S, page 33, section 4.2, "Marsden Point Crude Shipping Project Landscape Assessment", Dated August 2017
[441] Brown, S, page 33, section 4.2, "Marsden Point Crude Shipping Project Landscape Assessment", Dated August 2017
[442] Brown, S, page 38, section 4.3, "Marsden Point Crude Shipping Project Landscape Assessment", Dated August 2017
[443] Brown, S, page 42, section 4.4, "Marsden Point Crude Shipping Project Landscape Assessment", Dated August 2017
[444] Brown, S, page 42, section 4.4, "Marsden Point Crude Shipping Project Landscape Assessment", Dated August 2017

is doubtful that it would have any appreciable impact on the wider natural character values of the outer harbour and its margins, or those of Bream Bay, and would therefore, have a minimal effect on the Home Point High Natural Character area[445]. Furthermore, Mr Brown considers that public appreciation of Home Point and its coastline, including the reserve's identity and sense of place, would not be noticeably altered by the physical presence of the proposed marker[446].

Overall, this leads Mr Brown to the opinion that any landscape and amenity effects of this Navaid would be nil, and any natural character effect would be very low.

3.10.5 Sediment Plumes

Mr Brown notes, based on the advice of Dr McComb, that the sediment plumes associated with the Proposal will generally be limited to the more immediate confines of the areas subject to the works and the tidal channel. As a consequence, Mr Brown records his opinion that the sediment plumes associated with the dredging activity will have little impact on the perceptions of the harbour and its water quality[447]. He also notes that the plumes associated with the disposal activities will dissipate rapidly without any appreciable impact on perceptions of the Bream Bay seascape.

Mr Brown also comments that such effects would be concentrated over an initial period of five to six months for the Capital Dredging campaign, and that the Maintenance Dredging campaigns would be more infrequent and targeted[448] (with Maintenance Dredging campaigns expected to occur every 2 to 5 years in the Berth Pocket area and 5 to 20 years in the outer channel sections[449]). Consequently, Mr Brown advises that once the Capital Dredging campaign is complete, the seascapes of both Whangarei Harbour and Bream Bay would return to a more stable and 'normal / natural' state. Overall, Mr Brown considers that any landscape effect is expected to be 'low' as a result of the dredging and disposal operations[450].

Mr Brown advises that sediment plumes would, in his opinion, have an adverse effect on the natural processes and patterns found within Bream Bay and the outer Harbour. However, he notes that the majority of effects are likely to be confined to underwater locations near the dredging works, although Mr Brown records that plumes will be visible from passing vessels and specific locations, such as elevated tracks on parts of Home Point[451]. These plumes will also, he advises (drawing on the advice of Mr Don and Dr McComb), have an impact on the underwater environment and its habitats, although any effects would be physically very restricted and temporary[452]. Overall, Mr Brown concludes that the disposal plumes would dissipate rapidly, and, as a result, effects in relation to Bream Bay would be very limited and largely restricted to the immediate vicinity of the disposal vessel. Again, 'low' natural character effects are predicted[453].

In relation to effects on amenity, Mr Brown expects the public perception of plumes to be intermittent and specific to the areas subject to the works and the tidal channel. Mr Brown identifies that although the Capital Dredging has the potential to create the perception of the outer Harbour's waters being

[445] Brown, S, page 42, section 4.4, "Marsden Point Crude Shipping Project Landscape Assessment", Dated August 2017
[446] Brown, S, page 42, section 4.4, "Marsden Point Crude Shipping Project Landscape Assessment", Dated August 2017
[447] Brown, S, page 49, section 4.5, "Marsden Point Crude Shipping Project Landscape Assessment", Dated August 2017
[448] Reinen-Hamill, page 5, section 2.3, "Crude Shipping Project, Coastal Processes Assessment", Dated July 2017
[449] Brown, S, page 49, section 4.5, "Marsden Point Crude Shipping Project Landscape Assessment", Dated August 2017
[450] Brown, S, page 49, section 4.5, "Marsden Point Crude Shipping Project Landscape Assessment", Dated August 2017
[451] Brown, S, page 49, section 4.5, "Marsden Point Crude Shipping Project Landscape Assessment", Dated August 2017
[452] Brown, S, page 49, section 4.5, "Marsden Point Crude Shipping Project Landscape Assessment", Dated August 2017
[453] Brown, S, page 49, section 4.5, "Marsden Point Crude Shipping Project Landscape Assessment", Dated August 2017

visually affected by some of those works, any such effects would be of a short duration and would not significantly impact on the longer-term appeal of Whangarei Harbour from an aesthetic standpoint. Overall, Mr Brown considers that the sense of place and identity of the Whangarei Heads area would not be appreciably affected by the plumes[454] generated by the Proposal. He also advises that any effects associated with disposal plumes within Bream Bay would be even more limited.

3.10.6 Operations

The use of dredging vessels will result in the generation of noise and lighting. Mr Brown records, drawing on the advice of Mr Styles, that the noise levels will generally be consistent with that of other sea-faring vessels travelling at low to moderate speeds. He notes that lights will be utilised for operational and navigational purposes[455].

With regard to landscape effects, Mr Brown reiterates his previous advice that a range of vessels, such as freighters, tankers and leisure craft, are familiar components of Bream Bay and Whangarei Harbour. He notes however, the operations of the dredges will differ from that of normal vessel movements in the area, in that they would sit within the channel on a more regular basis. As a result, the generation of noise in the immediate vicinity of the dredge and an additional source of lighting at night-time will occur. However, Mr Brown records that noise effects will be subject to applicable Noise Standards (which we note Mr Styles advises will be achieved in this instance) and that the dredge's profile will be similar to that of other anchored vessels in the open expanse of Bream Bay. Mr Brown states that within the more confined waters of Whangarei Harbour, the dredge would be close to the settlements stretching from Reotahi to Urquharts Bay, but the Refinery and Northport facilities would be the vessels primary backdrop, complete with an array of lighting associated with these facilities and other berthed vessels[456]. In addition, Mr Brown considers that the dredging activity would be effectively screened from One Tree Point and Marsden Bay by the current Nothport wharves and berthed ships, both during the day and at night. Overall, Mr Brown concludes that as a result, any changes to the landscape of Marsden Point would be incremental and relatively small scale, taking into account the existing operational environment. A 'low' landscape effect is predicted by Mr Brown[457].

In terms of natural character effects, Mr Brown reiterates that a dredge would add to the man-made content of the outer harbour. However, he advises that this activity would not, in his opinion, alter the fundamental balance and interplay between natural and man-made components of this environment[458]. Rather, Mr Brown considers that the dredge would reinforce perceptions of a maritime working environment at Marsden Point, in the general vicinity of both the Refinery and Northport facilities. But, it would not appreciably encroach on, or degrade, those more natural features and patterns that are found down the northern side of Whangarei Harbour. A 'very low' natural character effect is also expected by Mr Brown.

Mr Brown records that the dredging and disposal activity would add to the more utilitarian qualities evident within and around Marsden Point. In that regard, he states that the Proposal would exacerbate a subtle shift away from the more tranquil, natural, qualities of the harbour's northern

[454] Brown, S, page 49, section 4.5, "Marsden Point Crude Shipping Project Landscape Assessment", Dated August 2017
[455] Brown, S, page 50, section 4.6, "Marsden Point Crude Shipping Project Landscape Assessment", Dated August 2017
[456] Brown, S, page 52, section 4.6, "Marsden Point Crude Shipping Project Landscape Assessment", Dated August 2017
[457] Brown, S, page 52, section 4.6, "Marsden Point Crude Shipping Project Landscape Assessment", Dated August 2017
[458] Brown, S, page 52, section 4.6, "Marsden Point Crude Shipping Project Landscape Assessment", Dated August 2017

beaches and coastline[459]. It would introduce another industrial element and activity to the southern side of the harbour, subtly reinforcing the existing encroachment by such activities into the more passive, and aesthetically appealing, coastline stretching from Reotahi to Home Point. Notably, Mr Brown advises that the effect would reduce with completion of the six month Capital Dredging campaign, but that the dredge would remain the one 'signature' component of the CSP. Given the foregoing, Mr Brown concludes that even though the dredge would not, by any objective measure, generate a significant level of effect, it might still become the focus for concerns about the project's impact on the identity and sense of place of the Whangarei Heads area. A 'low' impact on the visual amenity of the Site and its surrounds is predicted[460].

3.10.7 Mitigation and Monitoring

While Mr Brown notes that the Proposal will give rise to a number of small to very small effects, both above and below the surface of the ocean[461], he considers that the effects identified would have a low to very low impact and there will be no cumulative effects. As a result, Mr Brown does not recommend any monitoring or mitigation to minimise the expected effects as a result of the Proposal.

3.10.8 Summary

Overall, Mr Brown summarises his findings in table form (which we have repeated in **Table 3.10.8.1**, which follows), and also states:

"In effect, the current proposal would adhere to the maxim of concentrating new development and related effects within parts of the CMA and Coastal Environment that are already significantly modified. Consequently, the proposal would effectively avoid having an adverse effect on those parts of Whangarei Heads, Marsden Point and Bream Bay that are identified as having outstanding landscape or natural character values. It would also avoid having a significant effect in relation to the rest of the coastal environment and surrounding landscapes. Most components and activities associated with the project would have a quite limited impact on perceptions of the area's character, identity or sense of place."

	Values	Prominence	Landscape Effects	Natural Character Effects	Amenity Effects	Impact Rating
4.1 Channel formation	Moderate / High	Very Low	Very Low	Low / Moderate	None	Low / Moderate
4.2 Disposal Areas	High / Moderate	Very Low	Very Low	Low	Very Low	Low
4.3 Lead lights	Moderate / High	Low / Very Low	Very Low	Very Low	Very Low	Very Low
4.4 Home Point Marker	High	Very Low	None	Very Low	None	None

459 Brown, S, page 52, section 4.6, "Marsden Point Crude Shipping Project Landscape Assessment", Dated August 2017
460 Brown, S, page 53, section 4.6, "Marsden Point Crude Shipping Project Landscape Assessment", Dated August 2017
461 Brown, S, page 54, section 4.7, "Marsden Point Crude Shipping Project Landscape Assessment", Dated August 2017

4.5 Dredging and Disposal Plumes	Moderate / High	Low	Low	Low	Low	Low
4.6 Dredging and Disposal Operations	Moderate / High	Low	Low	Very Low	Low	Low

Table 3.10.8.1: Summary of Landscape and Visual Impact Assessments

3.11 Archaeological and Historic Heritage

Dr Clough has considered the actual and potential for the Proposal to adversely affect historic heritage effects. A full copy of the Archaeological Assessment[462] is contained within **Annexure Two** of this AEE. We set out our understanding of Dr Clough's key findings.

It is important to reiterate our early advice from section 2.8 of this AEE that the Site does not contain any recorded archaeological site, nor are there any historic heritage sites listed within the Whangarei District Plan relevant to the Proposal. Dr Clough notes, however, that a number of archaeological sites have been identified on the land at the entrance to the Whangarei Harbour, on both sides of the proposed dredging activity. These sites include evidence of both Maori and European settlement, agriculture and marine exploitation over the past few hundred years. Dr Clough also indicates that both the recorded archaeological sites and historical records demonstrate that the pipi beds at Mair Bank, the cockle beds at Snake Bank and the broader fishing resource have been important to populations living around the Harbour for several hundred years[463].

Given the foregoing, it is not surprising that Dr Clough's advice is that the Proposal (within the CMA) will not adversely affect recorded archaeological sites[464]. He does advise, however, that any land based disposal areas would need to be assessed from an archaeological perspective to ensure that no unacceptable archaeological effects eventuate. We note that such an assessment would be conducted by the party who would receive the sediment, as Refining NZ has confirmed that it would only supply the dredged sediment to a recipient with the necessary authorisations in place, and where practical (Martin, D, pers. com).

Dr Clough also addresses the potential for the Proposal to indirectly affect recorded archaeological sites as a result of changes to the coastal processes. Dr Clough highlights previous studies that, in general, suggest that land in proximity to coastline near the Site is already susceptible to naturally induced flooding, with coastal erosion significant in some areas, such as to the south of Marsden Point. The case studies cited showed how exposed midden on both sides of the Whangarei Harbour entrance were very likely to be destroyed by natural hazards and this prospect was likely to increase as a result of rising sea levels, increased storm events and erosion. In order to address this potential effect, Dr Clough reviewed the advice of Mr Reinen-Hamill[465]. He noted Mr Reinen-Hamill's advice

[462] Clough, Dr R, "Marsden Refinery, Whangarei harbour Dredging: Archaeological Assessment". Dated July 207
[463] Clough, Dr R, "Marsden Refinery, Whangarei harbour Dredging: Archaeological Assessment". Dated July 2017
[464] Clough, Dr R, page 25, "Marsden Refinery, Whangarei harbour Dredging: Archaeological Assessment". Dated July 2017
[465] Reinen-Hamill, "Crude Shipping Project, Coastal Processes Assessment", Dated July 2017

that "*overall the changes to tidal flows and wave conditions resulting from the channel dredging and marine disposal are small and typically within the existing variability of tidal currents and wave energy. No changes to existing coastal processes are anticipated on the open coast from Marsden Point to Ruakaka River or along the rocky coast from Home Point to Smugglers Bay, on the ebb tide shoal and Mair Bank or within the inner harbour area.*" Given this advice, Dr Clough advises that it is unlikely there will be any specific or identifiable effects on archaeological sites around the coastline. In that regard, he notes that current erosion patterns are likely to continue to damage and destroy archaeological sites, regardless of proposed dredging, with the most visible components, including cultural landscapes such as prominent coastal pa sites, would survive[466].

While Dr Clough advises that no archaeological authority is required for the Proposal to proceed, he has recommended that an Accidental Discovery Protocols be imposed (as a condition of consent) to ensure that archaeological matters are addressed if unrecorded sites and/or items are discovered during the proposed dredging activity[467]. Refining NZ has accepted this recommendation.

3.12 Cultural Values

Patuharakeke has prepared a draft CEA for the Proposal. The draft CEA sets out the actual and potential cultural effects of the Proposal against the cultural values within and adjacent to the Site, as detailed in the CVA[468]. Discussions are ongoing between Refining NZ and Patuharakeke regarding the content and recommendations of the draft CEA, and we expect that a final version will be made available during the consent process. In the meantime, a peer review of the draft CEA has been prepared by Antoine Coffin of Te Onewa Consultants and is summarised in sections 3.12.1, 3.12.1.1 and 3.12.2 of this AEE[469]. A full copy of Mr Coffin's peer review is contained within **Annexure Two** of this AEE. We now discuss Mr Coffin's findings, advice and recommendations.

3.12.1 Peer Review of the Draft CEA

In his advice, Mr Coffin acknowledges the relationship that exists between Patuharakeke and the Company, which includes a Memorandum of Understanding ('**MoU**'), and notes the extensive and ongoing consultation and engagement that has occurred between these two parties on the Proposal to date. He goes on to comment that the commissioning of both a CVA and the draft CEA, supported by several years of meaningful consultation, is a solid foundation for identifying and addressing concerns and effects identified by Tangata Whenua.

However, Mr Coffin identifies that, in his opinion, the draft CEA has unintentionally blurred the line between concerns of Tangata Whenua, and effects of the Proposal. In this regard, Mr Coffin states that an effect includes the actual and potential positive or adverse, temporary or permanent, past, present or future; and cumulative effects on the environment or change, as a result or consequence of an action. While a concern is a cause of anxiety, worry or a matter of interest or importance to someone.

In relation to the Proposal, Mr Coffin comments that much of the draft CEA is devoted to articulating the concerns of Tangata Whenua, which we understand have been raised at hui/meetings both with,

[466] Clough, Dr R, pages 20 to 22, "Marsden Refinery, Whangarei harbour Dredging: Archaeological Assessment". Dated July 2017
[467] Clough, Dr R, page 26, "Marsden Refinery, Whangarei harbour Dredging: Archaeological Assessment". Dated July 2017

[469] Coffin, A, "Peer Review Report of Refining NZ Crude Freight Proposal – Tangata Whenua o Whangarei Te Rerenga Paraoa DRAFT Cultural Effects Assessment", Dated 21 July 2017

and it's assumed without, representatives of Refining NZ. As a result, Mr Coffin's advice is that many of the concerns identified in the draft CEA are broad, general and contextual. As such, he recommends that Refining NZ continue to engage with Tangata Whenua to address the specific concerns raised in the draft CEA, which Refining NZ has agreed to do.

We now summarise the comments of Mr Coffin in regard to effects of the Proposal identified in the draft CEA.

3.12.1.1 Cultural Effects

As summarised by Mr Coffin, the draft CEA identifies a small number of environmental, social/economic and cultural effects. Given his area of expertise, Mr Coffin has only commented on the cultural effects raised in the draft CEA. Those being Kaitiakitanga, Treaty of Waitangi, Mauri, and Mana.

In terms of Kaitiakitanga, Mr Coffin highlights that while the draft CEA identifies a loss of knowledge for Tangata Whenua may occur (as a result of the loss of access to cultural sites and mahinga kai, loss of original placenames, and reduced abundance of mahinga kai), there is no specific timeframes as to how long this may last. Mr Coffin goes on to comment that further advice is required from Tangata Whenua to determine the degree of effects on Kaitiakitanga. Overall, Mr Coffin considers that:

"On the face of it this has the potential to be a minor to moderate effect of a temporary nature. Kaitiakitanga can be enhanced by ensuring tangata whenua appointed representatives are provided with a role to participate in the implementation of consents and having a role in projects and activities that will enhance environmental outcomes."

With regard to effects of the Proposal on Treaty rights, Mr Coffin records that the draft CEA has identified issues associated with Tangata Whenua fishing quotas and aquaculture space. Mr Coffin comments that the draft CEA suggests that there may be some temporary, local impacts on commercial species of shellfish, crabs, crayfish and other crustaceans that are commercially harvested within the dredging and disposal areas. However, having read the advice of Dr Coffey and Mr Boyd, Mr Coffin comments that effects on crabs, scallops, and other mobile species are wide spread and distributed. With any effects expected to be negligible. Further, we understand his advice to be that inshore and deep sea fish quotas are unlikely to be affected.

In terms of effects on aquaculture opportunities for Tangata Whenua, Mr Coffin comments that the Treaty of Waitangi Settlement Aquaculture rights of Mandated Iwi Organisations can be realised for new aquaculture space. He goes on to specify that such rights are likely to be exercised in large scale operations that are land-based, or at coastal locations some distance from Port and shipping facilities, and recreational boating activities. He then states that there do not appear to be any identified aquaculture sites associated with Tangata Whenua at the present time. As such, he concludes that any potential effects on aquaculture space are regarded as less than minor.

As we have noted, the draft CEA has highlighted that effects on mauri will occur as a result of the removal of sand out of the system, loss of benthic community, sediment plumes, and impacts on whales. Mr Coffin comments that the matter of mauri is a rather personal and perceptive concept and means many things to many people. He goes on to advise that mauri is one of the most important principles to Maori. However, our understanding of his advice is that the draft CEA does not adequately address mauri to a degree where accurate conclusions can be drawn as to the Proposal's potential to adversely affect mauri. In this regard, Mr Coffin states:

"*I am of the opinion that the matter of mauri could be explored and interrogated more in the context of the draft CEA. For that reason, I believe the draft CEA is not determinative on discussion and assessment of effects on mauri as a result of the proposal. The matters of removing sand out of the system, loss of benthic community, sediment plumes and any impact on whales as they relate to mauri are important and more discussion in the CEA may better support their conclusions*."

The draft CEA considers that the Proposal results in effects on Mana through constraints on participation in decision-making, past, present and future. After considering the comments in the draft CEA, Mr Coffin advises that Refining NZ has exceeded the requirements of the Act by actively engaging with Tangata Whenua throughout the development of the Proposal. He then highlights that the Company has agreed to, and resourced, the production of cultural and technical inputs into the application process. While he acknowledges that there have been historical activities that have occurred in the Whangarei Harbour, Mr Coffin states that Refining NZ has no mandate or control over past and future legislative provisions on Maori input into the decision-making process. In conclusion, Mr Coffin states:

"The engagement undertaken to date with tangata whenua is in my opinion appropriate, meaningful and conducted in good faith."

3.12.2 The Path Ahead

Having reviewed the draft CEA, Mr Coffin has identified a number of measures that he notes could be implemented by Refining NZ to address the matters raised in the draft CEA by Tangata Whenua. These measures include:

- The establishment of a Kaitiaki/Tangata Whenua forum to provide advice on matters of tikanga, have input into various management plans, the implementation of conditions of consent, and recommendations for environmental enhancement projects. In Mr Coffins opinion, this could assist in ensuring meaningful participation of iwi in the outcomes of decision-making, including an ongoing role in projects that enhance the natural harbour environment. His view is that any forum could be lead, at least initially, from the existing Tangata Whenua working group.
- The establishment of a technical advisory group that provides matauranga Maori expertise and provides for a role of Tangata Whenua in the selection of technical people. This technical advisory group could, in Mr Coffins opinion, provide independent technical support for any proposed Kaitiaki Forum (mentioned above) and/or the consent holder in the implementation of consents.
- In consultation with Tangata Whenua, undertake ecological mitigation projects that enhance the environment and the relationship of Tangata Whenua with sites and water. While the draft CEA does not identify appropriate enhancement programmes, Mr Coffin comments that any such programmes should have an obvious and direct relationship with the Whangarei harbour and immediate surrounds. For completeness, it is noted that Refining NZ has sought advice on appropriate mitigation measures and ecological enhancement activities. These have been detailed in section 1.5.16 of this AEE.

- The Company could contribute to local community participatory science research, where appropriate, which would assist in building capability and capacity locally among community.
- Tangata Whenua should be given an opportunity to have input into monitoring plans and, potentially, have a role in the implementation of the same.
- Refining NZ could investigate implementing a periodic review of new technology and techniques associated with dredging and disposal activities to ensure 'best practice' is implemented during the on-going Maintenance Dredging campaigns.

Refining NZ has accepted Mr Coffin's recommendation that further engagement is undertaken with Tangata Whenua over the list of possible measures that have been identified; its objective being to agree measures that are acceptable to both Tangata Whenua and themselves.

3.12.3 Summary

Overall, and having reviewed the draft CEA and provided recommendations, Mr Coffin ultimately concludes:

"*I am of the opinion that measures can be developed in consultation and agreed with tangata whenua that will ensure that any adverse cultural effects (including cumulative cultural effects) are appropriately avoided, remedied and mitigated.*"[470]

3.13 Recreation and Tourism

Mr Greenaway has considered the actual and potential recreation and tourism effects of the Proposal. As with all of the technical assessment, a full copy of Mr Greenaway's Recreational Assessment[471] is attached as part of **Annexure Two** of this AEE.

We understand that Mr Greenaway considered the potential for the Proposal to impact on uses within and adjacent to the Site including swimming, beach use, fishing, shell fish, diving, boating (including Stand Up Paddleboarding ('**SUP**'), kite surfing and recreational craft), and surfing. Having completed his assessment of these matters, Mr Greenaway goes on to discuss the Proposal's effects under the headings of Turbidity, Waves, Tides, Beaches, Marine Ecology, Contaminants, Dredge Activity and Navaids (which we have re-titled 'Aids to Navigation' for the purposes of this section). We summarise Mr Greenaway's advice in each of these headings in the following sub-sections of this AEE.

3.13.1 Turbidity

Mr Greenaway states that as a result of the dredging works, the release of sediment may reduce water clarity and decrease amenity for contact recreation (particularly swimming and diving). He advises that contact recreation activities are not anticipated in disposal areas 1.2 and 3.2, and therefore believes that any turbidity related effects are limited to the swimming and diving areas within the Harbour and near the Harbour entrance[472].

[470] Coffin, A, Page 18, Section 8.1, "Peer Review Report of Refining NZ Crude Freight Proposal – Tangata Whenua o Whangarei Te Rerenga Paraoa DRAFT Cultural Effects Assessment", Dated 21 July 2017

[471] Greenaway, R, "Refining NZ Crude Shipping Project Recreation and Tourism Effects Assessment". Dated August 2017

[472] Greenaway, R, page 54, section 5.2.1, "Refining NZ Crude Shipping Project Recreation and Tourism Effects Assessment". Dated August 2017

Having considered the advice of Dr Coffey and Dr McComb, Mr Greenaway notes that the plumes associated with the operation of the dredge(s) are expected to be confined to the Harbour channel and are not expected to disperse to recreational settings, such as the adjacent beaches, sand banks, the areas protected by the RCP or the Marine Reserve. As such, Mr Greenaway considers that there is unlikely to be any adverse effect on recreational diving and swimming sites as a result of the Proposal[473].

3.13.2 Waves

Mr Greenaway, drawing on the advice of Dr McComb and Mr Reinen-Hamill notes the bathymetry of the Site will be changed by the Proposal, which he notes has the potential to alter the direction and size of waves entering the Harbour and on the coast nearby. He advises that these changes may result in effects on the existing level of recreational amenity values associated with swimming, surfing, fishing, shellfish gathering, boating and diving[474].

Given, however, the advice of Dr McComb and Mr Reinen-Hamill, Mr Greenaway advises that the Proposal is unlikely to cause any change to the level of surfing amenity. Further, he comments that any effects on diving and swimming resulting from a change in wave energy will be small and only occur when there is little normal amenity for these recreational activities due to the presence of waves large enough to naturally limit access [475].

For completeness, Mr Greenaway records that the fully laden Suezmax ships will not result in larger wakes, as all large vessels reduce their speed as they enter the Harbour channel, and wake size is correlated to speed rather than draft. As a consequence, he does not expect that the more heavily laden vessels will create an adverse effect on beach users or other vessels[476].

3.13.3 Tides

Mr Greenaway, again drawing on the advice of Dr McComb and Mr Reinen-Hamill notes that the changes to the seabed caused by the Proposal could alter the direction and strength of tides, which could have implications for some recreation pursuits. Given, however, the advice of Dr McComb and Mr Reinen-Hamill, Mr Greenaway ultimately notes that by deepening the channel, tidal speeds generally decrease, albeit by a very small margin. He, therefore, expects there to be no associated adverse effects on recreation or tourism activities[477].

3.13.4 Beaches

Mr Greenaway records that changes to the seabed associated with the Proposal may result in changes to beach profiles, which, in turn may change the availability of sand for general beach recreation and the useability of boat launching ramps, because of changes in water depth and wave patterns. He notes Mr Reinen-Hamill's advice that no changes are expected to the existing coastal processes on the open coast from Marsden Point to Ruakaka River or along the rocky coast from Home Point to Smugglers Bay, on the ebb tide shoal and Mair Bank or within the inner harbour area, as a result of Capital Dredging. However, Mr Greenaway does record that based on the advice of

[473] Greenaway, R, page 55, section 5.2.1, "Refining NZ Crude Shipping Project Recreation and Tourism Effects Assessment". Dated August 2017
[474] Greenaway, R, page 55, section 5.2.2, "Refining NZ Crude Shipping Project Recreation and Tourism Effects Assessment". Dated August 2017
[475] Greenaway, R, page 55, section 5.2.2, "Refining NZ Crude Shipping Project Recreation and Tourism Effects Assessment". Dated August 2017
[476] Greenaway, R, page 55, section 5.2.2, "Refining NZ Crude Shipping Project Recreation and Tourism Effects Assessment". Dated August 2017
[477] Greenaway, R, page 56, section 5.2.3, "Refining NZ Crude Shipping Project Recreation and Tourism Effects Assessment". Dated August 2017

Mr Reinen-Hamill's, Maintenance Dredging may add to the existing trend of a loss of sand at Mair Bank and the coastline extending southward from Marsden Point. However, Mr Greenaway records that both of these effects are to be mitigated to an acceptable level that is less than minor, by placing dredged material within the ebb tide shoal area and monitoring the effects of the Proposal[478].

Given the advice from Mr Reinen-Hamill, Mr Greenaway considers that any changes that could affect recreation within and/or adjacent to the Site, particularly in relation to shellfish gathering, will be mitigated by the disposal of material at Disposal Area 1.2 and can therefore, be effectively managed[479].

3.13.5 Marine Ecology

Drawing on the advice of Dr Coffey, Mr Greenaway notes that local finfish will avoid disturbed areas while dredging and disposal activities are occurring, but these species are expected to progressively return within 6 to 12 months following the completion of the Capital Dredging. He goes on to note that the proposed Maintenance Dredging campaigns are predicted to be less disruptive because of the smaller areas/volumes involved, and the disturbed areas are expected to experience quicker recolonisation by finfish. Mr Greenaway notes that there is likely to be a temporary increase in local finfish activity as the dredging activity exposes food sources, but he does not consider this to be a mitigating factor of any real significance[480].

Having considered the advice of Dr Coffey, Mr Greenaway advises that:

"Due to the scale of the local fishing resource, the mobility of finfish, the lack of effect on biota beyond the activity footprints, the progressive recovery of the benthos, and the temporary nature of the effect, the net outcome for recreational fishing from capital dredging is likely to be adverse but also minor. Maintenance dredging will have a lower scale of effect during each event, but due to its frequency (2 to 5 yearly) its net effect will also be adverse but minor." [481]

3.13.6 Contaminants

Mr Greenaway takes comfort from Dr Coffey's advice that the dredged material is not expected to be contaminated with any toxins and have very low levels of organic matter. As a consequence of this advice, Mr Greenaway advises that there are no water quality issues associated with the Proposal that will adversely affect contact recreation[482].

3.13.7 Dredge Activity

The use of a dredge(s) within the Harbour has, in Mr Greenaway's opinion, the potential to compete for marine space and present a navigational hazard to recreational users. Importantly, however, Mr Greenaway advises that the presence of a dredge in the entrance channel is not expected to limit recreational vessels any more than occurs at present, as all marine users must comply with the navigation rules that govern the use of the entrance channel. To minimise the prospect of any adverse effect, Mr Greenaway does, however, recommend that Refining NZ advertise both the

[478] Greenaway, R, page 57, section 5.2.4, "Refining NZ Crude Shipping Project Recreation and Tourism Effects Assessment". Dated August 2017
[479] Greenaway, R, page 57, section 5.2.4, "Refining NZ Crude Shipping Project Recreation and Tourism Effects Assessment". Dated August 2017
[480] Greenaway, R, page 57, section 5.2.5, "Refining NZ Crude Shipping Project Recreation and Tourism Effects Assessment". Dated August 2017
[481] Greenaway, R, page 58, section 5.2.5, "Refining NZ Crude Shipping Project Recreation and Tourism Effects Assessment". Dated August 2017
[482] Greenaway, R, page 58, section 5.2.6, "Refining NZ Crude Shipping Project Recreation and Tourism Effects Assessment". Dated August 2017

location of the dredging activity and its duration: on the Company's website; to recreational users via local media; and directly to the Harbourmaster. With these measures in place, Mr Greenaway advises that any adverse effect will be minor or less than minor[483].

3.13.8 Aids to Navigation

Mr Greenaway advises that the proposed relocation and introduction of additional Navaids is a necessary component of the Proposal, as they will mark the safe passage through the new channel alignment and reduce the risk of marine accidents. Ultimately, he does not expect the Navaids to adversely affect recreation[484].

3.13.9 Summary

In summary, Mr Greenaway advises that when all things are considered, the actual and potential recreation and tourism effects of the Proposal are expected to be *"… confined and slight."*[485]

3.14 Economics

Mr Clough has considered the economic impact of the Proposal. A full copy of the Economics Report[486] is contained within **Annexure Two** of this AEE.

3.14.1 Context

Mr Clough advises that Refining NZ currently supplies[487]:

a. Approximately 86% of New Zealand's jet fuel;
b. Approximately 67% of all diesel;
c. Approximately 63% of all petrol;
d. Between 60 to 75% of all bitumen for roading; and
e. All fuel oil for ships.

In addition, he advises that Refining NZ produces sulphur that is used in fertiliser manufacture, and carbon dioxide, which is used in the food and beverage industries.

Furthermore, we understand Mr Clough's advice to be that Refining NZ is a substantial employer in the Whangarei District, offering relatively highly–skilled and highly paid job opportunities. In that regard, he advises that in the year ending 31st of December 2015, Refining NZ paid out salaries amounting to $48 million per year to employees of the Company, with a further $20 million paid to contractors. Significantly, he understands that 94% of those payments were made to employees and/or contractors' businesses residing in the Northland Region[488]. Of note, Mr Clough advises that the incomes earned by Refining NZ staff and its contractors directly helps retain nearly 500

[483] Greenaway, R, page 59, section 5.2.7, "Refining NZ Crude Shipping Project Recreation and Tourism Effects Assessment". Dated August 2017
[484] Greenaway, R, page 60, section 5.3, "Refining NZ Crude Shipping Project Recreation and Tourism Effects Assessment". Dated August 2017
[485] Greenaway, R, page 62, section 6, "Refining NZ Crude Shipping Project Recreation and Tourism Effects Assessment". Dated August 2017
[486] Clough, P, "Crude Shipping project, Economic assessment of channel deepening at the Marsden Point Refinery". Dated 02 August 2017
[487] Clough, P, page 6, section 2.2.1, "Crude Shipping project, Economic assessment of channel deepening at the Marsden Point Refinery". Dated 02 August 2017
[488] Clough, P, page 10, section 2.4, "Crude Shipping project, Economic assessment of channel deepening at the Marsden Point Refinery". Dated 02 August 2017

households in the region and their consumption of goods and services generates income and employment for local businesses in Whangarei. He also states that periodic shutdowns and investments provide additional income streams to the Northland Regional region, and expenditure by the Company and its employees has flow on effects in stimulating other business in the economy[489]. Given the foregoing, it is not surprising that Mr Clough considers the continued operation of the Refinery to be a significant driver of economic activity for the region.

3.14.2 Economic Consequences of the Proposal

Mr Clough advises that significant economic value could be added from the Proposal. In that regard, he highlights:

a. A producer surplus is expected from efficiencies in cargo handling that improve profitability for the oil supply industry, including for both Refining NZ and its customers;

b. A consumer surplus could arise if New Zealand consumers obtained lower prices, new products or improved security of products. However, in practice Mr Clough advises that the 'landed cost' of imported refined product sets the price across the market, so these consumer benefits are extremely limited for refined oil products; and

c. Externalities are expected, and would include both positive and negative environmental effects. He sees the potential positive effects as including a safer channel due to realignment with reduced environmental spill risk, or fewer ship movements enabled by deeper draught vessels and larger loads, with less disruption for other activities around the shipping channels. He highlights that the potential negative effects include any residual unmitigated adverse environmental effects, which have been assessed by other technical experts within this AEE.

For the individual consumer of oil products (that is, those that fill up their car at the petrol station) there is likely to only be a very small consumer gain as a result of the Proposal. This is because, as Mr Clough advises, the price of refined oil product is driven by the cost of importing into the country, so there is little price advantage to the consumer in local production. Put another way, when international prices for oil and oil products move, domestic prices move with them. However, Mr Clough does advise that the Proposal would result in the avoidance of disruption costs (such as extra costs and time in finding alternative transport methods of oil products) as a result of improving security of supply[490].

Mr Clough advises that the customers of Refining NZ (being the oil product wholesalers), and indeed the Company, are expected to protect their producer surplus, should the Proposal proceed. Mr Clough estimates that for a fully laden Suezmax tanker that carries 1.05 MMbbl, the saving to Refining NZ could be approximately $17 million per year when compared to the current Aframax tankers that carry 700,000 barrels of oil[491].

Mr Clough notes that the cost of the Proposal (to Refining NZ) has been estimated at $37 million. He notes that Refining NZ will also incur costs for additional tank capacity to handle the larger

489 Clough, P, page 11, section 2.4, "Crude Shipping project, Economic assessment of channel deepening at the Marsden Point Refinery". Dated 02 August 2017

490 Clough, P, pages 16 and 17, section 3.1.1, "Crude Shipping project, Economic assessment of channel deepening at the Marsden Point Refinery". Dated 02 August 2017

491 Clough, P, page 17, section 3.1.2, "Crude Shipping project, Economic assessment of channel deepening at the Marsden Point Refinery". Dated 02 August 2017

volumes being imported to the Refinery, the cost of which has been estimated at $20 million. Overall, the total project initial cost is expected to be approximately $57 million. Mr Clough calculates that this figure amounts to costs of $4.9 million per year (over 35 years) or $6.2 million (over 15 years). Mr Clough goes on to advise that both of these cost estimates are well below the potential savings ($17 million) as a result of the Refinery receiving larger loads in shipments of 1.05 MMbbl). Importantly, Mr Clough notes that the net benefit of receiving larger loads appears to be positive on an annualised basis, assuming constant prices over time. However, the net present value over the full consenting period (being 35 years) would vary according to future movements in the delivery cost per barrel[492].

In terms of effects on the local economy, Mr Clough records that although the Company is expected to invest $57 million in capital expenditure to complete the Proposal, much of this expenditure will not be spent in the local economy if dredging contractors and materials for tank expansion are obtained from suppliers outside Northland. However, a proportion of labour on tank installation is likely to be sourced locally and support incomes in the region. In addition, he expects that there may also be periodic maintenance spending, but these are unlikely to exceed $1 million per year. As consequence, Mr Clough notes that the direct impact, and any indirect impact from flow on expenditure in the local economy, is likely to be small, with the main effect of the Proposal being on the local economy (that is, the benefit is associated with the improvement in the Refinery's competitiveness and the improved likelihood of its current operations continuing)[493].

In terms of effects of the Proposal on the wider economy, Mr Clough advises that completing the Proposal will avoid the requirement to increase imports of refined products. He notes that, in principle, increasing imports of refined products instead of crude oil can impact on the balance of payments[494], which, in turn, places pressure on the exchange rate. In this regard, Mr Clough explains that Refining NZ contributes approximately 0.2% to the National GDP. As such, any reduction in the Refinery's activity is likely to be met by increases in refined product imports by oil product wholesalers, who generate less value to the economy through their procurement process of refined products, rather than utilising Marsden Point to refine crude oil. In practice, however, Mr Clough does not expect any increased 'pressure' to be significant, as the Company's wholesale customers import crude oil, to which Refining NZ adds value. We understand that importing a refined product is likely to have a larger impact in that regard. Indeed, the advice of Mr Clough is that as the difference between imported crude and the imported refined product is only a small proportion of the cost of supplying oil products to New Zealand, macro-economic effects (such as pressure on balance of payments or exchange rates) can be ignored in this case [495].

Mr Clough also advises that should the Proposal not proceed, Refining NZ may convert its facility so that it is an importer, rather than a refiner, of oil. This would enable the Refinery to distribute the refined product to Auckland via the RAP. As such, the risk of asset stranding, should the Proposal not proceed, is not considered significant by Mr Clough. Of note, however, is his advice that to avoid the double handling of the imported refined products, the distribution of refined oil from the Refinery

[492] Clough, P, page 17, section 3.1.2, "Crude Shipping project, Economic assessment of channel deepening at the Marsden Point Refinery". Dated 02 August 2017

[493] Clough, P, page 17, section 3.1.3, "Crude Shipping project, Economic assessment of channel deepening at the Marsden Point Refinery". Dated 02 August 2017

[494] The Balance of Payments is the difference in total value between payments into and out of a country over a period, usually being every quarter or year, and provides a comprehensive record of New Zealand's economic relationship with the rest of the world.

[495] Clough, P, page 18, section 3.1.4, "Crude Shipping project, Economic assessment of channel deepening at the Marsden Point Refinery". Dated 02 August 2017

to the regional centres (through coastal shipping) would cease[496]. This suggests, to us, that the jetty associated with the Refinery would not enjoy the same level of use that it does presently.

3.14.3 Effects on the National Environment

Refining NZ engaged a number of technical experts to investigate the effects on the environment. While Mr Clough advises that economic valuations of environmental protection are rarely used in a Resource Management Act setting (because of practical difficulties in estimation) economic principles still apply to the consideration of environmental effects. Given this, Mr Clough undertook an economic assessment in terms of effects on the natural environment. Having done so, he is of the opinion that the effects on the natural environment fall into three broad categories, being:

a. Effects on other vessels and activities sharing the harbour entrance;
b. Effects of seabed disturbance; and
c. Effects of emissions into the environment.

3.14.4 Vessels

Mr Clough notes that the delivery of larger cargoes reduces the number of vessel trips required to import unrefined oil. Mr Clough reiterates the advice of Mr Oldham, who states that enabling fully laden Suezmax tankers could reduce the number of deliveries to the Refinery from current yearly volumes of 59, to 48 visits per year on average[497], which represents a reduction of approximately 19%. While he observes that the current harbour channel is not congested, Mr Clough expects that a reduction in vessel movements will have a positive effect in reducing the likelihood of vessel encounters and the already low possibilities of collision or running aground[498]. He also notes, drawing on advice from Mr Bermingham, that the Proposal will also improve navigational safety for all commercial vessels, not just crude tankers.

Mr Clough notes that if the Refinery were to close, vessel movements would reduce as crude carriers and coastal tanker trips are discontinued and replaced by fewer deliveries of refined oil products to the Whangarei harbour. While he accepts that there might be implications for vessel movements to other ports in New Zealand (as shipments for refined product into other ports are driven by demand), Mr Clough advises that it is unlikely that there would be an increase in shipping movements in aggregate, as the average size of refined product tankers could be higher than that of the current coastal tankers[499].

3.14.5 Sediment Disturbances

Mr Clough states that seabed disturbance may be viewed as an adverse effect on the environment and will certainly be increased, at least temporarily, as a consequence of the Proposal. We understand Mr Clough's opinion to be that, from an economic perspective, while retaining the current configuration of the channel would avoid the cost of dredging as proposed, this would incur an

[496] Clough, P, page 18, section 3.1.4, "Crude Shipping project, Economic assessment of channel deepening at the Marsden Point Refinery". Dated 02 August 2017
[497] Oldham, K, page 21, section 7.3, "Environmental Spill Risk Assessment for Proposed Tanker Operations Associated with Engineered Channel", Dated 14 August 2017
[498] Clough, P, page 19, section 3.2, "Crude Shipping project, Economic assessment of channel deepening at the Marsden Point Refinery". Dated 02 August 2017
[499] Clough, P, page 19, section 3.2, "Crude Shipping project, Economic assessment of channel deepening at the Marsden Point Refinery". Dated 02 August 2017

opportunity cost of lost delivery savings over multiple years from not allowing fully laden Suezmax ships to visit the Refinery. As such, Mr Clough states retaining the channel in its current state would be inefficient, as the marginal cost of lost savings would be high, while the marginal benefit for the environment would be low, given that the channel occupies a very low proportion of sea bed within the Harbour entrance and is already subject to shipping movements. In the environment, as in other resources, scarcity and authenticity confer economic value and neither of those is considered significant by Mr Clough in this instance[500].

3.14.6 Emissions

Another consequence of channel deepening raised by Mr Clough is that with larger loads and fewer ships the volume of greenhouse gas emissions from crude deliveries should decline relative to continuing with the current operations. Mr Clough notes that larger loads reduce the emissions per barrel transported[501]. We take this to be a benefit of the Proposal.

While, in Mr Cloughs opinion, Section 104E of the Act precludes the consideration of climate change (except for energy efficiency and renewable generation), he notes that wider Government policy on climate change still allows Local Councils to consider emission-related measures that are not covered by existing policy instruments. As international shipping is outside the coverage of Kyoto Protocol and subsequent international agreements, Mr Clough contends that it is an external effect on environment which can be considered. He notes, however, that it is difficult to quantify[502].

Mr Clough also comments that there may be other environmental effects which are less amenable to quantification. But beyond the obvious impacts on dredging and deposition, Mr Clough records that the reduction in vessel movements and opportunities for reclamation are potentially positive for the environment and reduce costs for people in it, even if they cannot all be quantified[503].

3.14.7 The Future Without Channel Deepening

Mr Clough also reiterates advice that we have previously conveyed, being that if the channel deepening is not completed, Refining NZ would be unable to accommodate fully laden Suezmax ships. He notes, however, that this would forgo reduced cost of transport per barrel that fully laden Suezmax vessels generate. Without access to larger cargoes, Mr Clough expects that the Company's margins will be 'squeezed' by competition from more scale efficient refineries in Asia. This could, he notes, result in the closure or reduction of operations of the Refining NZ's operations, which he reports has occurred in a number of refineries in Australia due to competition from more modern, larger and efficient refineries in the Asian region driving structural change on the supply chain[504].

If the Refinery shut down and New Zealand moved to importing all its refined oil products Mr Clough advises that the Refining NZ's expenditure and employment in Northland would cease, except to the

[500] Clough, P, page 19, section 3.2, "Crude Shipping project, Economic assessment of channel deepening at the Marsden Point Refinery". Dated 02 August 2017
[501] Clough, P, page 19, section 3.2, "Crude Shipping project, Economic assessment of channel deepening at the Marsden Point Refinery". Dated 02 August 2017
[502] Clough, P, page 20, section 3.2, "Crude Shipping project, Economic assessment of channel deepening at the Marsden Point Refinery". Dated 02 August 2017
[503] Clough, P, page 20, section 3.2, "Crude Shipping project, Economic assessment of channel deepening at the Marsden Point Refinery". Dated 02 August 2017
[504] Clough, P, page 12, section 2.6, "Crude Shipping project, Economic assessment of channel deepening at the Marsden Point Refinery". Dated 02 August 2017

extent it retained some oil terminal operations to receive imported products and feed them into the RAP. He then offers advice as to the choice that exists between this Proposal and retaining the status quo[505]. In that regard, we understand his advice to be:

a. With channel deepening, there would be a saving in the cost of deliveries of crude oil, some operational efficiencies for Refining NZ and its customers, and improvement in the Company's competitiveness, which could sustain spending and employment in Northland's economy.

b. With the retention of the status quo:

    I. In the short term, RNZ would continue to operate but, without the savings and operational efficiencies provided by larger cargoes, losing competitiveness against larger refineries overseas; and

    ii. In the long term, RNZ could not compete with imported refined product and would close its refining operations and likely convert to an import terminal and distribution point, with reduction in spending and employment in the Northland region and in New Zealand at large. In addition, and as noted by Mr Clough, if the Refinery were to permanently close there may be additional site remediation costs due to the activities that have taken place on the Site. If that were to occur, Mr Clough records that the Site remediation costs have been estimated to be in the order of $300 million. Therefore, retaining the operation of the Refinery by improving access in the channel could defer these costs for up to 35 years (being the term of the consent sought.)[506]

3.14.8 Summary

Mr Clough advises that if the Proposal does not proceed, then the Company will continue to face competition from refineries outside of New Zealand. This could, he notes, result in the closure of the Refinery processes undertaken at Marsden Point, which, in turn, would have a significant negative impact on the Northland regional economic activity and well-being.

In addition, Mr Clough concludes that there are a number of external benefits for the wider community, including a reduction in vessel movements in the Harbour that, in turn, reduces greenhouse gas emissions from fewer crude deliveries, all things being equal. The proposed realignment of the channel also provides, in his opinion, a benefit for other shipping in the approach to Whangarei Harbour. Further, Mr Clough notes that if the Refinery closed, the facilities at Marsden Point are likely to be converted to an oil terminal that handles imported oil products for dispatch via the RAP to Auckland. That would reduce the overall number of shipping movements around Marsden Point, as crude carriers and coastal tankers were discontinued and replaced by tankers importing refined oil products. Mr Clough summarises that the environmental effects of such changes would need to be weighed against the loss of economic contribution from the Refinery's probable contraction to an oil terminal, which is likely to contribute a much lower level to the economy when compared to the Refinery in operation.

Overall, Mr Clough states that:

---

[505] Clough, P, page 12, section 2.6, "Crude Shipping project, Economic assessment of channel deepening at the Marsden Point Refinery". Dated 02 August 2017

[506] Clough, P, page 14, section 2.6, "Crude Shipping project, Economic assessment of channel deepening at the Marsden Point Refinery". Dated 02 August 2017

"From the analysis in this report the channel deepening is likely to enable benefits that are larger than the costs incurred by the project, indicating it is an efficient use of resources, in line with the Resource Management Act's section 7(b). By assisting the refinery to continue its current operations and supply of economic surplus to the region and New Zealand at large, it also enables communities to provide for their economic well-being in line with the Act's section 5."[507]

3.15 Positive Effects

There are a number of actual and potential positive effects associated with the Proposal, some of which have been previously highlighted. We now provide a complete list of the beneficial effects, including items identified by Poten and Partners Limited ('**P&P**')[508] but not yet highlighted. When considered collectively, we are of the opinion that they represent a significant beneficial impact.

a. The larger the oil carrying capacity of a tanker, the lower the cost per transported barrel, especially for long haul crude oil supply routes. Large oil tankers offer significant economy of scale advantages as the operating expenses of larger vessels are (relatively speaking) much lower than those of smaller vessels. The annual savings to Refining NZ (in delivery costs) are estimated to be up to $17 million a year. This range is well above the annualised cost of undertaking the Proposal works, which is estimated to be around $6 million a year. This would improve the competitive position of the refinery against foreign supplies and sustain the operation of the refinery into the future. We also understand from Mr Clough that this relationship means that the Proposal is economically efficient[509].

b. The direct impact of the Proposal will involve a capital expenditure of $37 million on dredging operations, and $20 million on installing further tank capacity at the Refinery. Of this $57 million, much of it will not be spent in the local economy, if dredging contractors and materials for tank expansion are obtained from suppliers outside the Region. However, a proportion of labour on tank installation is likely to be sourced locally and support incomes in the region. There may also be periodic maintenance spending of up to $1 million a year.[510]

c. The main effect on the local economy is derived from the improvement in the Refinery's competitiveness and the consequential impact of increasing the probability that the Refinery will continue to operate. This will, we understand, prolong the period over which the Refinery contributes to the economy of Northland. We further understand that the Refinery has a particular significance for the Northland economy, given poor performance on a number of economic and social measures. Closure of the Refinery, with its well-paid workforce and its contribution to business expenditures in the Region, would have, we understand, a significant negative impact on regional economic activity[511].

d. Larger cargoes reduce the number of vessel trips required to deliver the crude oil to the Refinery. This is expected to reduce the number of deliveries for current yearly volumes from 59 to 48, a reduction of about 19%. Mr Oldham advises that this has a consequential reduction in the level of environmental risk that is faced from oil spills[512].

[507] Clough, P, page 23, section 4, "Crude Shipping project, Economic assessment of channel deepening at the Marsden Point Refinery". Dated 02 August 20107
[508] Crude Shipping Alternatives: Marsden Point – NZ, Prepared by Poten & Partners for Refining NZ, Dated August 2016
[509] Clough, P, "Crude Shipping project, Economic assessment of channel deepening at the Marsden Point Refinery". Dated 02 August 2017
[510] Clough, P, "Crude Shipping project, Economic assessment of channel deepening at the Marsden Point Refinery". Dated 02 August 2017.
[511] Clough, P, "Crude Shipping project, Economic assessment of channel deepening at the Marsden Point Refinery". Dated 02 August 2017.
[512] Oldham, K, "Environmental Spill Risk Assessment for Proposed Tanker Operations Associated with Engineered Channel", Dated 14 August 2017

e. Mr Bermingham advises that the proposed realignment of the entrance channel will improve navigational safety for all shipping, not just crude tankers[513].

f. Mr Clough also advises that another consequence of Proposal is that larger loads of crude oil and fewer tankers will reduce the volume of greenhouse gas emissions from crude deliveries, all things being equal[514].

g. Mr Clough also advises that there is strategic benefit in prolonging the Refinery's operation. We understand the benefit to be that this outcome defers the date at which refinery closure would incur site remediation costs, which are estimated to be approximately $300 million[515].

h. Mr Reinen-Hamill advises that the placement of dredged material within Disposal Area 1.2 will maintain the volume of the ETD and maintaining a supply of sand to both the shoal and the adjacent shoreline. This, we understand, will both offset an effect of the Proposal, while improving the resilience of Mair Bank to the expected effects of sea level rise.

i. Mr Don advises that the breeding opportunity and potential success of little penguin will be enhanced via the provision of nesting boxes both within the Harbour if they are maintained in the long-term[516], which is what we understand Refining NZ proposes (Martin, D, pers. com).

j. Mr Don advises that in the longer term, the maintenance of little penguin nesting boxes, especially in predator controlled areas, will generate a positive benefit to the Harbour's population of the same[517].

k. Dr Coffey also advises that the proposed ecological enhancement / restoration initiatives will benefit the ecology of the Whangarei Harbour ongoing resilience within Bream Bay and the Harbour[518].

[513] Bermingham, G, "Report in Support of an Assessment of Effects on the Environment, Navigational Risk Assessment of Engineered Channel Designs". Dated 15 August 2017.
[514] Clough, P, "Crude Shipping project, Economic assessment of channel deepening at the Marsden Point Refinery". Dated 02 August 2017.
[515] Clough, P, "Crude Shipping project, Economic assessment of channel deepening at the Marsden Point Refinery". Dated 02 August 2017.
[516] Don, G, "Crude Shipping Project, AEE Report, Coastal Birds, Final", Dated 09 August 2017
[517] Don, G, page 40, section 5.2.1.1, "Crude Shipping Project, AEE Report, Coastal Birds, Final", Dated 09 August 2017
[518] Don, G, "Crude Shipping Project, AEE Report, Coastal Birds, Final", Dated 09 August 2017

4.0 CONSULTATION

4.1 General Approach

Refining NZ sought to both understand who is likely to have an interest in the Proposal, and then to proactively engage with them in a manner that was, in our opinion and experience, genuine, transparent, and open (insofar as the outcome was not preconceived) and provided sufficient time for parties to consider the material and respond.

Initially, this saw the Company seeking feedback from key staff, members of the expert team appointed to assist with the advancement of the Proposal, representatives from Patuharakeke and Ngati Wai and the Regional Council as to:

1. The Tangata Whenua and iwi groups with an interest in the Proposal and the environs that could be effected;
2. The potentially affected parties (in addition to those set out in bullet point (1.));
3. The applicable stakeholder groups; and
4. Parties who could be interested in the Proposal, but whom may not fall within the ambit of the groups set out in bullet points (1.) to (3.)

Having developed an initial list, Refining NZ then engaged with a number of parties early in the Proposal's development. The engagement was typically detailed and was focussed on explaining the Proposal (both in terms of the concept being considered and the need for it) and seeking feedback as to the issues that would need to be addressed and the studies that would need to be commissioned. This approach was seen as being critical for the Company to both maintain existing relationships with the parties that were identified, and to develop new (effective) relationships where none presently existed.

In recognition of their status as Tangata Whenua, consultation initially began with the hapu and iwi that could be potentially impacted or affected by the Proposal. That focus was, however, quickly expanded to include the likes of the WDC, the Regional Council's, various stakeholders and interested parties, and the general public.

In addition, and in accordance with the MACA Act, Refining NZ has written to the twelve tangata whenua parties, listed in Section 1 of this AEE, that have made applications to recognise Customary Marine Titles across the Site. Refining NZ notified the applicants for Customary Marine Title of its upcoming application for resource consent for the Crude Shipping Project, and sought the views of those applicants on its application. Where a substantive response has been received, Refining NZ has considered, and where appropriate, responded to that feedback. Copies of that correspondence are available on request.

A consultation database was established to record ongoing engagement.

We now summarise the consultation that was undertaken with Tangata Whenua, the general public, and stakeholders.

4.2 Consultation with Tangata Whenua

An engagement process for Tangata Whenua was developed in 2014 following early discussions with local hapu, Patuharakeke, representatives from Ngatiwai, and the Regional Council. The output of this initial consultation was a list of hapu and iwi with known relationships both in and around the Whangarei Harbour and Bream Bay who were likely to have an interest in the Proposal.

It is important to recognise that engagement with Tangata Whenua has been facilitated by Patuharakeke representative, Juliane Chetham. It is also important to recognise, however, that Ms Chetham has remained separate from the independent experts that the Refinery has engaged. In this regard, while the Refinery funded Ms Chetham's work, her client was the Tangata Whenua groups (collective) that she prepared both the CVA and the CEA for.

From 2014 until the lodgement of this resource consent application, a working group headed by the Patuharakeke and Ngatiwai resource managers has been provided with regular updates, draft reports and completed studies by the independent experts. Additionally, Ms Chetham has attended three workshops with the experts that are assisting Refining NZ. The workshops were to set out a preliminary framework for the potential disposal sites; consider alternatives to dredging and update on progress of individual expert studies.

The purpose of this ongoing engagement has been for Tangata Whenua to identify cultural values on the Harbour and the Bay, agree areas where whanau could be practically involved in the expert studies (such as being involved in the marine ecology sampling and acting as an observer in the ship simulations) and to prepare both the CVA and CEA.

In addition, consultation hui have been held with the broader Tangata Whenua groups, the objective of which has been to inform attendees about the Proposal, and to update on progress. Four hui of this nature have been conducted, being:

1. Two consultation hui with were conducted with staff from the Company in May and September 2014. Both hui were used to introduce the Proposal, and to seek broad feedback as to areas of concern, and reports that were needed. The need for a CVA and draft CEA arose out of these hui, as did the suggestion that it be prepared by Ms Chetham;
2. A consultation hui with some of Refining NZ independent experts'[519] present was held in March 2015 to discuss the methodology to be used by the experts for their studies; and
3. A second consultation hui was held in April 2017 where the three independent experts[520] talked through the findings of their reports. The reports discussed related to marine mammals, marine ecology (excluding avifauna) and coastal processes.

During the engagement process, Refining NZ has offered to attend separate consultation hui with Tangata Whenua groups and/or individuals that were not able to be present, or who wanted to engage separately and directly with the Refinery. This was taken up by Ngati Kahu in November 2014. A consultation hui with Te Waiariki is also scheduled to take place in October 2017, with key independent experts to attend.

[519] The hui was attended by Dr Coffey, Dr McComb, Mr Don, Dr Clement, Mr Reinen-Hamill, Mr Simmons (of Chancery Green) & Mr Kemble (of Ryder)
[520] Being Dr Coffey, Mr Reinen-Hamill & Dr Clement.

Furthermore, in early April 2017, Refining NZ emailed each of the hapu and iwi on the list prepared at the outset of the consultation process, a link to the deeper story website, pop-up container dates and locations for public consultation events.

Lastly (on this matter), Refining NZ has also periodically checked with the Ms Chetham that all of the relevant hapu and iwi have continued to be included in the engagement process; either directly through attendance at the consultation hui, or via briefing from the Ms Chetham. The advice provided to the Company was, we understand (pers. com; McNeill, G) that this level of broad engagement was being achieved.

4.3 Feedback from Tangata Whenua

The Tangata Whenua groups consulted have raised a number of issues, which we now summarise:

1. At the consultation hui on 9 March 2015, Tangata Whenua raised several cultural issues that touched on almost every aspect of the Proposal. The common and recurrent consideration was ecosystem health. Put another way, the feedback was that the Proposal must not be allowed to negatively impact on the ecological health of the Whangarei Harbour or Bream Bay.
2. A recurrent concern that has been frequently raised is the potential for the Proposal to contribute to the declining pipi numbers on Mair Bank, and the potential for the introduction of pest organisms in the Harbour.
3. The cumulative effects of development (in general) on the Harbour has been highlighted as a concern, as has the potential for the Proposal to worsen that situation. Many have stated that Refining NZ needs to leave the environs in a better condition than they found them in. When raising this issue, a number of groups have advised that mitigation and offsetting are likely to be needed, but that 'avoidance' should be the priority.
4. Some of the Tangata Whenua groups have indicated that the effects of dredging plume on the ecology of the Harbour and Bream Bay is of concern, and will need to be carefully managed. Others have asked that the geomorphological and hydraulic changes that could be caused by the Proposal need to be carefully considered to ensure that any change is not unacceptably adverse.
5. Land disposal of dredged material considered important and is generally regarded as being the preference of most of the Tangata Whenua representatives that Refining NZ has consulted.
6. The risk of oil spill as a consequence of the more heavily laden tankers visiting the Site was also raised as an important issue by many that were consulted.
7. Repeated concern was expressed about the potential impact of the proposal on marine mammals, with most focus being on whether the Proposal could lead to further mass stranding's of marine mammals. Examples were given of a mass pilot whale stranding in the area in 2006 and an Orca stranding, after chasing a stingray. Another query raised was whether water quality was impacting on marine mammals.

In response to 'consultation draft' of the technical reports and the discussion points raised during the hui held in April of 2017, Ms Chetham provided a 'Technical Review'. The Technical Review was prepared by a consulting entity that Refining NZ funded, but that reported directly to Ms Chetham. The Technical Review posed a number of queries in relation to the draft technical reports. The

Technical Review was shared with the independent experts that have been advising Refining NZ and their feedback, sought. Ultimately every query raised in the Technical Review was responded to by Refining NZ (the response was issued on the 12th of May, 2017). A copy of the Technical Review and Refining NZ's response is attached as **Annexure Five** to this AEE.

A draft copy of the Cultural Effects Assessment ('**the draft CEA'**) was presented to Refining NZ by Juliane Chetham and members of the Patuharakeke Trust Board on 15 June, 2017. Following discussion at that hui, the draft was shared with a number of the independent experts advising Refining NZ (including independent cultural expert, Antoine Coffin). Each expert was asked to consider the draft CEA and to provide a response to the issues and cultural concerns of relevance to their expertise. Refining NZ considered the responses from the experts and provided its formal written response to Juliane Chetham on 2 August, 2017. Ms Chetham has subsequently requested further discussion with Refining NZ before the draft CEA is finalised.

In addition to the formal response to the draft CEA, in June 2017 Refining NZ had discussions with representatives of Ngati Kahu (Waimarie Bruce Kingi) and in July 2017 with the Chairman and Chief Executive of the Ngatiwai Trust Board, (with Juliane Chetham in attendance) regarding options to mitigate (or otherwise address) the concerns highlighted in the draft CEA. Both sets of discussions focused on the possibility of a Kaitiaki forum as the primary 'vehicle' for mitigation measures to be pursued. These discussions are ongoing.

4.4 Public Consultation

Two rounds of public consultation on the Proposal were held in March 2015, and the March/April 2017, respectively. We now summarise each round.

4.4.1 Round One: 2015

The consultation conducted during March of 2015[521] introduced the need for the Proposal and outlined the study methodologies that were to be employed by a number of the independent experts engaged to assist Refining NZ[522]. The independent experts were on hand to discuss the methodology of their studies with members of the public.

Consultation was conducted via a series of 'drop-in' sessions with Refining NZ staff and independent experts. This form of consultation was chosen ahead of a 'public meeting' format as it offered better opportunity for discussion with individual members of the public, whereby the independent experts could gain local commentary as to the issues, and access to data to help inform their studies. Sessions were held at the Refinery's Visitor Centre; Forum North (Whangarei city); Parua Bay School (Whangarei Heads).

The public consultation was supported by flyers that were sent to all households in Whangarei, advertising in community papers, The Northern Advocate, The Leader and media releases with details of consultation dates, times and locations. Examples of the materials used are attached at

[521] The public consultation spanned the 9th and 10th of March 2016

[522] Both days were attended by Dr Coffey, Dr McComb, Mr Don, Dr Clement, Mr Reinen-Hamill, Mr Simmons (of Chancery Green) & Mr Kemble (of Ryder Consulting Limited)

Annexure Six to this AEE. An estimated 100 members of the public were consulted during the two day of public consultation that were undertaken in 2016.

4.4.2 Round Two: 2017

The public consultation in 2017 reiterated the need for the Proposal, reported on the findings of the independent expert studies and made those studies available to the public (as a draft for consultation).

A stand-alone, website was developed (www.deeperstory.co.nz). The website included an introduction to the Proposal; summaries of the independent export reports as well as the full reports; dates, times and locations for the pop-up information container and 'drop-in' sessions for members of the public to speak to staff from the Refinery and a selection of the independent experts that have been advising the Company; contact details for further information; and a link for the public to feedback on the Proposal. The website is still operational and will be updated as the Proposal advances through the resource consent application process.

Visibility in the Whangarei District was a key objective for the public consultation process. This was achieved in 2017 via a pop-up information container in key locations over a period of three weeks, (refer to **Figure 4.4.2.1)**. Six locations were chosen for their visibility, foot traffic, and accessibility (Town Basin, central library, Hatea Loop, McLeod's Bay, Parua Bay, Ruakaka town centre). The locations within Whangarei's town centre were chosen after advice from WDC staff.

Figure 4.4.2.1: Pop-Up Container in Use in 2017

Drop-in sessions were also held at the Bream Bay Community Support Trust, Ruakaka (April 7); Forum North, Whangarei (April 8); Parua Bay School hall, Whangarei Heads (April 8). A variety of material was made available during the drop-in sessions and from the pop-up information container. It included an introductory brochure to the Proposal, and summary effects brochures for each key study area. Copies of all of the brochures are attached at **Annexure Six** to this AEE.

The public consultation was supported by a publicity programme (which consisted of mail flyers that were delivered to each house in Whangarei and advertising in community newspaper, The Leader. Additionally, a media release was distributed to Northland based media, and posts were made on the Refining NZ Facebook page before during and after the public consultation[523]. Copies of the flyers, a sample of the advertisements, media release and the Facebook posts are attached at **Annexure Six** to this AEE.

An estimated 560 members of the public visited the pop-up container and/or attended the drop-in sessions. The website launched in mid-March in 2017 and up to the lodgement of this resource consent application has had around 3030 web visits (400 per day at their peak) and around 5,224 page views.

4.5 Consultation with Stakeholder Groups

Throughout the consultation process, the applicable stakeholder groups have been briefed on the Proposal, either by staff of Refining NZ attending regular meetings of these groups (notably, residents and ratepayers' associations), by separate appointment, or via email and/or telephone contact. The objective of this engagement was to enable informed responses to the Proposal, input into the types of investigations that were required, input into the methodologies to be employed in undertaking the investigations and to gain feedback on the technical reports that were provided as 'consultation drafts'.

The public consultation days in March 2015 were used as an opportunity for the independent experts to brief stakeholder groups. A meeting with Northport raised no concerns about the Proposal, but an additional comment from the Harbourmaster was that Proposal would improve navigability in the entrance channel[524]. At a meeting with NIWA, DoC and Regional Council representatives, DoC raised a general concern about the impact of the Proposal on marine mammals[525].

Other opportunities for the independent experts to engage / meet with stakeholder groups were undertaken as they arose, such as where an update on study progress was required, or where it was clear there were concerns about the Proposal to be addressed. In November 2015 expert Mr Mocke[526] briefed the Regional Council's Harbourmaster on channel design options. A 'Harbour Catchment Group' meeting convened by the Regional Council in May 2016 raised queries around the potential impact of an oil spill on kai moana, ship safety, and the potential impact of noise from dredging[527]. In March of 2017 Mr Boyd [528] attended a meeting of commercial fishermen where concern was expressed about the potential impact of dredging disposal on fish and shellfish stocks (such as crabs and scallops). In April 2017 Mr Greenaway[529] spoke to the owner of the 'Top Catch' fishing shop in Whangarei about the potential impact of the Proposal for recreational fishers in the Harbour, where he is principally provided information concerning the potential impact of dredge plumes and the silt content of dredge material.

[524] Attended by Dr McComb, Mr Don, Dr Clement, Mr Reinen-Hamill & Mr Kemble
[525] Attended by Mr Reinen-Hamill, Mr Don, Dr Clement & Mr Kemble
[526] Representing Royal Haskoning DHV Limited
[527] Attended by Mr Reinen-Hamill, & Dr Coffey
[528] Representing Boyd Fisheries Consultants Limited
[529] Representing Rob Greenaway and Associates Limited

The stakeholder groups[530] consulted included: residents in Ruakaka and across the Whangarei Heads community (Parua Bay, McLeods Bay, Urquharts Bay, Taurikura, Reotahi),; recreational boating groups; recreational surfing and fishing groups; environmental organisations (such as DoC, the Royal Forest and Bird Protection Society and the Environmental Defence Society); harbour users; commercial fishermen; oil company customers; the Regional Council; the WDC; national authorities; and Members of Parliament[531].

Each engagement has been noted in a consultation database held by Refining NZ. A full list of the applicable stakeholders is repeated in Footnote 531.

4.6 Feedback from the Public & the Stakeholders

1. As with Tangata Whenua, a recurrent concern was the decline in numbers of pipi on Mair Bank. Several stated that the Proposal should not do anything to worsen the decline that is being seen at Mair Bank or elsewhere.
2. Concern was also expressed about where the dredged material should be disposed, and the effects of the disposal process on benthic populations (particularly, again, on Mair Bank). A number of members of the public expressed a preference for the dredged material to be disposed on land. The suggestion was made that dredge material be used for beach and dune restoration at Whangarei Heads, Bream Bay, Riverside and on the Onerahi foreshore.
3. There was a general perception that increasing the size of crude shipments would increase the risk of an oil spill. However, the proposed navigational improvements were understood, with most people seeing the benefits of improved channel design for navigational safety.
4. Concern was expressed about the potential impact on the harbour environment: on the Marine Reserve and from dredging plumes on marine mammals. Commercial fishermen briefed on the proposal were concerned about an impact on scallop and crab fishing from dredge disposal. Recreational fishermen expressed concern about potential impact for fishing from tidal changes, dredging plumes.
5. The vast majority consulted via the pop-up information container and the expert drop-in sessions were supportive of the Proposal, with the caveat from some, that it be carried out in a considered way, with care for the environment. The opportunity to talk to independent experts was appreciated. Additional comment was made that Refining NZ's 'science' must be of an excellent standard.
6. Overall, members of the public were complimentary about the public consultation process: the quality of the website; the pop-up information container; and the Refinery taking the time to consult with the community.

[530] Residents: Ruakaka Residents and Ratepayers Association; Whangarei Heads Citizens Association, Marsden Point Liaison Committee. Recreational boating groups: Whangarei Cruising Club, Outdoor Boating Club; Onerahi Yacht Club. Environmental groups: Department of Conservation; Northland Conservation Board; Forest and Bird; Environmental Defence Society; Bream Head Conservation Trust; Bream Bay Coastal Care; Mountains to Sea Conservation Trust; Marine Reserve Advisory Committee (convened by DOC); Dr Ingrid Visser. Harbour users: Northport; Harbour Safety Group; Harbourmaster; NorthTugz. Commercial fishermen: Scallop Enhancement Group; crab fishermen; Danish Siene trawlers. Oil Company Customers: BP; Z Energy; Caltex; Mobil, Coastal Oil Logistics Ltd (COLL). Regional authorities: Whangarei District Council; Northland Regional Council (NRC); NRC Maori Advisory Committee; Whangarei Harbour Catchment Group (convened by NRC); Harbour Safety Committee. National authorities: Maritime New Zealand; Members of Parliament: Dr Shane Reti, MP for Whangarei; Dr Nick Smith, Environment Minister. Recreational surfing and fishing groups: Whangarei Deep Sea Anglers Club; Mangawhai Boating & Fishing Club; North Coast Boardriders; Waipu Cove Surf School; Waipu Cove Surf Lifesaving Club; Ruakaka Surf Lifesaving Club

In March 2015, the independent experts were sent feedback from the meetings conducted with DoC, NIWA, Tangata Whenua, Northport and North Tugz, and from the public information events for their consideration.

In April 2017, the independent experts were sent the feedback from the second round of public consultation and from the Deeper Story website and requested to consider it in light of the information conveyed in their 'consultation draft' reports. We understand that the experts have considered and responded (as appropriate and necessary) to the issues that were raised.

Furthermore, drafts of the independent expert reports were made available to Tangata Whenua and stakeholders either directly or via link to the Deeper Story website. Feedback was received from Tangata Whenua, via a Technical Review report and responded to by Refining NZ with input from a number of the independent experts[532]. Feedback was also received from the Regional Council on the avifauna, geomorphology and coastal dynamics, and marine ecology reports. That feedback has also been passed to the experts for their consideration. Their reports have been updated, as deemed appropriate and necessary by the experts, to respond to the comments that have been received.

4.7 Further Consultation

Further consultation is planned to be undertaken when the resource consent applications for the Proposal are publically notified. The objective of this phase will be to convey information in order to inform the submission process. This phase may include further public information events and/or direct meetings between the parties.

Once the submission period has closed a further phase of consultation will commence. This 'post submission/per-hearing' consultation will see further engagement with submitters in an effort to see if any concerns raised can be addressed, and to determine if issues can be resolved or confined prior to a hearing.

[532] Mr Reinen-Hamill; Dr Coffey; Peter Clough (NZIER author)

5.0 STATUTORY PLANNING ASSESSMENT

5.1 Is a Resource Consent Required?

A fundamental question facing the Proposal is whether it requires a resource consent to proceed. Should a resource consent(s) be required, a further question is 'what considerations are relevant under both the Act and the applicable planning instruments (both statutory and non-statutory)?'

In order to determine if a resource consent is required, regard needs to be paid to Part 3 of the Act and then to the applicable provisions of the statutory planning instruments.

5.1.1 Part 3 of the Act

Part 3 of the Act contains 14 sections. Of those sections, 9 to 15C set out the instances where certain types of activities require a resource consent. We now discuss those sections that are relevant to the Proposal.

Section 12(1)(b) of the Act places restrictions on the structures that can be erected, altered, reconstructed, removed, placed (or fixed) or demolished in, on or under the seabed or foreshore. Section 12(1)(c) restricts disturbance activities that either have, or are likely to have an adverse effect on the foreshore and seabed. Furthermore, section 12(1)(d) restricts the deposition of material in, on or under the foreshore or seabed, where it could have an adverse effect on either of these two areas (the foreshore and seabed). The disturbance, damage or destruction of the foreshore and seabed is also restricted where it has adversely effected, or could adversely affect flora and fauna, or their habitat; or historic heritage (refer to sections 12(1)(e) and 12(1)(g) of the Act).

Sections 12(2) and 12(3) make it plain that proposals that contravene a rule of an applicable statutory planning instrument, and remove any sand, shingle, shell or other natural material from the CMA may only do so with a resource consent, or (in the case of the removal of material from the CMA) where a rule in an applicable statutory planning instrument enables it to occur as of right.

Sections 14(1) to 14(3) restrict the taking and use of open coastal water (meaning, in the context of this AEE, water from Bream Bay) and other coastal water (from within the likes of the Whangarei Harbour). In summary, unless the taking of the coastal water is permitted by a relevant statutory planning instrument, a resource consent is required for the activity to proceed.

Section 15(1)(a) of the Act restricts the discharge of contaminants or water to water (which, by definition, includes coastal water) unless it is expressly allowed by an applicable statutory planning instrument, or by a resource consent.

Lastly, section 15B of the Act is clear that the discharge of contaminants to water, or of water to water cannot proceed unless it is allowed by a statutory planning instrument or by a resource consent, or if, after reasonable mixing, it gives rise to all or any of the following effects:

a. The production of any conspicuous oil and grease films, scums or foams, or floatable or suspended materials.

b. Any conspicuous change of colour or visual clarity.

c. Any emission of objectionable odour.

d. Any significant adverse effects on aquatic life.

Section 15B is also clear that a discharge that falls within its ambit cannot occur in contravention of relevant regulations that have been made under the Act.

As we note later in this analysis, we understand the advice of Dr Coffey[533] to be that the Proposal will not cause any of the effects listed in sections 15B(1)(b) and 15B(2)(b) of the Act to arise. We note that he also confirms that the Proposal will comply with the regulations that apply to the discharge of sediment and water to the two disposal sites, and from the overflow of the dredge when it is dredging the harbour / sea bed. As a consequence, we conclude that a resource consent is not required under section 15B of the Act.

Given sections 12, 14 and 15 of the Act, the Proposal may only proceed if it is permitted as of right, or if a resource consent has first been secured for all aspects of its component parts. In order to determine if a resource consent is required, regard has been paid to the rules of the RCP. As no aspect of the proposal occurs outside of the CMA, and as no applicable NES exist[534], no other statutory planning instruments have been consulted to determine if a resource consent is needed.

5.2 The RCP

The dredging proposed is to be confined to the channel shown on **Figure 1.5.1**. This alignment has been overlaid across the 'zoning map' B25 from the RCP. The result of this exercise is shown on **Figure 1.4.1**. As is apparent from **Figure 1.4.1**, the proposed dredging would be undertaken in sections of the CMA that the RCP 'zones':

a. Marine 2 (Conservation) Management Area (or '**M2MA**'); and

b. Marine 5 (Port Facilities) Management Area (or '**M5MA**').

The dredged material will be discharged in two areas, being Disposal Area 1.2 and Disposal area 3.2. These spoil disposal locations are also located on **Figure 1.4.1**. As is apparent from that illustration, both disposal areas are also zoned M2MA.

It is important to note, given Rule 31.412(d) of the RCP, that **no** port development activities (which could only, in our opinion, be associated with works on the Marsden Point Jetty or its associated 'dolphins'[535]) will be undertaken within an area of the CMA zoned M2MA. In this regard, where any such works undertaken we are advised that they would occur entirely within the area zoned M5MA.

[533] Dr Coffey, B, page 54, section 6.4, "Crude Shipping Project. Proposal to Deepen and Partially Realign the Approaches to Marsden Point. Assessment of Marine Ecological Effects Excluding Seabirds and Marine Mammals". Dated 10 August 2017

[534] ChanceryGreen (counsel to Refining NZ) has considered the National Environmental Standard for Assessing and Managing Contaminants in Soil to Protect Human Health 2011 and determined that, as it deals with a function of a Territorial Authority under section 31 of the Act, that it does not apply in this instance.

[535] The RCP contains a broad definition of the term 'Port Area' (section 40 – Definitions, page 383, RCP). In this regard, and in summary, it could include any jetty where a commercial ship of over 4500 DWT regularly berths to load/unload cargo. Given that definition, we are of the opinion that the Marsden Point Jetty and the associated 'dolphins 'are a Port Area – as they are structures that fulfil the broad purpose set out in the RCP's definition. The RCP defines the term 'Port Development' to be "*the construction of a new port area or the expansion or alternation of an existing port area*". The Proposal involves dredging of the harbour channel to enable more fully laden vessels to enter the Port Area associated with Marsden Point. Those dredging works do not expand or alter the Port Area at Marsden Point.

That said, no works associated with the jetty and/or the dolphins form part of the Proposal. As a consequence, they are not discussed further in this analysis.

Lastly, it is important to record that none of the three additional Navaids, or the relocation of any of the existing Navaids will encroach into the areas of the CMA zoned Marine 1 (Protection) Management Area (or '**M1MA'**) by the RCP. In this regard, Refining NZ has confirmed that all of the works associated with the Navaids, and the structures themselves will be located within the M2MA zone.

Table A, which is attached as **Annexure Seven**, assesses the proposal against the applicable rules of the RCP. We note, for completeness, that a final draft of this assessment was reviewed by Officers of the NRC, whom agreed with our analysis, noting that it was, if anything, conservative.[536] As is apparent from Annexure A, the following resource consents are needed, and the following permitted activities are relied on, for the Proposal to proceed.

1. A coastal permit for a **Discretionary Activity** to undertake Capital Dredging in portions of the CMA zoned M2MA.
2. A coastal permit for a **Discretionary Activity** to undertake Capital Dredging in portions of the CMA zoned M5MA
3. A coastal permit for an **Innominate Activity**[537] to discharge water containing sediment and other contaminants (from the overflow of the Dredge) to the area of the CMA defined as M2MA.
4. A coastal permit for a **Discretionary Activity** to take water (as part of the Capital Dredging campaign) from within areas zoned M2MA.
5. A coastal permit for a **Discretionary Activity** to take water (as part of the Capital Dredging campaign) from within an area zoned M5MA.
6. A coastal permit for a **Discretionary Activity** to place / dispose of dredged material (from the Capital Dredging campaign) to two areas of the seabed zoned M2MA (being Disposal Areas 1.2 and 3.2).
7. A coastal permit for an **Innominate Activity** to discharge water with sediment and other contaminants, and sediment (containing other contaminants) to two areas of the CMA zoned M2MA.
8. A coastal permit for a **Discretionary Activity** to extract the dredged material (from within areas zoned M2MA) for sale, or provision to others whom are undertaking beach nourishment activities.[538]
9. A coastal permit for an **Innominate Activity** to extract the dredged material (from within an area zoned M5MA) for sale, or provision to others whom are undertaking beach nourishment activities.
10. A coastal permit consent for a **Controlled Activity** to relocate, replace and establish new Navaids in the two areas zoned M2MA. The discharge of contaminants into the CMA

[536] Email from Allan Richards to Gavin Kemble on the 27th of September 2016
[537] We note, for completeness, that section 87B of the Act states that an Innominate Activity is to be treated as an application for a Discretionary Activity
[538] Please note: The parties receiving the sediment and using it on land would be responsible for securing the necessary authorisations (including those required under the Resource Management Act 1991) to enable it to be 'received' and used. As a consequence, the 'receipt' and use of the dredged sediment on land does not form part of the Proposal, and thus is not considered further in this assessment

associated with the establishment of the aids requires a coastal permit for an **Innominate Activity**.

Please note that the Capital Dredging campaign relies on the following permitted activity:

1. That the discharge of overflow water (including the contaminants therein) is permitted in the area of the CMA zoned M5MA (please refer to Rule 31.7.6(a)). The rationale for this conclusion is set out in **Table A** of **Annexure Seven** of this AEE.

Maintenance Dredging Campaigns

1. A coastal permit for a **Discretionary Activity** to undertake Maintenance Dredging campaigns in portions of the CMA zoned M2MA.
2. A coastal permit for a **Controlled Activity** to undertake Maintenance Dredging campaigns in the portions of the CMA zoned M5MA.
3. A coastal permit for a **Discretionary Activity** to take water (as part of the Maintenance Dredging activity) from within areas zoned M2MA.
4. A coastal permit for a **Discretionary Activity** to take water (as part of the Maintenance Dredging activity) from within an area zoned M5MA
5. A coastal permit for an **Innominate Activity** to discharge water containing sediment and other contaminants (from the overflow of the Dredge) to the area of the CMA zoned M2MA.
6. A coastal permit for a **Discretionary Activity** to place / dispose of dredged material (from the Maintenance Dredging campaigns) to two areas of the seabed zoned M2MA (being disposal areas 1.2 and 3.2).
7. A coastal permit for an **Innominate Activity** to discharge water with sediment and other contaminants, and sediment (containing other contaminants) to two areas of the CMA zoned M2MA.
8. A coastal permit for a **Discretionary Activity** to extract the dredged material (from within areas zoned M2MA) for sale, or provision to others whom are undertaking beach nourishment or other land based activities.[539]
9. A coastal permit for an **Innominate Activity** to extract the dredged material (from within an area zoned M5MA) for sale, or provision to others whom are undertaking beach nourishment or other land based activities

Please note that the Maintenance Dredging campaigns rely on the following permitted activity:

1. That the discharge of overflow water (containing contaminants) is permitted in the area of the CMA zoned M5MA (please refer to Rule 31.7.6(a)). Again, the rationale for this conclusion is set out in **Table A** of **Annexure Seven** of this AEE.

Convention, case law and good planning practice dictate that 'bundling' occurs when a range of different resource consents are required for various components of a Proposal, and when the

[539] Please note: As with the Capital Dredging, the parties receiving the sediment and using it on land would be responsible for securing the necessary authorisations (including those required under the Resource Management Act 1991) to enable it to be 'received' and used. As a consequence, the 'receipt' and use of the dredged sediment on land does not form part of the Proposal, and thus is not considered further in this assessment

activities for which resource consent are sought are inextricably linked. In such situations, the 'linked' activities are assessed (as a whole) against the most restrictive classification, which in this instance is a Discretionary Activity.

It is possible to advance a line of argument that the Capital Dredging campaign is not inextricably linked to the Maintenance Dredging campaigns that could follow. Indeed, the experience of Northport suggests that this is the case, insofar that the Capital Dredging campaign was not followed by maintenance dredging (despite resource consent having been secured for maintenance dredging). If this line of argument was applied, a Discretionary Activity classification would continue to apply, albeit separately, to the Capital Dredging and Maintenance Dredging campaigns.

We see no meaningful difference (in this instance) between the two approaches to bundling. As a consequence, we have proceeded on the basis that the Capital Dredging and Maintenance Dredging campaigns are linked, and thus should be considered together, as an overall Discretionary Activity.

5.3 Other Resource Consents Required

We are not aware of any other resource consents that are, or may be required for the Proposal to proceed. In this regard and as we have already noted, all of the works are to be undertaken within the CMA. As a consequence, the RCP is the only statutory planning instruments that can determine what resource consents are required. As is apparent from the preceding analysis, the RCP has been considered and all aspects of the Proposal assessed against its rules. Staff of the NRC have been consulted over two draft versions of our analysis of the RCP. **Table A**, and the preceding summary, confirms the list of the resource consents that were agreed by NRC and ourselves.

We note, for completeness, that Refining NZ is presently assessing if additional / larger storage tanks (on land) are needed as a consequence of the Proposal. This is not necessarily a straightforward exercise, as there are a number of commercial and strategic factors which be relevant the assessment of whether, and if so, when, any additional tankage is required. We are advised (Elliot, E, pers. com) that any additional / larger tanks may require a resource consent from WDC. Should such a resource consent be required, Refining NZ will make a separate resource consent application.

In a similar vein, we understand that Refining NZ is investigating the need for scour protection to be installed around its jetty structure. We are advised (Martin, D, pers. com) that this scour protection could also require resource consents from the NRC. Should such a resource consent be required, Refining NZ has also advised that it will make a separate resource consent application for these works.

We note, again for completeness, that the advice before us is that both the additional storage tanks and the scour protection are contingent on the Proposal proceeding. We also understand that the actual and potential effects of both of these possible projects are expected to be localised and discreet. It follows, therefore, that there is no need for any resource consent applications to be sought concurrently with the Proposal. Put another way, we do not believe that any resource consent applications for either the additional tanks and / or the scour protection measures (should they be needed) are needed to better understand the effects of the Proposal.

5.4 Statutory Criteria

The requirements of the Act that relate to the decision-making process are contained within sections 104 to 116. Section 104(1) is of particular relevance. This section states:

"When considering an application for resource consent and any submissions received, the consent authority must, subject to Part 2, have regard to –

(a) any actual and potential effects on the environment of allowing the activity; and

(b) any relevant provisions of –

(i) a national environmental standard,

(ii) other regulations,

(iii) a national policy statement,

(iv) a New Zealand coastal policy statement,

(v) a regional policy statement or proposed regional policy statement,

(vi) a plan or proposed plan; and

(c) *any other matters the consent authority considers relevant and reasonably necessary to determine the application."*

As section 104(1) is 'subject to' Part 2 of the Act, some have interpreted this to mean that the purpose and principles of the Act are paramount. Put another way, should there be a conflict between any of the matters listed in section 104(1) and Part 2, Part 2 is to prevail. Recent case law has, however, suggested that there are only limited instances where a consent authority should consider a resource consent application against Part 2 of the Act (being where there is invalidity, incomplete coverage or uncertainty of meaning in the statutory planning instruments), the premise appearing to be that the statutory planning instruments give effect to Part 2, and thus are the paramount consideration. Put another way, we understand the line of reasoning to be that if a proposal is consistent with the planning instruments, they are also deemed to be consistent with the Act's purpose and thus that there is no need to consider Part 2 explicitly. Given that the case law around this point is still, we understand, developing, we have assessed the Proposal against Part 2. We have also, however, assessed the Proposal, in a forensic manner, against the planning instruments that exist and apply to the Proposal.

In the context of the obligations arising out of section 104(1) of the Act:

1. The actual and potential effects of the Proposal (both positive and negative) are set out in section 3.0 of this AEE.
2. The relevant provisions of the various statutory planning instruments are discussed in section 5.0 of this AEE.
3. The various Iwi Management Plans and the Statutory Acknowledgements are considered in section 2.9 of this AEE.
4. We discuss the relevant Part 2 matters in section 5.8 of this AEE.

We note that there are several other sub-sections of section 104 that have relevance to the Proposal. We discuss those sub-sections (such as section 104(2)) elsewhere in this AEE.

Section 104B of the Act states that after considering an application for a Discretionary Activity the Council may grant or decline it. If granted, conditions of consent can be imposed under section 108 of the Act.

Section 108 of the Act is a lengthy provision that contains 10 sub-sections. In summary, it regulates the type of consent conditions that can be imposed on the grant of resource consent. The discretion section 108 provides the Consent Authority is wide, but not limitless. By way of a broad summary, a condition may be imposed if it falls within the broad ambit of section 108, serves a resource management purpose, fairly relates to the Proposal, and is not unreasonable. While conditions of consent are yet to be developed, Refining NZ has committed to developing a comprehensive suite of conditions that accords with the requirements of section 108 of the Act and, indeed, good planning and resource management practice. The expectation is that these conditions will be developed and shared (for comment) before the report from the Council's processing officer (otherwise known as '**the section 42A Report**') is exchanged with the parties involved in the processing of this application. Given this, section 108 is not discussed further in this AEE.

5.5 Matters Relating to the Grant of Discharge Permits

In addition to the broad framework set out in sections 1.2 and 1.3 of this AEE, the Act (section 105) lists matters that a Consent Authority must have regard to when considering resource consent applications for discharge permits that would contravene section 15 or 15B of the Act.

Furthermore, section 107(1) of the Act restricts the grant of a resource consent application for the discharge of contaminants into water, or onto land in circumstance where it may enter water, if it will cause certain (listed) adverse effects in receiving waters after reasonable mixing. As we have noted, Section 15B of the Act includes similar restrictions.

We now specifically address these three sections.

5.5.1 Section 105

Section 105 of the Act requires the consent authority to have regard to the following matters when considering resource consent applications for discharge permits:

"a. The nature of the discharge and the sensitivity of the receiving environment to adverse effects; and
b. The applicant's reasons for the proposed choice; and
c. Any possible alternative methods of discharge, including discharge into any other receiving environment."[540]

The nature of the discharge is discussed in section 1.0, 2.0 and 3.0 of this AEE. The sensitivity of the CMA to adverse effects is addressed in sections 3.0 of this AEE. Refining NZ's reasons for selecting the Proposal (from the various alternatives considered) are briefly discussed in section 1.4

[540] The Act. section 105(1)

of this AEE, and are set out in detail within, principally, the reports of Mr Broekhuizen and Ms Cornish (copies of which are attached as annexures 2(e) respectively). It is noteworthy that Dr Coffey also offers what we consider to be a useful commentary about section 105 in section 1.5.17.3 of this report[541]. Given that the matters raised by section 105 have previously been addressed, we do not address them further in this section. Suffice to say, however, that we conclude, based on the information that is before us, that the matters raised by section 105 have been addressed to a level of detail that corresponds with the nature and scale of the Proposal.

5.5.2 Section 107

Section 107 states that no discharge permit shall be issued for the discharge of contaminants to water, or land where it may enter water, including dumping of waste or other matter from ships to the CMA, if after reasonable mixing, the contaminant or water discharged (either by itself or in combination with the same, similar, or other contaminants or water), is likely to give rise to all or any of the following effects in the receiving waters:

"c. The production of any conspicuous oil or grease films, scums or foams, or floatable or suspended materials;
d. Any conspicuous change in the colour or visual clarity;
e. Any emission of objectionable odour;
f. The rendering of fresh water unsuitable for consumption by farm animals;
g. Any significant adverse effects on aquatic life."[542]

We note, for completeness, that section 107(2) does provide some exceptions to the prohibition established by section 107(1). In this regard, a consent authority may grant a discharge consent that would cause an effect of the nature listed in section 107(1), where, in summary, exceptional circumstances exist, the discharge is of a temporary nature, or the work is associated with maintenance activity, and it would be consistent with the Act's purpose to grant the discharge consent.

Dr Coffey addresses the requirements of section 107 on page 55 of his report.[543] Having considered the applicable clauses of section 107, we understand Dr Coffey to conclude that either the matters listed in this section of the Act will not arise, or that conditions of consent can be imposed to ensure that the effects raised do not occur.

Given this, and again on the information that is before us, we conclude that section 107 does not present a bar to the resource consent application lodged by Refining NZ being assessed on its merits.

5.5.3 Section 15B

As we have already noted in section 5.1.1 of this AEE, section 15B of the Act imposes a similar prohibition on the grant of a resource consent to that set out in section 107(1). Dr Coffey has also addressed these considerations in his report. We understand his advice to be that the Proposal will not, after reasonable mixing, give rise to any of the effects listed in section 15B of the Act or cause any applicable regulations made under the Act to be contravened.

[541] Dr Coffey, B, page 54, section 6.5, "Crude Shipping Project. Proposal to Deepen and Partially Realign the Approaches to Marsden Point. Assessment of Marine Ecological Effects Excluding Seabirds and Marine Mammals". Dated 10 August 2017
[542] The Act, section 107(1)
[543] Dr Coffey, B, page 55, section 6.6, "Crude Shipping Project. Proposal to Deepen and Partially Realign the Approaches to Marsden Point. Assessment of Marine Ecological Effects Excluding Seabirds and Marine Mammals". Dated 10 August 2017

5.6 Planning Instruments and 'Other Matters'

The planning instruments and documents of particular relevance to this application are:

National Statutory Planning Instruments

- New Zealand Coastal Policy Statement 2010

Regional Statutory Planning Instruments

- The Regional Policy Statement for Northland May 2016 (partially operative) ('**the RPS**')
- The Regional Coastal Plan for Northland, June 2004

Other Planning Instruments

- Ngātiwai Trust Board, Ngātiwai Iwi Environmental Policy Document 2015
- Patuharakeke Te Iwi Trust Board, Hapū Environmental Management Plan 2015
- Te Uri O Hau Statutory Acknowledgement
- The Resource Management Act (Marine Pollution) Regulations 1998

We note that the NRC is in the process of reviewing all of its regional plans (including the RCP), with the intention of combining them all into one, omnibus regional planning instrument. While we have considered the draft of the omnibus regional plan, we note that it has no legal effect and is likely, we understand, to be changed prior to it being publicly notified later this year. As a consequence, we do not discuss it further in this analysis. We expect, however, that a new proposed regional plan will be addressed in the planning evidence when this application is heard.

5.6.1 Resource Management (Marine Pollution) Regulations 1998

The Resource Management (Marine Pollution) Regulations 1998 ('**the Regulations**') were made operative on the 20th of August 1998. In summary, they regulate the discharge (via 'dumping') of a variety of substances from any ship, aircraft or offshore installation in the coastal marine area. While the great majority of the substances are not relevant to the Proposal, Regulation 4(2)(a) states that the discharge of dredge material is deemed to be a discretionary activity. Regulation 4(3) then notes, however, that this nothing in Regulation 4 applies to a discharge that is made in accordance with section 15B of the Act. As we discussed in sections 5.1.1 and 5.5.3 of this AEE, section 15B applies to the Proposal, and consent is being sought both under it and the provisions of the RCP (which provides the discharge of dredge material is a discretionary activity in both the M2MA and M5MA). As a consequence of this, we are of the opinion that the Regulations do not require an additional resource consent for the Proposal to proceed.

We note, for completeness, however, Dr Coffey's advice, that the various matters set out in Schedule 3, Part 1 of the Regulations (which set out the information that an application under Regulation 4(2)(a) would need to include) are addressed in his assessment. We agree that the body of work prepared for Refining NZ addresses, to the extent that seems relevant, the matters that are listed in Part 1 of the 3rd Schedule to the Regulations. We also note that Refining NZ has presented information that enables the Council to have regard to the avoidance, remediation and mitigation of 'environmental disturbance and detriment', and to consider the merits of impose conditions on matters such as the location of the disposal sites, the method of disposal, and the monitoring programmes. This accords, in our opinion, with Part 2 of the 3rd Schedule to the Regulations.

5.7 Relevant Provisions of the Planning Instruments

The applicable iwi management plans and the Te Uri O Hau Statutory Acknowledgement are addressed in section 2.9 of this AEE, insofar as they have been used to describe the existing environment and the cultural issues that are 'alive' within and adjacent to the Site. Given this discussion, they are not addressed specifically in the following sub-sections of this AEE.

We now address the relevant provisions of the various planning instruments. We start with the more specific instruments and work towards the more 'general' (regional and then national) instruments. In discussing each instrument, we set out (in table form) the notable provisions, and then list our conclusions regarding the same. In an attempt to keep this analysis targeted, we have kept our comments concise. Please note that all of the provisions that are cited in the tables are repeated in **Annexures 7, 8, 9, 10, 11 and 12** of this AEE.

5.7.1 The Regional Coastal Plan for Northland, June 2004

The RCP was made operative on the 30th of June 2004. It has been the subject of three plan change processes, all of which are now operative.

The RCP assists the Council to promote sustainable management of natural and physical resources in the CMA. As a consequence, it has effect from MHWS to the 12nm (22.3km) limit of New Zealand's territorial sea[544]. It is important to note that the NRC chose to confine the application of the RCP to the CMA, and not the broader Coastal Environment[545].

It is also notable that the RCP highlights that it adopts a 'cautious approach to use and development' in the CMA, due to a limited amount of information being available (at the time when the RCP was drafted) on the environmental values that are supported in the coastal waters, and an 'increased awareness' within the Council of the need to protect the natural and physical resources that exist. That is not to say, however, that the RCP precludes use and development within the CMA. Rather, it enables such use and development where:

a. Adverse effects are avoided, remedied or mitigated in accordance with the direction advanced by the Plan's provisions;

b. Activities are located in management areas that already contain similar uses and developments;

c. The environmental effects of the use and development are monitored; and

d. Areas of high conservation value are afforded 'special protection' from the adverse effects of the use and development[546].

The relevant provisions applying within the RCP are set out and discussed below, in the order that they are raised within the RCP. We reiterate that the provisions listed in the tables that follow are repeated, in full, in **Annexure Eight**.

[544] Page 9, Section 2 of the RCP
[545] Page 11, Section 2 of the RCP
[546] Pages 31 & 32, section 5.4 of the RCP

5.7.1.1 Marine Management Areas

As we have already highlighted, the NRC chose to use a series of 'Marine Management Areas' to regulate the type of activities that can be undertaken in the CMA of Northland.

The marine management area provisions of the RCP that relate to the Proposal are set out in **Table 5.7.1.1.1**

Objectives	Policies	Methods
Objective 6.3	Policy 6.4.1	Method 6.5
	Policy 6.4.2	
	Policy 6.4.5	

Table 5.7.1.1.1: Marine Management Areas

Having considered the Proposal against the provisions listed in **Table 5.7.1.1.1** we note that:

a. The Proposal avoids the M1MA, but occurs in close proximity to several areas that are zoned M1MA (that is, in some instances the proposed dredging comes within 100m of the areas, while the proposed new Navaids within Whangarei Harbour come closer to these areas). The extensive efforts that the Applicant has gone to, to avoid the areas zoned M1MA, and to avoid the adverse effects that could be 'felt' by the habitats within the proximate M1MA zones accords, in our opinion, with the outcome sought in Policy 6.4.1.

b. As we have already signalled, the Proposal extends into two of the zones established by the RCP. The vast majority of the Proposal sits within the M2MA. The technical information before us is that the Proposal, while generating adverse effects, is appropriate to the environs that would accommodate it. Put another way, we understand the advice of the experts engaged by Refining NZ to be that while the Proposal will not enhance all of the natural, cultural and amenity values that are present within and around the Site, it will improve the resilience of the ETD to events such as sea level rise[547], which is, in our opinion, a notable contribution to an area that supports (the culturally and ecologically significant) Mair Bank. Navigatus also conclude that a combination of the improved navigational access and fewer tanker visits will reduce the environmental risk associated with vessels transporting crude oil to the Refinery[548]. We also understand the expert advice to be that the Proposal provides the appropriate degree of protection to the environmental values that are present within the areas zoned M2MA that will support the Proposal. As a consequence, we are of the opinion that the Proposal accords with Policy 6.4.2.

c. Limited dredging will occur within the area zoned M5MA. Not only are the proposed dredging activities broadly, in our opinion, in accordance with the purpose of the M5MA (as they will enable port related activities at the jetty associated with Marsden Point) they will reduce navigational risk, which will benefit all shipping accessing the various port facilities within Whangarei Harbour. Given this, both the works within the area zoned M5MA and the dredging / realignment of the shipping channel accord, in our opinion, with Policy 6.4.5.

d. Given the foregoing, we are also of the opinion that the Proposal accords with Objective 6.3.

[547] Reinen-Hamill, page 64, section 5.7.3, "Crude Shipping Project, Coastal Processes Assessment", Dated July 2017
[548] Oldham, K, page 2, "Environmental Spill Risk Assessment for Proposed Tanker Operations Associated with Engineered Channel", Dated 14 August 2017

e. Method 6.5 refers to ecological, cultural and amenity values within the areas zoned M2MA being 'conserved'. As indicated when we discussed Policy 6.4.2, we do not believe that the M2MA zone promotes an outcome where no effects are anticipated and thus that every organism, value and area must be conserved in its present state. Rather, we are of the opinion that the M2MA is a 'catch all' zone that speaks of conserving the broad values that are supported by the areas that it applies to, while enabling some adverse effects where they are appropriate to the circumstance and the context. In our opinion, the Proposal accords with this outcome.

5.7.1.2 Protection Policy

The NRC sets out it's 'Protection Policy' in Part IV of the RCP. A number of the sections within Part IV are directly relevant to the Proposal. We discuss those sections, and the objectives and policies that apply below:

<u>Preservation of Natural Character</u>
The natural character provisions of the RCP that relate to the Proposal are set out in **Table 5.7.1.2.1**.

Objectives	Policies	Methods
Objective 7.3	Policy 7.4.1	Method 7.5.3
	Policy 7.4.2	
	Policy 7.4.3	
	Policy 7.4.4	
	Policy 7.4.6	
	Policy 7.4.7	

Table 5.7.1.2.1: Preservation of Natural Character

Having considered the Proposal against the provisions listed in Table 5.7.1.2.1 we note that:

a. We understand the advice of Mr Brown to be that effects on the recognised areas of outstanding natural character in close proximity to the Site will be avoided, while the areas of high natural character will be avoided, with one exception, being the aid to navigation at Home Point.[549] Notably, however, Mr Brown concludes that the area of high natural character will not be significantly affected by the Proposal, with only the channel formation (via dredging) resulting in effects that are greater than 'low - moderate'.[550] This leads us to the conclusion that the Proposal will result in a limited loss of natural character to only that area surrounding the navigation aid at Home Point. Further, given (i) the manner in which the Proposal has been designed to accord with the existing environment and to focus development on areas that are, with the exception of the two offshore disposal sites, modified, (ii) the measures that the Applicant is advancing to avoid, remedy or mitigate adverse effects, and (iii) the need for the Proposal to occur within the CMA, we are of the opinion that the Proposal is appropriate with regard to its setting and thus is not something that needs to be 'protected against'. This integrated approach accords with Objective 7.3 and policies 7.4.1 and 7.4.6.

b. Refining NZ has, in our experience, sought to first avoid the generation of adverse effects on all components of the environment, and thus the values that contribute to the area's level of

[549] Brown, S, pages 10, 11, 12 & 59, sections 3.1 & 5.0, "Marsden Point Crude Shipping Project Landscape Assessment". Dated August 2017
[550] Brown, S, page 54 to 55, section 4.7, "Marsden Point Crude Shipping Project Landscape Assessment". Dated August 2017

natural character. It is only where avoidance is not practicable that Refining NZ has sought the adoption of remediation and mitigation measures, to minimise the adverse effects. This, we believe, accords with Policy 7.4.2.

c. As is apparent from the following sub-section of this report, the provisions of the NZCPS 2010, including those that address natural character considerations, have been assessed in light of the Proposal. The conclusion of that analysis is that the Proposal achieves the direction that is advanced by the applicable provisions of the NZCPS 2010. That analysis, and the conclusions of the various technical assessments have lead us to the conclusion that the Proposal constitutes an appropriate use and development to its environmental setting. As a consequence, we are of the opinion that this outcome accords with Policy 7.4.3.

d. The works proposed are situated within the M2MA and M5MA zones. For the reasons that we have already set out, the work completed leads us to the conclusion that the Proposal is appropriate. The existing modification of the environs to be dredged was a factor that was considered in reaching that conclusion. This, in our opinion, accords with Policy 7.4.4.

e. Mr Brown, in assessing the level of natural character that exists, has been cognisant of the work that the Council has undertaken in the identification of areas of natural character, as well as with the guidance that is provided in the NZCPS 2010 and in the applicable case law.[551] This approach accords, in our opinion, with Policy 7.4.5.

f. We understand the advice of the experts to be that a robust and comprehensive regime of 'baseline' monitoring has been completed by Refining NZ (and is reported in a series of baseline monitoring reports that the various 'AEE reports' / technical assessment draw on), and is supporting the resource consent applications that have been made[552]. With the exception of the shellfish and eelgrass (which can also be called 'seagrass') values, which are highly dynamic and will (in accordance with the advice of Dr Coffey[553]) need to be defined immediately prior to dredging commencing, no additional baseline information is required. This is aligned, in our opinion, with the approach advanced by Method 7.5.3.

Natural Features & Landscapes

The natural features and landscape provisions of the RCP that relate to the Proposal are set out in **Table 5.7.1.2.2**.

Objectives	Policies	Methods
Objective 8.3	Policy 8.4.1	Method 8.5.1
	Policy 8.4.2	Method 8.5.3
	Policy 8.4.3	Method 8.5.6
	Policy 8.4.4	

Table 5.7.1.2.2: Natural Features & Landscapes

Having considered the Proposal against the provisions listed in Table 5.7.1.2.2 we note that:

551 Brown, S, pages 10 to 12, & 15 to 18, sections 3.1 & 3.2, "Marsden Point Crude Shipping Project Landscape Assessment". Dated August 2017
552 Refer, for example, to Dr Coffey, B, page 54, section 7.0, "Crude Shipping Project. Proposal to Deepen and Partially Realign the Approaches to Marsden Point. Assessment of Marine Ecological Effects Excluding Seabirds and Marine Mammals". Dated 10 August 2017
553 Dr Coffey, B, pages 56 to 58, section 7.2, "Crude Shipping Project. Proposal to Deepen and Partially Realign the Approaches to Marsden Point. Assessment of Marine Ecological Effects Excluding Seabirds and Marine Mammals". Dated 10 August 2017

a. Mr Brown has, after considering the existing information from the Council and the applicable case law and the guidance provided by the NZCPS 2010, identified the features and landscapes that are outstanding, none of which will be directly impacted, or indirectly effected by the Proposal.[554] Furthermore, Mr Brown considers that the effects of the Proposal on the remaining landscapes will not be unacceptable, given the care that has been taken with the design of the Proposal and the existing modifications that are apparent within and adjacent to the area to be dredged[555]. Further, Mr Brown's advice, and the advice from Refining NZ that the Proposal must occur within the CMA adjacent to Marsden Point, leads us to the conclusion that the Proposal (i) is not inappropriate, and thus something that must be protected against in accordance with Objective 8.3 and Policy 8.4.1, and (ii) gives effect to the approach that is advanced by policies 8.4.3 and, as it applies to the land adjacent to the parts of the CMA that is effected by the Proposal, 8.4.4, and methods 8.5.1 and 8.5.6.

b. While not being a geologist, Mr Brown has considered the proximity of the Proposal to the important geological features that are listed in Appendix 3 of the RCP. His advice is that the Proposal is not expected to affect any of the features that are listed. As a consequence, the Proposal does not cut across the direction advanced by Policy 8.4.2 and Method 8.5.3.

Indigenous Vegetation

The indigenous vegetation provisions of the RCP that relate to the Proposal are set out in **Table 5.7.1.2.3**.

Objectives	Policies	Methods
Objective 9.1.3A	Policy 9.1.4.1	Method 9.1.5.2
	Policy 9.1.4.4	Method 9.1.5.12
	Policy 9.1.4.7	
	Policy 9.1.4.8	

***Table 5.7.1.2.3*: Indigenous Vegetation**

Having considered the Proposal against the provisions listed in **Table 5.7.1.2.3** we note that:

a. Dr Coffey has confirmed that there is no nationally significant indigenous vegetation within the areas that will be directly impacted by the proposed dredging and disposal activities[556]. Considerable care is being taken to ensure that this flora is not affected by the dredging and disposal activities, with stringent and conservative suspended solids and turbidity trigger values being applied. Should the trigger values be 'triggered', a regime of responses (linked to robust, 'real time' and post event monitoring) is proposed, with cessation of dredge operations within the immediate vicinity of the monitoring station(s) recording the heightened data being the ultimate response.[557] We understand, that the erection of the aid to navigation on Home Point will, occur within a nationally significant rocky shoreline. Furthermore, we understand from Dr Coffey's report, that there is flora present adjacent to the dredge footprint and that the two new Navaids on each side of Calliope Bank are of ecological importance.

[554] Brown, S, pages 10 to 15 & 61, sections 3.1, 3.2 & 6.0, "Marsden Point Crude Shipping Project Landscape Assessment". Dated August 2017
[555] Brown, S, pages 54, 55 & 61, sections 4.7 & 6.0, "Marsden Point Crude Shipping Project Landscape Assessment". Dated August 2017
[556] Dr Coffey, B, pages 33 to 34, sections 2.9, "Crude Shipping Project. Proposal to Deepen and Partially Realign the Approaches to Marsden Point. Assessment of Marine Ecological Effects Excluding Seabirds and Marine Mammals". Dated 10 August 2017
[557] For a summary, please refer to Dr Coffey, B, pages 59 to 60, section 8.0, "Crude Shipping Project. Proposal to Deepen and Partially Realign the Approaches to Marsden Point. Assessment of Marine Ecological Effects Excluding Seabirds and Marine Mammals". Dated 10 August 2017

While the placement of the three new Navaids in the Whangarei Harbour will create a very localised area of disturbance, the advice of Dr Coffey is that any effects are 'less than minor'[558], which we understand to mean that they are negligible. Given Dr Coffey's advice and conclusions, we are of the opinion that the approach advanced by Objective 9.1.3A, policies 9.1.4.1 and 9.1.4.4, and Method 9.1.5.2 will be achieved.

b. At Dr Coffey's recommendation, a management response has been incorporated into the Proposal should adventive pests be found to dominate the recolonisation of the disturbed areas. It entails on-going monitoring, notification of MPI should aventive pests be found dominating the recolonization and then working with the Ministry in its responses to the pests. The incorporation of this measure into the Proposal aligns, in our opinion, with Policy 9.1.4.7. Similarly, the restoration enabled by the weed and pest control efforts and the proposed restoration mechanism associated with seagrass and shellfish habitat[559] seems aligned with the outcome sought by Policy 9.1.4.8 and Method 9.1.5.12.

Habitats of Indigenous Fauna

The indigenous fauna provisions of the RCP that relate to the Proposal are set out in **Table 5.7.1.2.4**.

Objectives	Policies	Methods
Objective 9.2.3	Policy 9.2.4.1	Method 9.2.5.1
	Policy 9.2.4.2	Method 9.2.5.2
	Policy 9.2.4.3	Method 9.2.5.4
	Policy 9.2.4.4	Method 9.2.5.9

Table 5.7.1.2.4 Habitats of Indigenous Fauna

Having considered the Proposal against the provisions listed in **Table 5.7.1.2.4** we note that:

a. From the advice of Dr Coffey[560] and Dr Clement[561] we understand that there are no significant habitats of indigenous marine taxa and marine mammals within the areas that will be directly impacted by the proposed dredging and disposal activities. Given the advice of Dr Coffey, however, we understand that the three new Navaids will encroach into ecologically significant areas of Calliope Bank and Home Point, the latter of which is nationally significant. We understand the advice of Mr Don to be that there are significant habitats of indigenous avifauna within the area that is to be impacted by the Proposal.[562] Dr Coffey and Mr Don also confirm that there are significant habitats for marine taxa and avifauna adjacent to the directly impacted areas.

As we have already commented in relation to the indigenous vegetation provisions, considerable care is being taken to ensure that the significant habitats of avifauna and marine ecology within and adjacent to the Site, and those significant habitats adjacent to the same are, in the first instance, not affected by the Proposal, with stringent and conservative suspended solids and turbidity trigger values and a management regime being applied to

558 Refer, for example, to Dr Coffey, page 7, Table 1, "Crude Shipping Project. Proposal to Deepen and Partially Realign the Approaches to Marsden Point. Assessment of Marine Ecological Effects Excluding Seabirds and Marine Mammals". Dated 10 August 2017

559 Coffey, B, page 51, section 5.1, "Crude Shipping Project, Proposal to Deepen and Partially Realign the Approaches to Marsden Point, Assessment of Marine Ecological Effects, Excluding Seabirds and marine Mammals". Dated 10 August 2017

560 Dr Coffey, page 33, section 2.9, "Crude Shipping Project. Proposal to Deepen and Partially Realign the Approaches to Marsden Point. Assessment of Marine Ecological Effects Excluding Seabirds and Marine Mammals". Dated 10 August 2017

561 Clement, D, page 4, section 2.2, "Assessment of Effects on Marine Mammals from Proposed Deepening and Realigning of the Whangarei Harbour Entrance and Approaches". Dated August 2017

562 Don, G, pages 24 to 31, section 4.0, "Crude Shipping Project, AEE Report, Coastal Birds, Final". Dated 09 August 2017

protect the same. Where there could be an impact, such as to the avifauna, management practices have been recommended and are proposed to be implemented (such as the proposed lighting audit of the dredge and support vessels to minimise effect on petrel) to minimise (if not eliminate) that impact. Additionally, initiatives such as penguin nesting boxes and associated pest eradication, and a catchment management initiative (or similar) are being advanced to offset the same[563]. With respect to the encroachment into the three marine habitats of significance, we again cite Dr Coffey's advice that the installation of the Navaids will only generate negligible effects; and monitoring of, and operational responses to, turbidity levels will avoid sedimentation effects. Given the advice and conclusions from Dr Coffey and Mr Don, we are of the opinion that the approach advanced by Objective 9.2.3, policies 9.2.4.1, 9.2.4.2 and 9.2.4.3, and methods 9.2.5.1 and 9.2.5.4 can be achieved in this instance. We note, for completeness, that none of the ecological advisors predict that the Proposal will cause a significant adverse effect on the ecological habitats of the CMA, be they deemed to be significant habitat or otherwise[564].

b. We understand Dr Coffey's advice to be that while it has not occurred as a consequence of dredging proposals advanced elsewhere in New Zealand, adventive pest could colonise areas that will be disturbed by the Proposal. Refining NZ will, on the recommendation of Dr Coffey[565], monitor the disturbed areas for any such colonisation and will notify the relevant Crown agencies in the event that pest species dominate the recolonisation. Ultimately, Refining NZ has confirmed that it will collaborate with these agencies in whatever response they think is appropriate (Martin, D, pers com). This broad approach accords, in our opinion, with the intent of 9.2.4.4. It is also aligned with the direction advanced by Method 9.2.5.9.

c. From their reports, we understand that Dr Coffey, Dr Clement and Mr Don have assessed the ecological significance of the various habitats using the approach advanced within the NZCPS 2010. While this may not strictly accord with the direction advanced by Method 9.2.5.2, it is considered to be the most appropriate response given the planning framework that applies to the applications being advanced by Refining NZ. In that regard, we understand that the superior planning instruments establish a more advanced and appropriate approach than the direction that is set out within the RCP. That planning framework has been discussed with Council officers and its expert consultants in pre-application discussions, and no issues were raised with regard to the broad approach that had been adopted by the experts advising Refining NZ.

Public Access

The public access provisions of the RCP that relate to the Proposal are set out in **Table 5.7.1.2.5**.

Objectives	Policies	Methods
Objective 10.3.1	Policy 10.4.1	Nil

Table 5.7.1.2.5: Public Access

563 Don, G, page 51, section 6.0, "Crude Shipping Project, AEE Report, Coastal Birds, Final". Dated 09 August 2017, & Dr Coffey, page 51, section 5.1, "Crude Shipping Project. Proposal to Deepen and Partially Realign the Approaches to Marsden Point. Assessment of Marine Ecological Effects Excluding Seabirds and Marine Mammals". Dated 10 August 2017

564 Please refer to, for example Dr Coffey, B, pages 8 to 9, Table 1, "Crude Shipping Project. Proposal to Deepen and Partially Realign the Approaches to Marsden Point. Assessment of Marine Ecological Effects Excluding Seabirds and Marine Mammals". Dated 10 August 2017, Clement, D, page 7, Table 2, "Assessment of Effects on Marine Mammals from Proposed Deepening and Realigning of the Whangarei Harbour Entrance and Approaches". Dated August 2017, Don, G, pages 1 to 2, "Crude Shipping Project, AEE Report, Coastal Birds, Final". Dated 09 August 2017.

565 Dr Coffey, B, pages 46 & 47, section 4.1.3b, "Crude Shipping Project. Proposal to Deepen and Partially Realign the Approaches to Marsden Point. Assessment of Marine Ecological Effects Excluding Seabirds and Marine Mammals". Dated 10 August 2017

Having considered the Proposal against the provisions listed in **Table 5.7.1.2.5** we note that:

a. The Proposal will not restrict access to the CMA any more than presently occurs. Similarly, while the operation of the dredge(s) will introduce additional vessels to the CMA, the vessels will be slow moving and will, we expect, be easily avoided by pleasure craft and users. We note that Mr Greenaway states in his report[566] that *"any recreation skipper operating in or near the harbour entrance would expect to encounter large ships and to comply with harbour navigation rules. While the presence of a dredge is an additional navigational issue, it should not limit recreation participation by large and small recreational vessels."* Given this, we are of the opinion that the Proposal will maintain the level of access to and along, and indeed within, the CMA. Consequently, we conclude that it does not cut across the outcomes sought by Objective 10.3.1 and Policy 10.4.1.

Maori Culture & Traditions

The Maori culture and traditions provisions of the RCP that relate to the Proposal are set out in **Table 5.7.1.2.6**.

Objectives	Policies	Methods
Objective 11.3	Policy 11.4.1	Method 11.5.1
	Policy 11.4.2	Method 11.5.2
	Policy 11.4.4	Method 11.5.4
		Method 11.5.7

Table 5.7.1.2.6: Maori Culture & Traditions

Having considered the Proposal against the provisions listed in **Table 5.7.1.2.6** we note that:

a. Refining NZ has engaged extensively with Tangata Whenua. That has included inviting the representatives to workshops as the Proposal advanced, direct engagement with Tangata Whenua representatives and individual hapu (where this was requested), commissioning a CVA early in the resource consent phase of the project (to inform the technical assessments and the design of the Proposal), inviting Tangata Whenua to have representatives present during some of the ecological investigations, seeking information from Tangata Whenua on the presence and habits of marine mammals, commissioning a draft CEA and seeking input from Tangata Whenua into the assessment of alternatives. In our experience, this level of engagement represents best practice. Suffice to say that we believe it accords with the outcomes sought in methods 11.5.1, 11.5.2, 11.5.4 and 11.5.7.

b. A driver for the engagement that Refining NZ has undertaken was to understand cultural values and relationships that exist within the area that will be directly impacted by the Proposal, and those that apply to the adjacent areas, as well as working with Tangata Whenua to develop responses to the same. Proposing land based disposal of the dredged sediment, where a demand exists and the necessary resource consents / authorisations have been obtained, is an example of Refining NZ's response to a preference expressed by Tangata Whenua during the engagement process. Further examples are the various avoidance, remediation and

566 Greenaway, R, page 58, section 5.2.7 "Refining NZ Crude Shipping Project Recreation and Tourism Effects Assessment", Dated August 2017

mitigation measures that Mr Coffin sets out in section 8 of his report[567], and which Refining NZ are seeking to discuss with Tangata Whenua. Given these measures, we are of the opinion that the Proposal can be advanced so as to appropriately acknowledge the cultural values and relationships that exist, and to minimise any impact on those values. This is aligned with the direction advanced in Objective 11.3, and policies 11.4.1, 11.4.2 and 11.4.4 and Mr Coffin's advice[568].

Cultural Heritage Values

The cultural heritage values provisions of the RCP that relate to the Proposal are set out in **Table 5.7.1.2.7**.

Objectives	Policies	Methods
Objective 12.3.1	Policy 12.4.1	Method 12.5.1
Objective 12.3.2	Policy 12.4.2	Method 12.5.4
	Policy 12.4.3	Method 12.5.8

Table 5.7.1.2.7: Cultural Heritage Values

Having considered the Proposal against the provisions listed in **Table 5.7.1.2.7** we note that:

a. Refining NZ sought advice from Tangata Whenua and Dr Clough regarding the presence (or otherwise) of cultural (which incorporates both Maori and non-Maori) heritage considerations. Dr Clough reports that there are no known archaeological sites within or adjacent to the area that will be disturbed by the Proposal[569]. Consequently, he concludes that the Proposal will not generate direct adverse effects on known archaeological values, and that any indirect effects on known sites / values are unlikely[570]. Out of an abundance of caution and in keeping with a suggestion of[571] (as opposed to a recommendation of) Dr Clough, an 'accidental discovery protocol' is proposed to manage the disturbance of any unknown archaeological site.

   In contrast, the CVA identifies an array of overlapping significant cultural sites and areas. As is discussed in section 4.0 of this AEE, Refining NZ has taken advice from Mr Coffin and is actively seeking to work with Tangata Whenua to develop a range of responses to ensure that the values are, as the policy direction seeks, both recognised and protected. This approach, in our opinion, accords with the direction advanced by objectives 12.3.1 and 12.3.2, policies 12.4.1, 12.4.2 and 12.4.3 and methods 12.5.1, 12.5.4 and 12.5.8.

Water Quality

The water quality provisions of the RCP that relate to the Proposal are set out in **Table 5.7.1.2.8.**

Objectives	Policies	Methods

[567] Coffin, A, pages 15 to 18, section 7, "Refining NZ Crude Shipping Project - Peer Review Report of Refining NZ Crude Freight Proposal – Tangata Whenua o Whangarei Te Rerenga Paroao DRAFT Cultural Effects Assessment (11 June 2017)", Dated 21 July 2017

[568] Coffin, A, pages 18 to 20, section 8, "Refining NZ Crude Shipping Project - Peer Review Report of Refining NZ Crude Freight Proposal – Tangata Whenua o Whangarei Te Rerenga Paroao DRAFT Cultural Effects Assessment (11 June 2017)", Dated 21 July 2017

[569] Clough, Dr R, page 17, "Marsden Refinery, Whangarei harbour Dredging: Archaeological Assessment". Dated July 2017

[570] Clough, Dr R, pages 18 to 23, "Marsden Refinery, Whangarei harbour Dredging: Archaeological Assessment". Dated July 2017

[571] Clough, Dr R, page 23, "Marsden Refinery, Whangarei harbour Dredging: Archaeological Assessment". Dated July 2017

Objective 13.3	Policy 13.4.1	Method 13.5.1
	Policy 13.4.2	Method 13.5.3(b)
		Method 13.5.4

Table 5.7.1.2.8: Water Quality

Having considered the Proposal against the provisions listed in **Table 5.7.1.2.8** we note that:

a. The great majority of the waters in or adjacent to the area that is to be disturbed within the Whangarei Harbour (which the RCP defines as extending out to Busby Head and across to an area to the south of the Refinery) is classified as water quality standard 'CA'. There is, however, a mixing zone off from Marsden Point for a 'major discharge' from the Refinery. There are also relatively small areas within three of the northern bays (Urquharts Bay, Taurikura Bay and Little Munro Bay) that are classified as water quality standard 'CB'. Appendix 4 of the RCP defines the standards, and states that the CA standards are a 'General Water Quality Standard', while the CB standards are a 'Contact Recreation Standard'. Method 13.5.3(b) states that unclassified waters in near shore areas are to be managed in accordance with the AE (aquatic ecosystems), CR (contact recreation), A (aesthetic), C (cultural) and SG (gathering or cultivation of shellfish for human consumption) standards set out in the Third Schedule to the Act.

b. Dr Coffey has, (drawing on a series of turbidity tests, available water quality data, analysis of the sediments to be dredged, and modelling undertaken at Dr McComb's direction) assessed the Proposal in accordance with these standards and concluded that the Proposal is expected to meet the applicable water quality standards after reasonable mixing[572]. The ability for the Proposal to achieve the applicable water quality standards leads us to the opinion that the existing water quality will be maintained after what will be a series of short-term disruptions during the construction phase of the Proposal. This, in our opinion, is aligned with the direction advanced by Objective 13.3, Policy 13.4.1 and methods 13.5.1, 13.5.3(b) and 13.5.5.

c. Given Dr Coffey's advice that the Proposal will not result in water column effects that are greater than minor in magnitude[573], we do not expect that the water quality of the CMA will be significantly degraded by the Proposal. Consequently, remediation action is not, in our opinion, warranted under Policy 13.4.2.

<u>Natural Hazard Management</u>

The natural hazard management provisions of the RCP that relate to the Proposal are set out in **Table 5.7.1.2.9.**

Objectives	Policies	Methods
Objective 15.3.1	Policy 15.4.1	Method 15.5.4
Objective 15.3.2	Policy 15.4.2	Method 15.5.5
	Policy 15.4.3	Method 15.5.6

Table 5.7.1.2.9: Natural Hazard Management

[572] Dr Coffey, B, page 44, section 4.1.2e, "Crude Shipping Project. Proposal to Deepen and Partially Realign the Approaches to Marsden Point. Assessment of Marine Ecological Effects Excluding Seabirds and Marine Mammals". Dated 10 August 2017

[573] Dr Coffey, B, pages 8 to 9, Table 1, "Crude Shipping Project. Proposal to Deepen and Partially Realign the Approaches to Marsden Point. Assessment of Marine Ecological Effects Excluding Seabirds and Marine Mammals". Dated 10 August 2017

Having considered the Proposal against the provisions listed in **Table 5.7.1.2.9** we note that:

a. Refining NZ, via the work undertaken by Dr McComb and Mr Reinen-Hamill, has considered whether the Proposal will affect coastal processes, including the potential for the Proposal to create or worsen any existing coastal erosion or inundation, including how those processes could be impacted by sea level rise. We understand the advice of Mr Reinen-Hamill (who draws on the analysis completed by Dr McComb) to be that any changes caused to the geomorphic processes in and adjacent to the disturbed area will be negligible following mitigation. We understand this to mean that any associated adverse effects, including on natural hazards will also be negligible. Indeed, he points to Disposal Area 1.2 as potentially providing greater resilience to the ETD and Mair Bank to the impacts associated with sea level rise, which we understand represents a beneficial effect, while also mitigating any risk of an affect associated with the Proposal.[574]

b. Given the advice of Dr McComb and Mr Reinen-Hamill, we are of the opinion that the Proposal is consistent with the direction advanced by objectives 15.3.1 and 15.3.2, policies 15.4.1, 15.4.2 and 15.4.3 and Method 15.5.5.

c. We note that conditions of consent are anticipated to ensure that the dredging and disposal activities occur as is proposed. This approach is, in our opinion, in keeping with the outcome sought in Method 15.5.4.

d. Mr Reinen-Hamill advises that shore profile monitoring is not required in this instance. In this regard, he advises that recurrent monitoring (in the form of bathymetric surveys and the on-going measurement of waves and water levels) would be appropriate. While not being strictly aligned with the wording of Method 15.5.6, we are of the opinion that the monitoring regime proposed by Mr Reinen-Hamill is appropriate given his assessment of the actual and potential effects, and accords with the intent of this provision.

5.7.1.3 Use and Development Policy

The RCP, via 14 sub-sections, sets out its 'Use and Development Policy' in Part V. A number of the sections within Part V are directly relevant to the Proposal. We now discuss those sections, and the objectives and policies they apply:

<u>Recreation</u>
The recreation provisions of the RCP that relate to the Proposal are set out in **Table 5.7.2.1**.

Objectives	Policies	Methods
Objective 16.3	Policy 16.4.2	Method 16.5.4
	Policy 16.4.3	Method 16.5.7

Table 5.7.2.1: Recreation

Having considered the Proposal against the provisions listed in **Table 5.7.2.1** we note that:

[574] Reinen-Hamill, pages 62 to 63, section 5.7.1, "Crude Shipping Project, Coastal Processes Assessment", Dated July 2017.

a. Mr Greenaway has assessed the various recreation activities, use and values that are within the area of the CMA that will be disturbed, and those that are known to occur adjacent to it[575]. As we have already noted in section 3.13 of this AEE, Mr Greenaway points to a number of areas that are important for recreation. Having, however, considered the various technical assessment and contributed to both the design of the Proposal and the alternatives assessment associated with the same, Mr Greenaway concludes that the Proposal can be conducted in a manner that causes ‘confined’ and ‘slight’ effects, which we understand equates to effects that are minor or less in their magnitude[576]. This is aligned, in our opinion, with Objective 16.3 (as provision for recreation uses will continue during and following the dredging proposal and will ultimately benefit from the improved safety associated with re-aligned channel) and policies 16.4.2 and 16.4.3 and Method 16.5.4.

b. We are advised (Martin, D, pers. com) Refining NZ proposes to make compliance with the applicable Regional Council Harbour Bylaws (and any resource consent that is granted for the Proposal) a condition of contract for the successful tender. This, in our opinion, accords with Method 16.5.7.

Structures

The structures provisions of the RCP that relate to the Proposal are set out in **Table 5.7.2.2**.

Objectives	Policies	Methods
Objective 17.3	Policy 17.4.3	Method 17.5.8
	Policy 17.4.4	
	Policy 17.4.8	Method 17.5.16
	Policy 17.4.9	

Table 5.7.2.2: Structures

Having considered the Proposal against the provisions listed in **Table 5.7.2.2** we note that:

a. The only structures associated with the Proposal are the Navaids. As we set out, a number of existing navigation aids are to be relocated, while an additional three are to be established, all of which are to be located in close proximity to, but not within, areas zoned M1MA.

b. Dr Coffey, Mr Don, Dr Clement, Mr Greenaway, Dr Clough, Mr Reinen-Hamill and Mr Brown[577] have considered the actual and potential effects associated with the additional / relocated structures. The effects of the Navaids are also addressed within the draft CEA. We understand that all but the draft CEA conclude that any effects that do arise will be minimal, and can be (where necessary) remedied or mitigated levels that the experts believe are acceptable. In terms of the cultural effects associated with the Navaids, we take comfort from the advice of Mr Coffin that a range of measures can be developed to ensure that the adverse effects of the Proposal, including those associated with the Navaids, can be appropriately avoided, remedied or mitigated[578]. This body of advice, when coupled with the efforts that

[575] A useful summary is contained within Greenaway, R, pages 6 to 14, section 1.2, “Refining NZ Crude Shipping Project Recreation and Tourism Effects Assessment”. Dated August 2017

[576] Greenaway, R, page 62, section 6.0, “Refining NZ Crude Shipping Project Recreation and Tourism Effects Assessment”. Dated August 2017

[577] Refer, for example, to Dr Coffey, B, pages 8 to 9, Table 1, “Crude Shipping Project. Proposal to Deepen and Partially Realign the Approaches to Marsden Point. Assessment of Marine Ecological Effects Excluding Seabirds and Marine Mammals”. Dated 10 August 2017

[578] Coffin, A, pages 18 to 20, section 8, “Refining NZ Crude Shipping Project - Peer Review Report of Refining NZ Crude Freight Proposal – Tangata Whenua o Whangarei Te Rerenga Paroao DRAFT Cultural Effects Assessment (11 June 2017)”, Dated 21 July 2017

Refining NZ has gone to, to ensure that the navigation aids do not encroach into the M1MA areas or constrain public access, leads us to the conclusion that the Proposal can proceed in a manner that is consistent with the direction advanced by Objective 17.3 and policies 17.4.4.

c. The navigation aids are used to demarcate the safe extents of the navigation channel and this is achieved by having the navigation aids situated in close proximity to the channel. Correctly positioned navigation aids therefore contribute, in our opinion, to the safe passage of vessels using the entrance channels. We understand that Refining NZ has concluded that the relocation of existing navigation aids and the construction of the new navigation aids (in the positions proposed) is needed to enable the safe navigation of large vessels through the realigned channel[579]. We note, also, that the Harbour Master has given his written approval to the location and the type of Navaids that are proposed. A copy of the written approval is attached as **Annexure 13** to this AEE. Given this, it seems to us that there is a functional need for the proposed navigation aids to be located with the CMA. This conclusion, when coupled with the observation set out in paragraph (b) demonstrates, to us, that the structures incorporated into the Proposal are consistent with Policy 17.4.3 and Method 17.5.8.

d. We are advised that Refining NZ will not be the party that ultimately maintains the Navaids in a good state of repair (Martin, D, pers com). That responsibility will, we are also advised, fall to either Northport or the Harbour Master. Refining NZ are, however, very confident that the Navaids will be maintained, as the existing aids to navigation are. This advice and expected outcome is, in our opinion, aligned with Policy 17.4.8 and Method 17.5.16.

e. While the Navaids have a number of similarities to 'signs', their presence and function are, we understand, they are critical to the safe operation of the entrance channel. These circumstances, when considered in light of Mr Brown's conclusion that the navigation aids will only have a very low impact on the environs in which they are to be located, is aligned, in our opinion, with the outcome advanced by Policy 17.4.9.

<u>Discharges to Water</u>

The discharges to water provisions of the RCP that relate to the Proposal are set out in **Table 5.7.2.3**.

Objectives	Policies	Methods
Objective 19.3	Policy 19.4.4	Method 19.5.11
	Policy 19.4.7	

Table 5.7.2.3: Discharges to Water

Having considered the Proposal against the provisions listed in **Table 5.7.2.3** we note that:

a. Dr Coffey has, as we have previously noted, closely considered the water quality effects associated with the Proposal, including the discharges from the dredges. We understand his advice to be that aside from suspended sediment and turbidity, the proposed dredging is not expected to result in contaminants (at concentrations that could harm the environment or threaten human health) being discharged into the CMA. Indeed, Dr Coffey concludes that no

[579] Refer, for example, to Potter, M, Mocke, R and Cross, J, pages 41 to 47, section 7.0, "Refining New Zealand Crude Shipping Project, Shipping Channel - Concept Design Report". Dated 12 November 2016, contained within Appendix B of the Reinen-Hamill, R, "Dredging and Disposal Options – Synthesis Report"; Dated July 2017

adverse contamination effects are anticipated[580]. In that regard, the contaminants expected to be discharged are restricted, generally speaking, to clean shell and sand with a limited 'fines' content[581]. With the adoption of the proposed response to suspended solids and turbidity that we have already set out, Dr Coffey concludes that the discharge will not affect the ecologically significant habitats or values that are adjacent to some of the harbour dredging locations. In all other instances, the affect (outside of the mixing zone) will be moderate (at worst - in the disposal sites) to less than minor[582].

While Mr Don records that the turbidity has the potential to adversely affect birds (with the Little Blue Penguin being the species with the greatest potential to be impacted) we understand his advice to be that he expects, on balance, any effect on the penguin population to be negligible with his recommended nesting box / predator control measures in place[583].

Dr Clements advises that the potential for the proposed discharge of sediment to impact on marine mammals is slight, and is predicting no, to De Minimis adverse effects[584].

Given the foregoing, we are of the opinion that the Proposal is aligned with the outcome sought in Objective 19.3.

b. As we have also already discussed, Dr Coffey advises that the Proposal will not cut across the existing water quality standards that apply to the disturbed areas. This outcome is aligned, in our opinion, with that sought by Policy 19.4.4.

c. We understand that Refining NZ operates with the objective of achieving full compliance with its resource consent and environmental authorisations, has invested significant time and resource into developing and implementing its environmental management systems (including having a dedicated spill response unit), is in the process of upgrading and repairing its drainage network and treatment systems to capture/treat contaminants that may other be discharged to the wider environs and has a good track record of responding to oil spills that are associated with its operations and premises (Elliot, R, pers. com). This aligns, in our opinion, with Policy 19.4.7. Of particular note, however, is the advice of Mr Oldham that the Proposal (due to a lower navigational risk and fewer vessel visits) will reduce the likelihood of an oil spill[585], which, in our opinion, is aligned with Policy 19.4.7.

d. We understand the advice from Dr Coffey is that the proposed monitoring regime associated with the Proposal, particularly the turbidity plumes, represents best scientific practice (given the context provided by the Proposal) and will contribute to the data that is available to the Council so it can achieve the outcome sought in Method 19.5.11.

<u>Taking, Use, Damming and Diversion of Coastal Water</u>
The taking and use provisions of the RCP that relate to the Proposal are set out in **Table 5.7.2.4**.

[580] Dr Coffey, B, pages 38 to 40, section 4.1.1b, "Crude Shipping Project. Proposal to Deepen and Partially Realign the Approaches to Marsden Point. Assessment of Marine Ecological Effects Excluding Seabirds and Marine Mammals". Dated 10 August 2017
[581] Reinen Hamill, R, quoted in Coffey, B, page 41, section 4.1.2, "Crude Shipping Project, Proposal to Deepen and Partially Realign the Approaches to Marsden Point, Assessment of Marine Ecological Effects, Excluding Seabirds and marine Mammals". Dated 10 August 2017
[582] Dr Coffey, pages 8 to 9, Table 1, "Crude Shipping Project. Proposal to Deepen and Partially Realign the Approaches to Marsden Point. Assessment of Marine Ecological Effects Excluding Seabirds and Marine Mammals". Dated 10 August 2017
[583] Refer, for example, to Don, G, page 36 to 44, section 5.2.1.1, "Crude Shipping Project, AEE Report, Coastal Birds, Final". Dated 09 August 2017
[584] Clement, D, page 7, Table 2, "Assessment of Effects on Marine Mammals from Proposed Deepening and Realigning of the Whangarei Harbour Entrance and Approaches". Dated August 2017
[585] Oldham, K, page 2, "Environmental Spill Risk Assessment for Proposed Tanker Operations Associated with Engineered Channel", Dated 14 August 2017

Objectives	Policies	Methods
Objective 21.3	Policy 21.4.1	Nil

Table 5.7.2.4: Taking & Use

Having considered the Proposal against the provisions listed in **Table 5.7.2.4** we note that the proposed take is associated with the dredging activity. We understand that all of the water taken will be discharged, either via the hopper overflow (depending on the dredge used) or to Bream Bay when the dredged sediment is discharged to disposal sites 1.2 and / or 3.2. While Dr Coffey has highlighted potential adverse environmental effects associated with the discharges, no concerns have been raised relating to the proposed taking and use of coastal waters in the manner proposed. We take this to mean than any adverse effects associated with the taking of coastal waters will be nil (in this regard, Dr Coffey advises that this aspect of the Proposal is, for all intents and purposes, a 'zero take'[586]).

Should the dredged sediment be disposed of to land, this could see water taken, discharged to land. Dr Coffey has considered this potential, in terms of the importance of the lost water to the CMA. As we have already noted, his advice is that the proposed take will not impact on the habitat that is available in Whangarei Harbour or the quality of that habitat.

As a consequence of the foregoing, the proposed take accords, in our opinion, with the direction advanced by Objective 21.3 and qualifies for a 'permissive approach' under Policy 21.4.1 of the RCP.

<u>Dredging & Dredged Sediment Disposal</u>
The dredging and dredging spoil disposal provisions of the RCP that relate to the Proposal are set out in **Table 5.7.2.5**.

Objectives	Policies	Methods
Objective 22.3	Policy 22.4.1	Method 22.5.1
	Policy 22.4.3	Method 22.5.3
	Policy 22.4.4	Method 22.5.8
	Policy 22.4.6	Method 22.5.9
	Policy 22.4.7	Method 22.5.11
	Policy 22.4.8	

Table 5.7.2.5: Dredging & Spoil Disposal

Having considered the Proposal against the provisions listed in **Table 5.7.2.5** we note that:

a. We understand that the proposed capital dredging is needed to enable the Refinery to operate efficiently, and competitively. More particularly, it is needed to enable Refining NZ to make best use of its existing jetty, dolphins and unloading facilities.

   As is apparent from section 2.0 of this AEE, considerable care has been taken to understand the existing environment, to predict the likely actual and potential adverse effects of the proposed dredging and disposal activities, and to develop avoidance, remediation and mitigation responses with the intention of ensuring that the adverse effects which arise from

[586] Refer, for example to Dr Coffey, B, page 43, Section 4.1.2d, "Crude Shipping Project. Proposal to Deepen and Partially Realign the Approaches to Marsden Point. Assessment of Marine Ecological Effects Excluding Seabirds and Marine Mammals". Dated 10 August 2017

the Proposal are minimised to the point that a group of respected experts conclude is acceptable, while maximising the beneficial effects of the same.

Furthermore, and as is apparent from section 5.0 of this AEE, Refining NZ is seeking the resource consents needed for all aspects of the proposal that are to occur within the CMA, which includes both the capital and maintenance dredging and for the disposal of the sediment associated with the same. This level of integration is, in our opinion, aligned with the outcome sought by the policies set out in section 22.4 of the RCP.

Given the foregoing, we are of the opinion that the Proposal accords with the direction advanced by Objective 22.3 and policies 22.4.1 and 22.4.4, and methods 22.5.1 and 22.5.11. It also accords, with the exception of the matter discussed in paragraph (d) (which follows), with the direction advanced by Policy 22.4.3.

b. Refining NZ has worked to ensure that its proposed dredging and spoil disposal activities are confined to the M2MA and M5MA, thus avoiding the M1MA areas that are in close proximity to the aspects of the Proposal that will occur within the Whangarei Harbour. Further, it has focussed considerable attention on the potential for the Proposal to indirectly affect these areas and the ecosystems therein, and has developed the turbidity controls (as recommended by Dr Coffey[587]) and penguin nesting box measure (as recommended by Mr Don[588]) to ensure that the effects are avoided, and offset in the case of the penguins, should an unanticipated local affect arise. This, we believe, is aligned with the direction advanced by Policy 22.4.6 and methods 22.5.3 and 22.5.8.

c. Land based disposal options have been considered and are not discounted (indeed, the option to disposal of up to 97.5% of the dredged sediment to land is provided for in the applications that have been sought from the Council). The body of advice (from an array of environmental experts) before us leads us to the opinion that when all matters are considered, the disposal of the dredged material to two discreet locations in Bream Bay is environmentally acceptable should there be no practicable market or recipient for all or part of the dredged sediment. The assessment of alternatives advanced by T&T summarises the alternatives that have been considered, and the reason for adopting a disposal strategy that includes both marine and land based options. This approach and analysis has, in our experience, been central in determining the various component parts of the Proposal, and is, in our opinion, aligned (when it is considered in tandem with environmental baseline work that has informed it) with the direction provided by policies 22.4.7 and 22.4.8 and Method 22.5.9.

d. Policy 22.4.3 allows capital dredging in the M5MA to *"… allow access to [a] new or extended authorised structure …".* Technically speaking, the relatively minor amount of capital dredging in the M5MA is not associated with a new or extended authorised structure. Rather, it is associated with making better, more efficient use of an existing suite of structures that are associated with, and integral to the Refinery. While some may suggest that this is contrary to the approach advanced by Policy 22.4.3, the explanation to the policy refers to the need for ports to remain economically viable, and notes that the size of the vessels visiting ports often necessitates capital dredging. The advice to us from Refining NZ is that in order to assist the economic competitiveness of the Refinery, fully laden 'Suezmax' vessels need to be able to berth and unload at the existing jetty. To enable that to occur in a safe manner, capital and

[587] Dr Coffey, B, page 44, Section 4.1.2e, "Crude Shipping Project. Proposal to Deepen and Partially Realign the Approaches to Marsden Point. Assessment of Marine Ecological Effects Excluding Seabirds and Marine Mammals". Dated 10 August 2017
[588] Don, G, page 52, section 7.1, "Crude Shipping Project, AEE Report, Coastal Birds, Final". Dated 09 August 2017.

on-going maintenance dredging is proposed. As a consequence of this advice, we are of the opinion that the Proposal is aligned with the intent of the policy.

Sand, Shingle & Mineral Extraction

The sand, shingle and mineral provisions of the RCP that relate to the Proposal are set out in **Table 5.7.2.6**.

Objectives	Policies	Methods
Objective 23.3	Policy 23.4.1	Method 23.5.1
	Policy 23.4.2	Method 23.5.2
	Policy 23.4.3	Method 23.5.5
		Method 23.5.7

Table 5.7.2.6: Sand, Shingle & Mineral Extraction

Having considered the Proposal against the provisions listed in **Table 5.7.2.6** we note that:

a. The proposal could (if land disposal options become available) see up to 97.5% of the spoil from the capital dredging removed from the CMA, and thus from the associated coastal processes. Similarly, up to 97.5% of any sediment that is periodically dredged as part of the maintenance dredging strategy will be made available for land disposal, should it not be needed to maintain the coastal processes associated with the ETD (which will take priority). Hence, while the dredging and disposal activity is not set up to 'mine' the sand resource, the disposal of the dredged spoil to land necessitates a resource consent for this activity.

b. While the disposal of the dredged spoil to land enjoys considerable, in the context of the RCP, policy support, the removal of the proposed volume of sand from the coastal system has the potential to generate adverse geomorphological effects. Having carefully considered the data of that has been collected for the relevant geomorphological parameters, the outcomes of Dr McComb's modelling of the geomorphological system and the bathymetric changes that would be caused by the Proposal, and considered the geomorphic processes that have been at play in the outer harbour and northern extent of Bream Bay, Mr Reinen-Hamill has advised that the removal of the sediment that could occur as a consequence of the Proposal:

    i. Would not adversely affect the ETD. Indeed, the placement of a minimum of 2.5% of the sediment from the capital and maintenance dredging campaigns at Disposal Site 1.2 is expected to generate a positive effect;[589] and

    ii. While there will be a net loss of sediment from the ETD as a consequence of (mainly) the capital dredging campaign, the amount of sediment lost is small and is primarily from the deeper parts of the ETD. He notes that it will be retained within the wider Bream Bay system.

    Given the foregoing advice, we are of the opinion, that the removal of the volumes of sediment enabled by the Proposal is consistent with the outcomes sought in Objective 23.3 and policies 23.4.1 and 23.4.2, and Method 23.5.1.

[589] Reinen-Hamill, R, pages 58 & 59, section 5.6.1 "Crude Shipping Project, Coastal Processes Assessment". Dated July 2017

c. Mr Reinen-Hamill has set out the monitoring that needs to be undertaken after the capital dredging for at least five years[590]. Of note is that the monitoring is not proposed to 'understand' the environmental effects of the extraction proposed. Rather, we understand that the monitoring is proposed to confirm that the effects felt by the environment reflect those predicted in this AEE, and to trigger a response from the consent holder in the unlikely event that an unanticipated affect is identified. The monitoring will also, we understand, be used to refine the volume of sediment that is deposited at Site 1.2. This approach accords, in our opinion, with the outcomes sought in methods 23.5.2, 23.5.5 and 23.5.7.

d. Mr Brown, Mr Styles, Mr Greenaway, Mr Reinen-Hamill, Mr Don, Dr Clement and Dr Coffey have variously assessed the impact of the Proposal on the matters that contribute to the area's amenity and natural character, and on the ecology of the outer Whangarei Harbour and the northern extent of Bream Bay. From our reading of their advice, none have identified what we understand would be an unacceptable environmental effect(s). Indeed, all conclude that the sand extraction activities (in this case, being the dredging of sand) will not, following the adoption of appropriate avoidance, remediation or mitigation measures, result in any adverse effects that are greater than moderate, and largely minor or less, in their magnitude. This body of advice leads us to the conclusion that the Proposal can be advanced so as to also accord with the outcome sought by Policy 23.4.3.

M1MA

The M1MA provisions of the RCP that relate to the Proposal are set out in **Table 5.7.2.7**.

Objectives	Policies	Methods
Objective 25.3.1	Policy 25.4.1	Nil

Table 5.7.2.7: M1MA

Having considered the Proposal against the provisions listed in **Table 5.7.2.7** we note that:

a. Considerable care has been taken to ensure that the Proposal does not encroach into the various M1MA areas that exist in close proximity to the dredging activities that are to occur within the outer portions of the Whangarei Harbour. Furthermore, and as we have noted, considerable attention has also been paid to the potential for the proposed dredging activities to impact upon the values that the M1MA areas support. While the proposal has the potential to adversely affect these areas, the conservative approach to the setting of the mitigation measures, such as the proposed turbidity levels and response, is expected to ensure that the proposal does not impact the values that are supported by the areas zoned M1MA by the RCP.[591] This is aligned, in our opinion, with Objective 25.3.1.

b. Refining NZ asked its experts to advise what, in addition to avoiding their disturbance, could be done to avoid the values supported by the M1MA zoned portions of the Whangarei Harbour being adversely affected by the Proposal. We describe that approach as 'an avoidance first philosophy'. The expert advice that was offered was, in our experience, ultimately accepted, and incorporated into the Proposal. Consequently, none of the values supported by the M1MA

[590] Reinen-Hamill, R, page 65, section 7.2, "Crude Shipping Project, Coastal Processes Assessment". Dated July 2017

[591] Dr Coffey, B, pages 8 to 9, Table 1, & pages 44 to 45, Section 4.1.2e, "Crude Shipping Project. Proposal to Deepen and Partially Realign the Approaches to Marsden Point. Assessment of Marine Ecological Effects Excluding Seabirds and Marine Mammals". Dated 10 August 2017

areas are expected to be adversely effected by the Proposal. This accords with the approach that is advanced in Policy 25.4.1.

M2MA

The M2MA provisions of the RCP that relate to the Proposal are set out in **Table 5.7.2.8**.

Objectives	Policies	Methods
Objective 26.3.1	Policy 26.4.1	Nil
Objective 26.3.2	Policy 26.4.2	
	Policy 26.4.3	

Table 5.7.2.8: M2MA

Having considered the Proposal against the provisions listed in **Table 5.7.2.8** we note that:

a. The Proposal is predicted to cause changes in discreet areas of the outer Whangarei Harbour and the northern extent of Bream Bay (which in turn will cause what Mr Reinen-Hamill describes as small changes (that are typically within the existing natural variability) to some of the adjacent geomorphological processes and no changes to others[592]). The body of advice before us is that this change will not cause an overall loss of the existing amenity, natural or cultural values that are present in the portions of the Site that are zoned M2MA, when the various compensation, remediation and mitigation measures are considered. In that regard, care is being taken to ensure that the values present within the areas zoned M2MA are, when all things are considered, protected from harm, and will persist during and following the various activities that are proposed. As a consequence, we are of the opinion that the existing natural, cultural and amenity values can be maintained in the areas zoned M2MA.

b. That is not to suggest, however, the changes caused by the Proposal will result in any adverse effects on natural values. Indeed, Dr Coffey is clear that the dredging and disposal activities will cause a minor to moderate loss of the benthic ecology within the footprint of the dredging and disposal activities[593], while Mr Don points to potential impacts on the feeding activities of Little Blue Penguins and to bird collision risk for both pelagic bird species in general and the grey-faced petrel.[594] We understand both to predict, however, that any effects will be temporary and can be offset by mitigation measures such as the installation of penguin and grey-faced petrel nesting boxes, 'lighting audits' of the vessels associated with the dredging and disposal activities[595] and ecological enhancement / restoration initiatives associated with the shellfish and seagrass communities[596]. Furthermore, while Dr Clement also highlights a number of actual and potential effects of marine mammals, she has recommended a series of measures[597], which if implemented (as is proposed) will result in effects being avoided, or minimised to the point that they are no more than De Minimis in their magnitude.[598]

[592] Reinen-Hamill, R, page 57 to 65, "Crude Shipping Project, Coastal Processes Assessment". Dated July 2017
[593] Dr Coffey, B, pages 8 to 9, Table 1, "Crude Shipping Project. Proposal to Deepen and Partially Realign the Approaches to Marsden Point. Assessment of Marine Ecological Effects Excluding Seabirds and Marine Mammals". Dated 10 August 2017
[594] Don, G, pages 33 to 50, section 5.0, "Crude Shipping Project, AEE Report, Coastal Birds, Final". Dated 09 August 2017
[595] Don, G, pages 52 to 54, section 7.0, "Crude Shipping Project, AEE Report, Coastal Birds, Final". Dated 09 August 2017
[596] Dr Coffey, B, page 51, section 5.1, "Crude Shipping Project. Proposal to Deepen and Partially Realign the Approaches to Marsden Point. Assessment of Marine Ecological Effects Excluding Seabirds and Marine Mammals". Dated 10 August 2017
[597] Clement, D, pages 21 & 22, Table 4, "Assessment of Effects on Marine Mammals from Proposed Deepening and Realigning of the Whangarei Harbour Entrance and Approaches". Dated August 2017
[598] Clement, D & Elvines, E, page 7, Table 2, "Assessment of Effects on Marine Mammals from Proposed Deepening and Realigning of the Whangarei Harbour Entrance and Approaches". Dated August 2017

Consequently, while there may be a short-term loss of natural values, we understand that it will not persist and will not detract from the values and ecosystems that are present within and around the M2MA areas. Furthermore, the draft CEA and Mr Coffins peer review of the same highlight an array of actual and potential cultural effects and concerns. A variety of measure are, however, being advanced to address both the effects and the concerns to a point where they are acceptable.

c. Given the foregoing, we are of the opinion that the Proposal will cause some adverse effects, with the majority of these being confined geographically and temporally. Having, however, considered this matter against the advice that is before us (which sets out the various values that exist within the portion of the Site that is zoned M2MA[599]), we are of the opinion that these short-term effects, the majority of which are very small and the largest of which is 'low to moderate', will not cause the natural, cultural and amenity values associated with the Site to be lost, or diminished to a point that they (the values) are not maintained. This outcome accords, in our opinion, with the intent of Objective 26.3.1 and Policy 26.4.2.

d. In our experience, Refining NZ has actively engaged with the community when defining the Proposal and during the preparation of this AEE. We are advised (Martin, D, pers. com) that engagement is to continue through the remainder of this resource consent process, into the implementation of the Proposal and beyond in the post event monitoring and maintenance dredging phase. This will, we expect, enable parties' external to Refining NZ and the Council to be involved in the maintenance of the areas that the Proposal effects, including those portions that are zoned M2MA. Such an approach is, in our opinion, aligned with the approach advanced by Objective 26.3.2.

e. Based upon our experience in the project, we are of the opinion that a cautious approach has been adopted in the assessment of the environmental effects that could be generated by the Proposal, despite there being a significant body of information about the environmental values and processes that exist within and adjacent to the area that would be disturbed by the Proposal. This approach is, in our opinion, consistent with Policy 26.4.1.

f. Mr Brown, Mr Styles, Mr Reinen-Hamill, Dr Coffey, Mr Coffin and Dr Clough address the various 'environmental value' considerations that are highlighted by Policy 26.4.3. We interpret the advice of these experts to be that the effects associated with the Proposal can be avoided, remedied or mitigated to a level that they consider to be appropriate. We understand this to mean that the Proposal is compatible with the character, heritage and amenity values that exist, which achieves the outcome promoted by Policy 26.4.3.

<u>M5MA</u>

The M5MA provisions of the RCP that relate to the Proposal are set out in **Table 5.7.2.9**.

Objectives	Policies	Methods
Objective 29.3.1	Policy 29.4.1	Method 29.5.8
	Policy 29.4.4	Method 29.5.9

Table 5.7.2.9: M5MA

Having considered the Proposal against the provisions listed in **Table 5.7.2.9** we note that:

599 Please refer to section 4 of this AEE, and to the reports of Mr Don, Mr Brown, Dr Clement, Dr Coffey and Mr Reinen-Hamill for a description of the values supported by the portion of the Site that is zoned M2MA.

a. For the reasons that we have already set out, we understand that the Proposal will assist Refining NZ to make provision for its 'commercial port operations'. We also understand that the improvements to the channel alignment will also assist all of the other commercial port operations in the Whangarei Harbour, and will reduce the navigational risk associated with all vessels entering and leaving the Harbour [600] while, at the same time, reducing the environmental risk of an oil spill from the vessels visiting the Refinery[601]. The body of advice before us leads us to the opinion that the care taken by Refining NZ to design the Proposal will also ensure that any effects that could arise will be avoided, remedied or mitigated to an extent deemed acceptable by a number of respected environmental experts, whose opinion has been informed by feedback from parties during the consultation processes that Refining NZ has conducted to support its resource consent applications. As a consequence, we are also of the opinion that the Proposal is consistent with Objective 29.3.1.

b. Should the resource consents sought by Refining NZ for the Proposal be granted, the advice to us is that the Council would be recognising and providing for the requirements of the port operations associated with Marsden Point in a manner that is expected to be beneficial, and could only be, at worst, environmentally benign for the other commercial port operations within the Whangarei Harbour. As we have stated, our experience is that where a potentially unacceptable environmental affect has been predicted by the experts retained to assess the Proposal, Refining NZ has first sought to avoid the generation of that effect (by modifying the design of the proposal or proposal operational controls), and then to remedy or mitigate all other effects. This approach accords, we believe, with the direction advanced within Policy 29.4.1.

c. The advice of Mr Styles[602] and Mr Oldham lead us to the opinion that the proposal will reduce the likelihood of oil spills and will not generate unacceptable noise emissions. This is consistent, in our opinion, with the outcome sought by Policy 29.4.4 and methods 29.5.8 and 29.5.9.

5.7.1.4 Administrative Issues

The RCP sets out various provisions that discuss a variety of other matters in Part VII. There are a number of sections within Part VII that are directly relevant to the Proposal, being the sections on financial contributions and royalties (section 34), consent term duration (section 33.6) and the management of effects of fishing activity (section 35). We discuss sections 33.6 and 34 when we traverse the assessment criteria that the RCP prescribes. We now turn to, and discuss the relevant objective, policy and method of section 35.

<u>Management of Environmental Effects of Fishing Activity</u>
The fishing activity provisions of the RCP that relate to the Proposal are set out in **Table 5.7.3.1**.

Objectives	Policies	Methods
Objective 35.2	Policy 35.3.2	Method 35.4.3

[600] Bermingham, G, pages 1 & 2, section 1.0, & page 35, section 7.1, "Report in Support of an Assessment of Effects on the Environment, Navigational Risk Assessment of Engineered Channel Designs", Dated 15 August 2017.
[601] Oldham, K, page 2, "Environmental Spill Risk Assessment for Proposed Tanker Operations Associated with Engineered Channel", Dated 14 August 2017
[602] Which is summarised in Styles, J, pages 17 to 18, section 8.0, "Whangarei Harbour Entrance and Marsden Point Channel Realignment and Deepening: Assessment of Environmental (Airborne) Noise Effects". Dated 31 July 2017

Table 5.7.3.1: Fishing Activity

Having considered the Proposal against the provisions listed in **Table 5.7.3.1** we note that:

a. Dr Coffey notes that the Proposal will have an impact, albeit a temporary one, on the fish stocks in the outer Whangarei Harbour and in the northern portion of Bream Bay[603]. Mr Greenaway has considered this advice and advised that it is not expected to cause a consequential recreation effect that is, at worst, more than minor, due principally to the ability of recreational anglers to move 'to where the fish are biting'[604]. Mr Boyd has also considered, amongst other things, Dr Coffey's advice and advised that the Proposal will have a negligible effect on both commercial fish stocks and the associated fishing activity[605]. The draft CEA also addresses this matter and highlights concerns, principally being that the Proposal could confine existing and future fishing activities that are undertaken by Tangata Whenua. Mr Coffin, relying on the advice of Dr Coffey and Mr Boyd, concludes that these effects are expected to be less than minor to moderate in nature[606]. Given the foregoing, we are of the opinion that the extent of the advice taken by Refining NZ on this matter is consistent with that envisaged by Policy 35.3.2 and Method 35.4.3.

b. When considered together, this advice leads us to the opinion that the Proposal will not prevent the sustainable management of either the coastal fishery or the habitats of fish. As a consequence, we are also of the opinion that the Proposal can achieve Objective 35.2.

5.7.1.5 Assessment Criteria

The RCP sets out a number of assessment criteria in section 32 (which is located in Part VI of the Plan). As we have already recorded, those criteria are supplemented by additional criteria that are contained within two sections of Part VII (being financial contributions and royalties (section 34) and consent term duration (section 33.6)). We now discuss the applicable assessment criteria. Please note that the assessment criteria repeat, in large part, matters that are raised in the extensive policy framework of the RCP, and that we have already discussed in this AEE. To avoid unnecessary repetition, we have kept our responses as concise as possible, and have included them as **Annexure Nine** to this AEE. Please note that we have also only cited (referenced) the advice that we are relying on where we did not do so our discussion of the policy framework for this planning instrument.

5.7.2 The Operative Northland Regional Policy Statement, 2016

The Regional Council developed a second-generation regional policy statement to the point that it was made operative (with the exception of three discreet revisions that have no relevance to the Proposal) on the 9th of May 2016.

The planning maps associated with the Operative Northland Regional Policy Statement ('**the RPS**') record that the environs adjacent to the Site support an array of significant values. A printed extract from the planning maps website is attached as **Annexure 10** to this AEE. In summary, however:

[603] Dr Coffey, B, pages 47 to 48, section 4.1.3c, "Crude Shipping Project. Proposal to Deepen and Partially Realign the Approaches to Marsden Point. Assessment of Marine Ecological Effects Excluding Seabirds and Marine Mammals". Dated 10 August 2017

[604] Greenaway, R, page 58, section 5.2.5, "Refining NZ Crude Shipping Project, Recreation and Tourism Effects Assessment". Dated August 2017

[605] Boyd, R, refer, for example, to pages 39 & 40, section 4.9, "Commercial Fishing in Whangarei Harbour & Bream Bay". Dated 11 August 2017

[606] Coffin, A, pages 12 & 13, section 6, "Refining NZ Crude Shipping Project - Peer Review Report of Refining NZ Crude Freight Proposal – Tangata Whenua o Whangarei Te Rerenga Paroao DRAFT Cultural Effects Assessment (11 June 2017)", Dated 21 July 2017

a. Mair Bank, Marsden Bank and a large area extending from the Marine Reserve and around Home Point are deemed to be an area of high natural character. Of note is that the description of the 'Mid-outer harbour' area makes it clear that the dredged channels are not included within these areas.

b. The natural character of Bream Head (above the MHWS mark) and the Marine Reserve are deemed to be outstanding.

c. An area encompassing Bream Head (called the 'Bream Head / Manaia Sequence') is deemed to be an outstanding landscape.

d. The Refinery and its jetty are deemed to be within the coastal environment.

We now discuss the relevant sections of the RPS, in the order that they are presented.

5.7.2.1 Regional Issues

The RPS sets out (in Part 2) the regionally significant issues for Northland. We summarise and highlight the applicable issues, as they apply to the Proposal, as follows:

a. Fresh & Coastal Water: The key pressures facing Northland's fresh and coastal waters that are of direct relevance to the Proposal are climate change, and elevated levels of fine sediments, nutrients and faecal pathogens. In the explanation to the issues, it is noted that the water quality issues are normally as a consequence of land uses, and poorly treated / untreated discharges. Harbours seem to be the focus of the marine aspect of this issue, with water quality of the open coast being higher and, as a general rule, uncontaminated.

b. Indigenous Ecosystems & Biodiversity: The key pressures on indigenous coastal marine ecosystems are said to be the water quality issue highlighted in bullet point (a), marine pest plants, animals and organisms, and the fragmentation, loss and isolation of populations and communities of indigenous species due to, amongst other things, habitat loss.

c. Economic Potential & Social Wellbeing: The RPS contends that Northland has not effectively and sustainably managed its natural and physical resources to realise its economic potential and social wellbeing. The 'limiting factors' that follow this statement have limited relevance to the Proposal, and thus are not discussed further. What is of some note, however, is the acknowledgement (in the explanatory text that follows the issue statement) that the Refinery is nationally significant.

d. Tangata Whenua Participation: The areas of this section that are of relevance to the Proposal are the inadequate provisions for the early and effective participation of Tangata Whenua as partners in Regional Council decision making (from the explanation associated with this issue it is clear that the main source of concern is with NRC's decision making function, and not with an inability to submit to a resource consent application), insufficient recognition and utilisation of Matauranga Maori in the management and monitoring of natural and physical resources (which can be expressed by the use of cultural indicators and/or marae based monitoring), and the limited and/or ineffective inclusion of Maori concepts, values and practices within resource management processes (which is principally attributed to lack of agreed methodologies for the integration of practices such as kaitiakitanga).

e. Natural & Physical Resource Issues for Tangata Whenua: The key areas of concern that apply to the Proposal are climate change, a decline in the mauri of natural resources, a decline of mahinga kai (particularly kai moana sites) and the associated impact on the ability of Tangata Whenua to feed whanau and manaaki manuhiri, and a loss of indigenous biodiversity, particularly where it impacts on the ability of tangata Whenua to carry out cultural and traditional activities.

f. Natural Hazards: The focus of this issue is, in the context of the Proposal, on coastal erosion and inundation, as it exists and as it could increase with climate change.

g. Natural Character, Natural Features & Landscapes, & Historic Heritage: This issue focuses on how many natural features, landscape, natural character and historic heritage have been compromised, and remain at risk as a consequence of coastal structures, a lack of active management, and the inconsistent identification and protection of these features.

Part 3 of the RPS sets out the objectives that apply within Northland, while Parts 4 to 8 set out the associated policies and methods. We now discuss the applicable objectives, policies and methods, following the same structure that we employed in our discussion of the RCP. Please note that we have also only cited (referenced) the advice that we are relying on where we did not do so our discussion of the policy framework of the RCP, and that all of the provisions cited in **Tables 5.7.7.1** to **5.7.7.9** are repeated, in full, in **Annexure 10** to this report.

5.7.2.2 Objectives, Policies and Methods

Region-wide Water Quality

The provisions of the RPS that relate to region-wide water quality of the coastal environment and that are relevant to the Proposal are set out in **Table 5.7.7.1**.

Objectives	Policies & Methods
Objective 3.2	Policy 4.2.1

Table 5.7.7.1: Region-wide Water Quality

Having considered the Proposal against the provisions listed in **Table 5.7.7.1** we note that:

a. A general improvement in the quality of Northland's coastal water is sought by these provisions. While the advice before us is that the Proposal will result in a confined (in both a geographic and temporal sense) increase in turbidity, we understand the water quality and ecological effects associated with this outcome are not, in the opinion of Dr Coffey, cause for concern should the proposed approach to managing such turbidity be implemented. Further, we understand the advice of Mr Greenaway to be that these local changes will not prevent or otherwise constrain recreation – including swimming - at popular locations such as the Marine Reserve.[607] We understand the collective responses of both Dr Coffey and Mr Greenaway to mean that any such effects will not prevent the achievement of the overall goal promoted by Objective 3.2.

b. While the RCP preceded the NRPS and thus may not give full effect to Objective 3.2, it is none-the-less important to reiterate that the Proposal will comply with the water quality

[607] Greenaway, R, pages 54, 55 & 59, sections 5.2.1 & 5.2.6, "Refining NZ Crude Shipping Project, Recreation and Tourism Effects Assessment". Dated August 2017

standards set by the RCP, after the application of a reasonable mixing zone. Achieving this outcome has involved careful consideration of the existing environment and advancing a proposal that responds appropriately to the same.

Indigenous Ecosystems & Biodiversity

The provisions of the NRPS that relate to indigenous ecosystems and biodiversity and that are relevant to the Proposal are set out in **Table 5.7.7.2**.

Objectives	Policies & Methods
Objective 3.4	Policy 4.4.1

Table 5.7.7.2: Indigenous Ecosystems & Biodiversity

Having considered the Proposal against the provisions listed in **Table 5.7.7.2** we note that:

a. As they have done in the context of Policy 11 of the NZCPS, we understand that Dr Coffey, Dr Clement and Mr Don have evaluated the Proposal against the directions set out in Objective 3.4 and Policy 4.4.1 (Coffey, B, Clement, C and Don, G, pers. com). In doing so, we are advised that they have considered the significance of the ecosystems present against the 'criteria' set out in limb (1) of Policy 4.4.1[608].

b. We understand the advice of all three ecological experts to be that the ecosystems / taxa that qualify as being significant under limb (1) of Policy 4.4.1 will be protected by ensuring that the Proposal does not adversely affect them.

c. Further, we understand the same experts to conclude that the ecosystems that are listed in limb (2) of Policy 4.4.1 will not be significantly affected, and that all other actual and potential effects will be avoided, remedied or mitigated to an extent that the experts believe is acceptable. It is notable, in our opinion, that all of the experts advise that the effects of the proposal will be temporary and that there are opportunities for ecological benefits to accrue via mechanisms such as the penguin nesting boxes, if they are maintained in the long term. The latter is particularly aligned, in our opinion, with limb (c) of Objective 3.4.

d. As we have already noted, we understand that each of the experts considered the guidance provided by limb (4) of Policy 4.4.1 when giving their advice.

e. Given the foregoing, we are of the opinion that the Proposal can be advanced so as to be consistent with Objective 3.4 and Policy 4.4.1.

Enabling Economic Wellbeing

The provisions of the NRPS that relate to enabling economic wellbeing and that are relevant to the Proposal are set out in **Table 5.7.7.3**. These provisions are repeated, in full, in **Annexure 10** to this report.

Objectives	Policies & Methods
Objective 3.5	Policy 4.2.1

Table 5.7.7.3: Enabling Economic Wellbeing

608 Refer, for example, to Dr Coffey, B, pages 45 to 48, section 4.1.3, "Crude Shipping Project. Proposal to Deepen and Partially Realign the Approaches to Marsden Point. Assessment of Marine Ecological Effects Excluding Seabirds and Marine Mammals". Dated 10 August 2017

We have discussed the Proposal in the context of Policy 4.2.1 previously. We do not repeat that discussion, but rather now address Objective 3.5. In that regard:

a. The Refinery is itself a nationally significant physical resource that requires sustainable management in accordance with Objective 3.5.

b. Objective 3.5 traverses two interrelated considerations, being the need for Northland to attract investment, but ensuring that all investment is aligned with the environmental outcomes that are also sought by the Region.

c. For the reasons set out in section 3.0 of this AEE, we are of the opinion that the actual and potential environmental effects are well known, and that Refining NZ has been successful in developing a Proposal that is appropriate to the environs within which it would be located. Put another way, we are of the opinion that the Proposal is broadly aligned with the outcomes that are articulated in and sought by the planning instruments that apply.

d. The advice of Mr Clough is that the Proposal will generate a number of economic benefits for Northland and beyond, which is aligned, in our opinion with the goal of improving the economic wellbeing of Northland and its communities[609].

<u>Regionally Significant Infrastructure, Efficiency & Effectiveness, & Security of Energy Supply</u>
The provisions of the NRPS that relate to regionally significant infrastructure, efficient and effective infrastructure and the security of energy supply, and that are relevant to the Proposal are set out in **Table 5.7.7.4**.

Objectives	Policies & Methods
Objective 3.7	Policy 5.1.2
Objective 3.8	Policy 5.1.3, limb (c)
Objective 3.9	Method 5.1.5, limbs (1)(d) and (1)(e)
	Policy 5.2.1
	Policy 5.2.2
	Policy 5.2.3
	Policy 5.3.1
	Policy 5.3.2
	Policy 5.3.3, limbs (2) and (3)

Table 5.7.7.4: Regionally Significant Infrastructure, Efficient & Effectiveness, & Security of Energy Supply

Having considered the Proposal against the provisions listed in **Table 5.7.7.4** we note that:

a. The Refinery and the adjacent facilities at the Northport are physical infrastructure requiring sustainable management under the Act. Both are listed in Appendix 3 of the NRPS, and thus

[609] Refer, for example, to Clough, P, pages 22 & 23, section 4, "Crude Shipping Project, Economic Assessment of Channel Deepening at the Marsden Point Oil Refinery". Dated 02 August 2017

are deemed to be Regionally Significant Infrastructure for the purposes of this planning instrument. This is in addition to the nationally significant recognition that the Refinery receives in the introductory sections of the NRPS. As we have discussed, we understand that the Proposal is one of a range of other initiatives that the Refinery could use to maintain its competitiveness in the international market place[610]. We understand, on the basis of the advice from Mr Clough, that the continued existence and operation of the Refinery will generate a number of economic benefits, some of which are significant. Given these benefits, we expect the Proposal will also generate a range of positive social impacts for Northland. Equally, while the draft CEA highlights a number of actual and potential cultural concerns, the advice of Mr Coffin is that measures are available to address them. When all things are considered, and in keeping with the direction advanced by Objective 3.7 and policies 5.3.1 and 5.3.2, we are of the opinion that the benefits that are expected to be generated by the Proposal weigh heavily in the favour of the resource consents sought by Refining NZ being granted.

b. The Refinery, its associated jetty facilities and the entrance channel to the same already exist. We understand that, in summary, the Proposal seeks to upgrade the entrance channel so as to make more efficient use of the vessels that transport crude oil to New Zealand. In doing so, it will, we understand, reduce the navigational risk (and the associated environmental risk of an oil spill) of these vessels and those accessing Whangarei's other commercial port facilities. Further, and as we have previously noted, the Proposal enables this to occur in a manner that, in the opinions of a diverse array of respected experts, is environmentally acceptable. Given this, we are of the opinion that the Proposal represents a logical development of infrastructure 'in the right place' and 'at the right time'. Further, we are of the opinion that this outcome contributes to the optimal operation of at least the Refinery (and possibly the other port facilities in the Harbour), while enabling it to both meet the reasonably foreseeable needs of Northland (and, indeed, New Zealand) and support / lead further economic development and maintain / enhance community wellbeing. This accords with the goal advanced by Objective 3.8.

c. As already noted, we understand that the Refinery and its continued operation is an important means of ensuring that Northland and, indeed, New Zealand maintains a secure and reliable source of petrol, diesel and other associated fuels (Martin, D, pers. com). As the Proposal is a means of keeping the Refinery competitive, it follows that we believe that it accords with the direction advanced by Objective 3.9 and Policy 5.2.3.

d. As we have noted, the Proposal better facilitates the access of large vessels to the Refinery. In doing so it does not extend the Refinery or the jetty outside of its existing footprint, but rather consolidates that land based activities in an area of existing development. Furthermore, Refining NZ has commissioned an array of experts to assess the environmental effects of the Proposal, including on Whangarei Harbour, Bream Bay, and the adjoining and adjacent land, and on facilities such as Northport. The Company has also, in our experience, supplemented this advice with feedback from interested and potentially affected parties. The information gained in both exercises leads us to the opinion that any effects on adjacent or adjoining land will be extremely limited and therefore acceptable. In addition, the advice of Mr Greenaway is that it is very unlikely that surf-breaks will be effected by the Proposal[611], and specifically, none of the nationally significant surf breaks listed in the NZCPS will be impacted by the Proposal[612].

[610] Clough, P, page i, "Crude Shipping Project, Economic Assessment of Channel Deepening at the Marsden Point Oil Refinery". Dated 02 August 2017.
[611] Greenaway, R, pages 56 sections 5.2.2, "Refining NZ Crude Shipping Project, Recreation and Tourism Effects Assessment". Dated August 2017
[612] Greenaway, R, pages 46, sections 4.6, "Refining NZ Crude Shipping Project, Recreation and Tourism Effects Assessment". Dated August 2017

These conclusions, and the Proposal's alignment with the direction that is advanced by the relevant provisions of the NRPS, lead us to the corresponding opinion that the Proposal does not represent an 'inappropriate' use or development and accords with Policy 5.1.2, and limb (c) of Policy 5.1.3. These conclusions, and the consultation that Refining NZ has undertaken with Northport, also lead us to the opinion that the Proposal gives effect to limbs (d) and (e) of Method (1)(d) and (1)(e).

e. While some may contend that Policy 5.2.1 is not 'directly applicable', it contains themes that are, in our opinion, of relevance to the infrastructure and, given the Act's definition of that term, the Proposal. In this regard, it speaks of efficient (wise) resource use. In our experience of this resource consent application process, the Proposal has been designed and then refined to minimise the amount of dredging that is needed, ensures that any adverse effects are avoided where the policy direction requires avoidance and otherwise minimised, and provides both a notable navigational benefit to commercial vessels and future proofing of the Refinery. Policy 5.2.1 also speaks of minimising 'waste'. While the spoil disposal is not a waste product, care is still to be made to ensure that it is available for both beneficial uses outside of the CMA, and to nourish the ETD, therefore providing a heightened degree of resilience to sea level rise. These factors lead us to an opinion that the Proposal accords with the applicable components of Policy 5.2.1, while ensuring that the Refinery is better placed to respond to the international market in which it operates. This latter outcome is in keeping, in our opinion, with direction advanced by Policy 5.2.2.

f. Policy 5.3.3 establishes what we consider to be directive 'thresholds' for the maintenance and upgrading of the entrance channel and turning basin, and the relocation of the Navaids. We understand the advice from the independent experts assisting Refining NZ to be, that the Proposal will not generate significant adverse effects, and that beneficial effects are likely to be felt by the environs after the dredging campaigns are complete (as a consequence of initiatives such as the disposal of sediment at site 1.2) and the dredge and disposal locations have recovered from the disturbance activities.

g. Given this, and in the context of the various considerations set out in limb (3) of Policy 5.3.3 we note:

    i. The expert advice before us is that there are a number of benefits that will be generated by the Proposal. Some are mentioned in the preceding bullet points (bullet points (a) and (f) of this discussion). Others include the environmental restoration initiatives / fund recommended by Dr Coffey, and the reduced navigation and environmental risk associated with an oil spill that the new channel alignment and less frequent oil tanker movements generate. These considerations weigh, significantly in our view, in support of Refining NZ's resource consent applications.

    ii. Policy 9, which applies to Ports (and thus includes the entrance channel, turning basin and the jetty facilities associated with the Refinery) lends some support, in our opinion, for the Proposal, given that the Proposal will further enhance an element of New Zealand's 'national network of safe ports'.

    iii. A number of alternatives have been considered to the Proposal. As summarised in section 1.5 of this AEE, the analysis completed by T&T and P&P suggests that the

Proposal represents the most appropriate means of responding to the constraints that exists within the Whangarei Harbour and Bream Bay[613].

iv. The Refinery and Northport are included in Schedule 1 of the Civil Defence Emergency Management Act, and are thus deemed to be a 'lifeline utility'. By straightening the access channel, and thus reducing the navigation risk associated with the same, the Proposal is contributing to the reasonable needs of Northland's people and communities being met. This, in our opinion, is aligned with ensuring that both facilities are given the best prospect of being able to continue to operate, even in the event of an emergency. We note, for completeness, that the recognition of the Refinery as a lifeline utility further buttresses our opinion that it is nationally significant.

v. As we have noted, the approach adopted by Refinery NZ and its experts seeks to minimise the adverse effects that cannot be avoided to a practicable minimum, while providing benefits for the environment (including the communities located therein) of Whangarei, Northland and New Zealand.

vi. A range of detailed monitoring programs are proposed. Those programs will, we expect, link to review opportunities under section 128 of the Act should the monitoring not verify the effects that are projected by the independent experts advising Refining NZ.

vii. For the reasons we have already outlined, we understand that the Proposal will consolidate development in a highly-modified part of the Whangarei. While the disposal activities will disturb what we understand to be relatively undisturbed parts of Bream Bay, we understand the expert advice to be that the effects of that disturbance will diminish to a point where they a minor or less in relatively short order.

Use & Allocation of Common Resources

The provisions of the NRPS that relate to the use and allocation of common resources and that are relevant to the Proposal are set out in **Table 5.7.7.5**.

Objectives	Policies & Methods
Objective 3.10	Policy 4.8.1
	Policy 4.8.3
	Policy 4.8.4

Table 5.7.7.5: Use & Allocation of Common Resources

Having considered the Proposal against the provisions listed in **Table 5.7.7.5** we note that:

a. The only aspect of the Proposal that results in the occupation of space relates to the Navaid structures. Of those activities, only five new navigation aids are proposed, two in Bream Bay and three in Whangarei Harbour. The coastal space occupied by these facilities is very small.

b. As we have previously noted, there is a functional need for the Navaids to be relocated to, or installed in new areas. We also understand the advice of the independent experts advising Refining NZ (particularly Mr Bermingham, Dr Coffey and Mr Brown) to be that the proposed locations are appropriate in the context of navigation safety and can be constructed in a

[613] Reinen-Hamill, R, pages 33 & 36, sections 4.1 & 4.2, "Crude Shipping Project - Mid-Point Multi-Criteria Alternatives Assessment". Dated July 2017

manner that avoids the ONL and natural character areas, the most significant ecological habitats, and significant adverse effects on all other values that are present.

c. We understand the advice of Mr Bermingham to be that the public will not be formally precluded from the CMA in the immediate vicinity of the navigation aids. They are, however, not allowed to interfere with the Navaids. They are also actively discouraged from mooring in close proximity to the Navaids. This reflects the Regional Bylaws and the Maritime New Zealand Maritime Rules (Dickinson, P, pers. com[614])[615].

d. A 25-year term is sought for the resource consents associated with the installation and on-going operation of the navigation aids. This is aligned, in our opinion, with the term sought for the remaining elements of the Proposal, and reflects both the small scale and level of certainty associated with the environmental effects of these facilities and their inextricable relationship with the access channel. We question, also, if others would have a demand for the space that will be occupied, and if alternative uses could reasonably be expected to establish in such close proximity to the access channel.

e. Both the navigation aids and the wider Proposal provide significant public benefits, both in terms of the reduced navigation risks that they will enable for large vessels accessing the Whangarei Harbour, and the benefits that will accrue as a consequence of the Refinery's continued existence and operation. Whether these benefits outweigh the adverse effects of the Proposal, and therefore result in a net environmental gain is a subjective assessment. Given, however, the advice of the independent experts that the effects associated with the Proposal are, at worst moderate and are expected to diminish in a relatively short period, we are of the opinion, that a net environmental gain will result.

Tangata Whenua Role in Decision Making

The provisions of the NRPS that relate to Tangata Whenua's role in decision making and that are relevant to the Proposal are set out in **Table 5.7.7.6**.

Objectives	Policies & Methods
Objective 3.12	Policy 8.1.1
	Policy 8.1.2
	Policy 8.1.3
	Policy 8.1.4
	Policy 8.2.1
	Policy 8.3.1

Table 5.7.7.6: Tangata Whenua's Role in Decision Making

Having considered the Proposal against the provisions listed in **Table 5.7.7.6** we note that:

a. By the early and frequent engagement with Tangata Whenua, Refining NZ has sought, in our experience, to both understand and to enable kaitiakitanga. This is reflected in Refining NZ meeting with Tangata Whenua at the outset of the project, involving Tangata Whenua in the baseline monitoring, inviting iwi representatives to meetings where the expert team engaged

[614] Mr Dickinson is a 'Lead Consultant' with Navigatus Consulting Limited
[615] Mr Dickinson referred us specifically to Part 91 of the maritime rules

by the Company discussed their preliminary findings and reports, actively seeking comments on the draft technical reports from Tangata Whenua and their experts, and in the commissioning of both a CVA and a CEA. While it is not within Refining NZ's remit to enable Tangata Whenua to be actively involved in the decision-making process and/or provide opportunities for the use and incorporation of Matauranga Maori into the same, the Company has provided what we consider to be a very good basis for such involvement. This approach accords, in our opinion, with the intent of Objective 3.12 and policies 8.1.1 and 8.1.3, and 8.3.1.

b. For similar reasons to Bullet Point (a) of this discussion, we are of the opinion that the approach that Refining NZ has adopted to cultural considerations has resulted in a considerable body of information that enables the Council consider the matters set out in limbs (a) to (c) of Policy 8.1.2 and in Policy 8.1.4. For the reasons that we have set out in our discussion of the planning instruments, and in our consideration of sections 6(e), 7(a) and 8 of the Act, the information and advice before us (particularly from Dr Clough and Mr Coffin) leads us to the conclusions that (i) the Proposal can been advanced to recognise and provide for, have particular regard to and take into account the matters that are listed in Policy 8.1.2, and (ii) the detail that is provided in the CVA and draft CEA clarify the cultural concepts, values and practices that are relevant to the Proposal.

c. The relevant iwi and hapu management plans are discussed in the cultural effects sub-section of this AEE (refer to section 2.9) and are addressed in both the draft CEA and Mr Coffin's peer review of the same. This accords, in our opinion, with the outcome that is sought in policy 8.2.1.

<u>Natural Hazard Risk</u>
The provisions of the NRPS that relate to natural hazard risk and that are relevant to the Proposal are set out in **Table 5.7.7.7**. These provisions are repeated, in full, in **Annexure 10** to this report.

Objectives	Policies & Methods
Objective 3.13	Policy 7.1.3, limbs (d), (e) and (f)
	Policy 7.1.4, limb (f)
	Policy 7.1.5, limb (1)
	Policy 7.1.6
	Method 7.1.7, limb (7)
	Policy 7.2.1

Table 5.7.7.7: Natural Hazard Risk

Having considered the Proposal against the provisions listed in **Table 5.7.7.7** we note that:

a. We understand the advice of Mr Reinen-Hamill to be that the Proposal will not impact on the geomorphology of either the Whangarei Harbour or Bream Bay to an extent that is beyond the bounds of natural variation. Further, we understand that in addition to mitigating any impacts that the Proposal could have on the ETD, the requirement to dispose of a portion of the dredged material at disposal site 1.2 will improve the resilience of this feature following sea level rise. It follows, in our opinion, that the Proposal will not increase the risk of social, economic or environmental harm as a consequence of coastal hazards. This advice leads us to the associated opinion that the Proposal accords with the direction advanced by Objective 3.13 and the limbs (d) and (f) of Policy 7.1.3, limb (f) of Policy 7.1.4 and Policy 7.2.1.

b. Mr Reinen-Hamill has also advised that it is not possible to locate the entrance channel or turning basin away from an area that is potentially effected by coastal hazards without greater changes and consequential effects that are currently proposed. That said, we understand his advice to also be that the existing location has a reasonable amount of protection from wave action and that the proposed maintenance dredging will ensure that geomorphological processes, including those associated with coastal hazards are maintained and are not expected to damage both the integrity or functioning of the jetty associated with the Refinery and or the facilities of Northport. This aligns, in our opinion, with the outcome sought by limb (e) of Policy 7.1.3 and limb (1) of Policy 7.1.5.

c. Mr Reinen-Hamill's analysis included an assessment of the implications of climate change on the geomorphology of both the Whangarei Harbour and Bream Bay. We understand that he used the 'latest national guidance and the best available information' for his assessment. This approach accords, in our opinion, with Policy 7.1.6 and limb (7) of Method 7.1.7.

Natural Character, Outstanding Natural Features, Outstanding Natural Landscapes & Historic Heritage

The provisions of the NRPS that relate to natural character, outstanding natural features and landscapes, and historic heritage, and that are relevant to the Proposal are set out in **Table 5.7.7.8.**

Objectives	Policies & Methods
Objective 3.14	Policy 4.5.2
	Policy 4.5.3
	Policy 4.6.1, limbs (1) and (3)
	Policy 4.6.2
	Method 4.6.3, limb (3)(iii)
	Policy 4.7.1
	Policy 4.7.3

Table 5.7.7.8: Natural Character, Outstanding Natural Features, Outstanding Natural Landscapes & Historic Heritage

Having considered the Proposal against the provisions listed in **Table 5.7.7.8** we note that:

a. Mr Brown and Dr Clough have, we understand, considered the significance of the Site and its environs, in terms of natural character, natural landscapes and features, and the archaeological component of historic heritage (which as we note in our discussion of Part 2 of the Act, is an all-encompassing construct). Tangata Whenua have, in both the CVA and the draft CEA, set out the cultural significance of both the Whangarei Harbour and Bream Bay, which completes, in our opinion, the historic heritage assessment. Having undertaken this exercise, we understand that Mr Brown has advised that the Proposal is not expected to adversely affect the quality and characteristics that make up the outstanding areas of natural character of the Site and the adjoining environs, or of the outstanding natural features and landscapes that exist in close proximity to the area that will be impacted by the Proposal. While impacts on the landscape and natural character areas are, we understand, expected, they are predicted to be, at worst, moderate, and typically low to very low. For his part, Dr Clough advises that no known archaeological sites or areas will be directly impacted or placed at greater risk as a consequence of changes to the geomorphological process, which we take to mean that their integrity will not be threatened. While the draft CEA highlights the potential for cultural effects to be generated by the Proposal, Mr Coffin's advice is that measures can be advanced to ensure that any adverse effects are appropriately avoided, remedied or mitigated, which we take to mean that the integrity of the culturally significant areas and values are not threatened. Given these conclusions, we are of the opinion that the Proposal is aligned with Objective 3.14.

b. Mr Brown has assessed the level of natural character and the natural landscapes and features that exist within or in close proximity of the Site. Having completed that assessment, we understand his advice to be that he agrees with the areas and values ascribed within the NPRS. This accords, in our opinion, with the direction advanced by Policy 4.5.2. In a similar vein, we are of the opinion that the combination of the archaeological assessment, the draft CEA and Mr Coffin's advice addresses the matters set out in Policy 4.5.3.

c. We understand the advice of Mr Brown to be that the Proposal accords with Policy 4.6.1, insofar as it will not impact on the ONLs and features, and the areas supporting outstanding natural character. Further, we understand Mr Brown to conclude that all other areas of natural character and the other natural landscapes and features will not experience significant adverse effects, and that any effects that do arise will be avoided, remedied or mitigated to the extent that they are, at worst, moderate, and typically low to very low. We note, for completeness, that the dredging activities do not encroach into the areas of high natural character that apply to Mair Bank or the broader Calliope Bank area. The two new Navaids do, however, fall within the area of high natural character that is present in the Calliope Bank area.

d. We are of the opinion that Policy 4.6.2 does not apply to the Proposal, as the actions anticipated by both Policy 4.5.3 and Method 4.5.4(3) are yet to be completed. That aside, and looking at the substance of the Policy, we are of the opinion that the Proposal accords with the outcomes that are sought. In this regard, no known archaeological sites will be unacceptably impacted by the Proposal, while measures are proposed to ensure that the Proposal responds appropriately to the cultural values and sites of significance that existing within, or immediately adjacent to the area of interest.

e. The production of the draft CEA, the CVA, Mr Coffin's report and the Archaeological Assessment gives effect, in our opinion, to limb 3(iii) of Method 4.6.3.

f. Without reiterating the detail that we have provided in our response to the other planning provisions, we note that the Proposal incorporates a range of mechanisms (that will be implemented via conditions of consent - and thus are legally enforceable) that seek to both protect the notable environmental values in and around the Site, restore ecosystems, maintain areas of historic heritage and contribute to the resilience of areas that are culturally significant, such as Mair and Marsden banks. These measures, which we expect to be supplemented as a consequence of the recommendations that Mr Coffin has made, and following further discussion with Tangata Whenua, warrant recognition and promotion, in our opinion, in accordance with the direction advanced by policies 4.7.1 and 4.7.3.

<u>Active Management</u>

The provisions of the NRPS that relate to the use and allocation of common resources and that are relevant to the Proposal are set out in **Table 5.7.7.9**.

Objectives	Policies & Methods
Objective 3.15	Numerous provisions which we have previously addressed (and thus do not repeat here)

Table 5.7.7.9: Active Management

Having considered the Proposal against the active management provisions listed in **Table 5.7.7.9** we note that:

a. Our understanding of the body of expert advice to Refining NZ is that its proposed actions will maintain the natural character of Bream Bay and the Whangarei Harbour, the ONLs and features, areas of significant indigenous flora and habitats of indigenous fauna that exist in close proximity to the Site, public access to the coast and, after reasonably mixing, the quality of coastal water. In a similar vein, and as we have noted previously, we understand the advice of Dr Clough to be that no known archaeological sites will be impacted by the Proposal. While adverse cultural effects are anticipated, we understand that the proposed penguin nesting boxes and associated predator control, improved resilience of the ETD (which supports the culturally significant Mair and Marsden banks) to sea level rise and an environmental restoration fund are expected to offset those effects, and undo some of the harm that past activities have had on the culturally sensitive areas and values. The development of further measures, as recommended by Mr Coffin, in consultation with Tangata Whenua will also, we expect, contribute to the achievement of this outcome. Some of these initiatives are also expected to benefit aspects of the ecology within and surrounding the Site. Given this advice, we are of the opinion that the Proposal can be advanced so as to be consistent the outcome sought in Objective 3.15.

5.7.3 The New Zealand Coastal Policy Statement 2010

The NZCPS took effect from the 3rd of December 2010, and has continued since then without amendment. The NZCPS contains seven objectives and 29 policies, and provides the resource management framework for the coastal environment. As the Proposal is to be undertaken within the CMA, it is, in accordance with the guidance set out in Policy 1 of the NZCPS, situated within the coastal environment.

We discuss the relevant provisions of the NZCPS by topic, following the format that we have used for the RCEP and the RPS. Please note that, as we did for our discussion of the NRPS, we have also only cited (referenced) the advice that we are relying on where we did not do so our discussion of the policy framework of the RCP and NRPS. Further, all of the provisions cited in **Tables 5.7.8.1** to **5.7.8.6** are repeated, in full, in **Annexure 13** to this report.

<u>Form, Functioning, Resilience & Integrity of the Coast Environment, & Sustaining Its Ecosystems</u>
The provisions of the NZCPS that relate the geomorphological processes and ecology of the coastal environment and that are relevant to the Proposal are set out in **Table 5.7.8.1**.

Objectives	Policies
Objective 1	Policy 5
	Policy 11
	Policy 12
	Policy 21
	Policy 22
	Policy 23

Table 5.7.8.1: Form, Functioning, Resilience & Integrity of the Coast Environment, & Sustaining Its Ecosystems

Having considered the Proposal against the provisions listed in **Table 5.7.8.1** we note that:

a. We understand the advice of Mr Reinen-Hamill to be that the Proposal is to be undertaken in a manner that will maintain the geomorphic processes associated with the outer Harbour and Bream Bay within the level of natural variability. Further, we also understand Mr Reinen-Hamill to advise that the proposed disposal activities at disposal site 1.2 will improve the resilience of the ETD to both natural and anthropocentrically generated effects. Further, we understand the evidence of Mr Don, Dr Clement and Dr Coffey to be that the Proposal will avoid the vast majority of the areas of ecological significance, and will not generate adverse effects that are more than negligible on those areas that cannot be avoided. We further understand their collective advice to be that the Proposal will be undertaken in a manner that maintains the diversity of the indigenous coastal flora and fauna. As we have already noted, Dr Coffey also advises that outside of the mixing zone that is associated with the dredging and disposal activities, the water quality will be maintained within its natural range. Within that mixing zone, he concludes that any effects will be temporary. Given these conclusions, the Proposal can, in our opinion, be conducted so as to accord with the outcomes sought in Objective 1.

b. The Marine Reserve is located and is managed under the Conservation Act 1987. Dr Coffey's advice is that any effects on the Marine Reserve can be avoided, should the proposed turbidity measurement and response be adopted as is proposed. We are not aware of any new proposals, beyond the discussion from Rob Greenaway around a circa 2013 proposal for a 'national marine park'. As a consequence, we are also of the opinion that the Proposal can be advanced so as to not cut across Policy 5.

c. Dr Clement, Mr Don and Dr Coffey have considered if the habitats, flora and fauna within, adjacent to or which pass through the Site fall within the bounds of Policy 11(a) and 11(b). Mr Don and Dr Coffey advise that there are areas adjacent to the areas to be dredged and the proposed disposal locations that fall within the ambit of Policy 11(a), and thus must be protected from any adverse effects. We also understand the advice from both Mr Don and Dr Clement to be that some of the marine mammals and avifauna that may frequent the Site are on the New Zealand 'threatened' or 'at risk' Threat Classification System lists. The advice of all three experts to be that the Proposal can be advanced in a manner that ensures that any adverse effects are avoided, or that any adverse effects that cannot be totally avoided are negligible or less. Refining NZ has adopted the avoidance, mitigation and compensation measures that are recommended by all three experts to maximise the prospect of this outcome being achieved. Further, we understand the advice of all of the ecological experts to be that with the adoption of the strategies they recommend, significant adverse effects will be avoided, in accordance with the direction advanced by Policy 11(b), and that all other effects will be avoided, remedied or mitigated on the matters listed in Policy 11(b)(i) to (vi) to the point that any residual adverse effects are acceptable. Given these conclusions, we are of the opinion that the Proposal has been developed so as to accord with Policy 11.

d. Dr Coffey has addressed the potential for the Proposal to create or worsen the populations of harmful marine organisms in the outer Harbour or Bream Bay. We understand his advice to be that the experience at other ports has shown re-colonisation to be dominated by native species, but that the situation will be monitored in this context. Should marine pests dominate the re-colonisation, Dr Coffey has recommended that Refining NZ work with the MPI in its response to this issue[616]. We understand that Refining NZ will propose conditions of consent to formalise this commitment (Elliot, R, pers. com). As a consequence, the Proposal can, in our opinion, be advanced in a manner that accords with the direction set out in Policy 12.

e. The advice of Dr Coffey does not suggest, to us, that the water quality in close proximity to the dredge and disposal activities has deteriorated to the point that it is causing one of the outcomes listed in the introductory paragraph of this provision. That aside, we understand that Dr Coffey's advice to be that the water quality effects of the Proposal are limited in their extent and duration, and can be appropriately controlled to ensure that any associated ecological effects are not significant beyond the reasonable mixing zone, and that all effects (within and outside of the mixing zone) are to be minimised to the point that they are low to moderate. In setting the mixing zone, we understand that Dr Coffey has sought to derive a mixing zone that reflects the significance of the habitats within and in close proximity to the Site[617]. Lastly on this point, we understand the advice of Mr Reinen-Hamill and Dr Coffey to be that the Proposal will not cause or worsen the contamination of coastal waters, substrates, ecosystems and habitats that is more than minor. This combination of outcomes accords, in our opinion, with that sought in policies 21 and 23.

f. As we have noted, Mr Reinen-Hamill, drawing on the work of Dr McComb, advises that the Proposal will not cause a significant increase in sedimentation, either within the Whangarei Harbour or in Bream Bay. Further, he also recommends on-going monitoring of sediment levels, bathymetry and associated impacts of the Proposal. As Refining NZ has accepted Mr Reinen-Hamill's recommendations, we conclude that the Proposal accords with the intent of Policy 22.

Natural Character & Natural Features / Landscapes

The provisions of the NZCPS that relate natural character and natural features / landscapes are relevant to the Proposal are set out in **Table 5.7.8.2**.

Objectives	Policies
Objective 2	Policy 13
	Policy 14
	Policy 15

Table 5.7.8.2: Natural Character & Natural Features / Landscapes

[616] Dr Coffey, B, pages 46 to 47, section 4.1.3(b), "Crude Shipping Project. Proposal to Deepen and Partially Realign the Approaches to Marsden Point. Assessment of Marine Ecological Effects Excluding Seabirds and Marine Mammals". Dated 10 August 2017

[617] Dr Coffey, B, pages 41 to 45, section 4.1.2, "Crude Shipping Project. Proposal to Deepen and Partially Realign the Approaches to Marsden Point. Assessment of Marine Ecological Effects Excluding Seabirds and Marine Mammals". Dated 10 August 2017

Having considered the Proposal against the provisions listed in **Table 5.7.8.2** we note that:

a. While the Proposal is to be conducted in close proximity to areas that are recognised as supporting outstanding natural character, landscapes and natural features, we understand Mr Brown's advice to be that the Proposal is not inappropriate in the context provided by its surrounds and is not something that needs to be 'protected against'. Given this advice, we are of the opinion that the Proposal is aligned with the outcomes sought in with Objective 2.

b. We understand Mr Brown's advice to be that the Proposal will not significantly adversely affect areas supporting natural character values or landscape and visual values that are not outstanding. Indeed, we understand Mr Brown to conclude that any adverse natural character, landscape and amenity effects on these areas will be minimised to the point that they are, at worse, moderate, and more typically low to very low. In providing this advice, Mr Brown does not recommend any 'restoration' activities. As we have noted, however, Refining NZ is proposing, as a consequence of advice from Dr Coffey, enhancement / rehabilitation activities for the Harbour in close proximity to the areas that will be disturbed by the Proposal. These activities will include, we understand, actions that broadly accord with some of the limbs of Policy 14. Given these conclusions, we are of the opinion that the Proposal can be advanced in a manner that accords with policies 13 and 14.

c. Further, and as we have previously advised, we understand Mr Brown's report to state that the Proposal will not generate significant adverse landscape and visual (amenity) effects, and that any effects that do arise will be minimised to the point that they are, depending on the circumstance, low, very low or nil. Further, we understand Mr Brown's advice to be that the Proposal will not adversely affect any outstanding natural feature and/or landscape that is within the coastal environment. These outcomes are, in our opinion, aligned with the direction that is advanced by Policy 15.

<u>Treaty of Waitangi, Kaitiakitanga, Tangata Whenua Involvement & Historic Heritage</u>

The provisions of the NZCPS that relate to Treaty of Waitangi, kaitiakitanga, Tangata Whenua involvement, and historic heritage are set out in **Table 5.7.8.3**.

Objectives	Policies
Objective 3	Policy 2
	Policy 17

Table 5.7.8.3: Treaty of Waitangi, Kaitiakianga & Tangata Whenua Involvement

Having considered the Proposal against the provisions listed in **Table 5.7.8.3** we note that:

a. We shortly discuss the Proposal in the context of the principles of the Treaty of Waitangi, as part of our consideration of section 8 of the Act (please refer to section 5.8.3 of this AEE). For the reasons, we provide in that discussion, we conclude that the Proposal can be advanced in a manner that responds to the principles that apply in this instance.

b. Refining NZ has, in our opinion, actively engaged with Tangata Whenua since the inception of the Proposal. This has allowed Tangata Whenua to identify the areas of significance to them, feed into the assessment of the alternative ways of advancing the Proposal, review and comment on the draft technical assessments, and provide an assessment of cultural impacts.

Further, Tangata Whenua have been invited to engage over the means by which any actual or potential adverse cultural effects are avoided, remedied or mitigated, and advice has been taken from an independent cultural expert (Mr Coffin) to assist with that engagement. This approach is, in our experience, consistent with best practice, while at the same time:

i. Recognising the extremely important kaitiaki role that Tangata Whenua fulfil, and providing every opportunity for Tangata Whenua to exercise that role, both in the AEE preparation and 'post consent being granted' phases of the Proposal. This includes the possible involvement of Tangata Whenua in the monitoring activities for the capital dredging regime, and in the establishment of a Kaitiaki / Tangata Whenua Forum;

ii. Recognising the need for Tangata Whenua to be involved in the assessment of effects, and the manner in which such effects are addressed. This includes encouraging Tangata Whenua to advise on which customary, traditional and / or intergenerational knowledge applies to the Proposal and seeking advice as to how Refining NZ should respond to the same;

iii. Recognising the on-going and enduring relationship that Tangata Whenua have with the area that will be impacted (both directly and indirectly) by the Proposal; and

iv. Working to protect characteristics of the Whangarei Harbour and Bream Bay that are of importance to Tangata Whenua, such as Mair Bank and Home Point, and values it supports (such as the passage of marine mammals into and through Bream Bay and the Whangarei Harbour) where it has been possible to do so.

c. By engaging Tangata Whenua to advise on the timing and approach to engagement with the applicable runanga, iwi or hapu, Refining NZ has sought to undertake effective consultation that is early, meaningful and accords with tikanga Maori.

d. Refining NZ has considered the content of the applicable iwi management documents (this is a matter that is addressed in section 3.12 of this AEE, which assesses the cultural effects of the Proposal).

e. By commissioning a respected archaeologist who has previously worked in close proximity to the Refinery to advice on the existence of any archaeological sites within or in close proximity of the Site and to assess actual and potential effects of the Proposal on such sites, Refining NZ has, in our opinion acted in accordance with the direction advanced by Policy 17.

<u>Public Open Space & Recreation Opportunities</u>

The provisions of the NZCPS that relate to public open space and recreation that are relevant to the Proposal are set out in **Table 5.7.8.4**.

Objectives	Policies
Objective 4	Policy 16
	Policy 18
	Policy 19
	Policy 20

Table 5.7.8.4: Natural Character & Natural Features / Landscapes

Having considered the Proposal against the provisions listed in **Table 5.7.8.4** we note that:

a. As we have previously noted, Mr Greenaway advises that neither of the two Northland surf breaks that are listed in Schedule 1 of the NZCPS are within or adjacent to the area of interest. As a consequence, we understand that they will not be impacted by the Proposal. More broadly, however, we note the conclusions of Mr Greenaway that the surf breaks that exist within the area of interest are very unlikely to be adversely effected by the Proposal. We note, for completeness, that this conclusion is supported by the advice of both Dr McComb and Mr Reinen-Hamill.

b. Refining NZ has, in our experience with this resource consent project, recognised that both the Whangarei Harbour and Bream Bay are significant recreation assets. As a consequence, Mr Greenaway was retained to feed into the design of the Proposal (with the objective of avoiding areas of greatest recreation note - to the degree that is practicable) and to advise on the actual and potential effects on recreation opportunities within and in close proximity to the areas that will be directly impacted. Drawing on the advice of other experts and the outcome of consultation, Mr Greenaway has ultimately concluded that any recreation effects will be confined, temporary and 'slight', which we take to mean negligible.

c. We understand the advice of the independent experts, and Refining NZ to be that the Proposal will not alter or otherwise constrain public access to and along the CMA any more than is presently the case. More specifically, we understand the evidence of Mr Reinen-Hamill to be that the Proposal will not cause erosion that places existing access points and/or esplanade reserves / strips at risk. This includes, we understand, the potential for new effects, to changes to existing effects to arise as a consequence climate change. Furthermore, we understand Mr Reinien-Hamill to advise that any geomorphological changes caused by the Proposal will not prevent or otherwise restrict the development of new areas of open space in close proximity to the Proposal. This, in our opinion, is aligned with the applicable limbs of Policy 18 and the relevant aspects of Policy 19.

d. More specifically, we understand Mr Reinien-Hamill's advice to be that the Proposal will not affect walking access to the culturally significant sites within and adjacent to the area of interest, such as Mair Bank. This prediction aligns with Policy 19((c)(v).

e. Furthermore, Refining NZ advise that the proposed dredging will not result in vehicles accessing the beach, foreshore, seabed (aside from the dredge itself – the cutting / suction head of which will make contact with the seabed) or adjacent public land (Martin, D, pers. com). In that regard, we are advised that all associated vehicles will be confined to the Site that is currently occupied by the Refinery, and public authorised boat launching areas. Indeed, the only aspect of the Proposal that could cross the foreshore and access areas of land is a pipe from a cutter suction dredge. This would only occur if land disposal was advanced. When all things are considered, we are of the opinion that this approach accords with the direction advanced by Policy 20.

<u>Coastal Processes</u>
The provisions of the NZCPS that relate to coastal process that are relevant to the Proposal are set out in **Table 5.7.8.5**.

Objectives	Policies
Objective 5	Policy 13

	Policy 14

Table 5.7.8.5: Coastal Processes

Having considered the Proposal against the provisions listed in **Table 5.7.8.5** we note that:

a. The area of interest and the immediately adjacent parts of the CMA have been assessed to determine their existing stability, and their 'proneness' to natural hazards over the next 100 years. In undertaking this assessment, we understand that Mr Reinen-Hamill has had regard to the matters listed in Policy 24. We further understand Mr Reinen-Hamill to conclude that the area of interest is at risk of being affected by natural hazards in the 100-year window set by both policies 24 and 25.

b. We also understand the advice of Mr Reinen-Hamill to be that the Proposal will not increase the coastal hazard risk that is faced by the area of interest, and, indeed, that the proposal to dispose of up to 5% of the dredged material at Site 1.2 during the capital dredging campaign and, potentially, greater proportions during the maintenance dredging campaigns will improve the resilience of the ETD to the change that could occur, as a result of sea level rise. Further, we understand that this disposition could reduce the need for hard erosion control structures adjacent to the Refinery, while enabling the potential of a culturally significant, and once ecologically significant area (being Mair Bank). This approach accords, in our opinion, with the direction advanced by policies 25 and 26, and the applicable limbs of Policy 27.

<u>Activities in the Coastal Environment, Ports, Integration & the Precautionary Principle</u>

The provisions of the NZCPS that relate to activities in the coastal environment, ports, integration and the precautionary principle, and that are relevant to the Proposal are set out in **Table 5.7.8.6**.

Objectives	Policies
Objective 6	Policy 3
	Policy 4
	Policy 6
	Policy 9

Table 5.7.8.6: Activities in the Coastal Environment, Ports, Integration & the Precautionary Principle

Having considered the Proposal against the provisions listed in **Table 5.7.8.6** we note that:

a. While the Proposal has the potential to cause adverse effects, the expert advice before us is that measures can be developed to appropriately avoid, remedy or mitigate them. Due to the emphasis placed on achieving the direction advanced by the NZCPS, an array of effects have also been avoided. This approach, and the effort that has been invested by Refining NZ to ensure that the Proposal generates more than just economic benefits, means that the Proposal, in our opinion, represents a use and development that is appropriate to its environs.

b. As is apparent from the advice of Mr Clough, and within the RCP, NRPS and section 3.14 of this AEE, the Proposal will enable the ongoing operation of a regionally (if not nationally) significant (lifeline) physical resource that is dependent on its coastal location. While there are alternatives to the Proposal, an analysis completed by T&T, with input from Tangata Whenua and an array of independent experts, leads us to the opinion that they are not preferred, when considered on the basis of their practicability and environmental 'footprint'. As we have already noted, the advice of Mr Clough is that the Proposal will ensure that the various social and economic benefits it generates for Northland and, indeed, New Zealand continue into the foreseeable future.

c. The collective advice from Dr Clements, Dr Coffey and Mr Don lead us to the opinion that the Proposal will protect the 'living marine resources' to the extent that will ensure that the associated contribution they make to the social, cultural and economic, wellbeing of Northland will not be unacceptably harmed.

d. Considerable care has, in our experience with this resource consent project, been taken to protect those areas that are protected under the Act (such as the M1MA's and the areas of outstanding natural character and the outstanding landscapes), or associated legislation, such as the Marine Reserve. We understand that advice of the independent experts retained by Refining NZ to be that these areas will not be adversely effected by the Proposal.

e. As we have noted, Refining NZ has engaged Dr Clough and Tangata Whenua to investigate the potential for the Proposal to adversely affect historic heritage within and adjacent to the Site, and sought further advice from Mr Coffin on the draft CEA. We understand the advice from Dr Clough to be that very limited, if any adverse archaeological effects are anticipated. The outcome of the draft CEA is that adverse cultural effects could arise, but the advice of Mr Coffin is that they are capable of being avoided, remedied or mitigated. Refining NZ is seeking further engagement with Tangata Whenua, the objective of which is to ensure that any such effects are managed to the point that the Proposal is appropriate to the cultural environment that exists.

f. While the investigations commissioned by Refining NZ have done much, in our opinion, to define the existing environment that could be affected by the Proposal, there are some areas where uncertainty exists due to seasonal variation. These areas relate to the seagrass beds, the highly dynamic shell fish communities. There is also potential for unknown archaeological sites to be impacted. Further, while the broad types of dredge are known, the specific dredges are not. This has implications for the noise emissions that can be emitted both above and below water. In each of these instances, Refining NZ has adopted what we consider to be a precautionary approach to the management of these considerations. In this regard:

   i. The seagrass and shell fish resources are to be surveyed in advance of the dredging and disposal activities commencing, to ensure that the magnitude of any effects are able to be readily discerned, and measures adopted to ensure that any unanticipated effects are resolved;

   ii. An accidental discovery protocol is proposed for any archaeological resources that are unearthed by, or as a consequence of the proposed dredging, while a cultural monitoring officer is proposed to ensure that any cultural effects are within the levels that are expected;

   iii. Mr Styles has recommended a NMP approach that requires the airborne noise propagation to be monitored and confirmed early to ensure that the effects of the dredges on the residential receivers are no more than has been projected (or that the conditions of any resource consent are proposed to allow);

iv. An extensive monitoring programme is proposed, a large focus of which is to certify that the level of effects are equal to or less than those that have been projected by the experts retained by Refining NZ. Should the effects be greater than projected, operators are required to immediately cease activities (in the case of water column turbidity) or to review the conditions of consent to ensure that any maintenance dredging activity does not generate the same type of effects.

g. By approaching the assessment of its environmental effect in the manner it has, we are of the opinion that Refining NZ have acted in accordance with the direction provided by Policy 4. In this regard, Refining NZ instructed the independent experts to consider the actual and potential effects of the Proposal not only on the CMA, but on the land adjacent to the CMA. Put another way, Refining NZ has considered all of the actual and potential effects that could arise, not just those below the MHWS, which is where the activities themselves will occur. This is evident from, for example, the advice of Mr Brown and Mr Styles.

h. As we have already discussed, from the advice of Mr Peter Clough, we understand that the Proposal is important to the ongoing competitiveness of the Refinery. Given the advice of Mr Clough, we also understand that the Refinery plays an important role in maintaining and enhancing economic wellbeing of people and communities throughout Northland. This contribution leads us to the opinion that enabling the Proposal would be consistent with limbs (1)(a) and 2(a) of Policy 6.

i. The Proposal seeks to build upon and improve an existing shipping channel / entrance in a manner that maintains (albeit in some instances, after an initial impact) the various values that are supported within the Site, and is, we understand from Mr Brown, consistent with the character existing within the coastal environment. This is aligned, in our opinion, with the direction advanced by limbs (1)(b), (1)(c) and 1(f) of Policy 6.

j. Mr Brown has, as we have already discussed, addressed the potential for the Proposal to generate adverse landscape, visual (amenity) and natural character effects. We understand his advice to be that the most significant areas are avoided by the Proposal, and that the impact on those areas, and the wider environs of the CMA are, in all but one instance, minimal. The exception is the low to moderate natural character impact associated with the dredging of the entrance channel. We take this to mean that the Proposal is consistent with limb (1)(h) of Policy 6.

k. While it is not practicable or reasonable to set the Proposal back from the CMA (indeed, the nature of the Proposal means that it has a functional need to be located within the CMA), the advice provided by the experts retained by Refining NZ lead us to the conclusion that any effects of the Proposal will be minimised. Further, we understand the advice of these experts to be that where it is practicable to do so, all significant areas of Whangarei Harbour and Bream Bay have been avoided, and measures advanced to ensure that any adverse effects on them are also avoided, or are less than minor (or less). This provides a level of protection that is, in our opinion, consistent with that envisaged by the NZCPS. It also leads us to the conclusion that the Proposal is appropriate to its receiving environs, and thus accords with the intent of limbs 1(i) and 2(c) of Policy 6.

l. Refining NZ has been careful, in our experience with this resource consent project, to ensure that the Proposal is set back from, to the maximum practicable extent, the significant ecological areas that have been identified by Dr Coffey. While it is not possible to avoid all of the significant habitats of avifauna, care has been taken to ensure that any adverse effects are avoided and, in the case of the little penguin that could feed within the area directly impacted by the Proposal, beneficial effects arise. We understand Dr Rod Clough's advice to be that there are no known archaeological sites within the area that is to be impacted, and that those adjacent to the Site will not be placed at any greater risk of erosion as a consequence of the Proposal. In terms of the cultural element of historic heritage, the Proposal has been set back from known areas of significance (such as Mair Bank and Home Point) but does encroach into / occurs in close proximity to culturally significant areas. Refining NZ is working with Tangata Whenua to ensure that any actual or potential adverse effects on these areas are avoided in the first instance, and where that is not possible, remedied or mitigated to an acceptable extent. As we have noted, it has retained a respected independent cultural expert to assist in this regard. This approach is consistent, in our opinion, with that advanced by limb (1)(j) of Policy 6.

m. While the CSP will result in additional vessels being present in the entrance channel and in Bream, Bay, we understand the advice of Mr Greenaway to be that this will not limit the use of public open space to any material extent. Given Mr Greenaway's advice, we are of the opinion that recreation activities will be maintained, even when the dredging and disposal activities are underway. This level of acknowledgement and recognition accords, in our opinion, with the direction advanced by limb (2)(b) of Policy 6.

n. While the Proposal involves the relocation of a number of existing Navaids, only five new structures are proposed. Given their purpose, we understand that it is not reasonably necessary nor practicable to make them (the structures themselves) available to the public or for multiple use. The advice to us, however, is that the Navaids will be used by all vessels (to some extent at least) when they are navigating in and around the Harbour and the northern part of Bream Bay (Dickinson, P, pers. com). Given this advice, we are of the opinion that the Proposal is aligned with the direction advanced by limb (2)(e) of Policy 6.

o. We understand that the Proposal could assist, rather than detract from the operation of the Northport (Dickinson, P, pers. com), and will improve the functionality of the Jetty serving the Refinery. As we have previously advised, we understand that the Proposal will also enhance the efficiency of the Refinery and its jetty, and will generally improve (from both an efficiency and safety perspective) the entrance channel for all large vessels. Given this advice, we are of the opinion that the Proposal is consistent with Policy 9.

5.8 Part 2 of the Act

The Council's central task, in our opinion, is to determine whether the Proposal accords with the Act's purpose of promoting the sustainable management of natural and physical resources. Given recent case law, this brings the provisions of the various statutory planning instruments into sharp focus, which we have addressed in detail, in the preceding sections of this report. We now, for completeness, also considered the Proposal against the provisions of Part 2.

In completing our analysis of Part 2 we have treated the principles contained in sections 6, 7 and 8 as being subordinate to the purpose set out in section 5 of the Act. In that regard, we understand that the matters set out in sections 6, 7 and 8 are not an end in themselves, but inform the Act's purpose.

We now discuss sections 5 to 8 of Part 2.

5.8.1 Section 6

Section 6 lists seven matters of national importance that the Council has an obligation to recognise and provide for. All of the matters listed, with the exception of section (g), are, in our opinion, relevant to the applications lodged by Refining NZ.

The term 'protected customary right' applies to marine coastal areas[618]. We are not aware of any agreement or protected customary rights order that applies to the areas of Bream Bay or the Whangarei Harbour that could be affected (directly or indirectly) by the Proposal. While we understand that a number of applications for such rights / orders have been made, as well as a number of applications for recognised customary marine title, none have been granted. Given this, section 6(g) is not a directly relevant consideration in this instance. Refining NZ has, however, notified all of those that have lodged the applications for customary / marine title of the Proposal and the associated resource consent applications and has sought their views, as is its legal obligation.

Section 6(a) states that the preservation of the natural character of, amongst other things, wetlands, lakes and rivers and its protection from inappropriate subdivision, use and development, is a matter of national importance.

We have discussed natural character when addressing each of the statutory planning instruments, and again in section 2.7.5 and 3.10 of this AEE. As we have noted, the Proposal will not encroach into an area of outstanding natural character. While three of the new Navaids encroach into an area of high natural character, the predicted levels of adverse effects resulting from them are considered by Mr Brown to be very low. Indeed, the only adverse natural character effect that is predicted to be more than 'low', is the dredging of the entrance channel which is deemed to be 'low to moderate'. Consequently, while the level of natural character will not be preserved, we are of the opinion that the Proposal is appropriate to its environs, and thus is not something that needs to be protected against. Consequently, the Proposal can, in our opinion, be advanced so as to accord with section 6(a) of the Act.

Section 6(b) of the Act states that the protection of ONLs and natural features is a matter of national importance. Mr Brown addresses this matter in his report. In summary, we understand him to advise that Proposal will not encroach into, or cause adverse effects to be felt by any of the ONLs / natural features that abut or are in close proximity to the Site. Given this advice, the granting the consents sought, and allowing the Proposal to proceed would, in our opinion, be consistent with section 6(b).

The protection of significant indigenous vegetation and significant habitats of indigenous fauna is provided for as a matter of national importance in section 6(c). It is important to note that section 6(c) makes no reference to 'inappropriate subdivision, use or development', which leads us to the conclusion that its application requires a different approach to that which is employed for some of the

[618] Section 6(g) of the Act refers to:
" … the protection of protected customary rights …"
The term 'protected customary right' is defined by the Act as being the definition in Section 9 of the Marine and Coastal Area (Takutai Moana) Act 2011, which is:
"… an activity, use, or practice –
(a) established by an applicant group in accordance with subpart 2 of Part 3; and
(b) recognised by –
(i) a protected customary rights order; or
(ii) an agreement …"

other matters of national importance. In this respect, 'protection' is imperative. The standard of 'inappropriateness' has no relevance.

It is clear, in our opinion, from the reports of Dr Coffey and Mr Don that the Harbour and Bream Bay provide habitat that is significant in the context provided by section 6(c). Of equal note, however, is Dr Clement's conclusion that the Site is not ecologically significant in terms of the habitat that is provided for marine mammals.

We understand the advice of Dr Coffey to be that the Proposal will not adversely affect marine habitats or flora of particular significance. Some significant areas will, however, accommodate aspects of the Proposal. In this respect, the avifauna habitat associated with Mair Bank and out into Bream Bay will accommodate the activities associated with the channel dredging and disposal site 1.2, Home Point (which is significant for avifauna and marine values it supports) will accommodate a new aid to navigation, and Calliope Bank (which also supports avifauna and marine values of note) will support two new Navaids. Importantly, however, we understand the advice of both Mr Don and Dr Coffey to be that any effects felt by these habitats and flora will be small. Consequently, we are of the opinion that the matters set out in section 6(c) of the Act will be 'recognised and provided for' should the Proposal be advanced in the manner recommended by Dr Coffey and Mr Don. In that regard, the values that are present will be afforded the degree of protection that two respected experts believe is appropriate. We note, for completeness, that all of the recommendations made by these two experts have been accepted by Refining NZ.

Section 6(d) states that the maintenance and enhancement of public access to and along, amongst other locales, the CMA, is a matter of national importance. As we have previously discussed, we understand that the Proposal will not impede or otherwise hinder access to and along the CMA any more than is presently the case. We note, for completeness that there will be no change to the status quo in terms of access to and along the foreshore adjacent to, and under the jetty associated with the Refinery. Given this, the Proposal can, in our opinion, be advanced in a manner that recognises and provides for the matters set out in section 6(d).

The relationship of Maori and their culture and traditions with their ancestral lands, water, sites, waahi tapu and other taonga is a matter of national significance under section 6(e).

Section 4.0 of this AEE sets out the consultation that Refining NZ has undertaken with Tangata Whenua prior to the lodgement of the resource consent applications. This consultation is, we understand, to continue after the lodgement of the resource consent applications (Martin, D, pers. com). This reflects, in our opinion, the importance that Refining NZ has attached to Tangata Whenua's involvement in the design and advancement of the Proposal. It also reflects, again in our opinion, Refining NZ's recognition that Tangata Whenua has a special and enduring relationship with the environs associated with the Proposal, and that only Maori can determine the nature of the cultural effects that could be caused were the Proposal to proceed. The retention of an independent expert to assist with this engagement is a further example of Refining NZ's attempts to give effect to section 6(e) of the Act.

We have previously highlighted the cultural effects of the Proposal and the relevant cultural provisions of the statutory planning instruments. For the reasons already set out, we share Mr Coffin's opinion that the Proposal can be advanced to appropriately recognise and provide for the matters highlighted in section 6(e).

The protection of historic heritage from inappropriate subdivision, use and development is a matter of national significance under section 6(f). The term 'historic heritage' is, as defined by the Act, an all-encompassing construct. It includes, for example, historic sites, structures, places and areas, archaeological sites, sites of significance to Tangata Whenua and the surroundings associated with natural and physical resources. These matters have all been considered in our assessment of the relevant planning instruments, in the draft CEA (and as, a consequence, in Mr Coffin's report) and in Dr Clough's report. For the reasons, we have already set out, we are of the opinion that the Proposal is not inappropriate in the context of section 6(f). Put another way, while the material before us is that the Proposal will adversely affect elements of 'historic heritage', we are not of the opinion that it constitutes an inappropriate activity and thus is something that needs to be protected against in the context of section 6(f).

5.8.2 Section 7

Section 7 lists 11 matters that the Council must have particular regard to when considering the resource consent applications lodged by Refining NZ. All but two of the matters listed are, in our opinion, of relevance to the Proposal. In this regard, section 7(ba) of the Act has limited, if any, relevance to the Proposal as it speaks of the 'efficiency of the *end use* of energy'. The Proposal is concerned with the refinement of crude oil so it can be supplied to consumers for use and does not deal with, or influence how that fuel is used by the end consumer. Similarly, Section 7(j) requires that particular regard be given to the benefits derived from the use and development of renewable energy. The Proposal relates to fossil fuels, which are not renewable, and therefore do not easily fall within the ambit of section 7(j).

Sections 7(a) and (aa) highlight the importance of kaitiakitanga and the ethic of stewardship to sustainable management in New Zealand. Kaitiakitanga, as defined by the Act, means the exercise of guardianship by Tangata Whenua in relation to natural and physical resources and includes the ethic of stewardship. The separate mention of the ethic of stewardship in section 7(aa) recognises, in our opinion, that parties beyond Tangata Whenua have an ongoing role to play in the management of natural and physical resources.

By providing opportunities for Tangata Whenua to become involved in, and to contribute (in a significant, enduring and meaningful way) to the design of the Proposal, Refining NZ is, in our opinion, acting in accordance with section 7(a). As is already noted in section 4.0 of the AEE, Refining NZ is committed to on-going engagement with Tangata Whenua as the project advances to ensure that the applicable runanga, iwi and hapu can continue to influence the Proposal. This, we understand, will include the free flow of information from the monitoring and further studies that are undertaken by the Applicant and the provision for a meaningful cultural monitoring component to the monitoring programme (Martin, D, pers. com). These measures, when coupled with the accidental discovery protocol and the types of avoidance, remediation and mitigation set out by Mr Coffin will assist, we expect, Tangata Whenua in their role of kaitiaki for the Site and the surrounding environs.

Similarly, Refining NZ propose to continue to engage with parties such as DoC, the Royal Forest and Bird Protection Society and the Environmental Defence Society regarding the Proposal as it advances. As with Tangata Whenua, we are advised this engagement will involve the free flow of information (Martin, D, pers. com). This requirement reflects, in our opinion, the role that other parties have to play in the CMA and is aligned with section 7(aa) of the Act.

Section 7(b) highlights the efficient use and development of natural and physical resources. Mr Clough briefly addresses section 7(b) in his technical report. We understand Mr Clough's advice to be that as the benefits are likely to outweigh the costs of the Proposal, the Proposal is economically efficient.

In addition to the foregoing, we note that the Proposal utilises existing infrastructure and occupies an area that has been heavily modified by past development. As we noted in our discussion of the statutory planning instruments, the information before us is that the continued use of the existing infrastructure, when coupled with the proposed dredging, represents the most practicable option to enhance the operation of the refinery. This suggests, to us, that the Proposal represents the most appropriate response when considerations such as financial implications, the predicted environmental effects and the state of the technical knowledge are weighed. Given the advice of Mr Clough, and the foregoing, we are of the opinion that the Proposal can be advanced / operated so as to be an efficient use of natural and physical resources.

Section 7(c) states that the maintenance and enhancement of amenity values must be given particular regard in the consideration of the resource consent applications lodged by Refining NZ. This brings the reports of Mr Brown, Mr Greenaway and Mr Styles into focus. In summary, we understand the advice of these experts to be that the various aspects of the amenity effects generated by the Proposal will be less than minor (airborne noise), low to nil (visual amenity) and confined and 'slight' (recreation). Given this advice, we are of the opinion that the Proposal can also be advanced so as to be consistent with section 7(c) of the Act, insofar as the level of amenity that will be maintained.

Section 7(d) highlights the importance of the intrinsic value of ecosystems, while section 7(f) states that the maintenance and enhancement of the quality of the environment is a matter to which particular regard shall be had.

We understand that section 7(d) requires that due regard be paid to the value of ecosystems in their own right, including their biological and genetic diversity, and the characteristics that are essential to the ecosystems integrity, form, functioning and resilience. We understand the advice of Dr Coffey, Mr Don and Dr Clement to be that the Proposal responds appropriately to the ecosystems (including the various values they support) that are present within and adjacent to the Site, and can be managed to generate a limited number of adverse effects, the majority of which are very slight. This, in our opinion, accords with the direction that is advanced by section 7(d) of the Act.

Due to the extremely broad definition of the term 'environment' within the Act, we are of the opinion that regard needs to be paid to all of the technical reports that are summarised in section 2.0 of this AEE in order to assess the Proposal against the requirement of section 7(f). As is apparent from the preceding sections of this Report, the advice of the independent experts is that both adverse and positive effects are anticipated as a consequence of the Proposal. Our assessment is that when the effects of the Proposal are considered as a whole, the quality of the environment will both be maintained and, in some instances, improved over the term of any resource consent that is granted.

Section 7(g) states that particular regard needs to be given to the finite characteristics of natural and physical resources. When considering section 7(g), particular regard needs to be paid, in our opinion, to the finite nature of the CMA's water quality and ecosystems, and to the Refinery being the only infrastructure of its type in New Zealand. For the reasons set out in our discussion of the relevant statutory planning instruments and in section 3.0 of this AEE, we are of the opinion that the Proposal can be advanced in a manner that appropriately responds to the environs within and surrounding it. Equally, we note the advice of Mr Clough as to the strategic benefit of the Refinery continuing to operate[619], and, more specifically, the significance of the operations to Northland. These factors weigh in favour of the Proposal, in our opinion.

The protection of the habitat of trout and salmon is highlighted under section 7(h) of the Act. Dr Coffey has considered if sea-run trout, could be affected by the Proposal. We understand his advice to be that the Proposal is not expected to impact on the habitat of trout[620]. It follows that we are of the opinion that the Proposal can be advanced so as to not cut across section 7(h) of the Act.

Section 7(i) requires that the Council have particular regard to the effects of climate change. As we have previously noted, Mr Reinen-Hamill has identified the potential for climate change to modify the geomorphological systems in the vicinity of the Proposal[621]. We understand him to advise, in summary, that the proposed disposal of the dredged sediment at site 1.2 will improve the resilience of the ETD to the long-term effects of sea level change by replacing sand on the more active part of the ETD. Further, we understand Dr Clement's advice to be that climate change will extend the distribution of marine mammals further south over a number of decades. We understand her to also advise that this does not change her assessment of effects of Refining NZ's proposal on marine mammals. Further, we understand Mr Don to advise that avifauna could experience climate change effects in the 35-year consent term sought by Refining NZ, but that the Proposal is not expected to exacerbate any such effects.

5.8.3 Section 8

Section 8 of the Act states that the Council shall take the principles of the Treaty of Waitangi into account when considering the resource consent application lodged by Refining NZ. While not defined by legislation, we understand the relevant principles referred to by Section 8 to be:

a. Partnership;

b. Active protection and rangatiratanga; and

c. Mutual benefit.

In our opinion, the principle of 'Partnership' has been addressed through consultation that has, and is, continuing to occur and by Refining NZ engaging early and actively throughout the resource consent application process, including by commissioning a CVA and a CEA. It is also evidenced by the ongoing relationship that Refining NZ has with Patuharakeke, as confirmed in the memorandum of understanding that exists between both parties.

'Rangatiratanga' has been recognised, in our opinion, by both Refining NZ acknowledging the mana whenua status of the various hapu, iwi and runanga at and proximate to the Site and by this AEE

[619] Clough, P, pages 20 & 21, section 6.2, "Crude Shipping Project, Economic Assessment of Channel Deepening at the Marsden Point Oil Refinery". Dated 02 August 2017

[620] Dr Coffey, B, page 47 to 48, section 4.1.3c, "Crude Shipping Project. Proposal to Deepen and Partially Realign the Approaches to Marsden Point. Assessment of Marine Ecological Effects Excluding Seabirds and Marine Mammals". Dated 10 August 2017

[621] Reinen-Hamill, R, pages 51 & 52, sections 4.2 & 4.3, "Crude Shipping Project, Coastal Processes Assessment". Dated July 2017

considering the direction sought in or provided by the CVA, the draft CEA, the advice of an independent cultural expert and the relevant iwi management plans.

The recommended avoidance, remediation and mitigation measures, and the proposed further engagement with Tangata Whenua over the same reflect, in our opinion, the principle of 'Active Protection'.

The principle of 'Mutual Benefit' is recognised, in our opinion, both through the benefits that the Proposal will bring to Tangata Whenua (via both mechanisms such as the seagrass and shellfish enhancement / rehabilitation initiative and as a part of the broader communities in which they reside), the local, regional and national communities, and more specifically, by the on-going engagement hui's that are proposed during this resource consent process, and then again when it is completed. In our experience, such engagement will, should it be supported by Tangata Whenua, provide an effective forum for future discussions of matters of mutual benefit to the iwi and Refining NZ.

5.8.4 Section 5

Section 5(1) states that the Act's purpose is *"to promote the sustainable management of natural and physical resources"*. Section 5(2) defines the term sustainable management. We understand that the application of the Act's purpose involves an overall broad judgement of whether a proposal would promote the sustainable management of natural and physical resources. In making such a judgement, we further understand that conflicting considerations may be compared and their relative significance assessed. We have approached our assessment of section 5 on this basis.

<u>People and Communities</u>
A key plank of sustainable management is, in our opinion, enabling people and communities to provide for their social, economic and cultural wellbeing, and for their health and safety. There is little question, in our mind, that the Proposal is, as things stand, an important part of the ongoing operation and competitiveness of a wider activity, being the refining of crude oil into various fuel and by-products. This wider activity is also, we understand from Mr Clough's advice, of particular importance to the social and economic wellbeing of many within Northland. More particularly, the advice of Mr Clough highlights the importance of the Refinery and its benefit to the communities at local and regional levels. It also highlights the challenges that the Refinery could face should the Proposal not be advanced. It follows, therefore, that should the Proposal proceed, it will benefit many people and communities.

In our opinion, social and economic wellbeing is, however, broader than the benefits that a proposal may bring. In that regard, it requires an environment (including all of its component parts, biophysical and metaphysical) that enables people to function as they would normally, in a safe, enjoyable and fulfilling way. Considerable care has been taken by Refining NZ, in our experience, to understand the environment that exists, to predict the environmental effects that could arise, and to develop appropriate avoidance, remediation and mitigation measures to ensure that environmental quality is maintained, if not enhanced as a consequence of the Proposal and all of its component parts. With these measures in place, we are of the opinion that the Proposal can be advanced so as to enable people and communities to provide for their social and economic wellbeing.

Cultural wellbeing is informed in this instance by both the draft CEA and Mr Coffin's advice. From the draft CEA we understand that there are a number of environmental effects and broader concerns that are at issue. Indeed, the advice embodied within the draft CEA is that there are a number of effects that cannot (and should not) be remedied or mitigated. Rather, avoidance is advanced. The independent advice to the Refinery tests the evidentiary basis for this position, and highlights that many of the cultural effects are founded on biophysical effects that are capable of being appropriately addressed by Refining NZ. The same advice also concludes that the cultural effects that are set out in the draft CEA are also capable of being appropriately avoided, remedied or mitigated. The advice to Refining NZ is that the wider cultural concerns expressed in the draft CEA are not directly related to the Proposal, but might be addressed through continued direct discussions. Further engagement with Tangata Whenua has been recommended to explore these measures. We understand Refining NZ has accepted this recommendation and is seeking to engage with Tangata Whenua with the assistance of Mr Coffin. While this consideration is yet to be resolved, we take considerable comfort from Mr Coffin's advice, and are therefore of the opinion that the Proposal can be advanced so as to enable Maori to provide for their cultural wellbeing.

We understand Dr Coffey's advice to be that the Proposal can occur in a manner that complies with the water quality standards that are set out by the RCP. We also understand his advice to be that the disturbance, removal and placement of the dredged sediments is not expected to generate adverse 'contamination effects', while the turbidity generated by the Proposal will not exceed what shellfish experience naturally, which we take to mean that the turbidity will not cause the shellfish and other kai moana to become inedible or dangerous to consume. These conclusions, when coupled with the reductions in navigation risk and risk of an oil spill lead us to the opinion that the Proposal can be advanced in a manner that enables people and communities to provide for their health and safety.

Given the foregoing, we are of the opinion that the Proposal can be advanced, when considered in its entirety, to enable people and communities to provide for their social, economic and cultural wellbeing and for their health and safety.

<u>Reasonably Foreseeable Needs of Future Generations</u>
Section 5(2)(a) is, in our opinion, clear that when enabling people and communities to provide for their wellbeing, health and safety, the potential of natural and physical resources must be sustained to *"meet the reasonably foreseeable needs of future generations"*.

Given the advice of the independent experts retained to assess the environmental effects of the Proposal, we are of the opinion that the CSP can be advanced in a manner that at maintains the natural values that are presently supported by the Site, and will, in a few discreet areas, enhance them. The areas of enhancement relate to the Little Blue Penguin nesting boxes (which are to be coupled with predator control), the areas that will benefit from Whangarei Harbour enhancement / rehabilitation initiatives, and the ETD, as a consequence of the disposal of the dredged sediment in site 1.2.

As we have already noted, the advice before us (from both Refining NZ and Mr Clough) is that the Proposal is important for the Refinery's continued reliance, international efficiency and long-term competitiveness. As a consequence of that advice, we conclude that the Proposal will help to sustain the Refinery's existence and operation into the future.

Lastly, we note that the Proposal will have navigation benefits for all vessels entering and exiting Whangarei Harbour, as a result of the straightening and deepening of the channel, and improvements to navigation aids.

Given the foregoing, we are also of the opinion the Proposal can be advanced so as to achieve section 5(2)(a) of the Act.

Safeguarding Life Supporting Capacity

Section 5(2)(b) requires that in achieving the purpose of the Act *"the life-supporting capacity of air, water, soil and ecosystems"* are to be safeguarded.

When assessing a proposal against section 5(2)(b) the appropriate approach, in our opinion, is to consider whether it will result in a significant reduction in the life-supporting capacity of one of the resources listed.[622] Should a significant reduction be likely, the proposal is in all probability (and again, in our opinion) contrary to section 5(2)(b). In determining what is significant, the magnitude of all related adverse effects is relevant, as is the relative scarcity of the resource.

Having considered the advice from the independent experts that have assessed the environmental effects of the Proposal, it seems very unlikely that the CSP will cause a significant reduction in (or loss of) the life-supporting capacity of the CMA, within or adjacent to the Site. In that regard, the advice before us is that the water and ecosystems within the adjacent to the Site will not be significantly affected by the Proposal. Rather, the most notable impact is recorded as being minor to moderate in magnitude, with the vast majority of the adverse effects predicted to be minor, less than minor, de minimis or non-existent.

Given the foregoing advice, we are of the opinion that the Proposal can be advanced so as to accord with section 5(2)(b) of the Act.

Avoidance, Remediation or Mitigation

Section 5(2)(c) of the Act makes it plain, in our opinion, that adverse effects on the environment must be avoided, remedied or mitigated. Section 5(2)(c) does not enable a weighing of positive and adverse effects, or suggest that minor adverse effects are automatically acceptable (or, for that matter, that significant adverse effects are unacceptable). Rather, it requires, again in our opinion, that due regard be given to all adverse effects, and that they be avoided, remedied or mitigated to the extent that is acceptable when regard is had to the circumstances of each case.

We have already set out the various adverse effects that a large body of independent experts advise could occur as a consequence of the Proposal, and the approach that Refining NZ is proposing to ensure that they are avoided, remedied or mitigated to the extent that is needed to achieve the Act's purpose. We understand that that this approach will neither eliminate all adverse effects nor result in a 'no net effect' outcome. Rather it will reduce the effects to a level considered by a number of independent experts to be appropriate, while maintaining the Proposal in a form where it will be able to occur. This, in our opinion, accords with section 5(2)(c).

[622] In this case, the relevant considerations are water and ecosystems

Quality Assurance Record:	
Prepared By:	Gavin Kemble, Managing Director & Environmental Planner Cole Burmester, Associate & Environmental Planner Myaan Bengosi, Environmental Planner
Version:	First Draft
Date Prepared:	6th of July 2017
Peer Reviewed By:	Stephanie Hantler, Environmental Planner David Greaves, Director & Environmental Planner
Dates Peer Reviewed:	6th of July 2017, 24th of July 2017
Approved for Release By:	Gavin Kemble
Version:	Final
Date Released:	23rd of August 2017

CRUDE SHIPPING PROJECT

PROPOSED DEEPENING AND REALIGNING OF THE WHANGAREI HARBOUR ENTRANCE AND APPROACHES

VOLUME TWO:

ANNEXURE ONE TO ANNEXURE TWO (b)

Prepared for:

ChanceryGreen on behalf of the New Zealand Refinery Company Limited **August 2017**

Prepared by:

Ryder

Crude Shipping Project

Proposed Deepening and Realigning of the Whangarei Harbour Entrance and Approaches

Prepared for: New Zealand Refining Company Limited

Prepared by: Gavin Kemble, *Managing Director and Environmental Planner*
Cole Burmester, *Associate and Environmental Planner*
Myaan Bengosi, *Environmental Planner*

Date Finalised: August 2017

Annexure One: Northland Regional Council Application Forms

APPLICATION FORM FOR RESOURCE CONSENT

NORTHLAND REGIONAL COUNCIL

Putting Northland first

Whāngārei Office	Phone:	(09) 470 1200
	Fax:	(09) 470 1202
Kaitāia Office	Phone:	(09) 408 6600
Ōpua Office	Phone:	(09) 402 7516
Dargaville Office	Phone:	(09) 439 3300
Free Phone		0800 002 004
E-mail		mailroom@nrc.govt.nz
Website		www.nrc.govt.nz

This application is made under Section 88/127 of the Resource Management Act 1991

To: Consents Department
Northland Regional Council
Private Bag 9021
Whāngārei Mail Centre
Whāngārei 0148

IMPORTANT NOTES TO APPLICANTS

(a) **Please read fully** the notes below and the Information Brochures and Explanatory Notes available from the Council, **before** preparing your application and any supporting information.

(b) The Resource Management Act 1991 sets out the information you must provide with your application for a resource consent. If you do not provide adequate information, your application cannot be received nor processed by the Council and will be returned to you. If you are unsure of what information should be included with your application, please contact the Council before submitting the application.

(c) Applications require notification (public advertising calling for submissions) unless the Council is satisfied that the adverse effects on the environment of the activity for which consent is sought will be minor; and written approval has been obtained from every person who the Council is satisfied may be adversely affected by the granting of the consent. The Council also has available a form "Form 8A – Affected Person's Written Approval", to help you record such approvals for applications that may be processed without public notification.

PART A – GENERAL

APPLICANT	Full Names	
(1) Full Name of Applicant(s): (in full e.g. Albert William Jones and Mary Anne Jones. For Companies, Trusts and other Organisations, commonly used name)	New Zealand Refining Company Limited, trading as Refining NZ	
Phone Number – Business:	09 432 8311	**Fax:**
Home:		**Mobile:**
E-mail:	dave.martin@refiningnz.com	

For applications by a company, private trusts or other entity/organisations, the Directors; Trustees and Officers' full names must be supplied and Section (12) completed and signed.

(2) Postal Address: (in full)	Private Bag 9024
	Whangarei, 0148
	New Zealand

(3) Residential Address: (if different from postal address)	

Application Form continued on next page

(4) Address for Service of Documents: (if different from postal address e.g. Consultant)	
	Ryder Consulting Limited
	PO Box 13009
	Tauranga, 3141

(5) Owner/Occupier of Land/ Water Body: (if different from the Applicant)	
	Coastal Marine Area

(6) Type(s) of Resource Consent sought from the Regional Council:

You will need to fill in a separate Assessment of Environmental Effects Form for each activity.
These forms can be obtained from the Northland Regional Council.

Coastal Permit

☐ Mooring ☐ Marine Farm ☒ Structure ☐ Pipeline/Cable

☒ Other (specify) Dredging and Placement/Disposal of dredged material in the Coastal Marine Area, Taking of Water during dredging, Discharge of Water containing sediment, and Extaction of dredged material for disposal to land.

Please see section 5.2 of the Assessment of Environmental Effects Report for a full list of resource consents being applied for.

Land Use Consent

☐ Vegetation Clearance ☐ Quarry ☐ Structure in/over Watercourse

☐ Earthworks ☐ Construct/Alter a Bore ☐ Dam Structure

☐ Other (specify) ______

Water Permit

☐ Stream/Surface Take ☐ Damming ☐ Groundwater Take ☐ Diverting Water

☐ Other (specify) ______

Discharge Permit

☐ Domestic Effluent to Land ☐ General Discharge to Land ☐ Farm Dairy Effluent to Land/Water

☐ Air ☐ Water

☐ Other (specify) ______

(7) Other Resource Consents required from the District Council:

Where other Resource Consents are required for the same activity, they must be applied for at the same time.
Not doing so will delay the processing of this application.

What other Resource Consents are required from the District Council?

☒ None ☐ Land Use Consent ☐ Subdivision Consent

Have the applications been made? ☐ Yes ☐ No

(8) Description of the Activity:

Please briefly describe the activities and duration for which Consent(s) are being sought. It is important you fill this out correctly, as the Council cannot grant Consent for any activity you do not apply for.

Please refer to section 1.5 of the attached Assessment of Environmental Effects Report. In summary, the Proposal comprises five separate but interrelated components, being:

1. The initial dredging of the approaches to the Whangarei Harbour (including some realignment of the same), and the 'pocket' next to the Marsden Point Jetty (hereafter referred to as 'Capital Dredging');
2. The dredging of the Harbour entrance and jetty pocket to maintain its depth (hereafter referred to as 'Maintenance Dredging');
3. The disposal of the dredged material (from both Capital Dredging and Maintenance Dredging) to two locations in Bream Bay;

4. The type of vessels (and their operations) that could be used to undertake components (1) to (3) above (hereafter referred to as the 'Dredging Methodology'); and

5. Changes to the Aids to Navigation ('Navaids') within the Whangarei Channel to facilitate the safe passage of vessels into and out of the Whangarei Harbour.

Application Form continued on next page

(9) Location of Property/Waterbody to which Application relates:

Describe the location in a manner which will allow it to be readily identified, e.g. street address, legal description, harbour, bay, map reference etc. Attach appropriate plans and/or diagrams.

Property Address: (see rate demand) ______________

Locality: **The Proposal is to be located, in broad terms, within the outer reaches of the Whangarei Harbour and in the Northern half of Bream Bay. All of the works related to this resource consent application will be located within the Coastal Marine area.**

Legal Description: ______________ **Blk:** ______________ **SD:** ______________

Other Location Information: **Please refer to section 1.3 of the attached Assessment of Environmental Effects Report**

PART B – ASSESSMENT OF EFFECTS ON THE ENVIRONMENT

You must include an assessment of the effects of your activity on the environment as part of your application.

The Resource Management Act 1991 requires that each application include an assessment of the actual and potential effects of the activity on the environment in accordance with the Fourth Schedule.

To assist you to supply this assessment of effects, the Council has prepared specific forms for various consent activities. For minor activities, all that will be required is for you to complete the specific form. Where the potential effects of the activity are more significant, we recommend you undertake a full assessment of effects, with professional assistance if necessary.

If you are unsure of what information to include with you application and the assessment of effects, please contact the Council before submitting your application. A pre-lodgement meeting with relevant Consent Staff is recommended.

PART C – GENERAL

(10) Renewal of an Existing Resource Consent:

☐ Yes ☒ No ☐ A change in conditions of a current Resource Consent

(11) Fee/Deposit Enclosed with Application(s):

Application to be processed as: ☒ Notified ☐ Limited Notified ☐ Non-notified

☒ Coastal Permit:	$ 3,296.00	☐ Land Use Consent:	$
☐ Water Permit:	$	☐ Discharge Permit:	$
☐ Bore Permit:	$	☐ Change Conditions:	$

(12) Signature of Applicant(s) or Persons authorised to sign on behalf of Applicant(s):

IMPORTANT NOTES TO APPLICANTS

(a) Your application must be accompanied by the minimum fee (deposit) as determined by the Council. A schedule of the fee/deposits for different consent applications is annexed. Please note that applications by private trusts and other group entities require the personal guarantees of the Trustees and/or Officers for the payment of costs to be submitted with the application.

- For complex applications, the Council may require an additional deposit pursuant to Section 36(3) of the Act, based on the estimated costs for processing such complex applications and may require progressive monthly payments during consent processing.
- The final fee is based on actual and reasonable costs including disbursements and where this fee exceeds the fee/deposit, the additional fee is subject to objection and appeal.

(b) All accounts are payable by the 20th of the month following the date of invoice. Any actual and reasonable costs, including but not limited to legal costs, debt collection fees or disbursements incurred as a result of any default in payment, shall be recoverable from the Applicant and is so notified in compliance with the Credit Contracts and Finance Act 2003. Submitting this Application authorises the Council to, if necessary, provide your personal information to a Credit Reporter in order to employ in its debt collection services in compliance with the Credit Reporting Privacy Code 2004, should payment default occur.

(c) Resource Consents usually attract an annual fee to recover the reasonable costs of the Council's monitoring, supervision and administration of the Consent during its term.

(d) The information you provide is official information. It will be used to process the application and, together with other official information, assist the management of the region's natural and physical resources. Access to information held by the Northland Regional Council is administered in accordance with the Local Government Official Information and Meetings Act 1987 and the

Privacy Act 1993.

Application Form continued on next page

I/we declare that, to the best of my/our knowledge and belief, the information given in this Application and attached Assessment of Environmental Effects is true and correct. I/we unconditionally guarantee jointly and severally to pay the actual and reasonable costs of processing this Application as and when charges become due and payable. I/we acknowledge that I/we understand the consequences of signing this declaration.

Signature: ______________________	**Signature:** ______________________
Full Name (print): ______________________	**Full Name** (print): ______________________
Date: ______________________	**Date:** ______________________

Continue with Trustees' and Authorised Officers' signatures below, as necessary.

Personal details and signatures of Trustees*, or Officers authorised to sign on behalf of and to bind Trusts, Societies and Unincorporated Entities.

* Private and Family Trusts only

Full Name and Status: (Trustee, Officer etc)	
Full Residential Address:	
Signature:	

Full Name and Status: (Trustee, Officer etc)	
Full Residential Address:	
Signature:	

Full Name and Status: (Trustee, Officer etc)	
Full Residential Address:	
Signature:	

Full Name and Status: (Trustee, Officer etc)	
Full Residential Address:	
Signature:	

CHECKLIST – Have you remembered to…

- ☒ Complete all details set out in this Application Form
- ☒ Include an Assessment of Effects of the activity on the environment, set out in the attached form
- ☒ Sign and date the Application Form
- ☒ Include a Site Plan
- ☒ Include the appropriate fee/deposit as set out in the "Schedule of Fees"
- ☐ Complete details of Trustees and/or Authorised Officers on this page

Annexure Two: Technical Reports

a) **Establishment of Numerical Models of Wind, Wave, Current and Sediment Dynamics. MetOcean Solutions Limited. Peter McComb, Florian Monetti and Sarah Gardiner. Dated 25th July 2017**

b) **Predicted physical environmental effects from channel deepening and offshore disposal. MetOcean Solutions Limited. Peter McComb, Florian Monetti, Brett Beamsley and Sarah Gardiner. Dated 25th July 2017**

Annexure Two: Technical Reports

a) **Establishment of Numerical Models of Wind, Wave, Current and Sediment Dynamics. MetOcean Solutions Limited. Peter McComb, Florian Monetti and Sarah Gardiner. Dated 25th July 2017**

MetOcean Solutions

Specialists in Oceanography and Meteorology

CRUDE SHIPPING PROJECT, WHANGAREI HARBOUR

Establishment of numerical models of wind, wave, current and sediment dynamics

Report prepared for
Chancery Green for Refining NZ

MetOcean Solutions Ltd: Report P0297-01

July 2017

Report status

Version	Date	Status	Approved by
RevA	15/06/2016	Draft for internal review	Monetti
RevB	17/06/2016	Draft for internal review	McComb
RevC	22/06/2016	Draft for client review	Gardiner
RevD	02/08/2016	Updated draft for internal review	Monetti
RevE	12/08/2016	Updated draft for client review	Gardiner
RevF	12/10/2016	Updated for client review	Monetti
RevG	19/01/2017	Updated for client review	Monetti
Rev0	07/02/2017	Draft for public consultation	Monetti
Rev1	25/07/2017	Final version	Monetti

It is the responsibility of the reader to verify the currency of the version number of this report.

Acknowledgements
Thanks to Ross Sneddon from the Cawthron Institute for ADCP deployment and data collection.

Thanks to Ricky Eyre from Northland Regional Council for supplying LIDAR and single-beam data for Whangarei Harbour, Stuart Caie from LINZ for supplying offshore multi-beam data and historic survey data of Mair Bank and Jae Staite from Northport Ltd for supplying multi-beam survey data for main channel and multiple historic surveys of Mair Bank.

PO Box 441, New Plymouth, New Zealand
T: 64-6-7585035 E: enquiries@metocean.co.nz
www.metocean.co.nz

EXECUTIVE SUMMARY

Refining NZ is investigating options for the deepening and the realignment of the shipping channel leading to the Marsden Point Refinery at the entrance to Whangarei Harbour. MetOcean Solutions Ltd (MSL) participation in the effects assessment for the project has involved an evaluation of the effects of the channel deepening on the wave, current and sediment dynamics of the harbour entrance, the effects of dredging and disposal on water quality, and the effects of sediment disposal on the receiving environment. This has been undertaken through the use of a suite of numerical model investigations supported by empirical data, observations and historical and contemporary oceanographic measurements.

The study investigations are presented in technical reference documents. The present report (MSL Report P0297-01) provides details on the establishment of numerical models for wind, wave, current and sediment dynamics, and the data collection program that was undertaken to support the model establishment and to validate the numerical schemes. The second report MSL Report P0297-02 (MSL, 2016) summarises the existing physical environment and outlining the likely effects of the Crude Shipping Project on the waves, hydrodynamics and short- and long-term sediment dynamics. These reports should be read together.

The dominant physical processes at regional and local scales were replicated through the application of industry-standard numerical models based on published scientific methodologies and the background knowledge acquired from previous numerical modelling studies. Several models were investigated and the most appropriates ones chosen for the domain of application. Wherever possible, models were validated using historical and contemporary oceanographic data sets.

Wave modelling

The open-source SWAN model has been used in numerous studies around the world to simulate the coastal spectral wave transformation processes. Here, the model was used to hindcast the wave climate and further examine the wave transformation across the ebb tide delta and the nearshore environment in the vicinity of the ebb tide delta and the offshore disposal areas. The model was successfully validated with measurements from 5 locations, and was shown to replicate the wave climate at the entrance of Whangarei Harbour and along Ruakaka Beach. Based on the physical processes involved and the good validation of the model, it is considered an appropriate tool to predict the effect of the channel deepening on the wave climate.

Current modelling

Ocean currents were simulated with two different models to investigate regional and local scales. The open-source ROMS model was used to perform 3D hydrodynamic downscaling of the oceanic and tidal flows over the Hauraki Gulf and Bream Bay and to provide information for the site selection and detailed simulations of the proposed offshore disposal grounds. Validation of ROMS with measured current profile data showed that the model adequately represented the non-tidal flow regime while tidal flows were somewhat under-predicted by the model at Disposal 3.2. In the context of sediment transport, it has been concluded that such biases in the current speed were insufficient to result in measurable changes. The impact of such bias on the plume modelling was investigated by forcing the model with the ADCP measured current profiles. Results did not highlight any increase of the predicted plume extension associated to the release of sediments compared to the scenarios using the ROMS forcing. At local scale, the open-source SELFE model was used to simulate the 2D tidal flows in the vicinity of the ebb tide shoal, entrance and through the entire Whangarei Harbour. SELFE applies a finite-element mesh to allow resolution over complex bathymetries such as Whangarei Harbour. The model was validated against water levels measured at four locations and current profiles measured over regions of the outer channel where dredging is proposed. The validation showed the model to replicate the governing hydrodynamics of the harbour well, including the phase and amplitude of the tidal elevations and the spatially complex flows along the main shipping channel.

Morphodynamic modelling of the harbour entrance

The open-source Delft3D system was used to run high-resolution process-based morphodynamic simulations based on fully-coupled wave, current and seabed interactions. The morphodynamic system at the Whangarei Harbour entrance is influenced by the shellfish biomass on Mair Bank. Dealing with this unique environment within the numerical framework required the application of a range of published methodology approaches.

Climatic conditions were modelled to consider potential sediment transport and morphology evolution under conceptual and realistic scenarios. Morphological Acceleration Factors (MORFACs) for morphodynamic upscaling were applied to represent the likely short-term and long-term evolution of the seabed. For these scenarios, the sediment grain size distributions of the seabed were initialised from a 6-month fair-weather Bed Composition Generator (BCG) run. The resulting sedimentology was then qualitatively validated against contemporary sediment grain size observations.

Sediment plumes created during dredging

A Lagrangian particle model (ERcore) developed by MSL was used to simulate the likely extent and concentration of sediment plumes created during the dredging operation. This was achieved by simulating a plume continuously over a 28-day period at the various locations along the channel, and performing a subsequent statistical analysis of the predicted plume concentrations and extents. The plume dispersion associated with two different trailing suction hopper dredgers (TSHD), one cutter suction dredger (CSD) and one backhoe dredger (BHD) was simulated in the present study. The depth-averaged SELFE tidal currents were used as the environmental driver. A sensitivity analysis of the plume model considering more conservative scenarios was also carried out to assess the impact of several model parameters on the predicted plume extension.

Sediment plumes created during disposal

The same Lagrangian particle model (ERcore) was also used to simulate the likely extent and concentration of sediment plumes created during the disposal operation. The 3D ROMS model and the measured current profile data were used as the environmental drivers to the plume modelling. Using measured data at the disposal site addresses the identified underestimation of tidal current speed in the ROMS model. Plumes were simulated over a 6-month period at 5 sites within the proposed offshore disposal ground 3.2, applying the same probabilistic approach to determine plume extent and concentration as for the dredging process. The modelling included three phases of convective descent, dynamic collapse and passive plume dispersion, using release depths according to the type of vessel involved.

Morphodynamic modelling of the disposal grounds

The Delft-3D modelling system was used to simulate the evolution of the proposed disposal grounds. A sequence of 16 representative wave and tide scenarios were run combined with weighted morphological acceleration factors to predict the long-term movement of material from the ground.

After an iterative process involving consideration of various alternatives and refinement of the preferred disposal areas, MetOcean modelled two offshore disposal sites. The first of these offshore disposal sites is referenced as Disposal Site 3.2, and is modelled for the placement of up to 97.5% of the capital dredge volume and up to 100% of the maintenance dredge volume. The capital dredge volume for this area is estimated at 3.7 million m^3, and the maintenance dredge volumes are estimated as 125,000 m3 per annum (Tonkin and Taylor, 2016a). Therefore, as a conservative estimate that 97.5% of the capital dredge volume, and the full amount of the maintenance dredge volume will be placed in Area 3.2, a 4 m high disposal mound was modelled over a proposed 2 km^2 area – equivalent to a total volume of 8 million m^3. The effect of the disposal mound on the wave climate within Bream Bay was assessed based on the wave modelling of the 16 representative scenarios including both the pre-disposal and the post-disposal bathymetries in the model.

Additionally, the Disposal Site 1.2 was designed for the disposal of 2.5 – 5% of the capital dredge and up to 100% of the maintenance dredge volume. The assessment of the disposal dynamics for the maintenance volumes was undertaken based on the numerical modelling of a representative value for a low mound, which was taken to be a 0.6 m high disposal mound (1.5 million m^3) defined on the ebb tide delta and corresponding to 5% of the capital dredge volume and 100% of the maintenance dredge volume over 10 years. Such approach is particularly conservative as the disposal mound will be continuously eroded between each disposal due to the relative low water depth (less than 10 m) characterising the southern flank of the tidal delta.

As for the offshore disposal mound, the long-term evolution of the disposal ground was simulated using a sequence of 16 representative wave and tide scenarios combined with weighted morphological acceleration factors.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

1. INTRODUCTION

Refining NZ (RNZ) is investigating options for the deepening and the realignment of the shipping channel leading to the Marsden Point Refinery at the entrance to Whangarei Harbour. Increasing the navigable depth is necessary to allow vessels with increased draft to safely transit to the refinery. MetOcean Solutions Ltd (MSL) has been contracted to provide coastal oceanographic expertise and investigate the potential effects of channel deepening on the physical environment. The scope of work includes i) an evaluation of the wave, hydrodynamic and sediment dynamic regime throughout the Whangarei Harbour entrance region, ii) consideration of the effects of capital dredging on this environment, iii) potential effects on the coastal sediment budgets, iv) the stability of the adjacent beaches and the sub-tidal delta, and v) the effects of dredging and disposal on water quality in the receiving environment. A flow chart of the study processes is shown on Figure 1.1, and a map of Whangarei Harbour with the different locations referred to in the study is presented in Figure 1.2. Figure 1.3 presents a map showing the location of the proposed deepening. The location of the proposed disposal grounds for the placement of capital and maintenance volumes is shown in Figure 1.4.

The study investigations are presented in two reports:

- The present report is a technical reference document that details the establishment of numerical models for wind, wave, current and sediment dynamics, and the data collection program that was undertaken to support the model establishment and to validate the numerical schemes.

- The second report (MSL Report P0297-02) first characterises the existing environment and then investigates the likely physical effects of the Crude Shipping Project.

We recommend that the two reports be read together, in order to gain a complete understanding of our assessment approach and findings.

1.1. Report structure

The numerical modelling approach applied to characterise the regional wind and wave climate in the study area, is described in Sections 2 and 3 respectively, including validation against contemporary wind and wave data. Sections 4 and 0 explain the regional and nearshore hydrodynamic modelling techniques and present validations of the models used. Section 6 outlines the nearshore and harbour channel sediment transport modelling methods. The plume modelling approach used to consider the effects of dredging and disposal is detailed in Sections 7 and 8, respectively. The methods used to estimate the sediment transport from the preferred offshore disposal ground is provided in Section 9. An executive summary is presented at the beginning of the report.

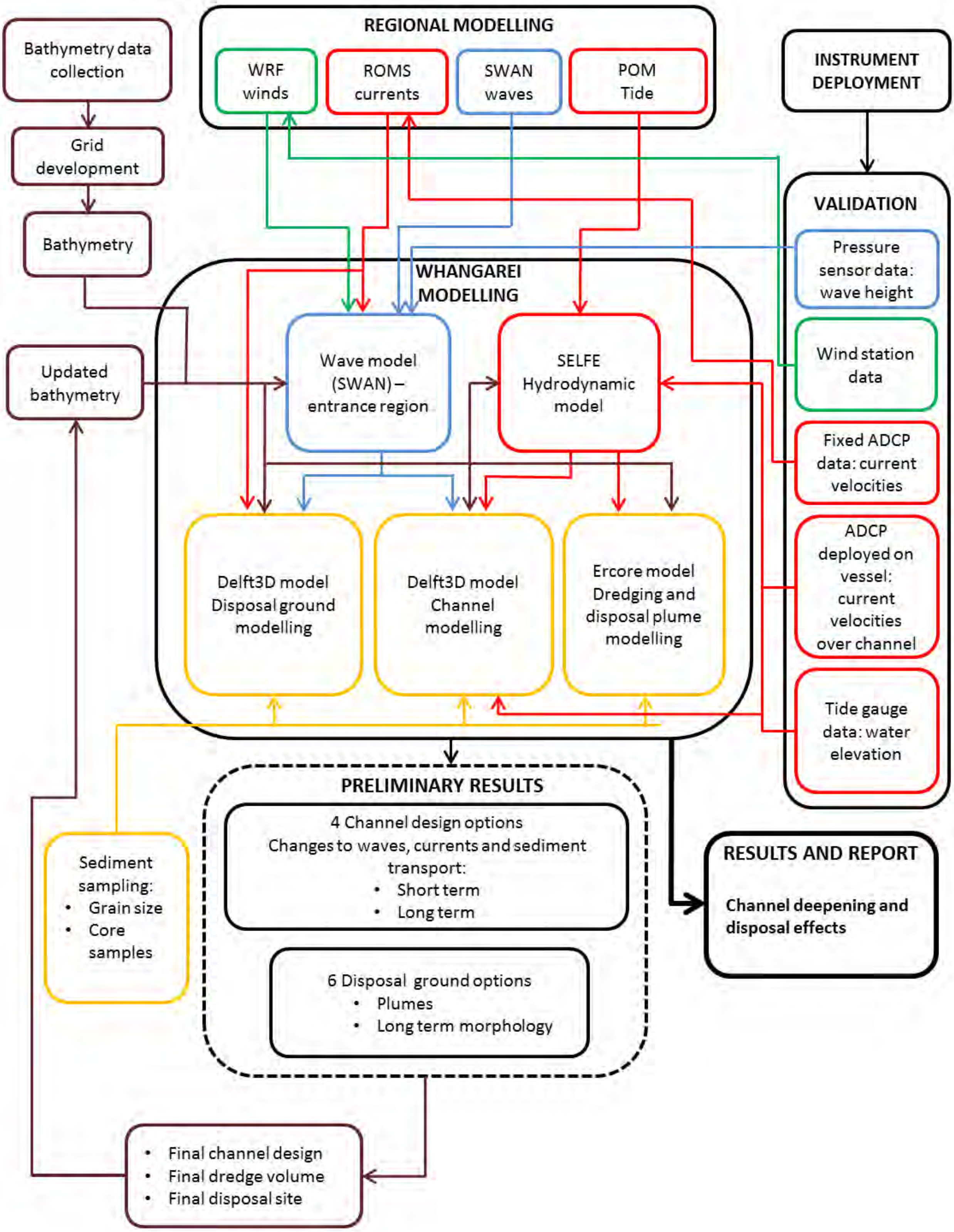


Figure 1.1 Flow chart showing the numerical modelling process for the study. Red lines indicate hydrodynamics; blue indicates waves; green indicate wind and yellow lines indicates bathymetry.

1.2. Study area

The different locations referred in the present report for the validation process and the description of the effect of the deepening channel on the coastal dynamics at Whangarei Harbour (MSL Report P0297-02) have been summarised in Figure 1.2.

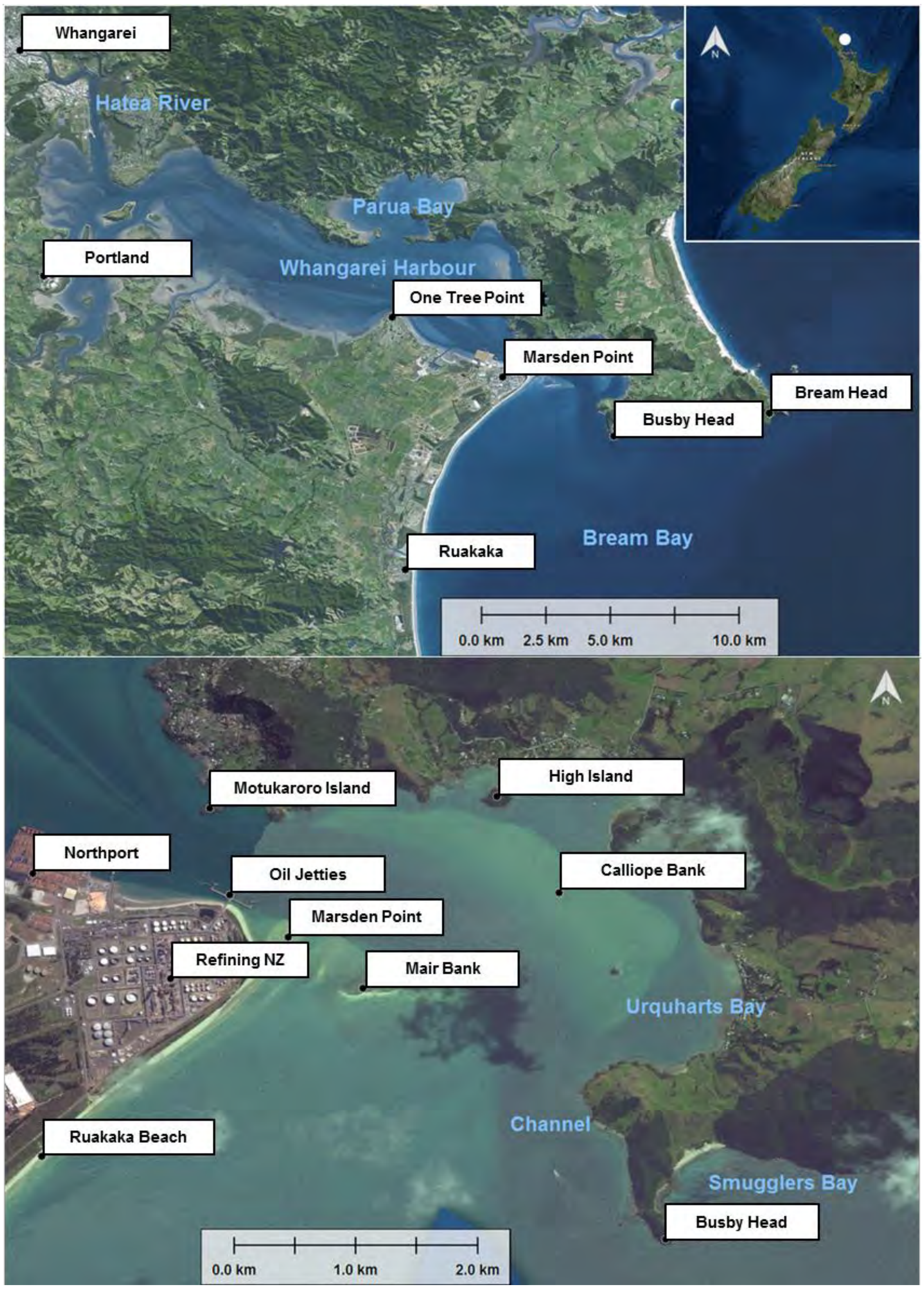


Figure 1.2 Maps of Whangarei Harbour (top) and its entrance (bottom) with the locations used in the present study for the establishment of the numerical models and the description of the effect of the channel deepening on the coastal dynamics.

1.3. Proposed channel deepening design

RNZ commissioned Royal Haskoning DHV (RHDHV) to define an optimal navigation channel design, including the associated dredging requirements, in order to provide high water access for vessels with increased draft to safely transit to the RNZ Crude Jetty.

Different options for the channel design (RHDHV Shipping Channel - Concept Design Report, Royal HaskoningDHV, 2016a) were provided and discussed with RNZ. An Under Keel Clearance study was completed by OMC in the OMC International (2016) - Mardsen Point Channel Optimisation report, based on the channel designs provided by RHDHV and the long period wave analysis performed by MSL. Further assessment of the channel was undertaken from a navigation perspective (RHDHV Report - Desktop Simulation Study, Royal HaskoningDHV, 2015). The Option 4.2 was the stated preferred option from a channel design perspective and was confirmed via the alternative assessment work presented in Tonkin and Taylor (2016a).

For the present study, Option 4.2 has been adopted as the design case for the numerical modelling. Details about the characteristics of the proposed channel and corresponding dredging requirements are described in Royal HaskoningDHV, 2016b, as part of the dredging methodology assessment provided by RHDHV to RNZ.

An overview of the proposed channel design (Option 4.2) and the resultant differences between existing and post-dredging bathymetries are shown on Figure 1.3 based on the depth datasets used by MSL to setup the model water depth.

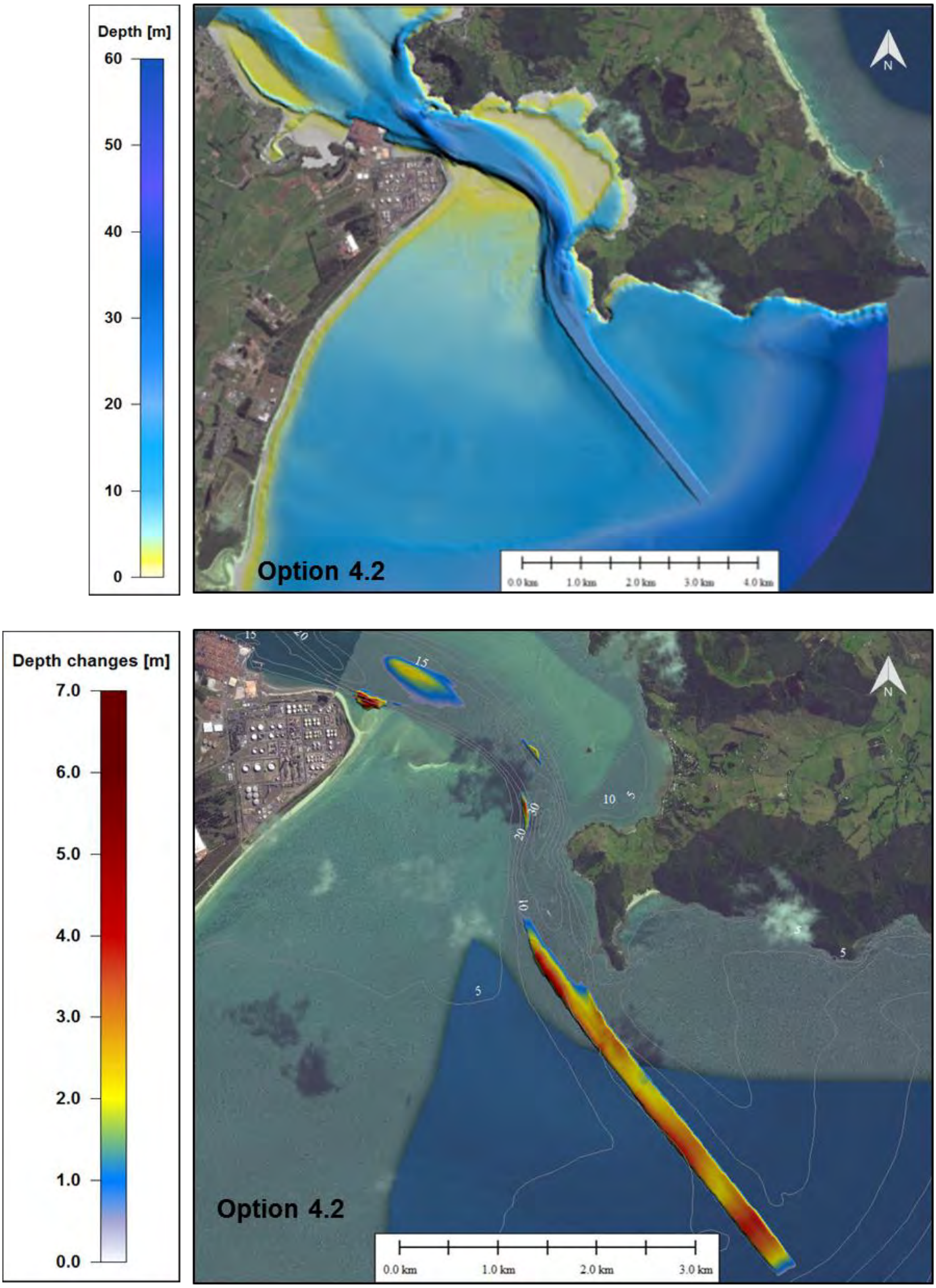


Figure 1.3 Depths (upper plot) and depth differences (lower plot) between the Option 4.2 channel design and the existing channel configuration. Positive amplitudes indicate a deepening of the channel.

1.4. Proposed offshore disposal ground designs

In consultation with Royal HaskoningDHV, Tonkin + Taylor, and MetOcean Solutions, as well as expert consultants from a range of other disciplines, the client went through a selection process which led to the identification of the preferred locations to dispose the capital and maintenance dredge volumes from the Crude Shipping Project. That process is described in the Tonkin and Taylor report (2016). In this context, two offshore disposal sites have been identified by RNZ as potential options for the disposal of capital and maintenance volumes (see Figure 1.4):

- Disposal Site 1.2 (yellow polygon) is located over the south-western flank of the tidal delta where depths range between 2 and 10 m. Its distance from Ruakaka Beach and Busby Head is approximately 2 km and 1.6 km, respectively. This disposal site is considered by RNZ as the preferred option for the placement of maintenance volume and up to 5% of the capital dredging volume, and the site has therefore been investigated in the present study.

- Disposal Site 3.2 (red polygon) is an area measuring approximately 2 km^2, which ranges in depth from 41 to 48 m. This option for the disposal of capital and maintenance volumes is located approximately 3.5 km to the South of Bream Head and 700 m to the east of 3 Mile Reef. Its distance from Busby Head and the inlet entrance is approximately 7 km. This disposal site is considered the preferred option for the placement of up to 95% of the capital volume and up to 100% of the maintenance volume by RNZ and the area was therefore investigated in the present study

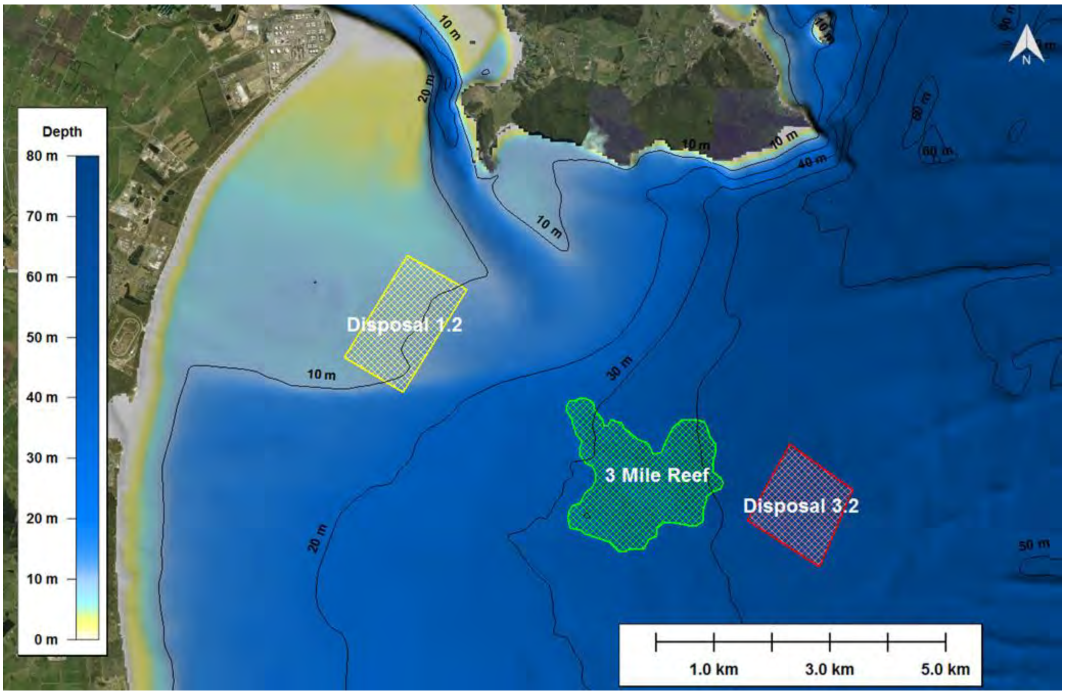


Figure 1.4 Location of Disposal grounds 1.2 and 3.2 (indicated by coloured diagonal cross-hatch polygons) for the disposal of capital and maintenance volumes. 3 Mile Reef indicated by a green polygon is a sensitive reef for its benthic encrusting communities.

1.5. Additional Northport berth

Additionally, the numerical modelling considered the existing Northport facilities, including Berths 1-3. It has also taken into account unimplemented resource consents held by NorthPort in respect of an additional proposed berth, known as Berth 4 (there are a series of consents issues by Northland Regional Council relating to the reclamation, construction, and use of Berth 4, primarily those consents numbered CON20030505523). As required pursuant to the RMA, the modelling included Berth 4 (see reclaim area in Figure 1.5) as if those resource consents had been given effect to as part of the “existing environment”.

Figure 1.5 Satellite image showing the NorthPort Berth4 reclaim area included in the hydrodynamic model bathymetry.

2. WIND MODELLING

The numerical modelling of the atmospheric dynamics at Whangarei was undertaken by MSL to provide the wind conditions required to force the regional hydrodynamic and wave models presented in Sections 3 and 4.

2.1. Model approach

The near-surface wind field was prescribed by a 36-year (1979-2014) regional atmospheric hindcast carried out by MSL. The WRF (Weather Research and Forecasting) model was established over all of New Zealand at hourly intervals and at approximately 12 km resolution. The hindcast was specifically tuned to provide appropriate marine wind fields for metocean studies around the country. The WRF model boundaries were sourced from the CFSR (Climate Forecast System Reanalysis) dataset distributed by NOAA, which was available at hourly intervals and 0.31° spatial resolution. While the WRF hindcast produced atmospheric parameters at hourly intervals over the 36 years, only the near surface wind field (i.e. 10 minute mean at 10 m elevation) is used here.

2.2. Model validation

Validation of the WRF hindcast was undertaken at the Marsden Point wind station situated at 35.840 S, 174.487 E (WGS84) as shown in Figure 2.1. Wind data were recorded at approximately 10 m elevation above mean sea level between 1979 and 1990.

Figure 2.1 Location of the wind station (red circle) at Mardsen Point. Geographic coordinates are provided in Appendix A.

The quantitative validation shows the model to exhibit a reasonable correspondence with the measured data (

Table 2.1). The hindcast wind speed was biased slightly high (0.59 ms^{-1}). The time series of measured and hindcast wind speed and direction are provided in Figure 2.2 and Figure 2.3 respectively, while the scatter and quantile-quantile (Q-Q) plots for the wind speed validation are presented in Figure 2.4. These figures illustrate the good consistency between the measured and hindcast wind speed data.

The comparison between modelled and measured annual wind roses at Mardsen Point shown on Figure 2.5 indicates that the model realistically replicates the regional coastal wind climate, albeit with a relative low bias of approximately 0.7 m.s^{-1} in speed and 11 degrees in direction, and illustrates that it does not include the influence of the local topography on the micro-scale wind regime. The topography of Mount Mania, Whangarei Heads, Bream Head and Ruakaka Forest creates wind corridors over some areas and provides sheltering for others; these are not fully replicated in the model given the resolution of the model grid is only 12 km. This spatial variability of the wind fields onshore is not expected to significantly affect the wave and current generation over the study area. On Figure 2.6, the distribution of wind directions are shown as histograms instead of Q-Q plots, which is more suitable for directional comparisons. The predominance of winds incoming from the SW sector is consistent between the measured and hindcast data, and the northeast and east sector winds are also relatively well replicated by the hindcast.

In summary, the model adequately replicates the regional wind dynamics, and it was therefore assessed that it is suitable for the forcing of the hydrodynamic and wave models.

Table 2.1 Comparison between measured and hindcast wind data. Accuracy measures for wind speed and direction at Marsden Point (1979-1990).

Parameter	Wind speed	Wind direction
MAE	1.92 ms^{-1}	31 deg.
RMSE	2.44 ms^{-1}	44 deg.
MRAE	0.59	0.31
BIAS	0.67 ms^{-1}	-11 deg.
Scatter Index	0.47	0.22

Mean absolute error (MAE): $$\overline{|x_h - x_m|} \quad (2.1)$$

Root Mean Square Error (RMSE): $$\sqrt{\overline{(x_h - x_m)^2}} \quad (2.2)$$

Mean relative absolute error (MRAE): $$\overline{\left|\frac{x_h - x_m}{x_m}\right|} \quad (2.3)$$

Bias: $$\overline{x_h - x_m} \quad (2.4)$$

Scatter Index (SI): $$\frac{\sqrt{\overline{(x_h - x_m)^2}}}{\overline{x_h}}$$ (2.5)

Where *h* and *m* indicate hindcast and measured data, respectively.

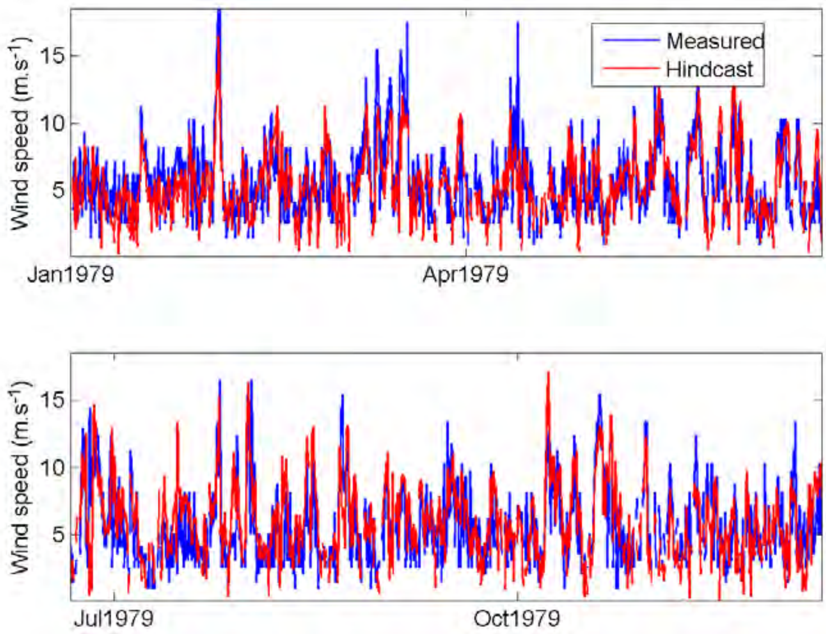


Figure 2.2 Time series plot of the measured and hindcast wind speed and wind direction at Marsden Point (year 1979). Note only a portion of the 12 years of data used for validation is shown here for better visualisation.

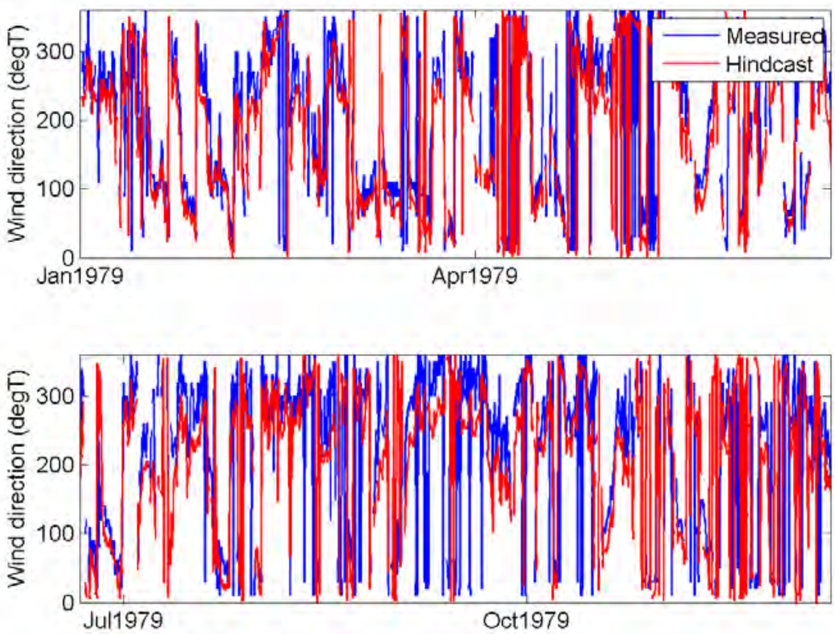


Figure 2.3 Time series plot of the measured and hindcast wind direction at Marsden Point (year 1979). Note only a portion of the 12 years of data used for validation is shown here for better visualisation.

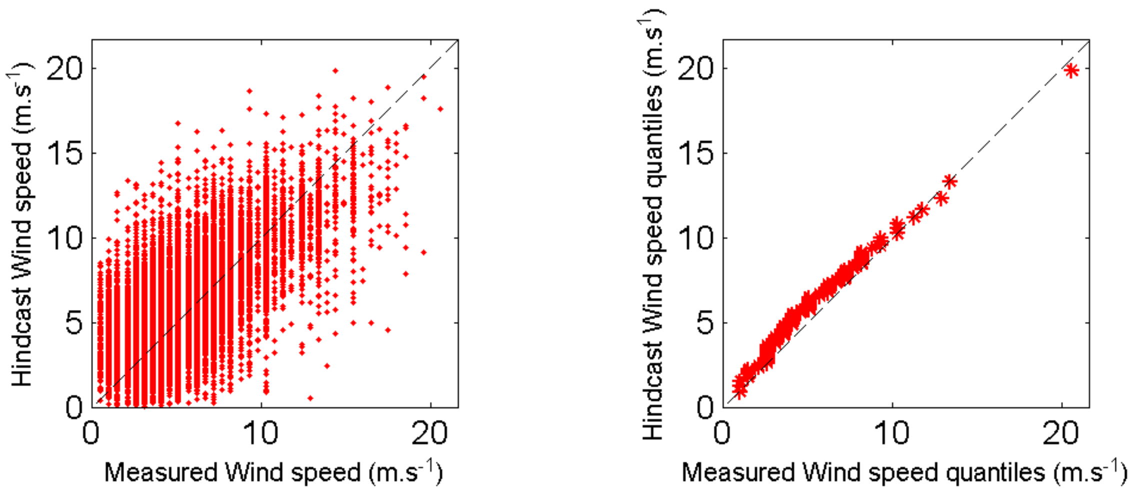


Figure 2.4 Scatter and Quantile-Quantile plots of the measured and hindcast wind speed at Marsden Point (1979-1990). Also shown are the lines of equivalence.

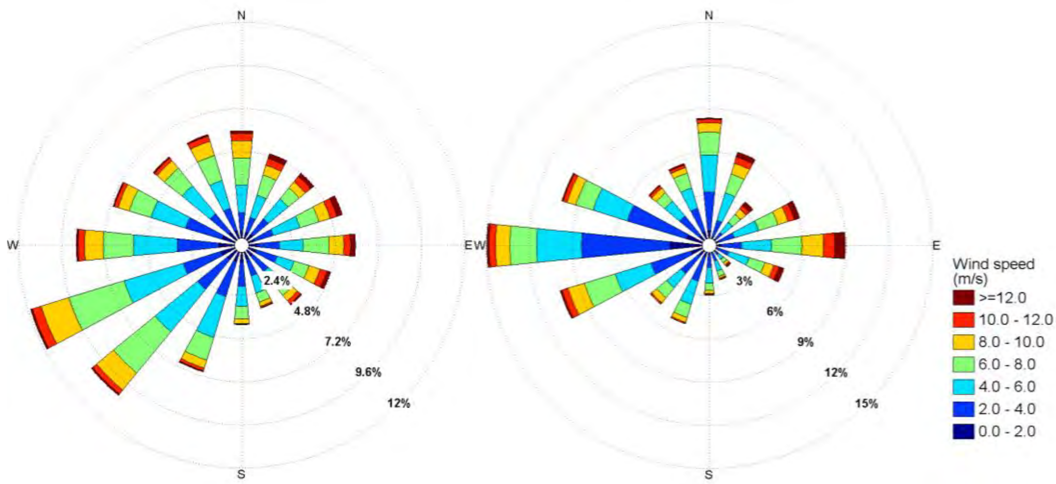


Figure 2.5 Modelled (left) and measured (right) annual wind rose at position WS shown on Figure 2.1. Geographic coordinates of this location are provided in Appendix A.

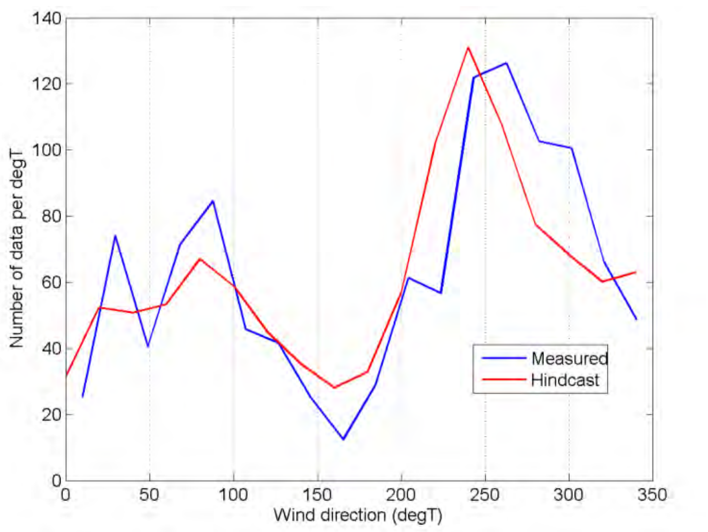


Figure 2.6 Histograms of measured and hindcast wind directions at Marsden Point (1979-1990).

3. WAVE MODELLING

This section details the numerical wave hindcast modelling used to characterise the regional wave climate as well as the nearshore wave transformations from offshore and into the harbour entrance.

3.1. Model approach

3.1.1. Model description

A modified version of SWAN[1] (Simulating Waves Nearshore) was used for the hindcast wave modelling for the project. The wave hindcast extended over a 36-year period between 1979 and 2015.

SWAN is a third generation ocean wave propagation model which solves the spectral action density balance equation for wavenumber-direction spectra. This means that the growth, refraction, and decay of each component of the complete sea state, each with a specific frequency and direction, is solved, giving a complete and realistic description of the wave field as it changes in time and space. A detailed description of the model equations, parameterisations and numerical schemes can be found in Holthuijsen (2007) or the SWAN documentation[2]. Physical processes that are simulated include the generation of waves by surface wind, dissipation by white-capping, resonant nonlinear interaction between the wave components, bottom friction and depth limited breaking. All 3rd generation physics are included. The BYDRZ physics package developed for WW3 model, which accounts for the effects of full air flow separation and therefore relative reduction of the input at strong wind forcing, was implemented in SWAN and used for the hindcast. The Collins (1972) friction scheme was used for wave dissipation by bottom friction.

The solution of the wave field is found for the non-stationary (time-stepping) mode. Boundary conditions, wind forcing and resulting solutions are all time dependent, allowing the model to capture the growth, development and decay of the wave field.

3.1.2. Pertinence of the model for the present study

The SWAN model was selected in the present study for its unconditionally stable numerical scheme and its ability to accurately reproduce the wave spectral transformations from deep to shallow water regions over complicated nearshore bathymetry. SWAN is considered the most suitable tool to compute the offshore-to-nearshore transformation of wave fields. Other types of models, notably non-hydrostatic or Boussinesq-type phase resolving time-domain models have a more complete description of the (nonlinear) wave transformation and resolve the wave shape, but are impractical to apply over large domains and/or over long-term periods.

SWAN has widely been applied all over the world in many coastal wave studies and successfully validated against measured data. Dodet (2013) investigated the wave-current interactions in a wave-dominated tidal inlet (Albufeira Lagoon) and showed that SWAN was able to faithfully represent the wave dynamics at the seaward entrance of the delta and within the inlet. The authors of that study used a three-level nested design structure within SWAN forced by WW3 spectra outputs

[1] Modified from SWAN version of the 40.91 release (publicly available code)
[2] http://swanmodel.sourceforge.net/online_doc/online_doc.htm

and coupled with a high-resolution hydrodynamic model. This corresponds to the same approach applied in the present study of the entrance to Whangarei Harbour.

3.1.3. Model domain and boundary conditions

The wave hindcast involved three-level SWAN downscaling to model the nearshore region at approximately 50 m resolution. Full spectral boundaries for the parent domain were prescribed from MSL implementation of WW3 global wave model (Tolman, 1991) with the Tolman and Chalikov (1996) physics.

The limits and resolutions for each SWAN nest are shown in Table 3.1 and Figure 3.1. The parent domain was forced with full spectral boundaries from WW3 and provided boundaries to run a first SWAN child at 0.0015 degree. A second child nest with about 50 m resolution was defined to resolve the complex bathymetric features near the shore. All nests were configured with 24 frequency bins (logarithmic scale from 0.04 to 0.66 Hz) and 36 directional bins. SWAN was run with wind fields specified from the MSL WRF New Zealand reanalysis.

Table 3.1 Boundary, resolution and limits defined for each SWAN nest.

Domain	Boundary	Longitude (degree)			Latitude (degree)		
		x1	x2	dx	y1	y2	Dy
Parent	WW3	174.45	176.15	0.009	-37.23	-35.23	0.009
Child 1	Parent	174.451	174.8	0.0015	-36.04	-35.8	0.0015
Child 2	Child 1	174.458	174.558	0.0005	-35.925	-35.825	0.0005

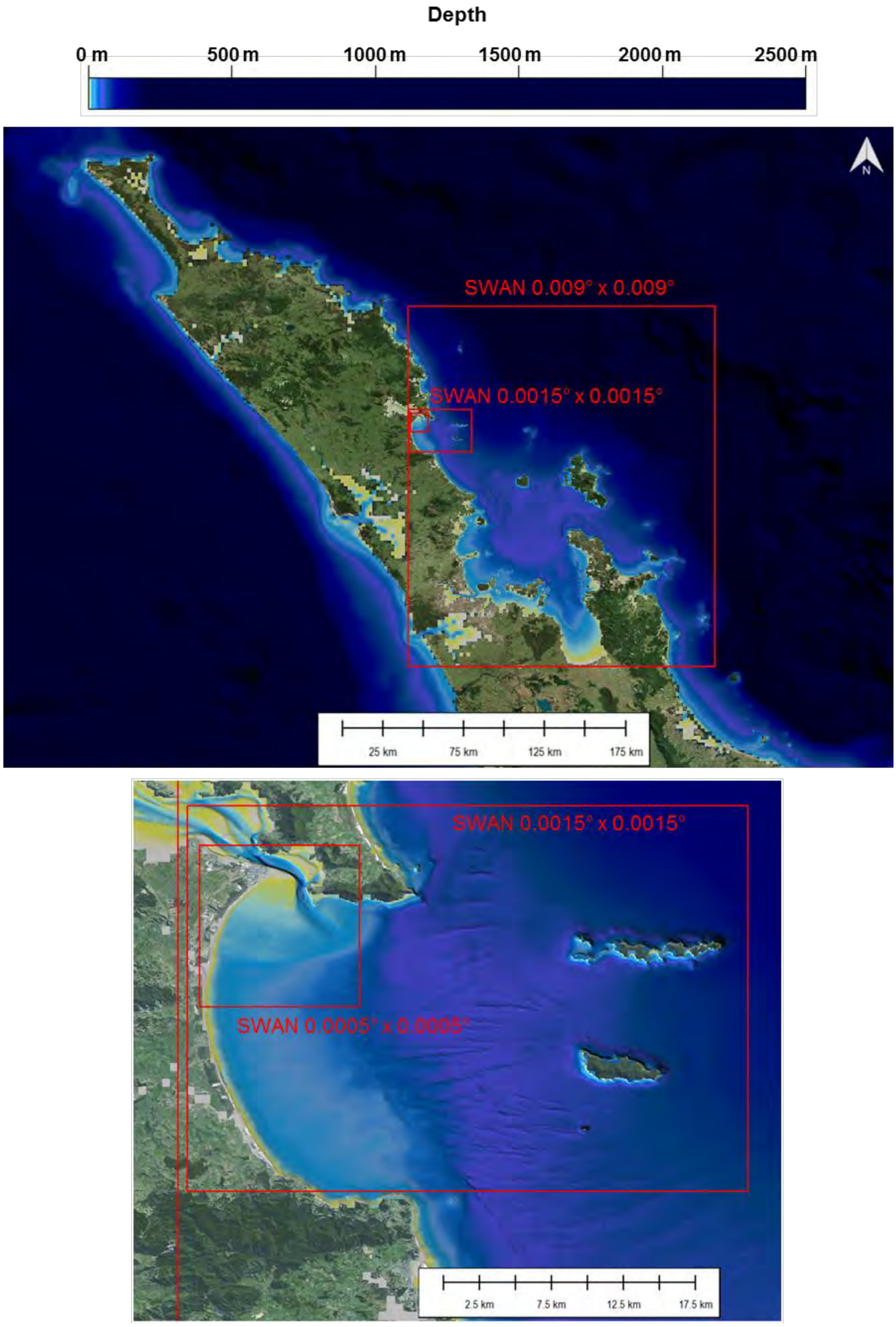


Figure 3.1 Water depth and model domains used to reproduce the spectral wave transformation from offshore to nearshore. The geographical extent of each domain is shown by the red rectangles.

3.1.4. Post-processing

Two-dimensional frequency-direction wave spectra were output at hourly intervals from the highest resolution SWAN domain at four nearshore. The spectra were post-processed to calculate wave statistics for the total wave field, as well as for sea and swell components. One – dimensional frequency spectra, spectral moments, significant wave height, mean direction at peak frequency and peak wave period were calculated based on the equations provided below:

- One-dimensional frequency spectra:

$$S_n(f) = \int_{-\pi}^{\pi} E_n(f,\theta)d\theta \tag{3.1}$$

- Spectral moments were calculated as:

$$m_x = \int \int f^x E(f,\theta)df\ d\theta \tag{3.2}$$

- Significant wave height , mean direction at peak frequency and peak wave period defined as:

$$H_s = 4\sqrt{m_0} \tag{3.3}$$

$$Dpm = tan^{-1}\frac{\int_{-\pi}^{\pi} E\left(f_p,\theta\right) sin\theta\ d\theta}{\int_{-\pi}^{\pi} E\left(f_p,\theta\right) cos\theta\ d\theta} \tag{3.4}$$

$$T_p = \frac{1}{f_p} \tag{3.5}$$

where f_p is the peak wave frequency of the one-dimensional spectra and $E\left(f_p,\theta\right)$ is the energy contained in the peak wave frequency band.

- Mean wave periods were defined from the first and second spectral moments as:

$$T_{m01} = \frac{m_1}{m_0}; \quad T_{m02} = \frac{m_2}{m_0} \tag{3.6}$$

- Spectral width parameter was calculated as:

$$S_{we} = \sqrt{\frac{1-m_2^2}{m_0 m_4}} \tag{3.7}$$

3.2. Model validation

A program of wave measurements was undertaken to validate the nearshore wave transformation model. This involved the deployments of a waverider buoy and pressure sensors. The validation data locations are shown on Figure 3.2 and the observational durations are specified in Table 3.2.

The model wave hindcast was first validated against the offshore waverider buoy (WRB) data to ensure the sequence of hindcast model domains could reproduce the wave boundary conditions to the study area. The second step was to demonstrate the ability of the nearshore model to capture the governing wave dynamics across the ebb tide delta from the nearshore wave data sites (W1 – W4) along Ruakaka Beach (Figure 3.2). Note that the water depth at these nearshore sites ranged from 2.8 to 7 m (see Table 3.2).

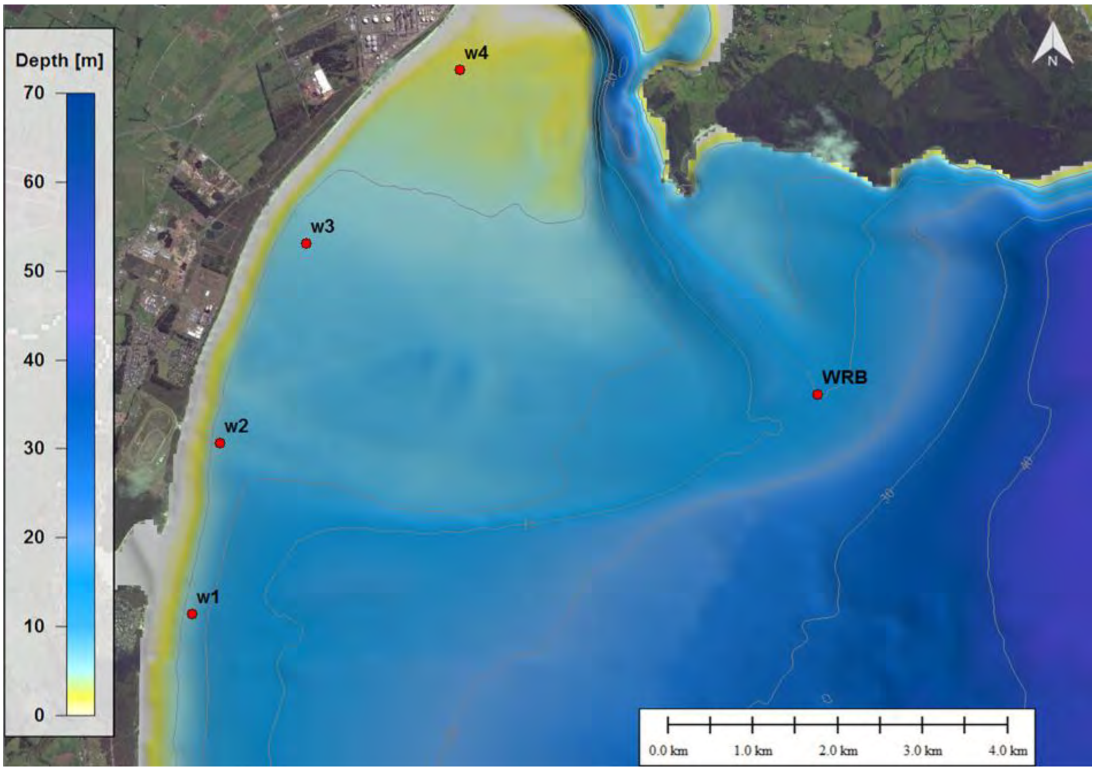


Figure 3.2 Locations of the instruments (red circles) deployed for measuring the wave conditions along Ruakaka Beach and offshore of the entrance.

Table 3.2 Measured wave data sources used for the hindcast validation.

Site name	Water depth (m)	Data coverage
WRB	15.0	continuous
W1	6.9	10/07 to 08/08 2015
W2	7.0	10/07 to 08/08 2015
W3	6.9	10/07 to 08/08 2015
W4	2.8	10/07 to 08/08 2015

3.2.1. Frequency range and accuracy measures

The wave spectra (measured and modelled) at the nearshore sites W1 – W4 were integrated over the 0.04 – 0.25 Hz range, while the entire frequency range was used at site WRB. Co-temporal, co-located wave parameters calculated from the hindcast model and from the measurements were compared directly.

3.2.2. Validation results

Comparisons between measured and modelled significant wave heights (Figure 3.3 and Figure 3.4) at location WRB outside the ebb-tidal delta indicate that the model adequately predicts the time-varying wave conditions. On average the hindcast wave heights were biased slightly high (0.07 m in absolute value) while the hindcast peak wave period was biased slightly low, by about 0.7 s (see Figure 3.5). The model tends to slightly under-predict the wave heights in the range low energy range (Figure 3.4) which could be due to a slight underestimation of the local wind wave growth. Moderate energy swell events (1-2 m in height) are slightly overestimated, which is due to the incident directional spectra from WW3 having a slightly high bias along the east coast of New Zealand.

The hindcast results for the nested inner wave domain, which includes the ebb tide delta and the harbour entrance region, are provided in Figure 3.5 to Figure 3.9. Here the time series of measured and predicted wave heights are co-plotted, showing a general agreement with the time varying conditions and also the gradient in wave energy that decreases with distance to the north along Ruakaka Beach. Site W1 exhibits some anomalous behaviour however, with the model over-predicting the wave height for one event, which is being well replicated at the other sites. Close examination of the model results indicates that strong wave refraction over the ebb tide delta causes zones of high and low wave energy to be distributed along the beach. The location of these zones depends on the incident wave period and wave direction. So, while the hindcast boundary spectra to the inner nest are a very good estimate, it is not a perfect replication of the 2D wave spectra and subtle differences in the incoming wave directionality will be readily expressed in the nearshore results. This is made particularly evident on the ebb tide delta because the waves travel for several km slightly oblique to the bathymetric contours, and therefore refraction effects on the nearshore wave conditions becomes highly evident. The measured and modelled data clearly shows that the shape of the ebb tide delta causes distinct redistribution of the wave energy along the shore, an important finding highlighting the influence of the offshore bathymetry on the nearshore wave conditions.

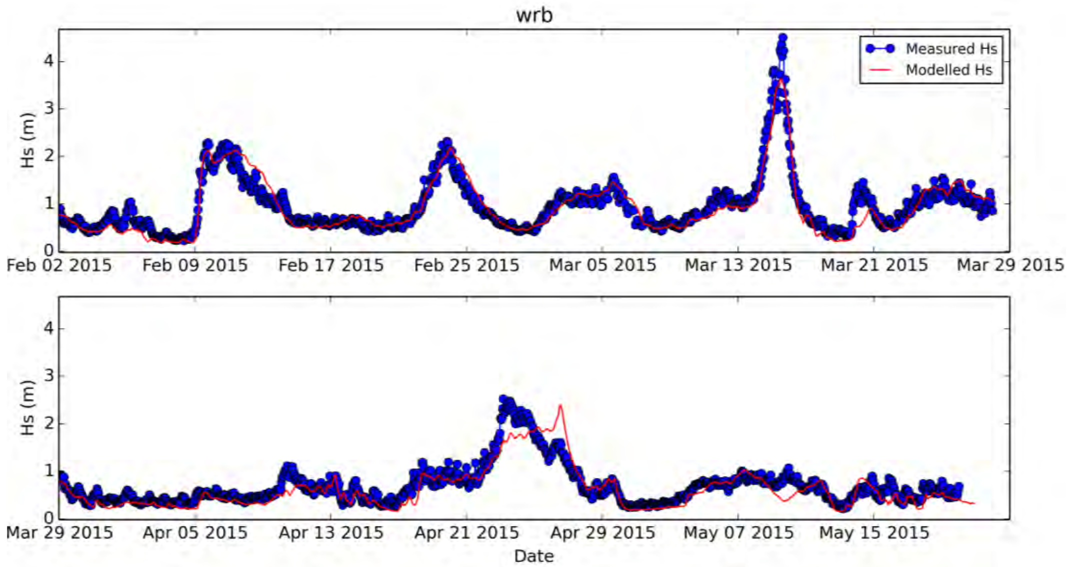


Figure 3.3 Time series of measured (blue) and modelled (red) significant wave height H_s at the WRB site.

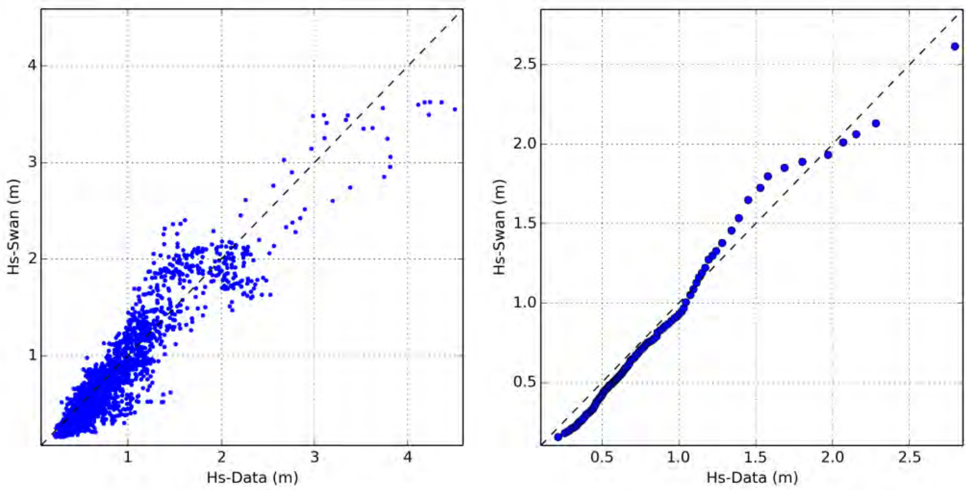


Figure 3.4 Scatter diagram (left) and quantile-quantile plot (right) of measured and modelled significant wave height H_s at WRB site.

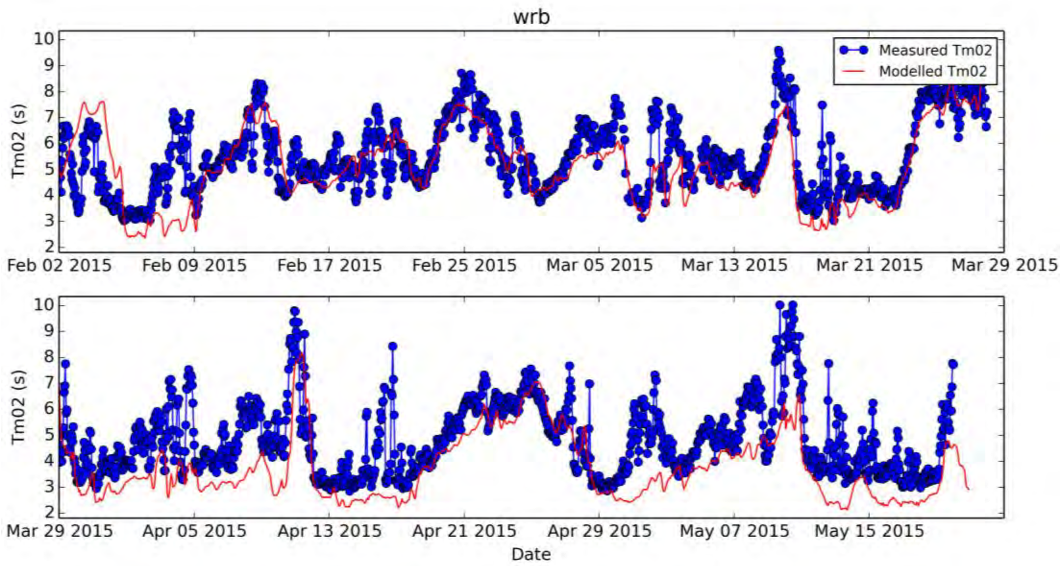


Figure 3.5 Time series of measured (blue) and modelled (red) mean absolute period from the second spectral moment T_{m02} at the WRB site.

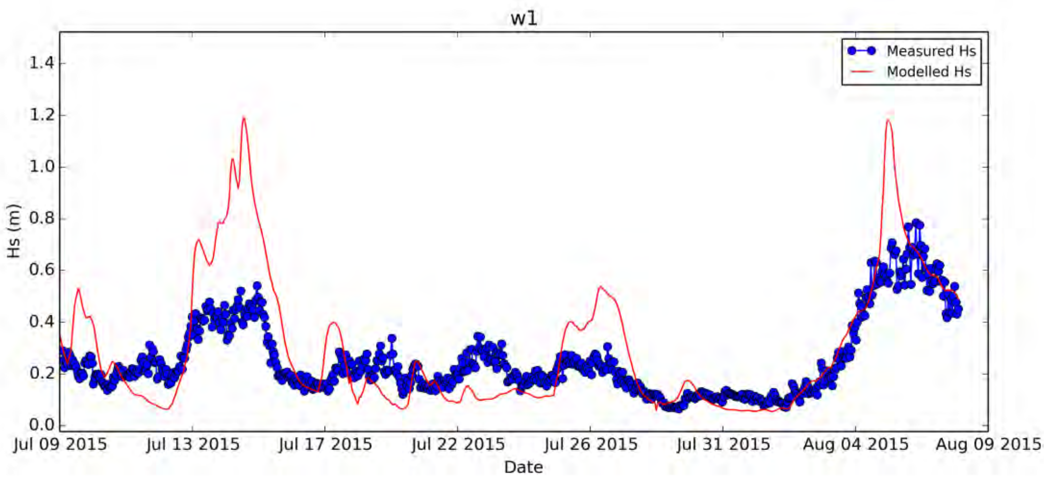


Figure 3.6 Time series of measured (blue) and hindcast (red) significant wave height H_s at site W1.

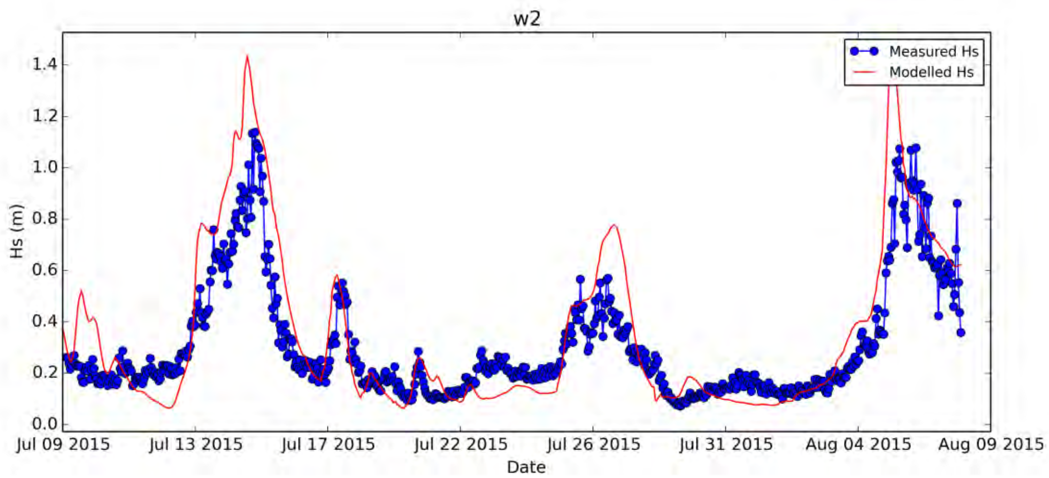


Figure 3.7 Time series of measured (blue) and hindcast (red) significant wave height H_s at site W2.

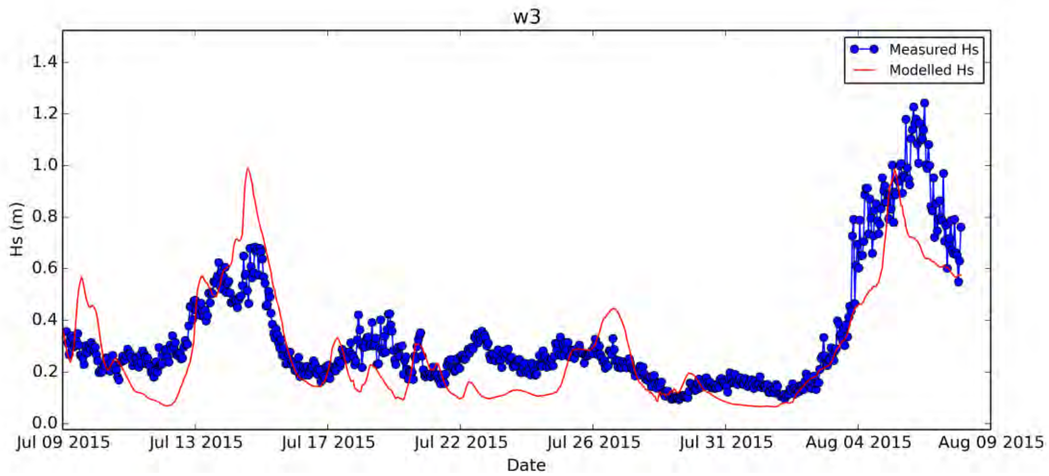


Figure 3.8 Time series of measured (blue) and hindcast (red) significant wave height H_s at site W3.

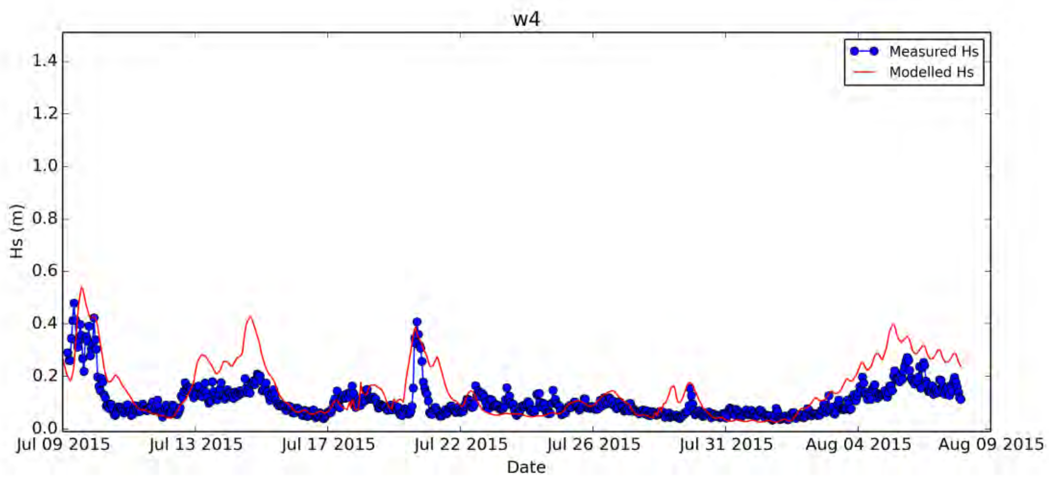


Figure 3.9 Time series of measured (blue) and hindcast (red) significant wave height H_s at site W4.

4. REGIONAL HYDRODYNAMIC MODELLING

Characterising the circulation in the continental shelf waters adjacent to Whangarei Harbour is important when considering the local scale hydrodynamic and sediment transport processes, as it prescribes the boundary conditions for the nearshore and harbour entrance numerical modelling. The presence of strong, along-shelf winds and offshore oceanic boundary currents year round can all play a role in forcing the circulation near the coast. A careful modelling strategy is required to reproduce the different spatial and temporal scales and circulation phenomena at the shelf and deep ocean environments and adequately feed the local scale models. This section describes the modelling studies that were undertaken to characterise regional hydrodynamics.

4.1. Model approach

4.1.1. Modelling description and pertinence of the model

A 10-year hindcast was performed using the ROMS hydrodynamic model version 3.7 (Regional Ocean Modelling System, described in Haidvogel (2008) to characterise the tidal and residual shelf scale circulation regime. The application of the ROMS model at regional scale fully captures the interaction of the wind and tidal circulation with the morphology of the Hauraki Gulf. This modelling tool has been used widely in the scientific and commercial consultancy communities for a wide range of ocean basin at regional and coastal scales.

ROMS has a curvilinear horizontal coordinate system and solves the hydrostatic, primitive equations subject to a free-surface condition. It is a state-of-the-art model widely used for regional and coastal dynamics assessment. Its terrain-following vertical coordinate system results in accurate modelling of shelf seas with variable bathymetry, allowing the vertical resolution to be inversely proportional to the local depth. Besides tidal and wind-driven currents, ROMS resolves frontal structures and baroclinic pressure gradients quite well. Vertical mixing may be resolved by different separate turbulent closure schemes, that are flexible to shallow and deep water dynamics. These features make ROMS particularly well-adapted for the modelling of regional hydrodynamic systems and ROMS is one of the hydrodynamic models most used for regional study applications. It is a modern code which captures sub-, meso- and macro-scale hydrodynamic mechanisms while maintaining robustness, accuracy and numerical stability.

4.1.2. Model domains

The hindcast setup was configured with a three-level nesting (Figure 4.1, top) approach to best transfer the energy gradually from larger to smaller coastal scales, and to properly resolve the flow associated with local and remote forcing, both essential for the resultant currents in the area of interest. The open boundary conditions that were imposed to the highest level nest (NZ) consisted of tri-dimensional velocity, temperature, salinity and sea surface height fields derived from the 6-hourly Climate Forecast System Reanalysis (CFSR) product (Saha et al., 2010) from the National Centers for Environmental Prediction (NCEP), which consisted of a 0.5 degree global reanalysis with comprehensive data assimilation.

The larger scale ROMS nest encompassed the area shown in the lower panel of Figure 4.1 with 7 km horizontal resolution, the goal of which was to absorb the basin scale circulation estimated by the CFSR global reanalysis, thus avoiding a large parent-to-child resolution step. This domain, called NZ hereinafter, was able to more adequately capture the oceanic circulation and its variability. The second domain (HRKI) covered the entire Hauraki Gulf and continental shelf surrounding the area of interest with a horizontal resolution of 1.7 km. With this grid spacing, the local bathymetry was more accurately captured resulting in fine scale representation of the local coastal currents. The third domain (WHANG) covers the continental shelf near the area of interest with a much higher resolution (350 m), and resolved the detailed, local wind-driven and tidal circulation, producing accurate currents and thermohaline fields to support the subsequent local scale hydrodynamic and sediment models.

The 3D flow and thermohaline fields were transferred from the top level domains to the refined ones by the offline one-way nesting technique commonly used with ROMS.CFSR 3D fields were fed to NZ at 6-hourly intervals and NZ-HRKI and HRKI-WHANG ROMS at 3-hourly intervals.

All ROMS domains were submitted to spin-up phases prior to the 10-year hindcast period to allow the adjustment of the coarser initial conditions to higher resolution and its better represented bathymetry. The spin-up times were hierarchically established according to the main scales that each one was required to resolve. This information, along with all other relevant information for each of the hydrodynamic model domains considered for this study, is summarised in Table 4.1. The bathymetry for the ROMS grids was derived from electronic navigation charts and field data whenever available.

Table 4.1 ROMS model nests configurations.

Model Settings	NZ	HRKI	WHANG
Horiz Resolution	8 km (0.08° x 0.06°)	1.7 km (0.02° x 0.02°)	350 m (0.004° x 0.004°)
Vertical layers	30	19	15
Tidal forcing	No	No	Yes
Meteo forcing	MSL WRF NZRA	MSL WRF NZRA	MSL WRF NZRA

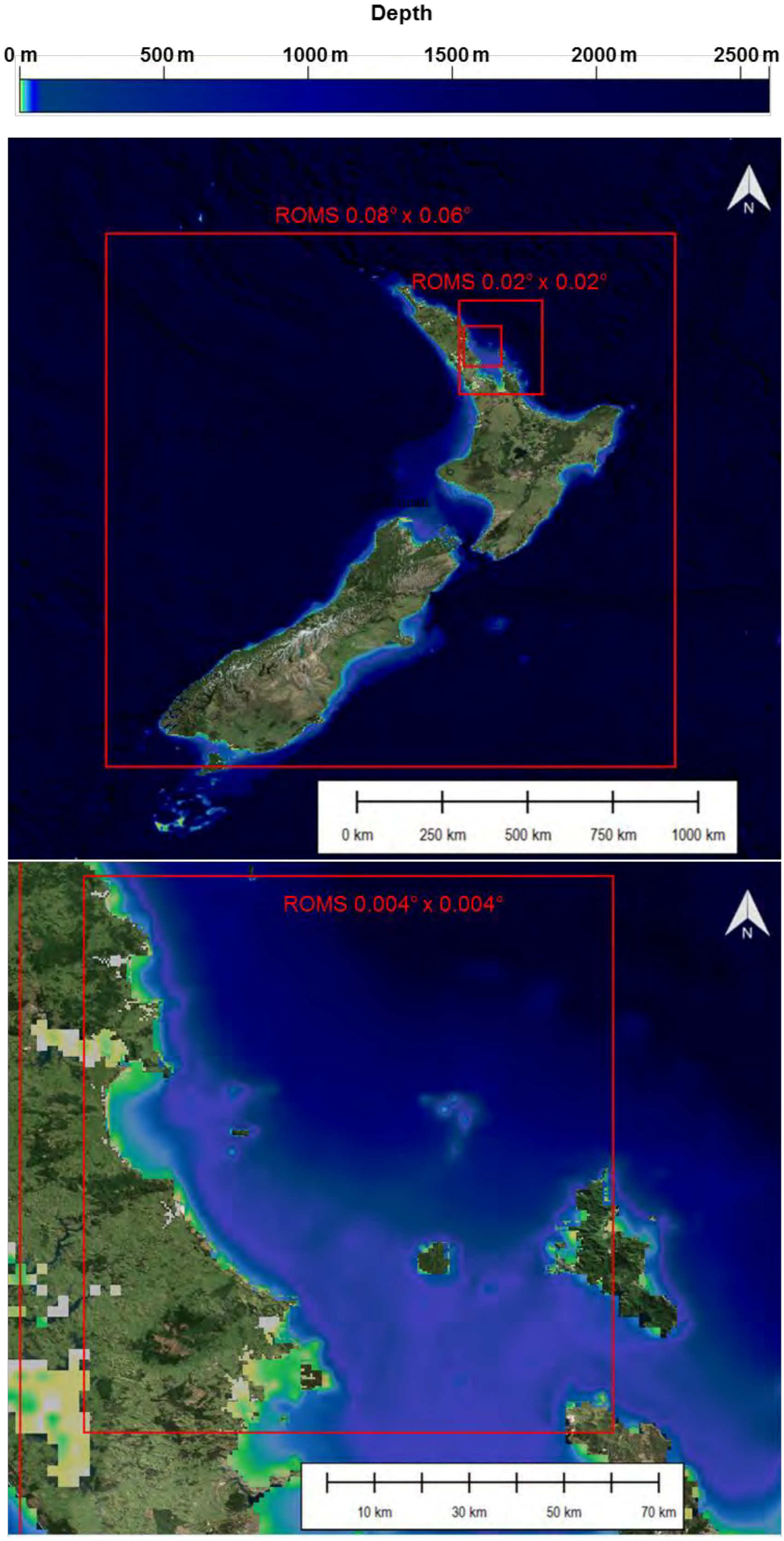


Figure 4.1 Hydrodynamic hindcast modelling approach with ROMS. Upper panel shows the NZ domain, and HRKI domain and lower panel shows the WHANG domain.

4.1.3. Atmospheric forcing

Atmospheric forcing for ROMS was derived from the WRF model outputs described in Section 2. Horizontal resolution varied from 16 to 4 km in the ROMS modelling area. Atmospheric fields consisted of winds, atmospheric pressure, relative humidity, surface temperature, long and short wave radiation and precipitation rate, imposed at hourly intervals to provide air-sea fluxes to drive ROMS in all domains, using a *bulk flux* parameterisation (Fairall et al., 2003).

4.1.4. Open boundary conditions

High frequency (6-hourly for CFSR-NZ and 3-hourly for NZ-HRKI and HRKI-WHANG) open boundary 3D thermohaline, velocity and sea surface height fields were included for all domains. Passive/active prescriptions were applied for all 3D variables at the open boundaries, where a radiation scheme was applied when outflows were estimated by ROMS algorithms. Where inflow was detected, a nudging condition was applied, allowing the penetration of 3D transports and T-S from the external sources, a key setting to guarantee the deep ocean circulation contributions to the smaller scales. To account for the fast propagating tidal oscillations, 2D velocities and surface elevations were treated with *Flather* and *Chapman* schemes, respectively.

4.1.5. Tidal forcing

ROMS WHANG was forced at the open boundaries by tidal elevations and currents, harmonic constituents derived from a MetOcean Solutions‟ New Zealand 2D hydrodynamic model consisting of a 5 km resolution grid, which was in turn forced at its open boundaries by the renowned OTIS Atlantic Ocean solution (Oregon State University Tidal Inverse Solution (Egbert and Erofeeva, 2002).

4.1.6. Model calibration

Through comprehensive testing of model parameters such as sub-grid scale parameterisations, forcing sources and grid settings including open boundary locations, spatial resolution and downscaling rate between parent and child grids, the model was calibrated with respect to available published literature and representation of the main identified forcing mechanisms. Numerical diagnosis such as checking kinetic energy equilibrium and trends in the 3D fields were successfully conducted.

4.2. Model validation

4.2.1. Current measurement program

Four ADCP measurement campaigns were undertaken between January and July 2016 at four different locations (see Figure 4.2). For each deployment, the ADCP was installed on the seabed facing upwards and recording data in 5-minute bursts every 30 minutes. The vertical bins ranged between 0.5 and 5 m depending on the water depth at the deployment location. The water depth and period of each deployment are summarised in Table 4.2 while the geographic coordinates of each deployment are provided in Appendix A and time series plots of the depth-average data in Appendix B.

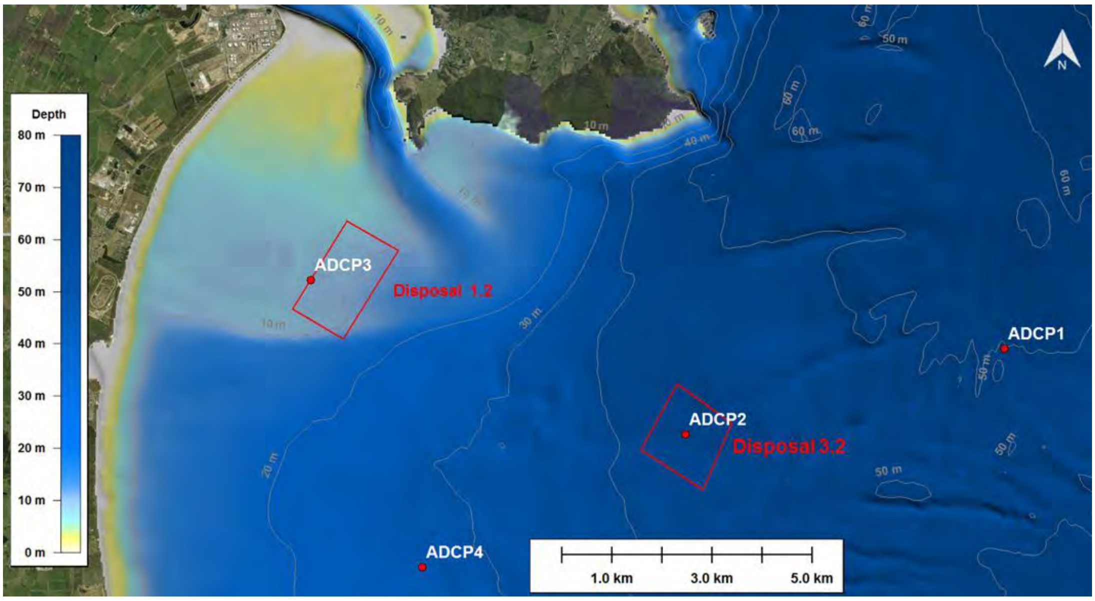


Figure 4.2 Location of the four ADCP deployments in Bream Bay between January and July 2016. The geographic coordinates of each position is presented in Table 4.2. Also shown are the proposed disposal grounds 3.2 and 1.2.

Table 4.2 Details of the current measurement program undertaken in Bream Bay from January to July 2016.

Position	Depth (m)	Measurement period (2016)
ADCP1	50	15 Jan - 5 Mar
ADCP2	44	5 Mar - 14 Apr
ADCP3	9	17 Apr - 3 Jun
ADCP4	25	12 Jun – 14 Jul

4.2.2. Validation

In addition to the 10-year ROMS hindcast used in the study, the ROMS model was run over a two-month period between March and May 2016 to allow the co-temporal validation of the model with measured data at position ADCP2, located at the centre of the proposed disposal ground 3.2 illustrated in Figure 4.2. The validation of the model at position ADCP2 allows a good assessment of the performance of the regional model, which was used to force both the disposal plume and the disposal ground models.

The model outputs were archived at 5-minute intervals to be consistent with the ADCP data, and the modelled and measured current speeds were vertically-averaged from 10 to 30 m depth for the time-domain comparison. Because the measured data duration was not long enough to resolve all tidal components by harmonic decomposition, a 25-hour filter was applied to separate the tidal and non-tidal flows for the validation.

The measured and modelled depth-averaged current velocities (Figure 4.3 - Figure 4.7) indicate that the model faithfully predicts the northeast-southwest bi-modal circulation at position ADCP2. The residual (non-tidal) component of the current is reasonably well replicated by the model, as shown on the Q-Q plot (Figure 4.7, top plot). The correlation between the model and measured dominant V-component of the non-tidal velocity provides a good level of confidence in the model. Given that the U-component of the velocity is very low (rarely exceeding 0.05 $m.s^{-1}$), the relative low correlation between the measured and the modelled data for this component is assumed to have minor importance on the model performance assessment.

On the other hand, the tidal component is under-predicted by around 20%. This results in a total bias (tidal and non-tidal components) ranging between 5 – 20% of the existing current speed (i.e. between 0.005 – 0.03 m/s). The impact of such bias on the prediction of sediment transport has to be considered based on the local sedimentology, the ratio between currents and waves and the water depth. In this regard, it seemed preferable to discuss the consequences of such bias in the context of short-term and long-term sediment transports caused by the placement of material over the offshore disposal area. This bias in modelled data is therefore considered in the interpretation of the disposal plume and ground modelling results in MSL Report P0297-02 (MSL, 2016). Note that a scenario including the use of measured current profiles as forcing within the sediment transport model was performed to assess the impact of such bias on the model results. Conclusions are also presented in MSL Report P0297-02.

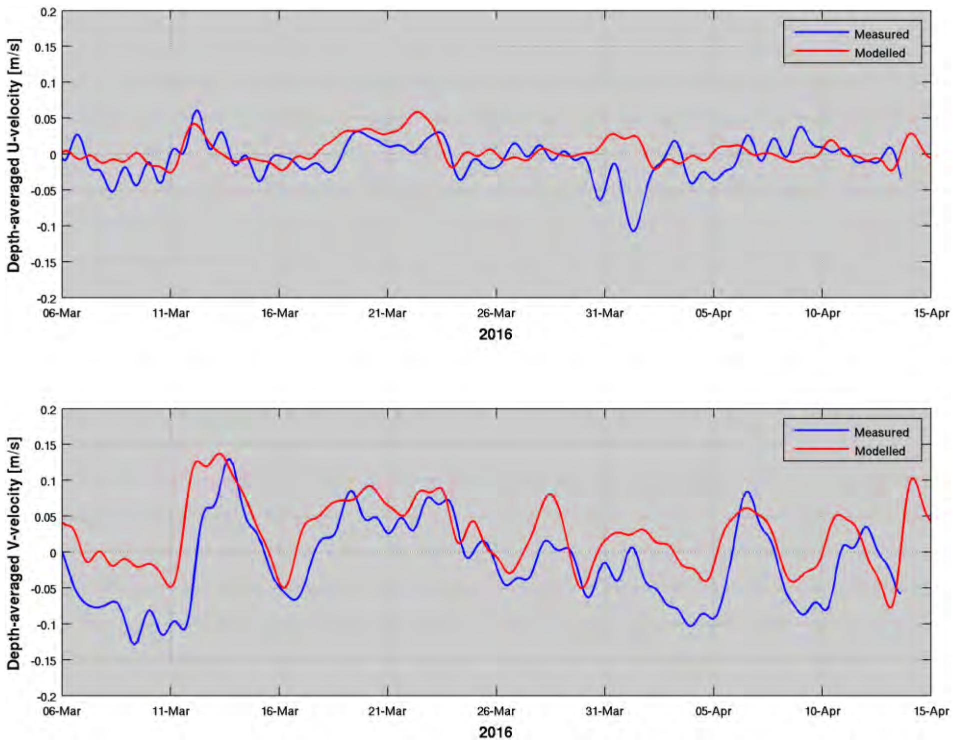


Figure 4.3 Time series of modelled and measured non-tidal depth-averaged current velocity at position ADCP2 from 5 March to 14 April 2016.

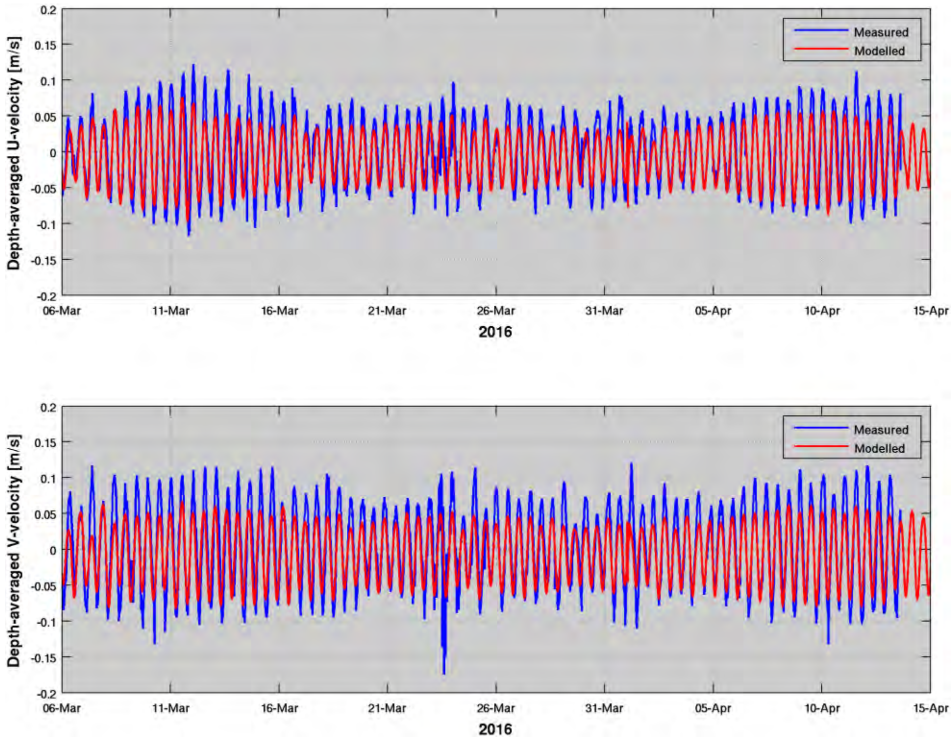


Figure 4.4 Time series of modelled and measured tidal depth-averaged current velocity at position ADCP2 from 5 March to 14 April 2016.

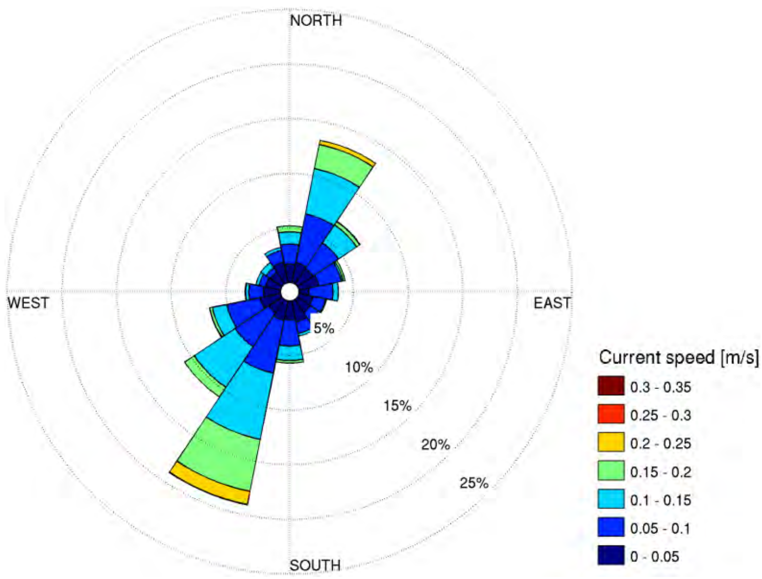


Figure 4.5 Measured depth-averaged current rose at position ADCP2 (5 March – 14 April 2016).

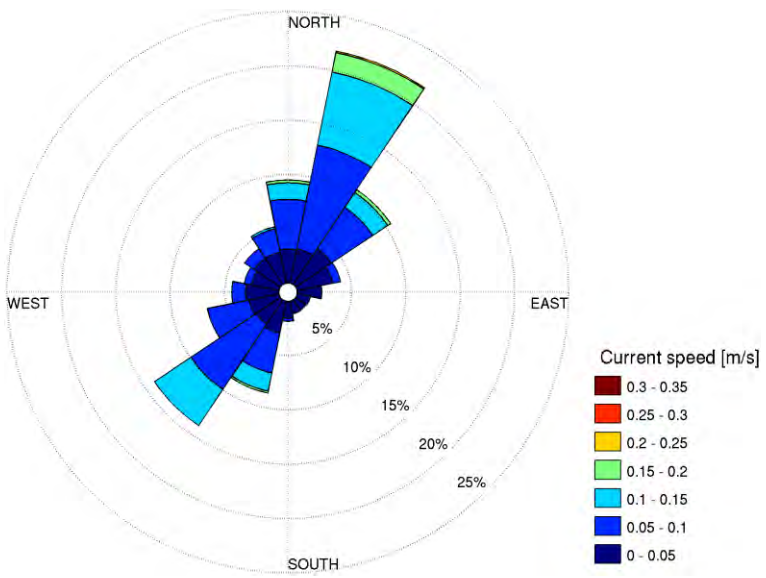


Figure 4.6 Modelled depth-averaged current rose at position ADCP2 (5 March – 14 April 2016).

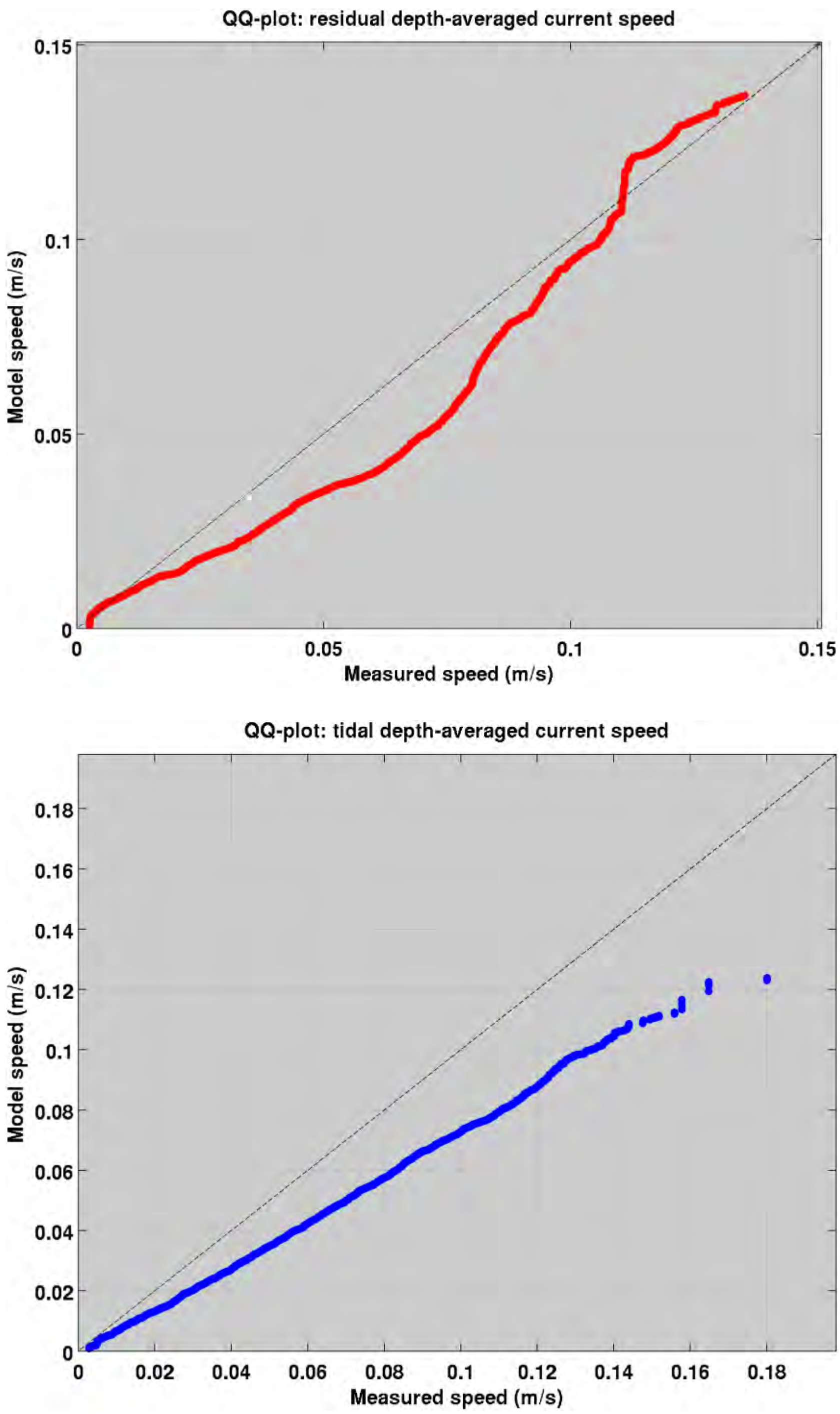


Figure 4.7 Quantile-Quantile plots of the measured and modelled non-tidal (top) and tidal (bottom) depth-averaged current speed at position ADCP2 (5 March – 14 April 2016).

5. HARBOUR TIDAL HYDRODYNAMIC MODELLING

Whangarei Harbour is characterised by a relative complex morphology with numerous channels, sand banks and small islands. In this context, a regional model such as ROMS is not the best option to accurately replicate the tidal flows over the study area and an alternate model, SELFE, was used that was better suited.

This section details the set-up of the high-resolution hydrodynamic modelling that was undertaken to simulate the tidal dynamics over Whangarei Harbour, given that the non-tidal component was of low importance. This nearshore hydrodynamic modelling stage aimed to provide the boundary conditions to the morphological model and assess the effect of the channel deepening on the local tidal dynamics.

The model water elevation and current velocities were validated at several positions within Whangarei Harbour and over the navigation channel using contemporary measured data. The key aim of the present numerical modelling was to capture both the temporal and spatial variability of the tidal dynamics to anticipate the changes in amplitude and phase caused by a different channel configuration.

5.1. Model approach

5.1.1. Model description

SELFE is a prognostic finite-element unstructured-grid model designed to simulate 3D baroclinic, 3D barotropic or 2D barotropic circulation. The barotropic mode equations employ a semi-implicit finite-element Eulerian-Lagrangian algorithm to solve the shallow-water equations, forced by relevant physical processes (atmospheric, oceanic and fluvial forcing). SELFE uses either pure terrain-following sigma, or S-layer coordinates in the vertical, or a hybrid system using both S and Z-layers as required and uses sophisticated vertical turbulent closure models. A detailed description of the SELFE model formulation, governing equations and numerics can be found in Zhang and Baptista (2008).

The SELFE model is physically realistic, in that well understood laws of motion and mass conservation are implemented. Therefore water mass is generally conserved within the model although it can be added or removed at open boundaries (e.g. through tidal motion at the ocean boundaries, or river discharges) and water is redistributed by incorporating aspects of the real-world systems (e.g. bathymetric information, forcing by tides and wind). The model transports water and other constituents (e.g. salt, temperature, turbulence) through the use of triangular volumes (connected 3-D polyhedrons) of varying size and is described as an unstructured finite element model.

5.1.2. Pertinence of the model for the present study

SELFE has been used for the present study as it provides robust capability to replicate the key hydrodynamic processes in shallow and intertidal environments. An important feature is its capability to simulate wetting and drying in shallow areas. The model sensitivity to bottom friction considered as a determinant mechanism in shallow waters has been demonstrated in the past. Moreover, the unstructured triangular grid approach implemented in SELFE allows for increase in model in the channel, along adjacent beaches and over sand banks without increasing dramatically the total computational runtime.

The SELFE model has been extensively applied to study circulation in coastal margins (bays, estuaries, tidal inlets and rivers) around the world (www.strccmop.org), including reported excellent representation of the hydrodynamic in a wave-dominated tidal inlet (Dodet, 2013).

5.1.3. High-resolution bathymetry and domain

Model bathymetries were derived from a combination of relevant ENC (Electronic Navigation Charts), LIDAR, and survey data (single-beam and multi-beam surveys). All data were converted to a common horizontal projection (NZTM), and reduced to a common vertical datum.

The model domain extents and bathymetry are shown in Figure 5.1. The domain was chosen to be sufficiently large to ensure the appropriate tidal boundaries (elevations and velocities) could be applied. The mesh resolution varies from approximately 300 m in the offshore, to ~5 m nearshore and around salient features.

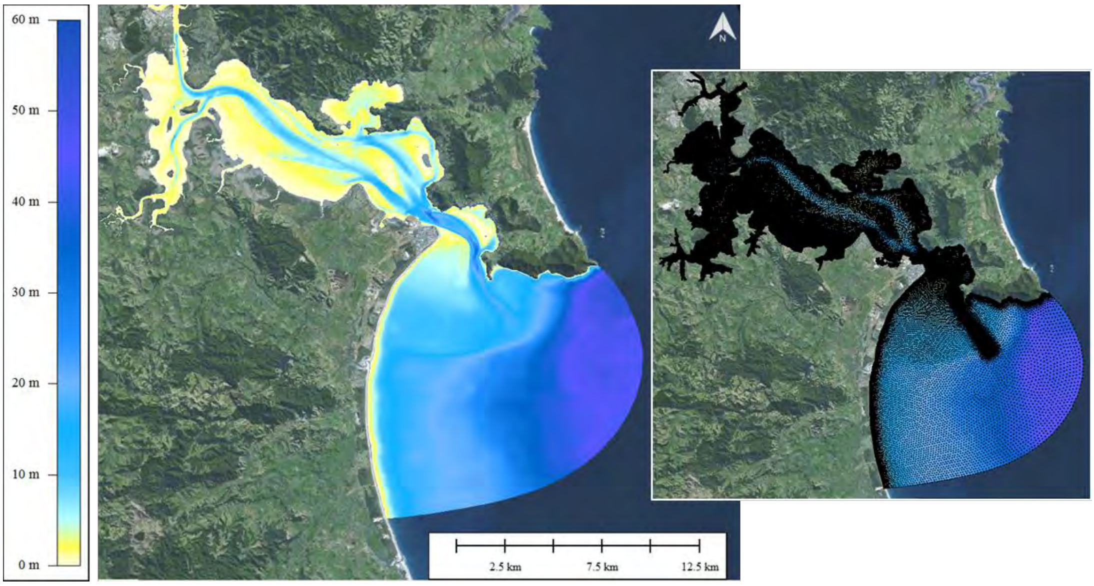


Figure 5.1 Model depth and mesh of the Whangarei Harbour and surrounds. Depths are given in metres below Mean Sea Level (MSL) The mesh covers the offshore region, including the ebb tidal delta, while salient bathymetric features are represented inside the harbour.

5.1.4. Open boundary conditions

A national New Zealand tidal solution derived from an implementation of the Princeton Ocean Model (POM) nested within the TPXO7.2 Pacific inverse tidal dataset (Egbert and Erofeeva, 2002) was used to prescribe the tidal elevation and current velocity at the boundaries of the grid. Depth dependent velocities along the offshore boundaries were defined using a standard logarithmic velocity profile (Van Rijn, 1993).

5.2. Model validation

5.2.1. Data collection program

A targeted measurement campaign was undertaken to provide data specifically for model validation. There were two components; water level measurements at four locations in the harbour over one month and a moving vessel ADCP survey in the entrance region. ADCP moving vessel deployments have the benefit of providing 3-dimensional velocity data over different sections of the navigation channel thereby allowing a spatial time-dependent validation of the tidal models. Note however that velocity data provided by ADCP moving vessel deployments are slightly degraded by various factors such as Doppler noise, large sampling volume and beam divergence over rapidly changing bathymetry. Nonetheless, it was the preferred method to provide a spatial validation source in the complex tidal flows of the entrance.

In the present study, the ADCP moving vessel deployment was undertaken over three different zones A, B, C illustrated on Figure 5.2 from 19 May to 21 May 2015. Current velocities were measured during 13 hours through each area to capture the peak ebb and flood tidal stages.

5.2.2. Validation results

Comparisons between the measured and predicted water levels (Figure 5.3 to Figure 5.6) indicate that the model reproduces the tidal water elevation variability within Whangarei Harbour well. The magnitude and timing of the tidal propagation throughout the harbour confirms both the suitability of the tidal boundary conditions as well as the ability of the model to replicate the hydrodynamics, which include the prescription of the bathymetry and the frictional parameterisation.

The validation of the depth-averaged flows in the channel indicates an acceptable capability to replicate the complex tidal hydrodynamics at the Whangarei Harbour entrance. Snapshots of the measured and modelled flows are presented in Figure 5.7 to Figure 5.9 for the peak tidal ebb and flood situation. Here, the modelled depth-averaged currents are plotted with co-located measured values. The modelled speeds and directions show good correspondence with the measurements in most of the areas, including the zones of high flow and the recirculating eddy features on the channel margins. This relative good agreement between modelled and measured data is also outlined by the Q-Q plots calculated from the peak ebb and flood tidal velocities for all the measured locations. Note that no statistics are provided for Zone C due to insufficient measured data for a meaningful analysis.

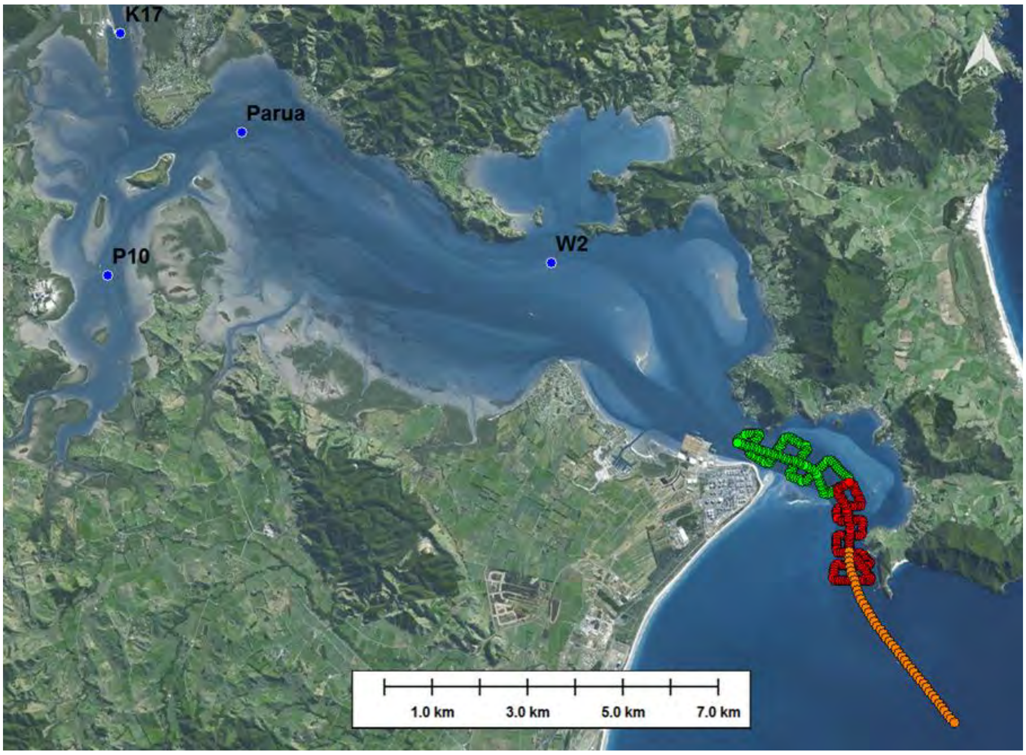


Figure 5.2 Locations of current velocity measurements (Zone A in green, B, in red and C in orange) and water level measurements (K17, P10, W2 and Parua)used to calibrate and validate the SELFE (and Delft3D) tidal model within Whangarei Harbour and Bream Bay.

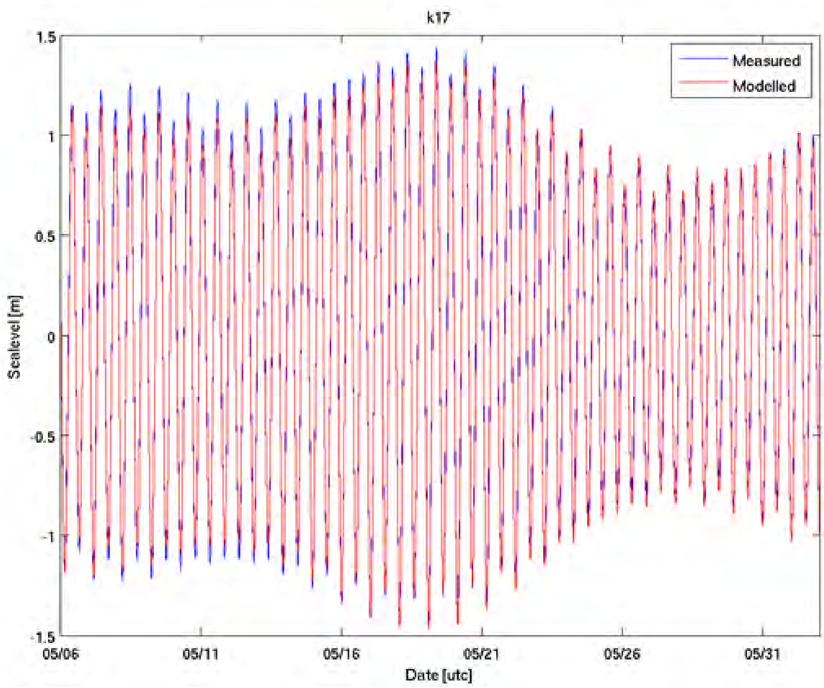


Figure 5.3 Measured and modelled water level comparisons at site k17.

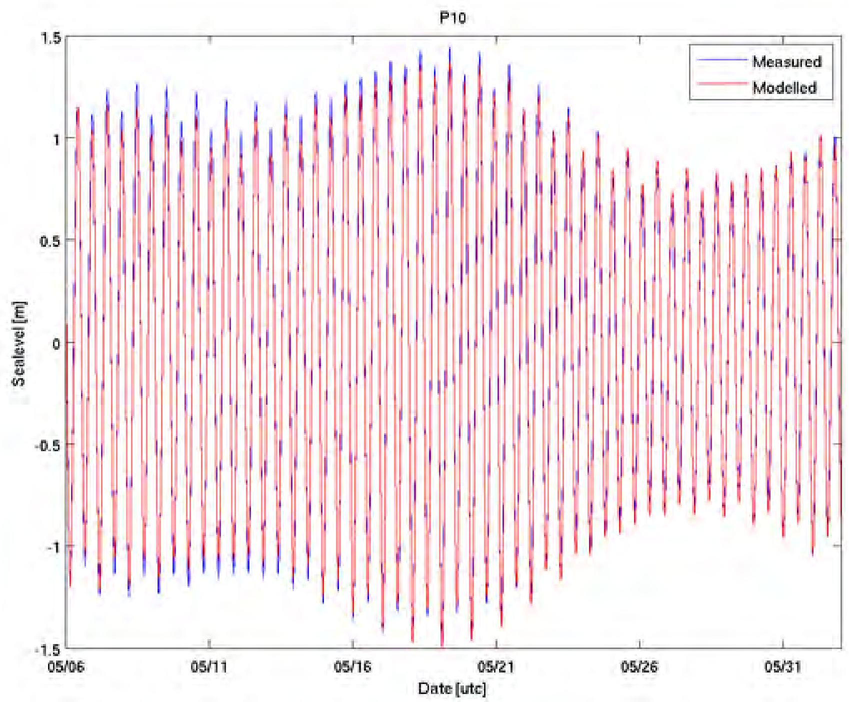


Figure 5.4 Measured and modelled water level comparisons at site p10.

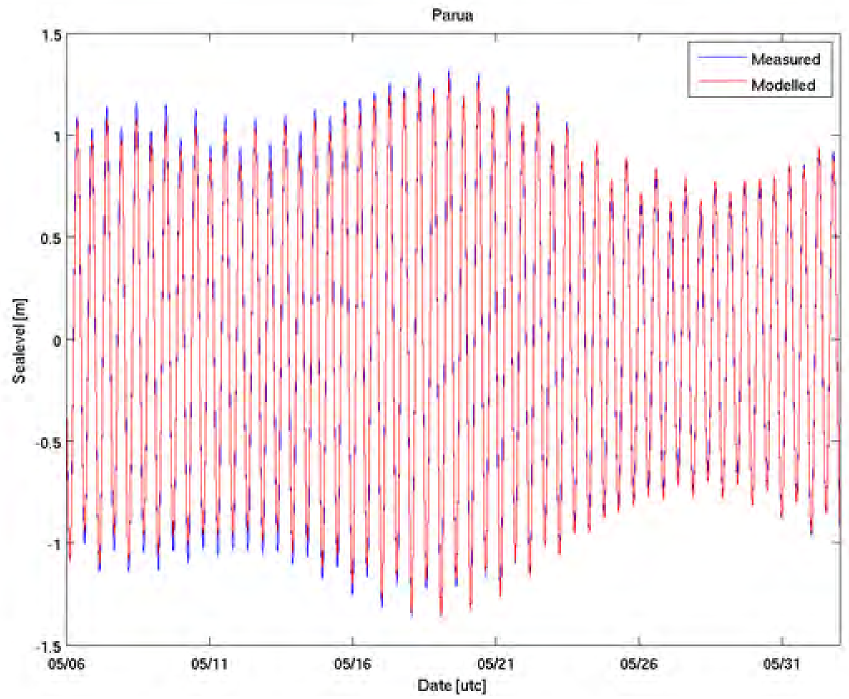


Figure 5.5 Measured and modelled water level comparisons at site Parua.

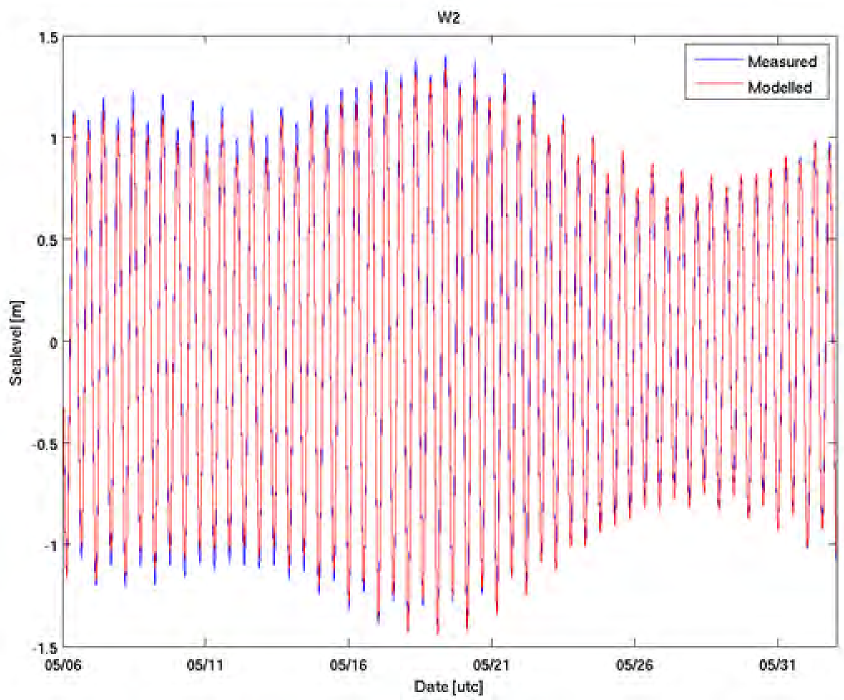


Figure 5.6 Measured and modelled water level comparisons at site W2.

Figure 5.7 Modelled (SELFE) and measured velocity comparisons within Zone A (Figure 5.2) for the peak ebb (upper) and flood (lower) tidal stages.

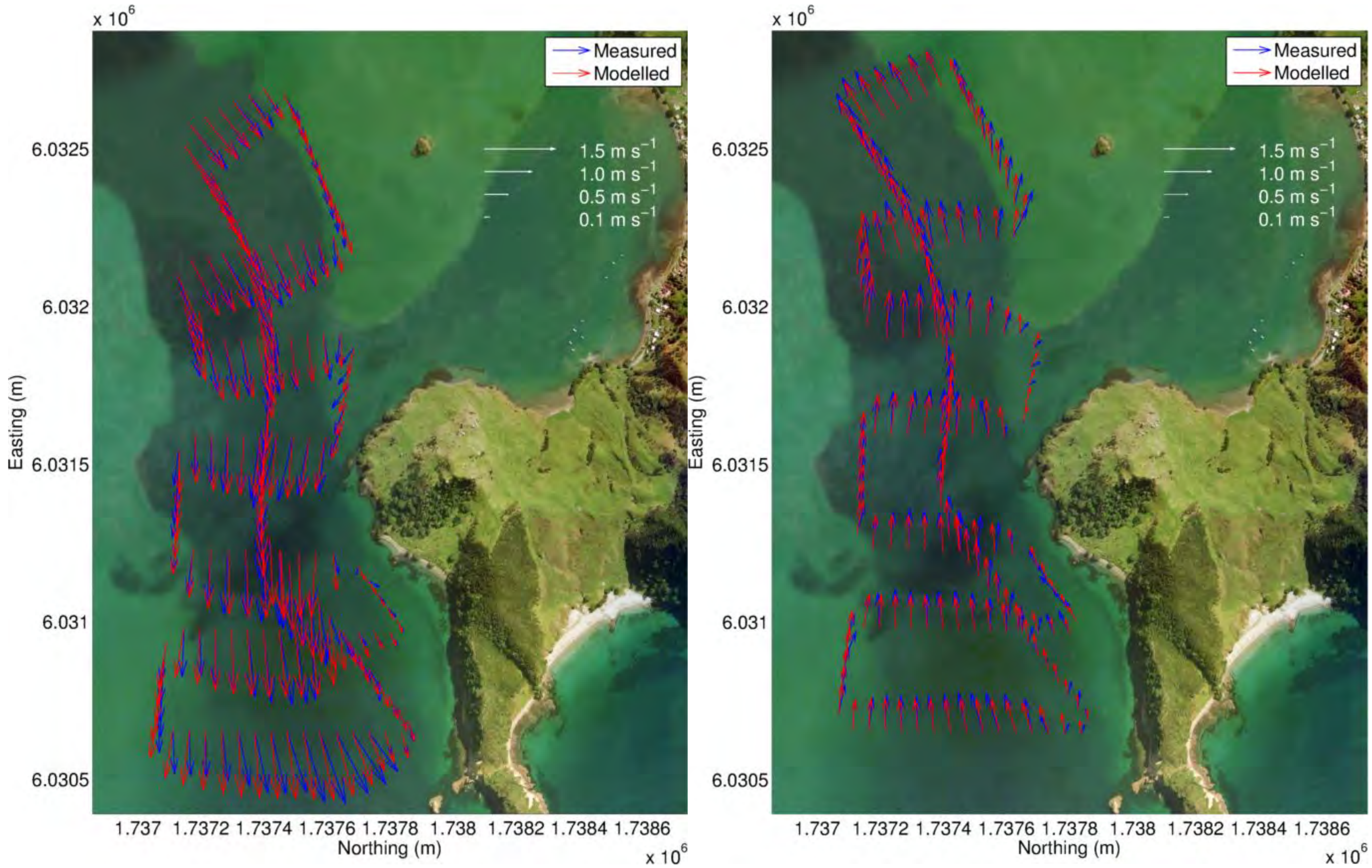


Figure 5.8 Modelled (SELFE) and measured velocity comparisons within Zone B (Figure 5.2) for the peak ebb (left) and flood (right) tidal stages.

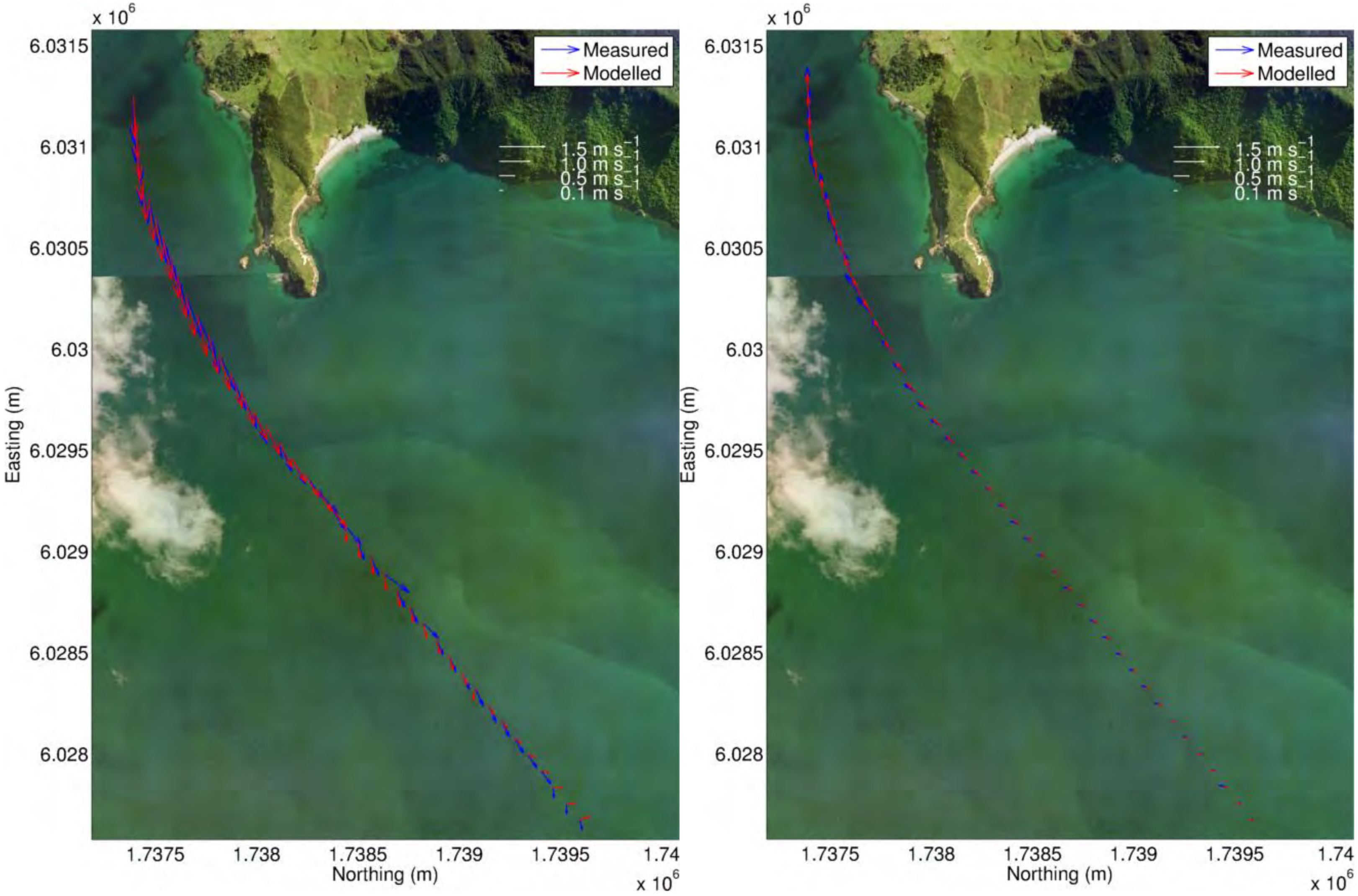


Figure 5.9 Modelled (SELFE) and measured velocity comparisons within Zone C (Figure 5.2) for the peak ebb (left) and flood (right) tidal stages.

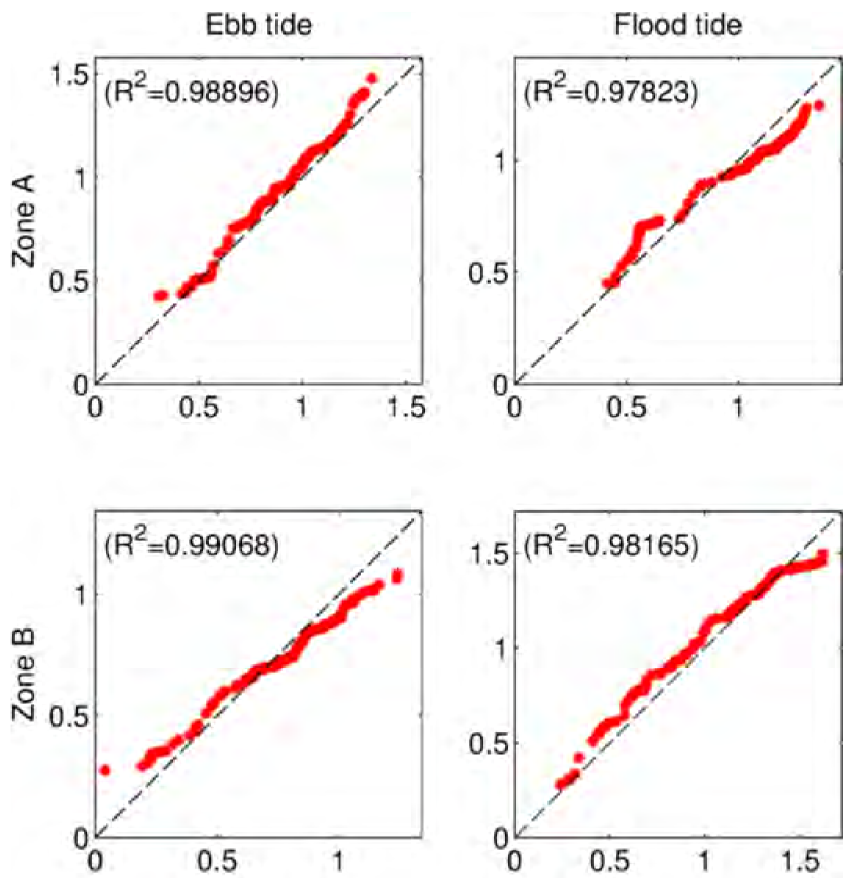


Figure 5.10 Quantile – Quantile plots of the measured and modelled (SELFE) peak tidal ebb and flood current speed (m/s) along the vessel tracks within zones A and B for both peak ebb and flood stages. The root mean squared errors corresponding to the different distributions are presented in the top-left corner of each plot.

6. SEDIMENT TRANSPORT MODELLING

Nearshore wave and tidal models were previously established at the entrance to Whangarei Harbour and the surroundings. One of the purposes of these models was to provide high-resolution data to force the morphological model. Indeed, the overall response of the coastal morphodynamic is largely controlled by the interactions between currents, waves and sediments. In this context, a fully coupled numerical model is required to capture the short-, medium- and long-term morphological processes that affect the study area in order that the effect of the channel deepening on the existing coastal dynamics can be anticipated. The fully coupled process-based numerical model, Delft3D, was thus implemented based on the wave and tidal conditions provided by SWAN and SELFE, respectively.

This section provides an overview of the model as well as the different approaches and settings used to undertake the sediment transport modelling in this highly complex region. The validation of the hydrodynamic component of the model applied to assess the model performance is also presented using the same methodology as previously applied for the SELFE model validation.

6.1. Modelling system

The modelling system Delft3D (Lesser et al., 2004) was used to set up and run high-resolution process-based morphodynamic models. The software is based on interlinking three separate components that together simulate flow, waves and sediment transport. The three components are fully coupled to simulate morphodynamic feedbacks. An overview of the main parameters and components is given in this section.

6.1.1. Delft3D-WAVE (SWAN)

The third-generation SWAN model (Simulating WAves Nearshore) was used as the wave module (Booij et al., 1999; Ris et al., 1999). SWAN computes the evolution of random, short-crested waves in coastal regions with deep, intermediate and shallow water depths. The SWAN model accounts for (refractive) propagation due to depth and current and can represent the processes of wave generation by wind, dissipation due to white-capping, bottom friction and depth-induced wave breaking, and non-linear wave-wave interactions explicitly with state-of-the-art formulations (Deltares, 2013a)).

For the present work, the local wave model boundary conditions were nested with 2D spectral boundaries obtained from a regional scale grid forced either by representative wave events (i.e. accelerated morphological simulations) or real hindcast conditions (i.e. real-time simulations). The nesting allows the retention of spatial variability in the incident wave field due to large scale regional refraction and sheltering effects. Bottom friction was modelled using the formulation of Collins (1972) and the default coefficient value was 0.016. Dissipation by friction and wave breaking was applied in the model. The formulation of Van der Westhuysen et al. (2007) was used to reproduce the wave dissipation due to whitecapping.

Hindcast conditions available at hourly intervals were applied as offshore boundary conditions. This coincides with the interval of the sequential two-way coupling between SWAN and the hydrodynamic module (Delft3D – FLOW) that allows the exchange of relevant parameters on curvilinear model grids via a communication file. Wave parameters and the forcing terms associated with the wave radiation stresses computed by SWAN were read by the FLOW module to model the hydrodynamic conditions. At the end of each assigned 60 minute runtime, bottom elevation, water level and current fields were used as input to the computation in SWAN. The model loops through these sequential module applications until the end of the complete simulation. Morphodynamic modelling is thus performed through the implementation of a fully coupled wave – hydrodynamic system based on wave and current interactions.

In the scientific community, there is an on-going debate about the vertical distribution of wave-induced radiation stresses that generally split up into a surface component, a bottom component and a body force and their implementation within 3D momentum equations (Ardhuin and Roland, 2013; Ardhuin et al., 2008; Bennis et al., 2011). The debate indicates that important wave-induced processes interacting with the flow circulation may still be inadequately implemented in Delft3D. These limitations are accepted in the present study considering that they do not fundamentally impact the sedimentology and morphology in the area of interest.

6.1.2. Delft3D-FLOW

The base hydrodynamics were computed in the Delft3D – FLOW module, which can be used in a full 3D or 2DH (depth averaged) mode. The hydrodynamic module Delft3D-FLOW solves the Navier-Stokes equations for an incompressible fluid under the shallow water and Boussinesq assumptions. The system solves the horizontal equations of motion, the continuity equation, the transport equations for conservative constituents, and a turbulence closure scheme. The details of equations and associated sub-models are fully described in Lesser et al. (2004) and in (Deltares, 2013b).

In a tidal inlet environment, the 3D mode is more appropriate than 2D as the cross-shore velocity profile in nearshore areas where breaking waves cause return flow and exhibit a strong vertical shear (Ranasinghe et al., 1999), which can significantly affect bed dynamics of deltas. A calibration process based on a comparison between 2D and 3D modes of Delft3D highlighted important wave effects in the 3D simulation, as wave-induced mass flux adjusted for the vertical non-uniform Stokes drift, additional turbulence and vertical mixing processes and streaming as an additional wave-induced shear stress in the wave boundary layer (Walstra et al., 2001). The model consisted of 10 *sigma* layers in the vertical direction focused on the surface and on the bottom levels of the water column to better reproduce wave – current interactions and sediment transport processes. Model domains implemented in the present study are presented in Section 6.2.

Bed shear stresses were computed using a quadratic friction law. The non-linear enhancement of the bed shear stress in the presence of waves was taken into account by means of the wave-current interaction model of Fredsøe (1984). Turbulence effects were modelled using constant background horizontal and vertical eddy viscosity and eddy diffusivity coefficients. Horizontal background eddy viscosity was set 1 $m^2\ s^{-1}$ while diffusivity was equal to 1 $m^2\ s^{-1}$. A value of 10e-6 was used for the vertical background viscosity and diffusivity. The bottom roughness distribution used in this study was based on Manning formulation (depth dependency) with a coefficient of 0.02, which is commonly used in Delft3D (Deltares, 2013b).

Current and water elevation conditions at open boundaries were prescribed based on tidal constituents generated from the high resolution SELFE tidal model (see Section 5). Hydrodynamic conditions were provided at intervals of 15 min to the Delft3D – FLOW module. The set value for the numerical time step was 3 s based on a stability criterion defined for a Courant Number lower than 10 in Delft3D-FLOW (Deltares, 2013b).

6.1.3. Delft3D-MOR

The module Delft3D-MOR combines the information provided by the flow and wave modules to compute the sediment transport fluxes at each computational time step. The seabed level can then be updated as a result of the sediment sink and sources terms and computed transport gradients.

Data on bed composition and sediment properties are essential to adequately predict morphodynamics in nearshore regions, particularly in tidal inlet environments where the seabed composition is usually divided into several fractions of sediments from silty cohesive material to non-cohesive fine gravel.

In the present study, based on vibrocoring results (Tonkin and Taylor, 2016c), model simulations were restricted to non-cohesive sand fractions with a grain size of 200 µm for the potential sediment fluxes approach, and from 100 to 10000 µm for the sediment transport pathways approach. For such an approach, a set of four layers was implemented, including the active layer and the base well mixed layer. Details on the methodology used to generate the bed composition with a multi-layer seabed scheme are discussed in Section 6.3.2.

The biomass of pipi over Mair Bank was mimicked by adding a fraction (80%) of coarse gravel in the uppermost layer of the bed layer model, the so-called active layer. This approach aims to decrease the sediment transport and thus reproduce the overall stability of Mair Bank as observed in Morgan et al. (2011). The potential erodibility of Mair Bank suggested by the shear stress values decreases because the Pipi population causes an increase in the shear stress resistance, as first described in (Black, 1983) and repeated in other studies completed since then.

For non-cohesive sediments, the total sediment transport is defined as the sum of the suspended load and bedload transport. The sediment transport predictor TRANSPOR 2004 of Van Rijn et al. (2004) was used in the present study rather than the default (Van Rijn, 1993) due to the recalibration against new data and the extension of the model to incorporate the wave zone. The approach first computed the magnitude and direction of the bed-load sand transport used by Van Rijn. The computed sediment transport vectors were then relocated from water level points to velocity points using an upwind computational scheme to ensure numerical stability.

The slope of the banks and of the channel is an important factor to consider in a tidal inlet environment. In tidal inlet environments, the non-cohesive bedload transport definitions in the model have a bed slope effect, which represents a gradient in the initial direction of sediment transport. The Bagnold (1966) equations were used for longitudinal transport (*AlfaBs*) and Van Rijn (1993) for the transverse direction (*AlfaBn*). It is reported that *AlfaBs* was of lesser importance in model calibration compared with *AlfaBn* which can cause „unrealistic incision of the main tidal channel" (Van der Wegen and Roelvink, 2008; Dastgheib, 2012; Dissanayake et al., 2012). The default value (AlfaBn 1.5) commonly leads to unrealistic channel slope with gradients larger than the angle of repose. However, calibration processes have shown that decreasing the default values (as suggested in Dissanayake et al. (2012)) leads to significant erosion of the edges of the channel, as a result infilling the channel, particularly to the east and northeast of Mair Bank. In reality, long-term bathymetry surveys between 2000 and 2015 have demonstrated that the channel is morphologically stable (MSL Report P0297-02).

The steep channel slope suggests some degree of cohesiveness and armouring induced by many decades of morphodynamics which cannot be fully reproduced by the model. Consequently, the channel stability was modelled within Delft3D - MOR using the non-restrictive upper range of values for the longitudinal and transverse bed slope factors (1.0 *AlfaBs* and 1.5 *AlfaBn*).

The erosion of dry cells in Delft3D was controlled by the drycell erosion factor (DCE, thetSd keyword in Delft3D) to simulate bank erosion. The DCE default value was originally set to zero in Delft3D. However, calibration processes showed that as suggested in Dissanayake et al (2012) large cell erosion factors produced better representations of the ebb-delta than did low values. Unrealistic seaward extensions of the delta in long term simulations were observed, which is contrary to the evolution of Mair Bank described in Morgan et al. (2011) and Williams and Hume (2014).The use of larger values, 0.5 (50% of erosion in neighbouring dry cell) as defined in the present study, is predicted to improve the model"s capability to reproduce the channel morphological variability.

In Delft3D, a commonly used approach for the bed composition modelling is based on 2DH computations as a well-mixed single layer including one or several grain sizes of sediments However, another approach described in Dastgheib (2012) incorporates the concept of layered bed stratigraphy. The bathymetry is subdivided into cells with a specific thickness and a specific fraction of different sediment grain size. The uppermost sediment layer corresponding to the transport layer (or active layer) imports sediments when sedimentation happens and export sediments when erosion happens. In case of deposition, sediment is imported to the transport layer by settling from the water column where it is mixed and redistributed to the underlayer, thereby maintaining its defined constant thickness. In case of erosion, the transport layer imports sediment from the underlayer directly beneath it to replenish and thereby retains its defined constant thickness. The underlayer is indirectly eroded. Conceptually, a layered bed stratigraphy permits specifications of bed composition and sediment characteristics corresponding to the hydrodynamic conditions and the bathymetry.

Both approaches described above have been used in the present study to simulate the potential sediment fluxes and the evolution of the sea bed. Configurations of the underlayers and sediment grain size distribution are described in Section 6.1.2. More information on numerical aspects can be found in the Deltares (2013b).

6.1.4. Pertinence of the model

Interactions between morphological, tidal and wave components play a major role in the dynamics of coastal areas such as bays, estuaries and inlets. In this context, using a process-based model as Delft3D, which integrates a fully 2-way coupled system between these components, is particularly pertinent. Delft3D has been specifically developed to simulate the physics of such complex regions and it provides the necessary multi-disciplinary approach and numerical modelling. Moreover, the Delft3D model has been successfully applied worldwide for a large range of coastal studies over both short – term and long – term periods. In New Zealand, the model has been successfully used at Port Otago (Weppe et al., 2015) and Tauranga Harbour (Ramli et al., 2015).

6.2. Model domains

The Delft3D - FLOW model grid covers the northern region of Bream Bay from the Ruakaka river mouth to Bream Head, and Whangarei Harbour entrance from Mair

Bank to One Tree Point, with grid resolutions of approximately 12 m over Mair Bank and within the inlet channel, and 150 m close to Ruakaka and Bream Head (Figure 6.1).

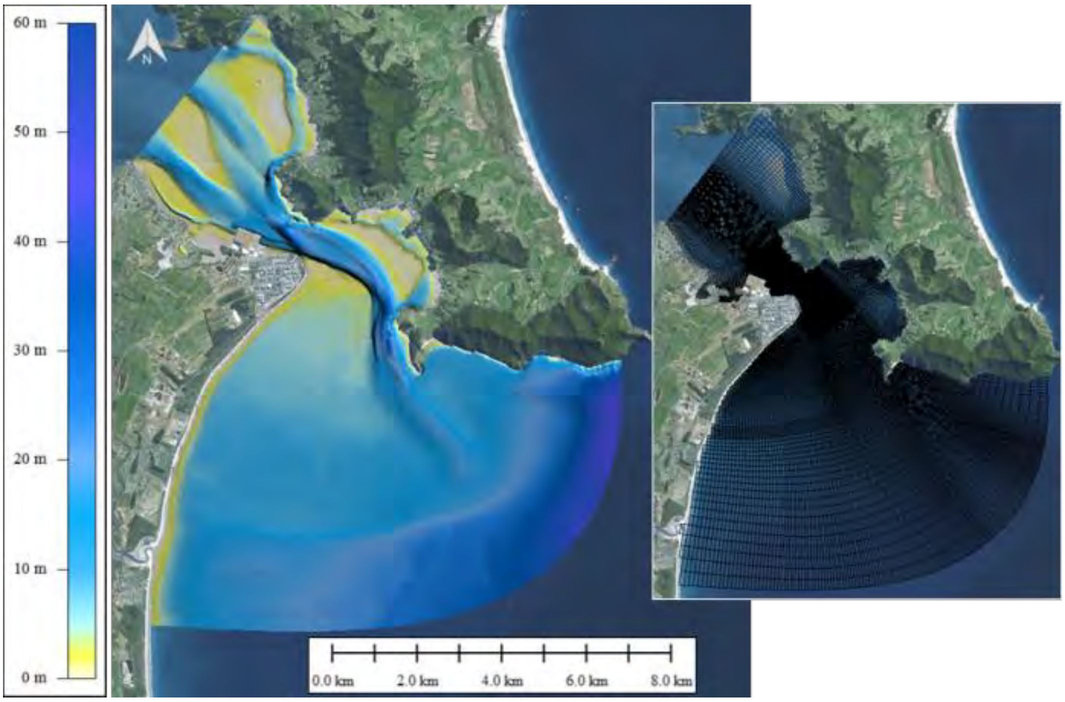


Figure 6.1 Delft3D – FLOW model grid (right) and depths (left).

A one-way online nesting technique was used for the wave modelling based on the implementation of multiple model grids with different grid resolutions. The coarse grid defined within Delft3D – WAVE covers the northern region of Hauraki Gulf, including Mokohinau Islands and Great Barrier Island, with resolutions ranging from 500 m to 3 km (see Figure 6.2). Boundary conditions were nested offline within a coarser regional SWAN domain described in Section 5. The fine grid used in the wave model is slightly more extended along the seaward boundary than the Delft3D – FLOW grid to more accurately force the hydrodynamic model.

The configuration of the model domains has been set-up to fully replicate important physical features in the study area such as:

- The retention of spatial variability in the incident wave field due to both large and high resolution scale regional refraction and sheltering effects.
- The inclusion of the ebb-jet flow extension at the delta entrance.
- The local hydrodynamic current patterns due to the presence of marginal channels sand banks within the harbour.
- The 3-dimensional wave – current interactions over Mair Bank and within the main channel.

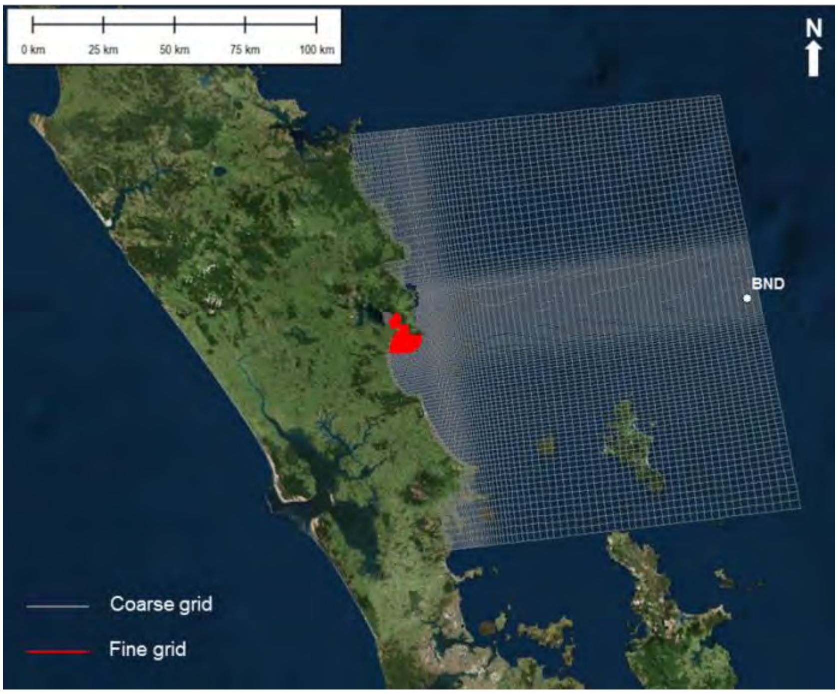


Figure 6.2 Delft3D – WAVE model grids for the modelling of the wave spectral transformation from the offshore region to the coast. The BND position indicates the site used to extract the wave climate described in Section 6.3.1.

6.3. Modelling approach

The main challenge with applying process-based models to predict morphological evolution is that the morphological behaviour of coastal systems generally develops over time scales several orders of magnitude larger than the time scale of the hydrodynamic fluctuations driving the sediment transport (i.e. hours to days versus years to decades and more). This means that while a model system is able to predict the time series of instantaneous hydrodynamics and sediment transport, it will require an unfeasibly long period of time to compute a multi-year real time simulation. Instead, several strategies are commonly used to understand and reproduce morphological dynamics.

The approach employed here combines the reduction of the input forcing (waves and tides) with the use of realistic simulations for both fair-weather and storm conditions. Input reduction essentially means selecting a limited number of representative forcing conditions (i.e. waves and tides) that will reproduce the medium-term residual sediment transport patterns and associated morphological evolution (De Vriend et al., 1993). The application of these techniques to the present study is explained in the following sections.

6.3.1. Hydrodynamic and wave forcing

a) Discrete wave scenarios

- Tidal input reduction

Astronomical tides are deterministic and can therefore be accurately predicted for any period of time. However, tidal oscillations exhibit significant long-term modulations (e.g. spring/neap, yearly and nodal cycles), which make chronological simulations of such cycles computationally demanding. The basis for tidal input reduction is to find a representative tide that most closely reproduce the net and gross sediment transport as the naturally varying tides over the region of interest and for the time period considered, here one year. In the present study, the representative tide was determined following the approach of Latteux (1995), which is commonly applied (e.g. Brown and Davies, 2009; Dastgheib, 2012; Grunnet et al., 2004).

Tidal signals at a reference point located at the harbour entrance were generated from a high resolution tidal constituents grid, and time series of sediment transport were estimated using a simple power law Q=A.u b (Q is the transport flux, A is a constant factor, u is current velocity, b=5 following Engelund and Hansen (1967)). The single tide best reproducing the net and gross transport magnitude of a given cycle relative to the long term mean transport values was identified and used in the representative scenarios (Figure 6.3).

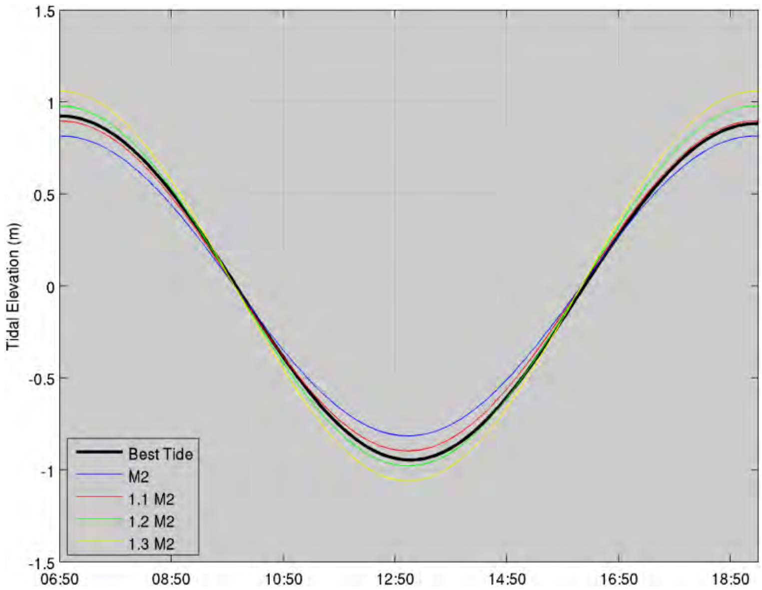


Figure 6.3 Comparison of the best tide, pure M2 tide, 1.1 M2, 1.2 M2 and 1.3 M2 tide curves at the harbour entrance.

- Wave climate reduction

The objective of wave input reduction is to define a set of offshore wave boundary conditions which reproduce the same residual sediment transport patterns and morphological evolution as the real time forcing over a given time period. The approach employed here follows the input reduction framework provided in Lesser (2009) and Walstra et al. (2013).

The first step is the selection of a reduction period, which is the length of the real time wave time series that is used to define the representative conditions. This is typically governed by the time scale of the morphological evolution of interest (e.g. monthly, seasonal or annual behaviour). In the present study, the reduction was undertaken based on a 10 year hindcast wave climate obtained from SWAN simulations to define an average annual wave climate (Section 3). The wave condition timeseries was extracted at the middle of the southern boundary of the wave model domain. In a second step, a set of representative wave classes was defined by distributing the discrete wave data points into a finite number of height and direction bins, and computing a representative value for each bin.

The basic method to determine a representative value within a bin is to use a weighted average of the data points by their frequency of occurrence. To account for the non-linear dependence of sediment transport on wave height, an additional weighting was applied for the computation of the representative height. The initial wave data binning is relatively arbitrary and can be equidistant or non-equidistant (i.e. exhibiting varying bin size). In the non-equidistant case, bins can be defined following either (subjective) scientific judgment or more objective approaches. In the current study, the height and direction bins were defined so that the relative "morphological impact of waves" was similar in each bin (Dastgheib, 2012; Lesser, 2009). The morphological impact of waves of a given wave class was estimated according to the "potential sediment transport" indicator used in Dastgheib (2012).

To automate the determination of bin limits, this indicator was initially computed for a joint probability of wave height and direction with very fine equidistant bins (ΔH=0.1 m, ΔDir=2 deg.). Based on the number of directional and wave height bins to be used for the classification, the directional bin limits were determined first, such that the sum of the morphological impact of waves, Mj, within each bin was (approximately) equal. The same principle was then used within each of these directional bins to define the wave height bin limits. This way, the "morphological impact of waves" was similar in each bin.

The wave climate classification (Figure 6.4 and Figure 6.5) used in the following morphological simulations was defined using four directional bins and four wave height bins. The general classification obtained for the wave climate at the reference site reproduced the different levels of wave energy coming in the northeast and southeast directions.

The wave height delimitations were relatively homogeneous regarding the directionality of the wave propagation:

- 1st class with wave heights of 1 – 2 m.

- 2nd class with wave heights of 2 – 2.8 m.

- 3rd class with wave heights of 2.8 – 3.5 m.

- 4th class with wave heights of 3.5 – 5.4 m.

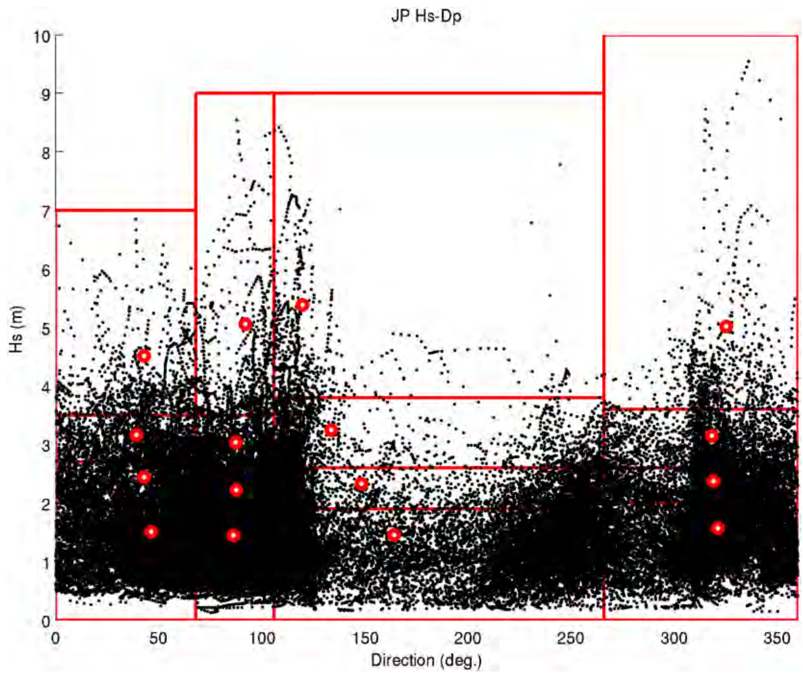


Figure 6.4 Scatter plot of wave heights as a function of wave directions for the 10-year time series, with delimitation of bins (red boxes). Red dots are the representative conditions of each bin.

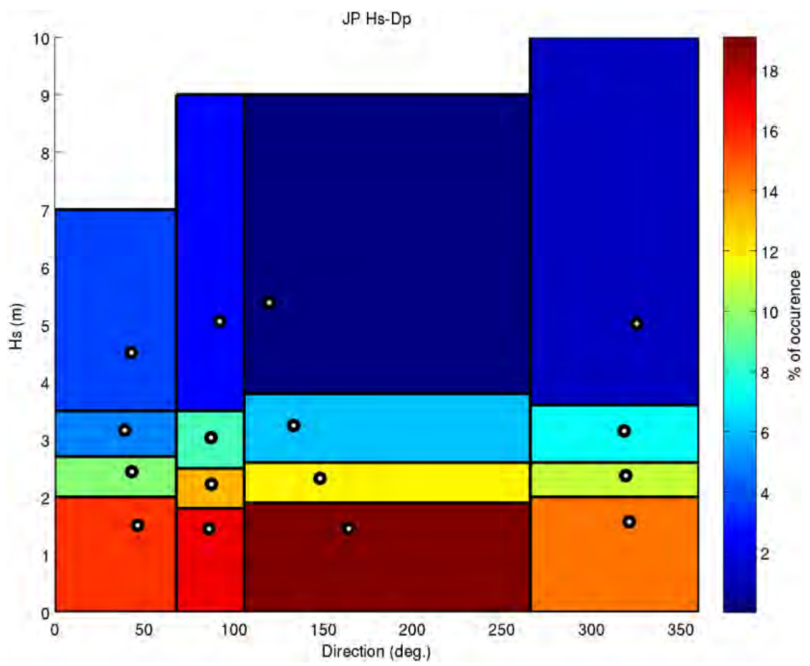


Figure 6.5 Reduced average annual wave climate based on the 10-year wave hindcast using four directional bins and four wave height bins (i.e. 16 wave classes). Colours indicate the probability of occurrence of a given class. The white dots are the representative wave condition of each wave class. Wave classes are summarised in Table 6.1.

Table 6.1 Wave classification based on an average annual wave climate defined from a 10-year hindcast.

Wave class	Representative Hs (m)	Representative Tp (sec)	Representative Dp (deg.)	Probability of occurrence
1	1.5	8.6	46.4	17%
2	2.4	9.0	43.0	4%
3	3.2	9.7	39.1	2%
4	4.5	10.4	42.9	1%
5	1.5	9.1	86.2	18%
6	2.2	10.1	87.6	6%
7	3.0	10.2	87.3	3%
8	5.1	11.0	92.1	1%
9	1.5	7.5	164.3	19%
10	2.3	8.8	148.3	5%
11	3.2	9.2	133.6	2%
12	5.4	10.6	119.7	1%
13	1.6	7.2	321.1	15%
14	2.4	7.4	319.1	4%
15	3.2	8.3	318.3	3%
16	5.0	10.7	325.3	1%

b) Tide-only scenario

A tide-only scenario was run with the best representative tide described in Section 6.3.1 to assess the impact of the tidal flows on the sediment transport dynamics. No wave forcing was considered for this simulation.

c) Historical simulations

The tide-only and discrete wave scenarios were supplemented by historical simulations for both fair-weather and storm conditions (Figure 6.6) based on time series of significant wave height *Hs*, peak period Tp and peak direction Dp provided by SWAN hindcast (see Section 3).

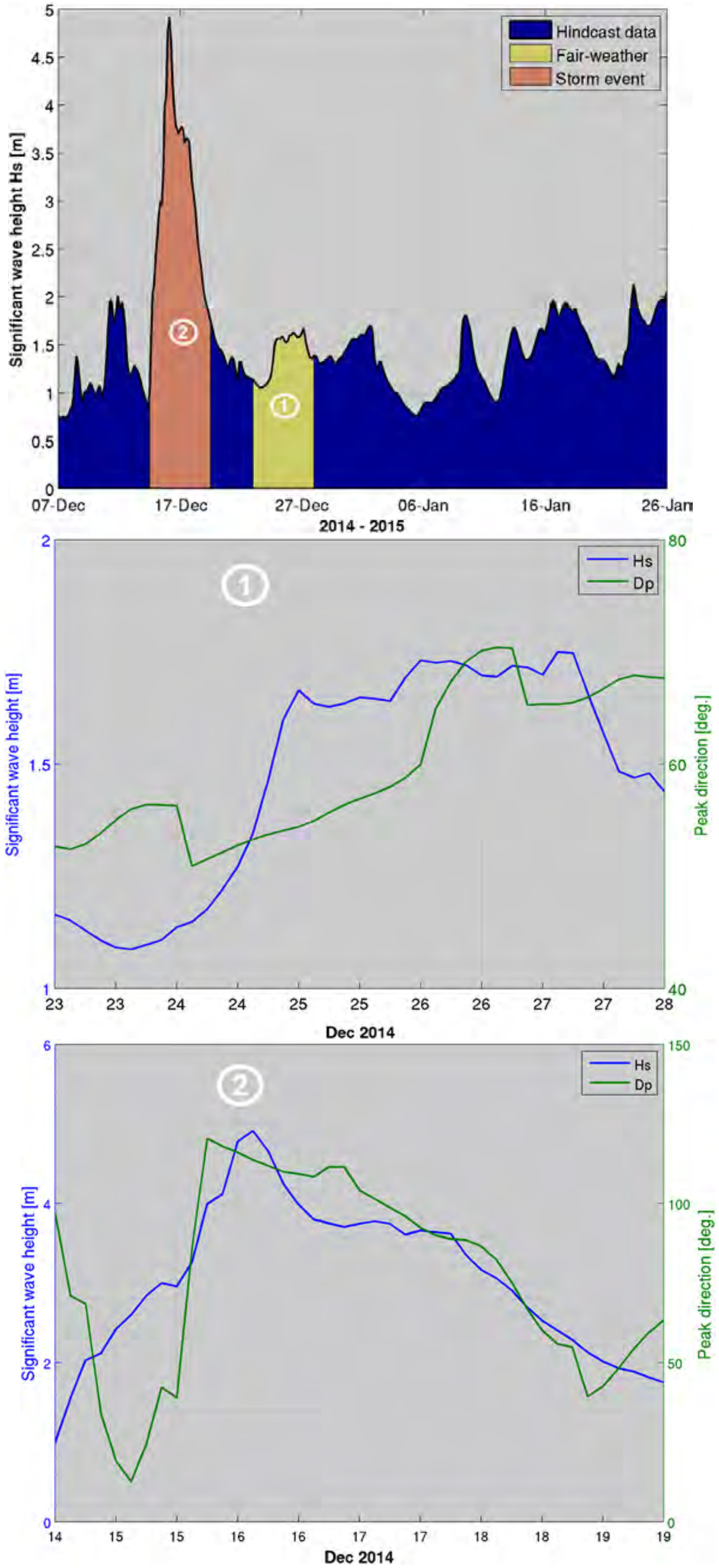


Figure 6.6 Time series of significant wave height and peak direction at location BND (see Figure 6.2) for December 2014 and January 2015. Wave conditions during periods 1) and 2) were used to simulate the sediment transport at Whangarei Harbour during fair-weather and storm conditions.

Firstly, a morphological acceleration factor (Section 6.1.3) of 45 was applied during a simulation of four days to predict the bed evolution that occurred during approximately six months of fair-weather conditions, keeping reasonably fast computations. The aim of this first run was to initialise the sediment grain size distribution over the domain. No bed level update was allowed. More details of the methodology are provided in Section 6.3.2.

In the second phase, the morphodynamic simulation during fair-weather conditions was followed by a 5-day storm simulation without any morphological acceleration (Morfac = 1) to avoid unrealistic changes in the bed evolution over a very short period of time due to high energy wave conditions. The distribution of sediment mass fractions characterised by a 6-month tidally dominated environment was directly fed into the subsequent storm event simulation. Note that the bed level update was turned on to reproduce the residual sediment transport, particularly around Mair Bank.

Finally, the 4-day fair weather simulation was rerun with a MORFAC 4 from the 5-day storm simulation outputs to assess the overall morphological response to a sequence of high/low wave energy events. This corresponds to the morphological evolution of 16 days.

6.3.2. Initial bed configuration and composition

The adequate initialisation of spatially varying grain size distribution of bottom sediment in a process-based model is often constrained by a lack of appropriate field data for the entire model domain. As the sea bed composition is partially dependent on the bed shear stress imposed by the local flow and wave environments, using grain-size observations as initial conditions of simulations based on the author"s judgement from the limited data available generally led to unrealistic erosion or accretion patterns. Indeed, Camenen and Larroudé (2003) and Pinto et al. (2006) have shown that the physical parameter responsible for the greatest errors in the sediment characteristics is the spatial heterogeneity of grain size distributions of the surface sediment in the area of interest. In accordance, two complementary approaches were implemented to avoid this problem.

First, the conceptual models, including both the “tide-only” and the discrete wave scenarios, were set-up with a homogenous 200 µm grain size sediment layer and a fixed bathymetry to determine the sediment transport fluxes in the system. No modification of the sea bed during the simulation was allowed. Such a method is particularly helpful for giving an overview of the combined effect of the tidal and wave forcing on the seabed. It was assumed that the critical bed shear stress variability determined by the distribution of the sediment grain sizes would make a difference in the results.

The second method applied in the present study is described in Van der Wegen et al. (2011) and based on a bed composition generation (BCG) run or “morphodynamic spin-up”. A synthetic simulation was initiated with a uniform sediment type distribution over two bed layers (the active layer and the underlayer) as described in 0. This is depicted in Figure 6.7. Six sediment fractions (100, 150, 200, 300, 500 and 1000 µm) were available at 16.7% mass each according to the general distribution obtained through the sediment sampling study (Tonkin and Taylor, 2016c). The active layer had a thickness of 0.40 m and the underlayer thickness was 10 m. Note that small active layers result in a rapid coarsening of the system which tend to reduce the spin-up for a gain of computational time. Both layers were set-up with the same fractions of sediment grain size. A spatially limited active layer including 80% of coarse gravel (>10000 µm grain size) and 20% of medium sand was defined to mimic the biomass of pipi over Mair Bank.

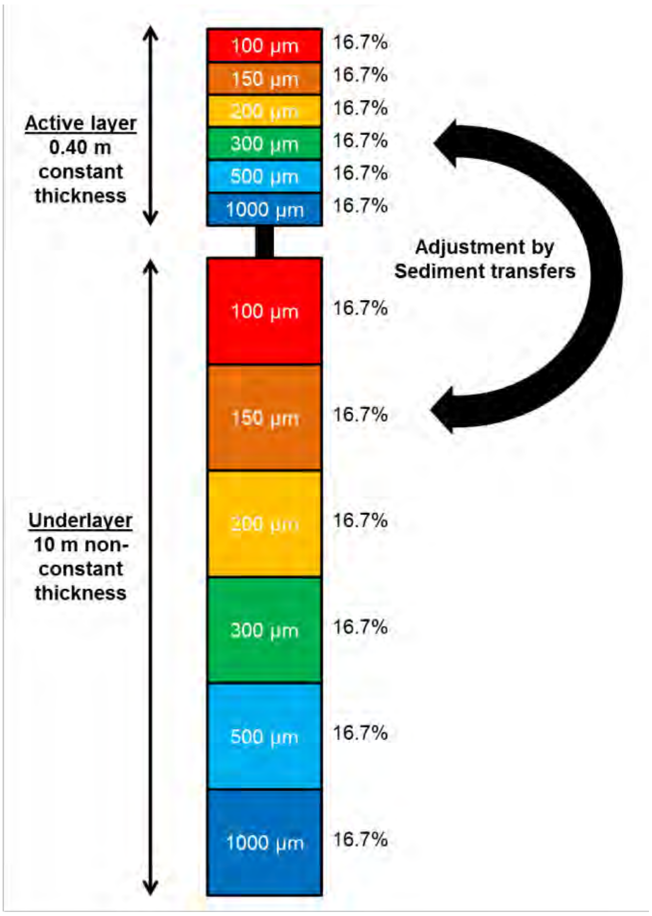


Figure 6.7 Bed stratigraphy approach implemented in Delft3D to initialise the bed composition over the domain.

During the simulation, sediment grain size fractions were redistributed vertically between layers and spatially over the domain in response to the combination of tide-induced currents and low energy wave conditions. At the end of the simulation, the bed composition converged to a more realistic sedimentological setting corresponding to the initial bathymetry, removing errors due to the initial model set-up. The BCG process rendered the model ready to investigate further morphodynamic developments.

6.4. Delft3D – FLOW hydrodynamic validation

The Delft3D – FLOW model was validated based on the measured data provided by the ADCP moving vessel deployment described in Section 5.2.1. Snapshots of measured and modelled peak ebb and flood tidal flows within zones A, B and C over the channel are provided on Figure 6.8, Figure 6.9 and Figure 6.10. Q-Q plots calculated from the measured and modelled peak ebb and flood tidal flows over these areas are presented on Figure 6.11. Note that these values are not co-temporal; the maximums were extracted from the measured and modelled period from that tidal cycle.

The validation of the depth-averaged flows indicates the model adequately replicates the complex tidal hydrodynamics at the Whangarei Harbour entrance. In

Zone A, the model represents the strong tidal flows in the channel between Marsden Point and Mair Bank. Within Zone B, the modelled current fields exhibit good overall agreement with the measured current fields between Mair Bank and the southern margin of Calliope Bank. Both peak tidal ebb and flood current speeds and directions are reasonably well replicated by the model. At Zone C, the peak ebb flows were slightly overestimated.

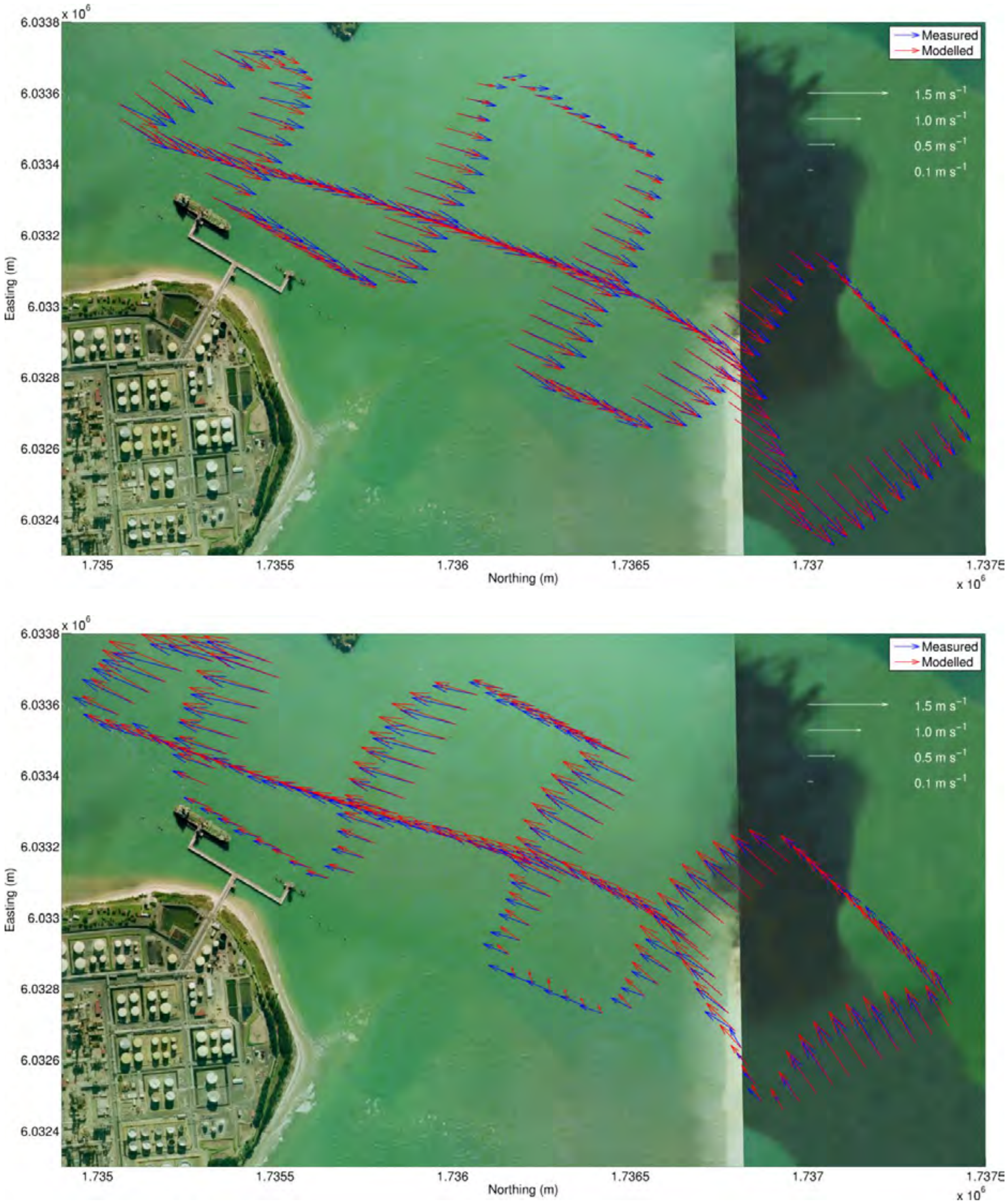
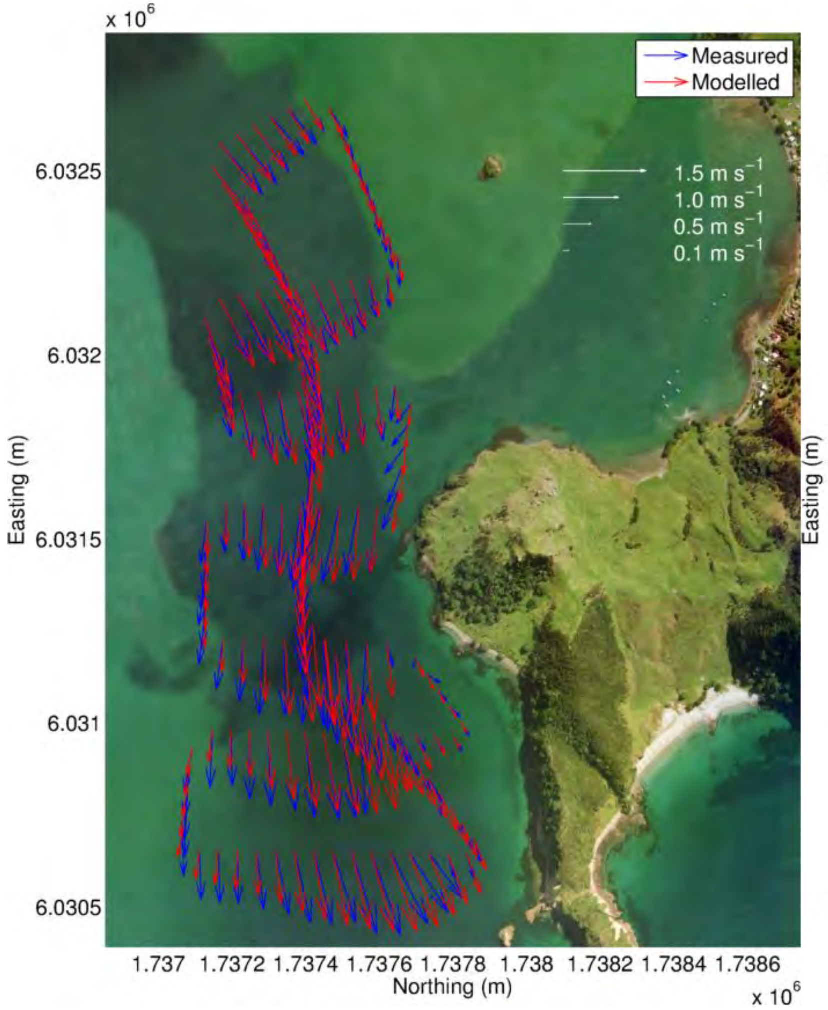


Figure 6.8 Modelled (Delft3D) and measured velocity comparisons within Zone A (Figure 5.2) for the ebb (upper) and flood (lower) tidal stages.



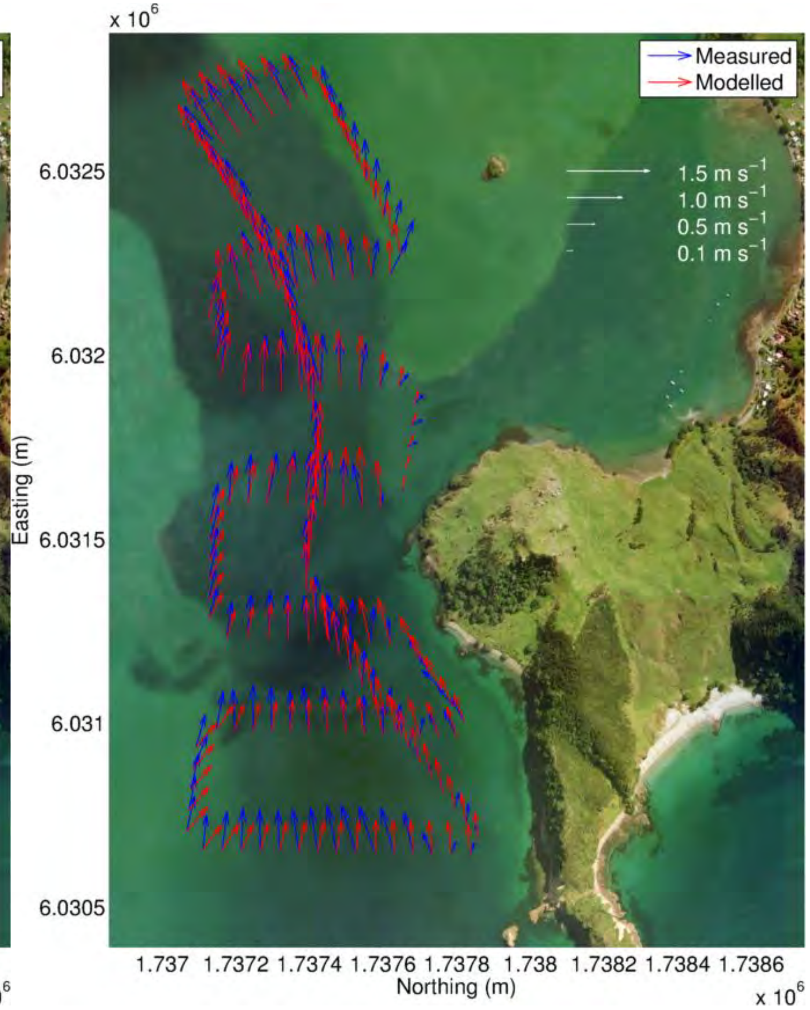


Figure 6.9 Modelled (Delft3D) and measured velocity comparisons within Zone B (Figure 5.2) for the ebb (left) and flood (right) tidal stages.

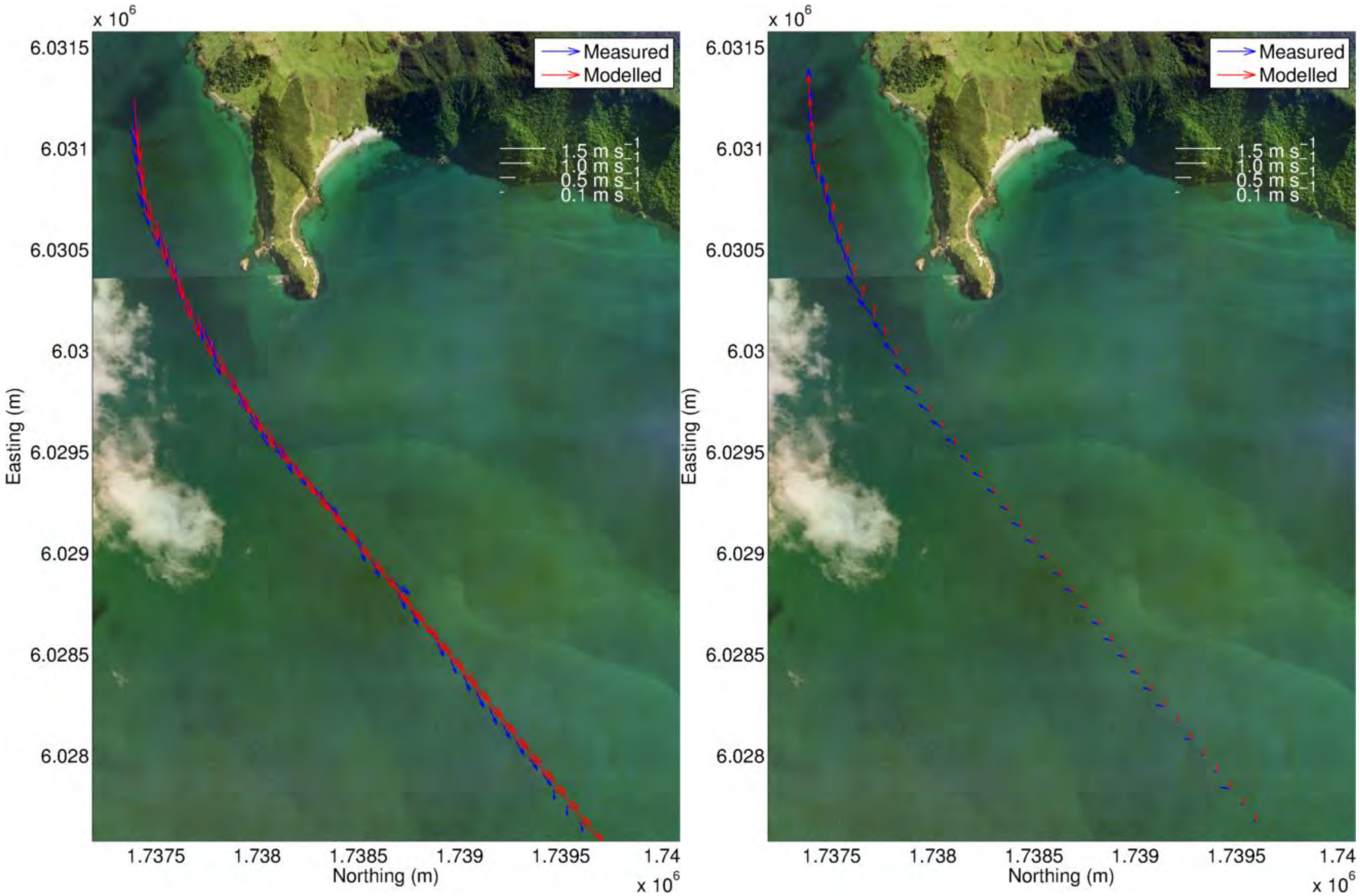


Figure 6.10 Modelled (Delft3D) and measured velocity comparisons within Zone C (Figure 5.2) for the ebb (left) and flood (right) tidal stages.

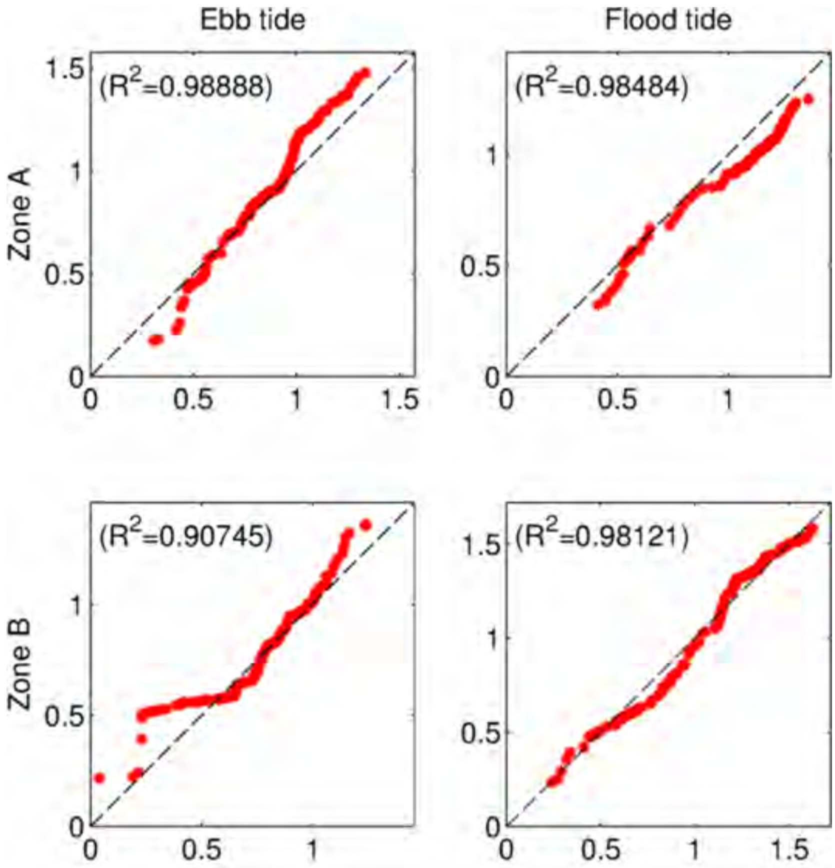


Figure 6.11 Quantile – Quantile plots of the measured and modelled (Delft3D) peak tidal ebb and flood current speed (m/s) along the vessel tracks within Zones A and B for both peak ebb and flood stages. The root mean squared errors corresponding to the different distributions are presented in the top-left corner of each plot.

6.5. Morphodynamic validation

The validation of a morphodynamic model by field observations is generally very difficult to achieve. The complexity of the morphodynamic evolution in a tidal inlet environment driven by both short-term and long-term processes requires appropriate measured data of bathymetry and sediment distribution, which should ideally be available at different time scales and for relatively large areas. Thus, the validation stage can be undertaken on a storm-induced bed evolution or on a long-term bed evolution to verify the level of agreement between the model and the measured data. Both methods provide useful information regarding the capability of the model to predict a range of morphodynamic mechanisms which control the overall tidal inlet dynamics. Analysing storm-induced bed evolution provides both calibration and a quantitative validation of the model configuration, while a long-term bed evolution study is useful in that it qualitatively characterises the overall relevance of the model.

In the present work, more than 15 years of annual bathymetric surveys over Mair Bank and within the tidal inlet channel were available. Such data is particularly valuable for the validation of the model as it describes the relative stability of the system very well. Note however that no validation of a short-term high energy event was possible as detailed pre- and post-storm data are not available. Moreover, the complex interactions between the shell fragment layers, the biomass of Pipi and the existing environment (both hydrodynamic and morphodynamic) made a strictly quantitative validation of the model difficult. Therefore, the sandbar migrations and the sediment grain size distribution obtained from the BCG run were compared qualitatively to the sediment sampling (MSL Report P0297-02). Available historical bed level data and recent sediment sampling inside the tidal inlet channel (Tonkin and Taylor, 2016c; Williams and Hume, 2014) were used for this purpose.

7. DREDGE PLUME MODELLING

The action of dredging the shipping channel will produce a plume of suspended sediments while the dredger is in operation. This section describes the modelling that was undertaken to simulate the extent and duration of such a plume.

An actual release of sediment in the oceanic environment is a process that is finite in time (i.e. occurring at a specific time, over a finite period) and inherently non-deterministic (i.e. controlled by a range of random and unpredictable variables such as currents and turbulences). However, unlike the offshore sediment disposal for which a range of forcing may be significant (i.e. wind, wave, residual currents), tidal forcing dominates the navigation channel from the delta entrance to Mardsen Point, the dredging activities within which are the focus of the present section.

The cyclic nature of tides, as well as the ability to confidently predict tidal hydrodynamics with numerical modelling, simplifies the approach to obtain robust estimations of the sediment dispersion patterns. To ensure the expected variability in plume dispersions is captured; simulations are usually undertaken over two complete spring-neap tidal cycles (~ 28 days).

Patterns of the dredging plume dispersion are initially investigated at key tidal stages including peak flows during ebb and flood phases of neap and spring tides. The full spring-neap tidal cycle simulations capture the entire range of hydrodynamic forcing encountered during a cycle; model outputs were combined and further post-processed into probabilistic suspended sediment concentration (*SSC*) fields which provide valuable guidance on the extents and magnitudes of dredging-related plumes.

7.1. Trajectory modelling

ERcore, a Lagrangian model, developed by MSL, was used to simulate the trajectories of particles released at the various dredging sites within the channel and turning basin. The model consists of trajectory scheme applied to the existing 2D Eulerian current field $(\tilde{u}, \tilde{v})$ (Section 0), solving for the motion of discrete particles.

$$\frac{dx_p}{dt} = \tilde{u}(x, y, z, t) + u_t$$
$$\frac{dy_p}{dt} = \tilde{v}(x, y, z, t) + v_t \qquad (7.1\ a,b,c)$$
$$\frac{dz_p}{dt} = -w_s + w_g + w_t$$

where (x_p,y_p,z_p) are the particle coordinates,. (u_t,v_t,w_t) are the diffusion components representing turbulent motions, w_s is the particle settling velocity and w_g is a vertical velocity component accounting for bathymetric gradients.

In the horizontal plane, the model uses an Ordinary Differential Equations (ODE) solver, including a 4th order Runge-Kutta method, to calculate the trajectory of a given particle (x_p,y_p) in the time-varying derivative field.

$$\int_t^{t+\Delta t} u_t . dt = \sqrt{6. k_{u,v} . \Delta t} \; . \theta(-1,1) \qquad (7.2)$$

where $\theta(-1,1)$ is a random number from a uniform distribution between -1 and 1, Δt is the time-step of the model in seconds and $k_{u,v}$ is the horizontal eddy diffusivity coefficient in $m^2.s^{-1}$.

In absence of specific field data on diffusive processes, the determination of the diffusion coefficient $k_{u,v}$ is generally based on guidance from empirical relationships. Several relationships are summarized in Fischer et al., 1979 including that of Elder, J.W., 1956 for simple unidirectional shear flows that estimates the longitudinal diffusion coefficient as a function of the water depth and current velocity of the form,

$$k_{u,v} = 5.93 .H .u^* \tag{7.3}$$

where H and u^* are the water depth and friction velocity respectively.

Transverse mixing can be estimated using a relationship of the same form but with reduced proportionality factor (with 50 % error bound).

$$k_{transverse} \sim 0.6 .H .u^* \tag{7.4}$$

The vertical diffusion is generally expected to be at least one order or magnitude smaller. Elder"s formula suggests a vertically averaged value of :

$$k_{vertical} \sim 0.067 .H .u^* \tag{7.5}$$

Here, both depth and mean current velocities vary along the channel but these equations can still be used to provide a bracketing of reasonable diffusion coefficient values for the present application.

Assuming a generic water depth of 16 metres in the channel and a mean current velocity of 0.8 $m.s^{-1}$, the above equations yields coefficient of ~[3-5] $m^2.s^{-1}$, [0.3-0.5] $m^2.s^{-1}$, and ~[0.03-0.05] $m^2.s^{-1}$ for the longitudinal, transverse and vertical diffusivities respectively.

Furthermore, in numerical models, the role of the horizontal diffusion coefficient is also to implicitly account for sub-grid scale turbulent processes such as eddies that are not explicitly resolved in the model due to the limited resolution. This means that horizontal diffusion must generally increase as grid size increases since eddies of increasing scale are unrepresented. Conversely, the reduction of grid size allows explicit resolution of flow patterns and eddies at finer scales which thereby reduce the required amount of added diffusion.

For dispersion at oceanic scales, (Okubo, A., 1971) notably showed that $k_{u,v}$ varies approximately (with wide scatter) as :

$$k_{u,v} = \alpha .L^{4/3} \tag{7.6}$$

where L is the horizontal scale of the mixing phenomena and α is an empirical proportionality factor. The hydrodynamic model resolution in Whangarei Harbour is generally less than 100 m which yields diffusion coefficient of order 0.1 $m^2.s^{-1}$. Here, the average of the longitudinal and lateral diffusivities obtained with the Elder formula yields coefficients of order ~0.1-0.2 $m^2.s^{-1}$. Given results provided by the Okubo Equations, a generic diffusion coefficient of 0.1 $m^2.s^{-1}$ was eventually selected. Vertical diffusion is not expected to be the dominant process during the descent of the disposed sediment and a small generic value of 0.0005 $m^2.s^{-1}$ was used.

The trajectory of particles in the vertical plane is controlled by the particle's settling velocity w_s, the vertical diffusion component w_t as defined in equation 7.1c, and a component w_g related to the bathymetric gradients to ensure that the trajectory of a particle close to the sea-floor is parallel to it (before settling and diffusion components are applied):

$$w_g = \frac{(h - z)}{h}\left(\tilde{u}(x, y, z, t) \times \frac{dh}{dx} + \tilde{v}(x, y, z, t) \times \frac{dh}{dy}\right) \quad (7.7)$$

where *z* is the particle elevation above the seabed, *h* is the water-column height at the particles' horizontal location (*x*,*y*), $(\tilde{u}, \tilde{v})$ is the current field from equation 7.1 and $\left(\frac{dh}{dx}, \frac{dh}{dy}\right)$ are the bathymetry gradients in the *x* and *y* directions, respectively. Note a logarithmic profile was used to extrapolate the 2D depth-averaged current magnitudes to any water column level (Smart et al., 2002).

In the present model implementation, any particle reaching the shoreline, the seabed or the outside domain boundaries remained at the position of intersection (*i.e.* 'sticky' boundaries), thus allowing no sediment re-suspension.

7.2. Particle size distribution and settling velocity

Representative particle sizes were determined from the observed sediment distribution (Tonkin and Taylor, 2016c). The particle size distribution used for the dredging and disposal plume modelling includes:

- 5% of silt (D50 = 60 µm)
- 26% of fine sand (D50 = 130 µm)
- 59% of medium sand (D50 = 400 µm)

Note that the coarse sand and gravel sediment fractions identified in sampling program were not included in the plume modelling analysis as they settle directly to the bottom and therefore do not contribute to a plume. The very low fraction of clays detected in the sampling results (approx. 0.3%) was considered below the tolerance threshold and was thus not included in the numerical modelling.

A more conservative scenario including 10% silt was tested as part of a sensitivity analysis of the plume model as well as changes to the fall velocity. Assuming 10% silt aims to simulate the case that the dredger encounters silt lenses in the substrate that have not been picked up by the vibro-core programme. Such scenario corresponds to the “worst-case scenario” in terms of plume dispersion as fine silt particles are characterised by low settling velocities making them more mobile than coarse sand particles.

Although general equations are available to compute the settling velocity of individual particles of given sizes (e.g. Stokes Law), it is unrealistic to assume that the sediment consists of single particles in the fine silt range (~60 µm or smaller) because of the cohesive nature of material and associated flocculation effects (e.g.

Van Rijn, 2007). A representative settling rate of 1 mm.s^{-1} for the flocculated sediment is applied, consistent with the findings of Whitehouse et al (2000) and Smith and Friedrichs (2011). Particle settling velocities were determined using the standard equation of Van Rijn, (1984) for non-cohesive sediment. Dry densities for the silt and sand material were set to 500 kg.m^{-3} and 1650 kg.m^{-3}, respectively. The characteristics of the 3 representative classes and relative proportion of the total volumes are summarized in Table 7.1

Note that simulations considering a settling velocity of 0.4 mm/s associated with finer silt particles were also undertaken to examine the effect of lighter particle dispersion on the plume extension.

Table 7.1 Representative median grain sizes, settling velocities, and proportions of total volume released for the 3 discrete sediment classes considered.

	Representative D50 [microns]	Settling velocity [m/s]	Percentage of total volume [%]
Class 1	60	0.0010	5
Class 2	130	0.0080	26
Class 3	400	0.0365	59

Appropriate simulation time steps were chosen to correctly capture the horizontal trajectories due to the ambient tidal and residual flows. A time step of 60 seconds was applied to ensure sufficient resolution of the vertical settling. The total number of particles released per time-step varied for each of the different size classes according to the different settling rates. This ensured a sufficient number of particles remained in suspension, taking into account the diffusion processes and allowing statistically representative concentrations to be derived. For example, a larger number of medium sand particles were released per discharge event compared to the fine sand since a greater proportion of the medium sand would settle over a given time period due to the higher settling velocities. Each sediment fraction is simulated separately and all results are combined afterwards to produce total suspended sediment concentration (*SSC*) fields.

7.3. Dredging scenarios

The processes by which sediment is released and suspended in the water column during dredging operations are briefly outlined in the context of the choice of the source term magnitudes and release depths for the particle tracking simulations undertaken in this study.

The dredging method likely to be used in the present case involves the use of two different types of trailing suction hopper dredgers (TSHD) (one large and one smaller), a cutter suction dredger (CSD) and a backhoe dredger (BHD).

7.3.1. TSHD

TSHD are vessel classes operating in two modes: dredging and overflow modes.

During the dredging phase, sediment is sucked into the hopper using a drag head; a fraction of the sediment disturbed by the drag head is not pumped into the hopper and remains suspended in the water column. Sediment suspension is also expected due to the action of propeller wash (Source 1 and 3 respectively in Figure 7.1). These two sources of sediment suspension form a passive plume that is expected to be contained in the bottom part of the water column. In the present study, the drag head source was defined over the water column at 2 m above seabed, while the propeller source was set to 4 m from the seabed.

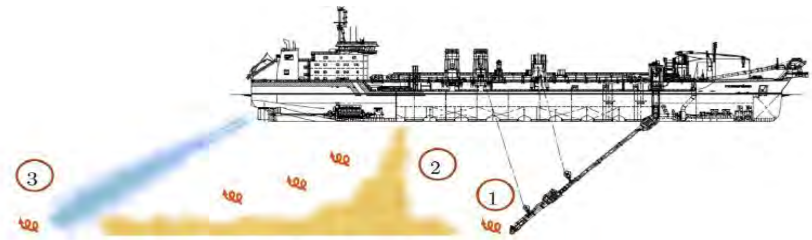


Figure 7.1 Sources of a dredge plume for a Trailing Suction Hopper Dredger: 1-Drag Head, 2-Overflow, 3-Propeller wash (after Becker J. et al., 2015).

The large and small TSHD considered for the present project are characterized by an average dredge work rate of 5400 m^3/hour and 1050 m^3/hour, respectively. Release rates of 6.15 $kg.s^{-1}$ (1.5% production rate) and 12.3 $kg.s^{-1}$ (3% production rate) were used for the drag head source term in the case of the small TSHD. For the large TSHD, values of 31.15 $kg.s^{-1}$ and 62.3 $kg.s^{-1}$ were applied.

The propeller wash component depends on many factors that are likely to vary in time and space (i.e. grain size, draft between prop and seabed, horsepower of dredger, angle of dredger relative to the ambient current etc) and is often included in the term related to overflow (Becker J. et al., 2015). For the purposes of this study, the propeller wash source term is considered separate to the overflow, and defined with rates of 25 and 80 $kg.s^{-1}$ for the small and the large TSHD, respectively, which is considered conservative but not unrealistic for these environs. This initial “dredging phase” will continue until the hopper is full and is expected to last up to 25 minutes in the present application.

After the initial hopper infilling, the actual content of the hopper is a sediment/water mixture which is expected to contain ~20% solids by volume (Spearman, J. et al., 2007). To maximize the amount of sediment in the hopper, the vessel can continue to pump sediment and water into the hopper, which will result in “overflowing” and thereby releasing some sediment into the water column. This phase is referred to as the “overflow phase”, and is shown as the source “2” in Figure 7.1. Depending on how the dredge is operated, the overflow rates can create highly-evident sediment plumes.

The overflow load consists of a highly concentrated mixture of sediment and water and the bulk behavior of that sediment mixture becomes dominant over the individual particle settling processes (Winterwerp, 2002). As a result, it is expected that the overflow release will be followed by a dynamic plume phase where the sediment mixture descends to the bottom as a jet-like feature, and impacts the seabed, suspending sediment and forming an initial density driven near-field plume. A fraction of the sediment load will also be de-entrained from the dynamic plume during descent and become suspended in the water column. This is comparable to processes involved during the offshore disposal presented in Section 8 (see Figure 8.1).

The general length scales expected for the overflow process are an order of magnitude smaller than the discharge of sediment at the offshore disposal ground.

Additionally, the overflow sediment mixture is less concentrated than in an offshore sediment disposal context. In the present study, this overflow phase was modelled considering two sources of sediment to the passive plume:

- Suspension of sediment de-entrained from the dynamic plume descent uniform released within the entire water column, and
- Passive plume generated following the dynamic plume impact: release within a cylinder of 2 m height and 60 m radius on the seabed (representing the boundary between the dynamic plume collapse and the passive plume). Sediment releases within cylinders of 2 m height and 100 m radius, and 4 m height and 60 m radius related to the large TSHD were also tested to assess the effect of larger release areas on the plume extension.

The release rate of the initial total raw overflow was taken as 63 $kg.s^{-1}$ and 20 $kg.s^{-1}$ for the large and the small TSHD, respectively.

In the present application, a fraction of 25% was considered appropriate for the sediment source term released within the entire column (i.e. sediment suspension due to dynamic plume descent). A similar proportion of 25% was used for the amount of the overflow load found in the bottom source release, i.e. resulting from the density current following the dynamic plume impact (see Figure 7.2). The impact of that overflow phase was tested considering overflow period times of 10, 20, and 50 minutes for both the small and the large TSHD. Maximum overflow period of 79 and 95 minutes were additionally tested for the large and the small TSHD respectively.

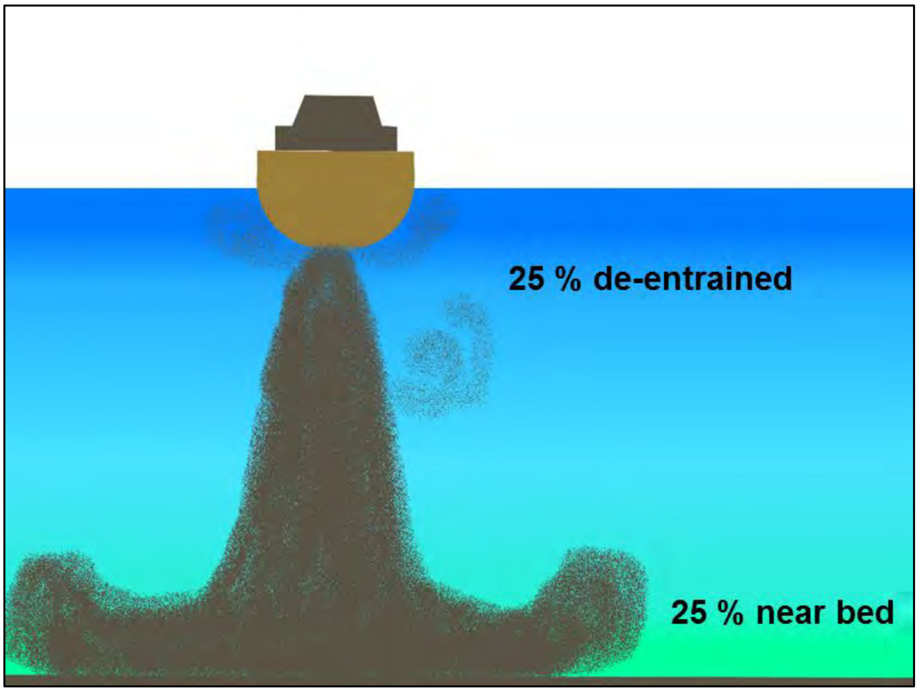


Figure 7.2 Percentages of sediment transferred from the near-field density driven plume to the far-field plume during overflowing

7.3.2. BHD

A BHD (Figure 7.3) is a stationary mechanical equipment, anchored by spuds and usually used for the dredging of small volumes in confined areas. The release mechanisms from a BHD include three main components:

- impact and excavation
- hoisting
- slewing to the barge

The release of sediments associated with a BHD varies with operator expertise and the use of open or closed buckets. A realistic discharge rate corresponding to the bucket source term was defined in Becker et al. (2015) as between 0 – 4 % of the production rate. For dredging at the jetty pocket area three BHD are considered, with production rates ranging between 270 – 475 $m^3.h^{-1}$. At a realistic, but conservative production rate (i.e. 500 $m^3.h^{-1}$), this corresponds to a discharge rate 8 $kg.s^{-1}$ released through the entire water column

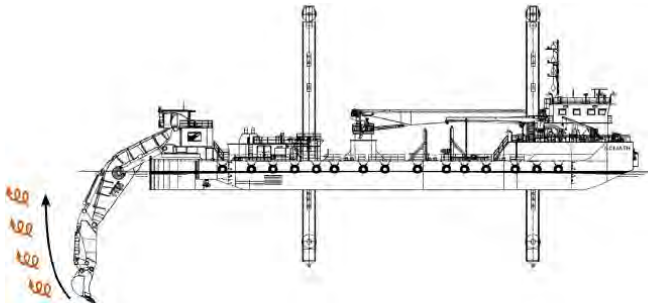


Figure 7.3 Source of a dredge plume for a Backhoe Dredger (after Becker et al., 2015).

7.3.3. CSD

The dredging operations associated with a CSD (Figure 7.4) include two simultaneous phases:

- The (hard) sediments are cut and fragmented by a rotating cutter head using different rotation and swing speeds.
- Sediment is sucked up by dredge pumps, and typically discharged through floating pipeline and pipes to a deposit area.

The sediment release mechanisms are thus largely associated with the rotating cutter head action and are located near the seabed. A fraction of the fragments are expelled during the fragmentation while the turbulence induced by the centrifugal force result in the suspension of sediments around the cutter head.

Although the corresponding sediment source term depends on specific parameters including the cut height and step length, the cutter head rotation and swing speeds, and the suction velocity, discharge rates are typically in the order 1 – 5% of the production rate (Becker et al., 2015). For this project, the CSD was characterised as having an average dredge work rate of 1600 $m^3.h^{-1}$. The resultant sediment discharge associated with the cutter head source term in the plume model was thus taken as 31 $kg.s^{-1}$ near the seabed, based on a 5% conservative discharge rate. Note that CSDs are usually fitted with spuds which increase their precision and avoid any suspension of sediments associated with the propeller wash (e.g. Figure 7.4).

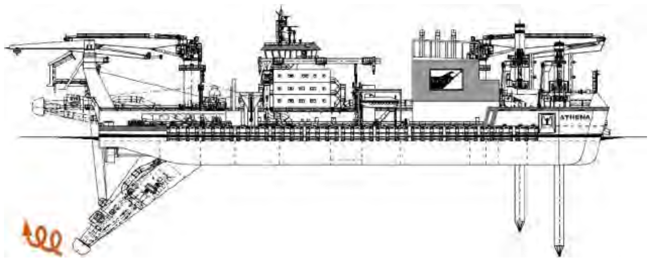


Figure 7.4 Source of a dredge plume for a Cutter Suction Dredger (after Becker et al., 2015).

The use of a CSD for the dredging operations at the jetty pocket and within the inner section of the channel is not the preferred option of RNZ, this dredger has been tested in the present study for completeness in case it"s required as an option.

7.4. Post-processing

The results of the 28-day particle tracking simulations were post-processed to produce maps of the instantaneous and probabilistic suspended sediment concentration fields. The probabilistic approach aimed to provide sufficient statistical power (capturing the effect of the monthly tide variability) to investigate the 3D plume dispersion associated with the sediments released by the dredging operations. This process, which is statistically more robust than a case by case approach, nevertheless requires a significant computational runtime. In the model, sediments are released continuously for 28 days, allowing consideration of two complete spring / neap tidal cycles.

The general methods employed to reconstruct concentration fields from the particle tracking model outputs are outlined below.

7.4.1. Concentration and depositional thickness computation

To reconstruct concentrations from the particle tracking simulations at chosen receptors, a kernel method with variable bandwidth was used. The use of a variable bandwidth (kernel size) attempts to represent true variability of spatial concentration, while minimizing statistical variability that inevitably occurs away from the source due to a necessarily finite number of particles. A small kernel is used in regions gathering a high number of particles, where it is statistically appropriate to infer relatively small scale changes in concentration. Conversely, a larger kernel is used in regions presenting a low number of particles, so as to prevent unrealistically high concentrations around the precise (but partially random) locations of a few isolated particles.

In practice, the concentration *C* at a given receptor location (*x,y*) is computed as:

$$C(x,y) = \sum_{i=1}^{n} \frac{m_i}{\lambda_x(x,y)\lambda_y(x,y)} K\left(\left|\frac{x_i - x}{\lambda_x}\right|\right) K\left(\left|\frac{y_i - y}{\lambda_y}\right|\right) \tag{7.8}$$

where (x_i,y_i) is the location of each particle i, *n* is the total number of particles, m_i is the loading for each particle, λ_x and λ_y are the kernel bandwidth in the *x* and *y* directions for location (*x,y*) and *K* is the kernel function.

Following Vitali et al. (2006), an Epanechnikov kernel function was used:

$$K(q) = \begin{cases} 0.75\left(1 - q^2\right), & |q| \le 1 \\ 0, & |q| > 1 \end{cases} \tag{7.9}$$

where q is the ratio of the particle distance from receptor to bandwidth (q_x=d_x/ λ_x , or q_y=d_y/ λ_y).

A receptor-based method derived from the RL3 method in Vitali et al. (2006) was used to define the bandwidths λ_x and λ_y.

For each receptor location, a neighborhood was defined as the region enclosing the 1/20th closest particles. Then, for each direction x and y, the bandwidths λ_x and λ_y were defined as the minimum value between the maximum projected distance of the particles within the neighborhood and twice the standard deviation of the projected distances within the neighborhood. Finally, in order to prevent unrealistically elongated kernels, the aspect ratio λ_x / λ_y was limited to be no greater than 5:1, with the smaller value increased.

The loading of each particle directly depends on the quantity being modelled. Here, each discrete particle was attributed a certain sediment mass which was determined as the ratio from the total true sediment volume of a given class released per step, to the total number of particles of that class introduced in the model at each release.

7.4.2. Application to the present study

Sediment concentration fields were determined following the methods outlined above for the suspended particle cloud associate with each sediment class. The individual sediment concentration fields were then combined to produce total SSC magnitudes considering all sediment classes. The particle load governs the concentration magnitudes and is a function of the amount of sediment released into the environment and the number of particles modelled. The predicted suspended sediment concentrations should be interpreted as dredging-related SSC only, and would add to any ambient SSC from other sources, such as river inputs or catchment run-offs.

7.5. Sites for dredge plume modelling

Nine sites along the navigation channel were used to simulate the dredge plume dispersion. The maps of peak ebb and flood tide flows over the channel (presented in MSL Report P0297-02) shows limited spatial variability in current velocities within each proposed dredged area. Using a limited number of points over the channel to perform the dredge plume modelling was thus justified in the present study. Locations and water depths associated with the different sites are presented in Table 7.2 and Figure 7.5.

The plume modelling at positions R0 to R8 was undertaken using the existing hydrodynamic fields from the SELFE model. Note however that hydrodynamic conditions at positions R2, R3 and R8 were derived from both the existing and the post-dredging configurations to assess the impact of changes in the hydrodynamic field on the plume dispersion.

Table 7.2 Depths and depth changes of release sites along the dredged channel.

Positions	Existing depth [m]	Depth $_{post\text{-}dredging}$ – depth $_{existing}$ [m]
R0	12.4	5.3
R1	16.3	2.1
R2	15.0	3.7
R3	15.2	4.4
R4	16.5	3.5
R5	16.7	3.8
R6	16.2	2.7
R7	17.2	1.1
R8	17.8	0.5

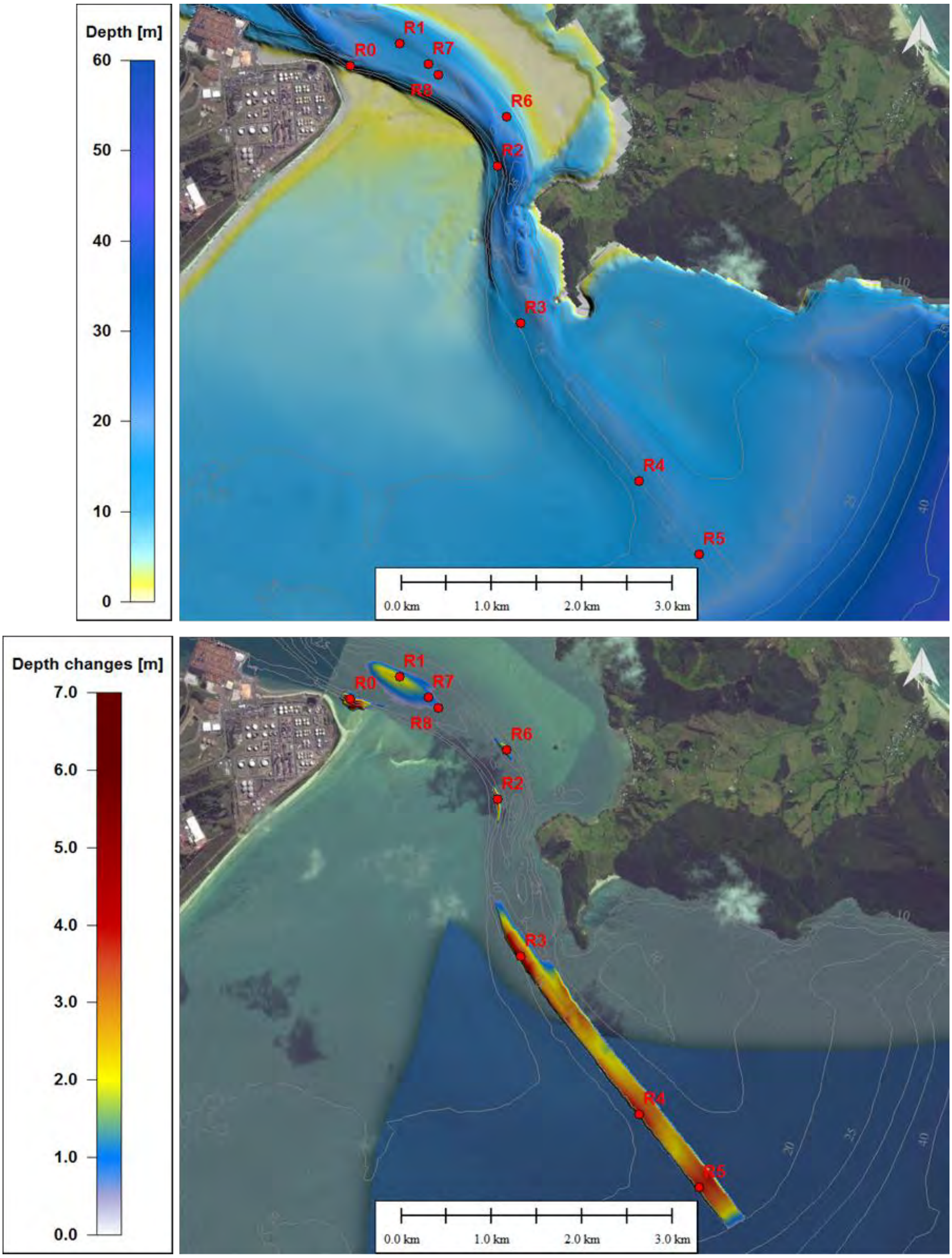


Figure 7.5 Simulated release sites along the dredged channel. Existing depth and depth changes are provided in Table 7.2. Geographic coordinates are presented in Appendix B.

8. DISPOSAL PLUME MODELLING

The placement of the dredged material over the proposed disposal areas is expected to produce a temporary plume of sediments in the water. The behaviour of this plume is driven by both the sediment grain-size distribution and the local hydrodynamics which control both the vertical and horizontal transport. In this context, a probabilistic approach was used to anticipate the plume dispersion under several hydrodynamic conditions.

This section presents the methodology applied, and the different scenarios considered, to assess the disposal plume dispersion.

8.1. Trajectory modelling

ERcore, the Lagrangian model used for the dredge plume modelling (Section 7) was applied to simulate the disposal plume in Bream Bay. The existing 2D Eulerian current field for the trajectory modelling was derived from the 10-year ROMS hindcast (Section 4) to ensure both residual and tidal current velocities were considered. This was chosen based on the importance of the non-tidal component of the current in the eastern region of Bream Bay characterised by increasing depths. In contrast, the hydrodynamic conditions used for the dredge plume modelling (Section 7) included only the tidal component which dominates the entrance region. A different vertical diffusivity was used for the disposal plume modelling, with a value of 0.0001 m^2s^{-1} chosen due to increasing water depths and decreasing current velocities compared to the navigation channel. The parameters for the trajectory modelling described in Section 7.1 were conserved, except those previously cited above.

8.2. Simulated scenarios

8.2.1. Sources terms

The processes by which sediment is released and suspended in the water column during disposal operations are briefly outlined here in the context of the choice of the source term magnitudes and release depths for the particle tracking simulations.

In the case of silt to fine sand, the content of a loaded dredge consists of a highly concentrated mixture of sediment and water and the bulk behaviour of that sediment mixture becomes dominant over the individual particle settling processes. When the dredge opens its bottom door for release, the contents will typically be released as a jet-like sediment flux quickly descending to the seabed. The behaviour of the released sediment can be separated in the three main phases illustrated on Figure 8.1.

During the convective descent, the dense sediment material quickly descends to the bottom. Ambient water can become entrained around the perimeter of the jet which can strip, or de-entrain some sediment, which becomes suspended in the water column. The proportion lost is expected to be small, commonly cited as 1-5% of the disposed load (Bokuniewicz et al., 1978; Bokuniewicz and Gordon, 1980; Gordon, 1974; Truitt, 1988).

Following its descent, the dredge material collapses on impact with the seabed; this phase is known as the dynamic collapse phase. The collapse results in a large fraction of the disposed sediment depositing on the seabed and is often coupled to the generation of the density current generated by the excess energy available following collapsing, whereby a fraction of the disposed sediment is suspended and propagates radially from the point of impact. The density current is expected to be contained within the bottom 15-20% of the water column, with excursion length scales of order 100-500 m (e.g. Aarninkhof and Luijendijk, 2010).

These two initial phases relating to the dissipation of the initial plume momentum are also referred to as dynamic plume stage (e.g. Spearman et al., 2007). The passive dispersion phase relates to the subsequent dispersion of the sediment that became suspended in the water column during the dynamic phase, i.e. de-entrained during descent, sediment entrained during the collapse of the dynamic plume, and sediment suspension by the density current developing near the seabed.

In the present study, the focus is on characterising the extents and concentrations of the plume resulting from this passive dispersion phase, as these plumes have the potential to effect order of magnitude greater spatial extents than the dynamic plume (which settles quickly). In that respect, the particle tracking simulations considered two main source terms:

A. De-entrained sediment during descent – release at the bottom of the vessel used for disposal as a point source.

B. Entrained sediment resulting from the collapse of the dynamic plume - release within a cylinder near the seabed of given height and radius.

C. Surface sediment losses - release within the top layer of the water column (from the sea surface to bottom of vessel hull)

Note a degree of conservatism is introduced by releasing the sediment de-entrained from the descending plume at the vessel bottom rather than distributed within the water column, as these sediments have further to fall. The present application also considered an additional sediment source released at near-surface, representative of sediment which, in the unlikely event, is entrained vertically around the hull of the dredger due to turbulence associated with the discharge of sediment.

Entrained sediment resulting from the collapse of the dynamic plume (B above) was simulated assuming 20% of the discharged sediment enters the passive plume phase. This entrained sediment was distributed within a circular volume of 100 m radius and a 2 m height centred on the discharge location. This was combined with the mid-water and near surface release source terms (i.e. de-entrained and surface loss) which were assumed to consist of 5% and 0.5% of the disposed load respectively (see Figure 8.2).

The use of ratios for the proportion of sediment involved transferred in the passive plumes due to de-entrainment during descent and other losses near the surface (i.e. 5 and 0.5% respectively), is a relatively simplistic approach. Sensitivity testing of the ratio suggests it does not significantly alter the predicted *SSC* magnitudes, particularly in the surface.

The release depths for the source terms and total discharged volumes were varied according to the dredge being simulated (i.e. for the large and small dredge). Details of the dredging vessels are summarized in Table 8.1 and associated source terms are given in Table 8.2.

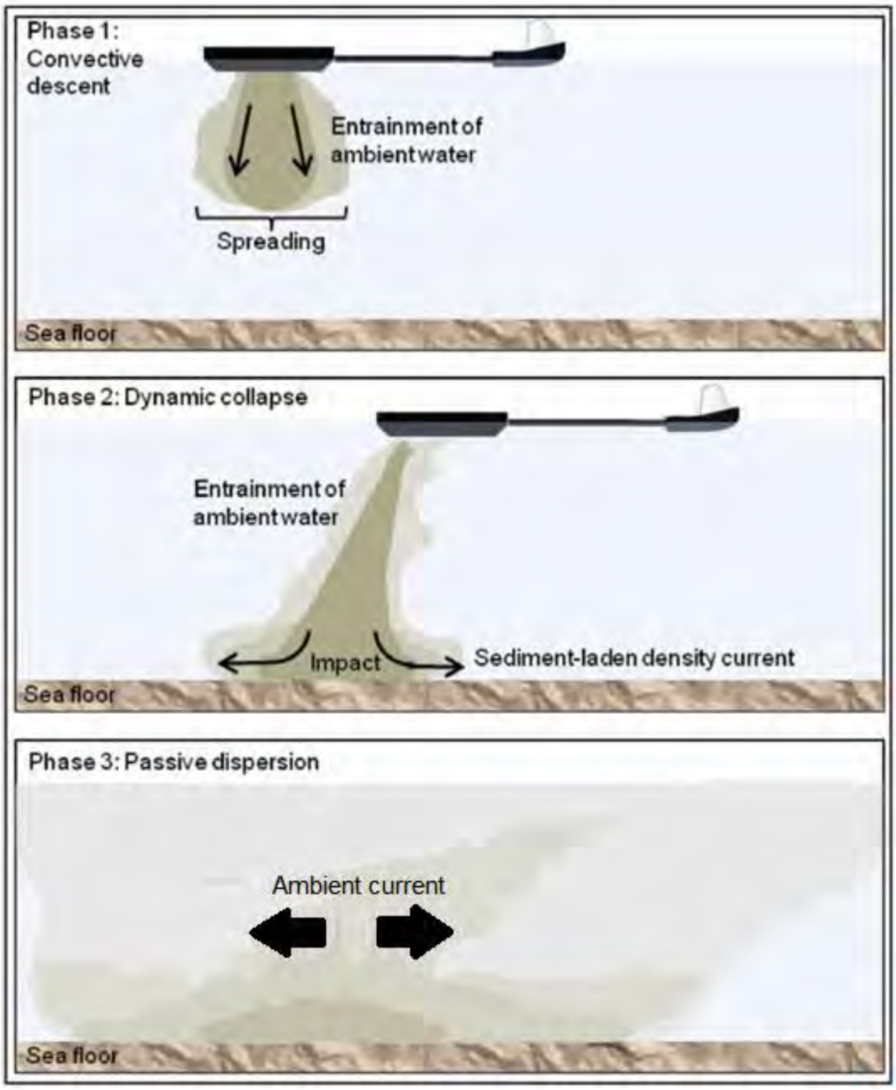


Figure 8.1 Three main phases occurring during the disposal of dredged material: 1) convective descent, 2) dynamic collapse, and 3) passive plume dispersion.

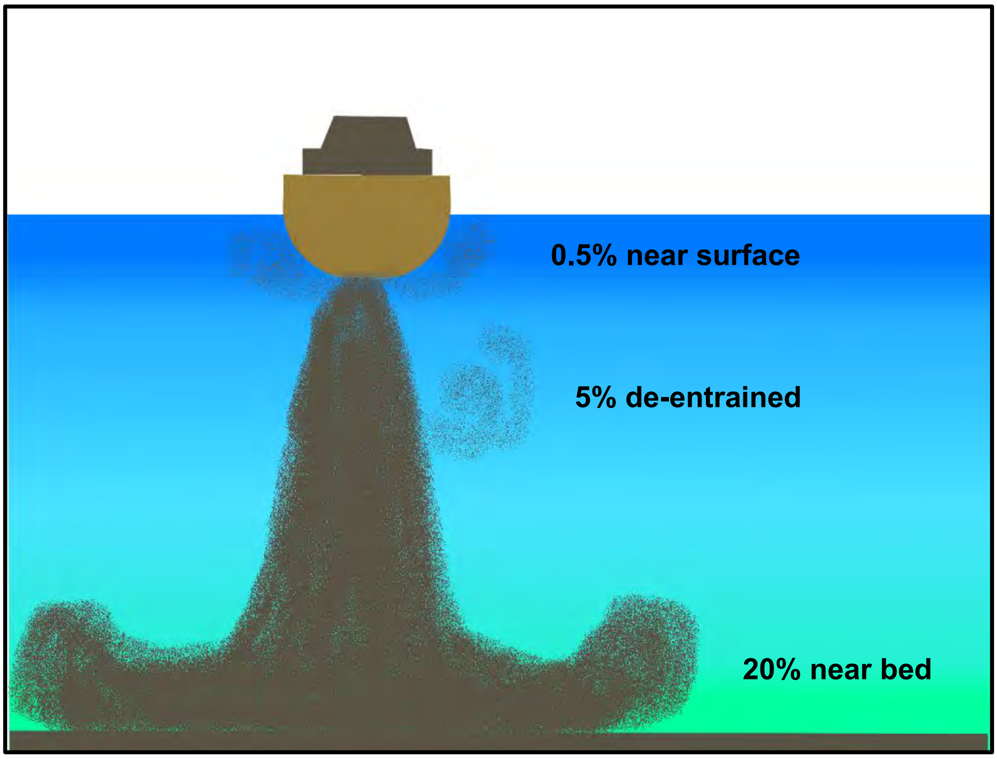


Figure 8.2 Percentages of sediment transferred from the near-field density driven plume to the far-field plume.

Table 8.1 Details of the dredging vessels likely to be used for dredging and disposal works.

Vessel	Hopper load [m3]	Draft [m]	Disposal load [min]
Large	10,830	-9.5	10
Small	2,130	-5.6	10

Table 8.2 Source terms and release depths.

Sources Terms	Percent of hopper volume	Release depth	Release type
Surface losses	1%	sea-surface to vessel draft	point source
De-entrained during descent	5%	vessel draft	point source
Density current	21%	2 m layer above seabed	100 m radius circle

8.2.2. Sediment distribution and settling velocity

The particle size distribution of the sediment to be disposed was conserved from the sediment distribution used for the dredge plume modelling. It includes three sediment fractions of silt (60 µm), fine sand (130 µm) and medium sand (400 µm). The coarse sand and gravel sediment fractions identified in the sampling results were not included within the disposal plume modelling as they directly settle to the bottom.

The particle size distribution and associated fall velocity of the sediment discharged at the proposed disposal site was identical to that of the distribution simulated during the dredging operations (see Table 7.1). The coarse sand and gravel sediment fractions identified in the sampling results were not included within the disposal plume modelling as they are expected to directly settle to the bottom.

8.2.3. Release sites and events

Five sites were considered for the discharge of dredge material (see Figure 8.3, Appendix C and Appendix B); one at each corner of the disposal and one in the centre where measured current data was collected using an ADCP current profiler.

The dispersion model was run for two discrete periods during which the hydrodynamic conditions were representative of the expected range at the disposal site, including strong west-directed currents at surface and bottom levels, respectively. This last scenario is considered as “worst case scenario” due to the location of 3 Mile Reef from the disposal area 3.2.

These discrete short-term simulations were also supplemented by two 1-month periods during summer and winter months (i.e. January and August, 1995 see Table 8.3). For the historical simulations, discharges were simulated at 140 minutes and 185 minutes interval for the large and small TSHD, respectively. These intervals were estimated based on the periods of dredging, overflow, travel and disposal.

The long-term simulation of the plume dispersion over a 6-month period assumed continuous release of sediment throughout the period, allowing statistical analysis of the predicted plume concentrations and extents. The choice of the modelling period was motivated by the necessity to consider a large range of weather conditions without increasing dramatically the computational runtime. Simulating plumes from the near-bed, near-surface and de-entrained from the dynamic phase of the plume descent for each of the representative grain sizes, while computationally expensive, provides the necessary information to allow realistic climatic and representative statistical measures of the predicted plume extents.

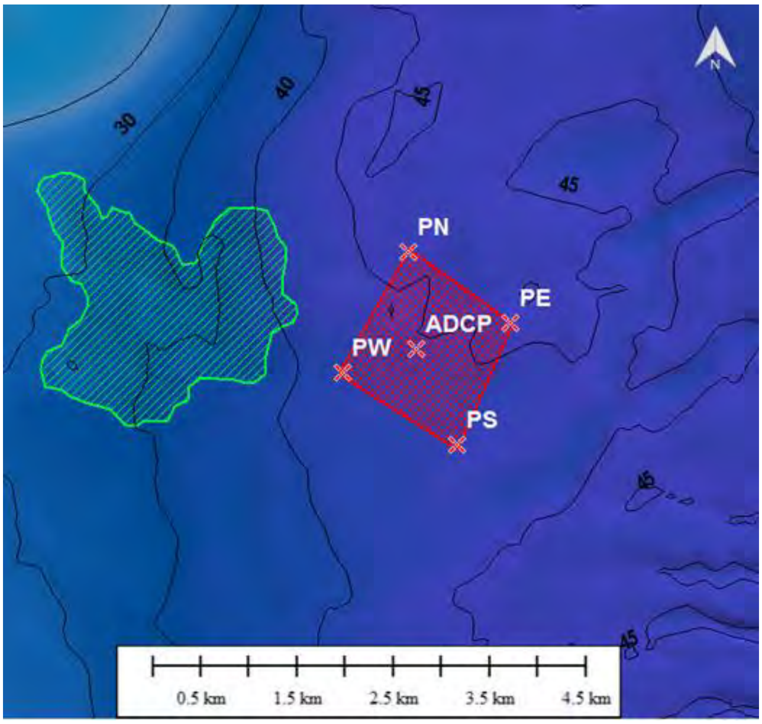


Figure 8.3 Location of the sites over the disposal ground used for the release of particles as part of the disposal plume modelling. The green polygon indicates the contour of a reef classified as sensitive.

Table 8.3 Summary of simulation periods.

Disposal simulations	Period
Strong west-directed current on surface	10/12/1995-12:00
Strong west-directed current near bottom	06/02/1995-12:00
Summer hydrodynamic conditions	January (1995)
Winter hydrodynamic conditions	August (1995)

9. DISPOSAL GROUND MODELLING

This section describes the numerical modelling that was adopted to estimate the long-term dynamics of the proposed disposal grounds 1.2 and 3.2 (see Figure 1.4) for the placement of maintenance and capital volumes, respectively. The present work aims to provide solid information regarding the predicted effect of the disposal mound on the physical and ecological components of the coastal system in Bream Bay. Main expected outcomes are listed below:

- Estimation of the degree of stability of the disposal mound under a range of wave and tidal forcing.
- Prediction of the magnitudes of the sediment transport over adjacent areas.
- Identification of potential ecological harm related to the transport of large amount of disposed sediments.
- Impact of the depth changes on the wave climate in Bream Bay and adjacent beaches associated to the disposal of material.

9.1. Modelling approach

The Delft3D model was implemented to predict the disposal ground dynamic using an input reduction approach. A limited number of representative forcing conditions (including tides, waves, residual currents and residual water elevations) was used to reproduce the long-term residual sediment transport patterns and associated morphological evolutions. This methodology was combined with the application of morphological acceleration factors (MORFAC) based on the occurrence of each scenario to improve computational efficiency by acceleration computed morphological evolution. Details about the input reduction approach and corresponding references are provided in Section 6.3.1.

Outcomes of the consultation process involving RNZ and the relevant experts resulted in the identification of two offshore disposal sites referenced as Disposal Sites 1.2 and 3.2. At Disposal Site 3.2 it is intended to place up to 97.5% of the capital dredge volume and up to 100% of the maintenance dredge volume. Although the capital dredge volume for this area is estimated at 3.7 million m^3, a 4 m high disposal mound was set-up over a proposed 2 km^2 area - equivalent to a total volume of 8 million m^3. This conservative approach aimed to consider both the total capital dredge volume and the maintenance dredge volumes accumulated over 35 years based on a stable disposal mound. The effect of the disposal mound on the wave climate within Bream Bay was assessed based on the wave modelling of the 16 representative scenarios presented in Section 6 (see Table 6.1) including both the pre-disposal and the post-disposal bathymetries in the model.

Disposal Site 1.2 is intended to receive 2.5 – 5% of the capital dredge and up to 100% of the maintenance dredge volume. The assessment of the nearshore disposal dynamics was undertaken based on the numerical modelling of a representative value for a low mound, which was taken to be a 0.6 m high disposal mound (1.5 million m^3) defined on the ebb tide delta.

This corresponds to a conservative approach considering 5% of the capital dredge volume and 100% of the maintenance dredge volume accumulated over 10 years. The relative low water depth (less than 10m) of the Disposal ground 1.2 is expected to make the mound morphologically unstable with a relative high rate of erosion per annum. In this context, considering 35 years of accumulation of sediments (as for the Disposal ground 3.2) for a total volume of 4.3 million m^3 would have been largely unrealistic. The 1-year disposal ground dynamics for disposal sites 1.2 and 3.2 were simulated using a sequence of 16 representative scenarios (Table 6.1). The modelled sediment thickness and depth changes obtained at the end of each scenario were used for the initialisation of the next one.

The distribution of sediments used to characterise the disposal mound composition included five classes according to the results of the vibrocoring (Tonkin and Taylor, 2016c):

- 5% of silt (D50 = 60 µm)
- 26% of fine sand (D50 = 130 µm)
- 59% of medium sand (D50 = 400 µm)
- 4% of coarse sand (D50 = 1300 µm)
- 6% of gravel (D50 = 2000 µm)

9.2. Model domains

The Delft3D – FLOW domain includes the whole of Bream Bay from Bream Head to Langs Beach. To the North, the grid extends to Busby Head excluding Mair Bank and the Whangarei Harbour entrance (Figure 9.1). The resolution of the hydrodynamic/morphologic model grid ranges between 35 and 180 m, with higher resolution focused over the proposed disposal grounds. Delft3D – WAVE model was implemented on the same high-resolution curvilinear grid than Delft3D – FLOW. However, a nesting approach was implemented, including a coarser grid (Figure 9.2) to correctly reproduce the spectral wave transformation during the propagation of wave energy from deep to shallow water.

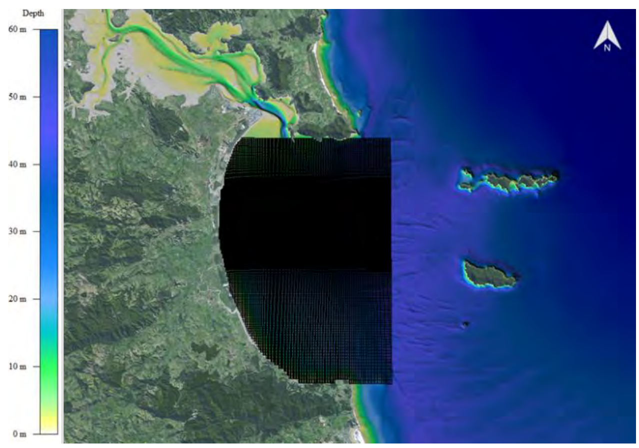


Figure 9.1 Bathymetry and Delft3D – FLOW model grid for the proposed disposal ground modelling.

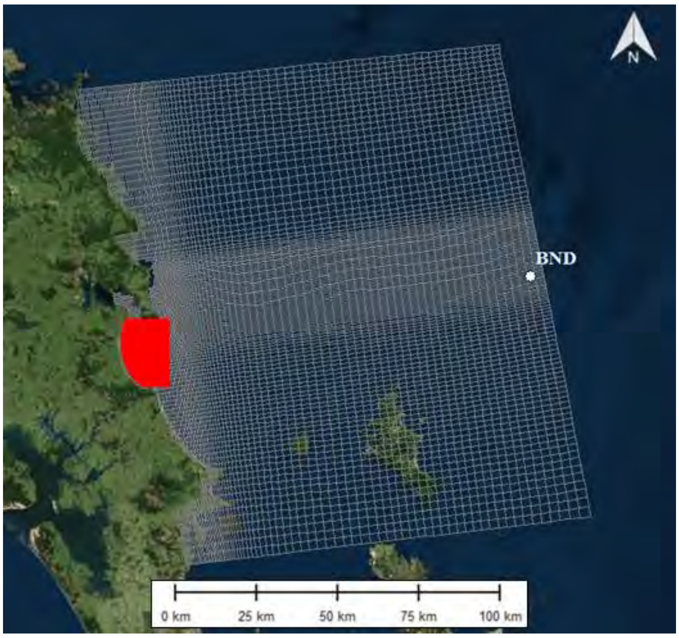


Figure 9.2 Delft3D –WAVE model grid for the proposed disposal ground modelling. Location (BND) for representative wave climate is shown at the centre of the eastern boundary.

REFERENCES

Aarninkhof, S., Luijendijk, A., 2010. Safe disposal of dredged material in an environmentally sensitive environment. Port Technol. Int. 47, 39–45.

Ardhuin, F., Rascle, N., Belibassakis, K.A., 2008. Explicit wave-averaged primitive equations using a generalized Lagrangian mean. Ocean Model. 20, 35–60. doi:10.1016/j.ocemod.2007.07.001

Ardhuin, F., Roland, A., 2013. The development of spectral wave models: coastal and coupled aspects, in: Proceedings of Coastal Dynamics. p. 7th.

Bagnold, R.A., 1966. An approach to the sediment transport problem. Gen. Phys. Geol. Surv. Prof Pap.

Becker J., van Eekelen E., van Wiechen J., de Lange W., Damsma T., Smolders T., van Koningsveld M., 2015. Estimating source terms for far field dredge plume modelling. J. Environ. Manage. 149, 282–293.

Bennis, A.-C., Ardhuin, F., Dumas, F., 2011. On the coupling of wave and three-dimensional circulation models: Choice of theoretical framework, practical implementation and adiabatic tests. Ocean Model. 40, 260–272. doi:10.1016/j.ocemod.2011.09.003

Black, K.P., 1983. Sediment Transport and Tidal Inlet Hydraulics. Hamilton, New Zealand: University of Waikato. Ph. D. thesis, 331p.

Bokuniewicz, H.J., Gebert, J., Gordon, R.B., Higgins, J.L., Kaminsky, P., 1978. Field Study of the Mechanics of the Placement of Dredged Material at Open-Water Disposal Sites. Volume I. Main Text and Appendices A-1. DTIC Document.

Bokuniewicz, H.J., Gordon, R.B., 1980. Sediment transport and deposition in Long Island Sound. Adv Geophys. States 21.

Booij, N., Ris, R.C., Holthuijsen, L.H., 1999. A third-generation wave model for coastal regions: 1. Model description and validation. J. Geophys. Res. Oceans 104, 7649–7666. doi:10.1029/98JC02622

Brown, J.M., Davies, A.G., 2009. Methods for medium-term prediction of the net sediment transport by waves and currents in complex coastal regions. Cont. Shelf Res. 29, 1502–1514.

Camenen, B., Larroudé, P., 2003. Comparison of sediment transport formulae for the coastal environment. Coast. Eng. 48, 111–132.

Collins, J., 1972. Prediction of Shallow Water Spectra. J. Geophys. Res. 77, 2693–2707.

Dastgheib, A., 2012. Long-term process-based morphological modeling of large tidal basins. UNESCO-IHE, Institute for Water Education.

De Vriend, H.J., Capobianco, M., Chesher, T., De Swart, H. de, Latteux, B., Stive, M.J.F., 1993. Approaches to long-term modelling of coastal morphology: a review. Coast. Eng. 21, 225–269.

Deltares, 2013. User Manual Delft3D-FLOW. version: 3.15.2789. Deltares.

Dissanayake, D., Ranasinghe, R., Roelvink, J.A., 2012. The morphological response of large tidal inlet/basin systems to relative sea level rise. Clim. Change 113, 253–276.

Dodet, G., 2013. Morphodynamic modelling of a wave-dominated tidal inlet: the Albufeira lagoon. La Rochelle.

Egbert, G.D., Erofeeva, S.Y., 2002. Efficient inverse modeling of barotropic ocean tides. J. Atmospheric Ocean. Technol. 19, 183–204.

Elder, J.W., 1956. The dispersion of marked fluid in turbulent shear flow. J. Fluid Mech. 5, 544–560.

Engelund, F., Hansen, E., 1967. A monograph on sediment transport in alluvial streams. TEKNISKFORLAG Skelbrekgade 4 Copenhagen V, Denmark.

Fairall, C.W., Bradley, E. F., Hare, J. E., Grachev, A. A., Edson, J. B., 2003. Bulk parameterization of air-sea fluxes: Updates and verification for the COARE algorithm. J. Clim. 16, 571–591.

Fischer, H.B., Koh, R.C.Y., Imberger, J., Brooks, N.H., 1979. Mixing in Inland and Coastal Waters. Academic Press, San Diego, Califonia USA.

Fredsøe, J., 1984. Turbulent boundary layer in wave-current motion. J. Hydraul. Eng. 110, 1103–1120.

Gordon, R.B., 1974. Dispersion of dredge spoil dumped in near-shore waters. Estuar. Coast. Mar. Sci. 2, 349–358.

Grunnet, N.M., Walstra, D.-J.R., Ruessink, B.G., 2004. Process-based modelling of a shoreface nourishment. Coast. Eng. 51, 581–607.

Haidvogel, D.B., Arango, H., Budgell, W.P., Cornuelle, B.D., Curchitser, E., Di Lorenzo, E., Fennel, K., Geyer, W.R., Hermann, A.J., Lanerolle, L., others, 2008. Ocean forecasting in terrain-following coordinates: Formulation and skill assessment of the Regional Ocean Modeling System. J. Comput. Phys. 227, 3595–3624.

Holthuijsen, L.H., Booij, N., Ris, R.C., Haagsma, I.J., Kieftenburg, A.T.M.M., Kriezi, E.E., Zijlema, M., van der Westhuysen, A.J., 2007. SWAN cycle III version 40.51, Technical Documentation. Delft, 2600 GA Delft The Netherlands.

Latteux, B., 1995. Techniques for long-term morphological simulation under tidal action. Mar. Geol. 126, 129–141.

Lesser, G.R., 2009. An approach to medium-term coastal morphological modelling. UNESCO-IHE, Institute for Water Education.

Lesser, G.R., Roelvink, J.A., van Kester, J.A.T.M., Stelling, G.S., 2004. Development and validation of a three-dimensional morphological model. Coast. Eng., Coastal Morphodynamic Modeling 51, 883–915. doi:10.1016/j.coastaleng.2004.07.014

Morgan, K.M., Kench, P.S., Ford, R.B., 2011. Geomorphic change of an ebb-tidal delta: Mair Bank, Whangarei Harbour, New Zealand. N. Z. J. Mar. Freshw. Res. 45, 15–28.

MSL, 2016. Crude Shipping Project, Whangarei Harbour - Predicted physical environmental effects from channel deepening and offshore disposal.

Okubo, A., 1971. Oceanic diffusion diagrams. Deep-Sea Res. 18, 789–802.

OMC International, 2016. Mardsen Point Channel Optimisation.

Pinto, L., Fortunato, A.B., Freire, P., 2006. Sensitivity analysis of non-cohesive sediment transport formulae. Cont. Shelf Res. 26, 1826–1839.

Prediction of shallow-water spectra - Collins - 1972 - Journal of Geophysical Research - Wiley Online Library [WWW Document], n.d. URL http://onlinelibrary.wiley.com/doi/10.1029/JC077i015p02693/full (accessed 4.25.16).

Ramli, A., de Lange, W.P., Bryan, K.R., Mullarney, J., 2015. Coupled flow-wave numerical model in assessing the impact of dredging on the morphology of Matakana Banks, in: Proceedings of the Australasian Coasts & Ports Conference.

Ranasinghe, R., Pattiaratchi, C., Masselink, G., 1999. A morphodynamic model to simulate the seasonal closure of tidal inlets. Coast. Eng. 37, 1–36. doi:10.1016/S0378-3839(99)00008-3

Ris, R.C., Holthuijsen, L.H., Booij, N., 1999. A third-generation wave model for coastal regions: 2. Verification. J. Geophys. Res. Oceans 104, 7667–7681. doi:10.1029/1998JC900123

Royal HaskoningDHV, 2016a. Shipping Channel - Concept Design Report, prepared for Refining NZ., Refining NZ Crude Freight Project.

Royal HaskoningDHV, 2016b. Dredging Methodology Assessment.Technical Memo, prepared for Refining NZ., Refining NZ Crude Freight Project.

Royal HaskoningDHV, 2015. Desktop Simulation Study, prepared for Refining NZ., Refining NZ Crude Freight Project.

Smart, G.M., Duncan, M.J., Walsh, J.M., 2002. Relatively rough flow resistance equations. J. Hydraul. Eng. 128, 568–578.

Smith, S.J., Friedrichs, C.T., 2011. Size and settling velocities of cohesive flocs and suspended sediment aggregates in a trailing suction hopper dredge plume. Cont. Shelf Res. 10.

Spearman, J., Bray, R.N., Land, J., Burt, T.N., Mead, C.T., Scott, D., 2007. Estuarine and Coastal Fin Sediments Dyanmics.

Tolman, H.L., Chalikov, D., 1996. Source terms in a third-generation wind wave model. J. Phys. Oceanogr. 26, 2497–2518.

Tolman, H.L., 1991. A Third-Generation Model for Wind Waves on Slowly Varying, Unsteady and Inhomogeneous Depths and Currents. J. Phys. Oceanogr. 21, 782–797.

Tonkin and Taylor, 2016a. Crude Freight Project, Whangarei Harbour - Dredging and disposal options - synthesis report. Tonkin and Taylor.

Tonkin and Taylor, 2016b. Crude Shipping project, Mid-point multi-criteria alternatives assessment. Prepared for ChanceryGreen for Refining NZ.

Tonkin and Taylor, 2016c. Marsden point Refinery - Crude Freight Project, Vibrocore report (No. 30488.1000). Tonkin and Taylor.

Truitt, C.L., 1988. Dredged material behavior during open-water disposal. J. Coast. Res. 489–497.

van der Wegen, M., Dastgheib, A., Jaffe, B.E., Roelvink, D., 2011. Bed composition generation for morphodynamic modeling: case study of San Pablo Bay in California, USA. Ocean Dyn. 61, 173–186.

Van der Wegen, M., Roelvink, J.A., 2008. Long-term morphodynamic evolution of a tidal embayment using a two-dimensional, process-based model. J. Geophys. Res. Oceans 113.

van der Westhuysen, A.J., Zijlema, M., Battjes, J.A., 2007. Nonlinear saturation-based whitecapping dissipation in SWAN for deep and shallow water. Coast. Eng. 54, 151–170. doi:10.1016/j.coastaleng.2006.08.006

Van Rijn, L.C., van Rijn, L.C., van Rijn, L.C., 1993. Principles of sediment transport in rivers, estuaries and coastal seas. Aqua publications Amsterdam.

Van Rijn, L.C., Walstra, D.J.R., Ormondt, M. van, 2004. Description of TRANSPOR2004 and implementation in DELFT3D-ONLINE: final report. Deltares (WL).

Van Rijn, L.C., 2007. A unified view of sediment transport by current and waves, Part II: Suspended transport. J. Hydraul. Eng. ASCE 22.

Van Rijn, L.C., 1984. Sediment Transport Part II: Suspended Load Transport. J. Hydraul. Eng. 110, 1613–1641.

Vitali, L., Monforti, F., Bellasio, R., Bianconi, R., Sachero, V., Mosca, S., Zanini, G., 2006. Validation of a Lagrangian dispersion model implementing different kernel methods for density reconstruction. Atmos. Environ. 40, 8020–8033.

Walstra, D.J.R., Hoekstra, R., Tonnon, P.K., Ruessink, B.G., 2013. Input reduction for long-term morphodynamic simulations in wave-dominated coastal settings. Coast. Eng. 77, 57–70.

Walstra, D.J.R., Roelvink, J.A., Groeneweg, J., 2001. Calculation of wave-driven currents in a 3D mean flow model, in: Coastal Engineering Conference. ASCE AMERICAN SOCIETY OF CIVIL ENGINEERS, pp. 1050–1063.

WEPPE, S., MCCOMB, P., COE, L., 2015. NUMERICAL MODEL STUDIES TO SUPPORT THE SUSTAINABLE MANAGEMENT OF DREDGE SPOIL DEPOSITION IN A COMPLEX NEARSHORE ENVIRONMENT, in: The Proceedings of the Coastal Sediments 2015. World Scientific.

Whitehouse R., et al, 2000. Dynamics of estuarine muds, Thomas Telford, London. ed.

Williams, J.R., Hume, T.M., 2014. Investigation into the decline of pipi at Mair Bank, Whangarei Harbour. Prepared for Northland Regional Council (No. AKL2014-022). NIWA.

Winterwerp, J.C., 2002. Near-field behavior of dredging spill in shallow water. J. Waterw. Port Coast. Ocean Eng. 128, 96–98.

Zhang, Y.L., Baptista, A.M., 2008. A semi-implicit Eulerian-Lagrangian finite element model for cross-scale ocean circulation. Ocean Model. 21, 71–96.

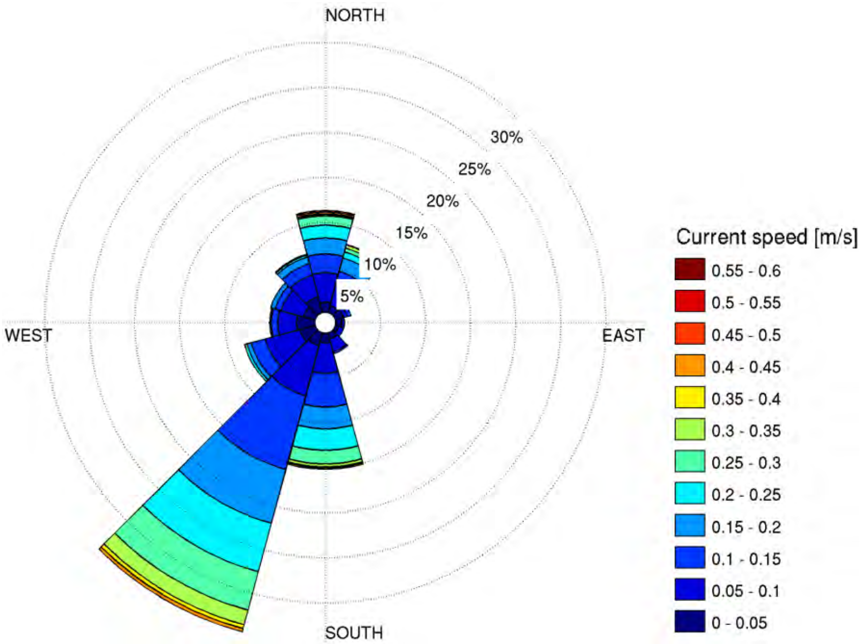
APPENDIX A – LOCATION OF INSTRUMENTS

Geographic coordinates of instruments used to collect data and validate the different models implemented in the present study.

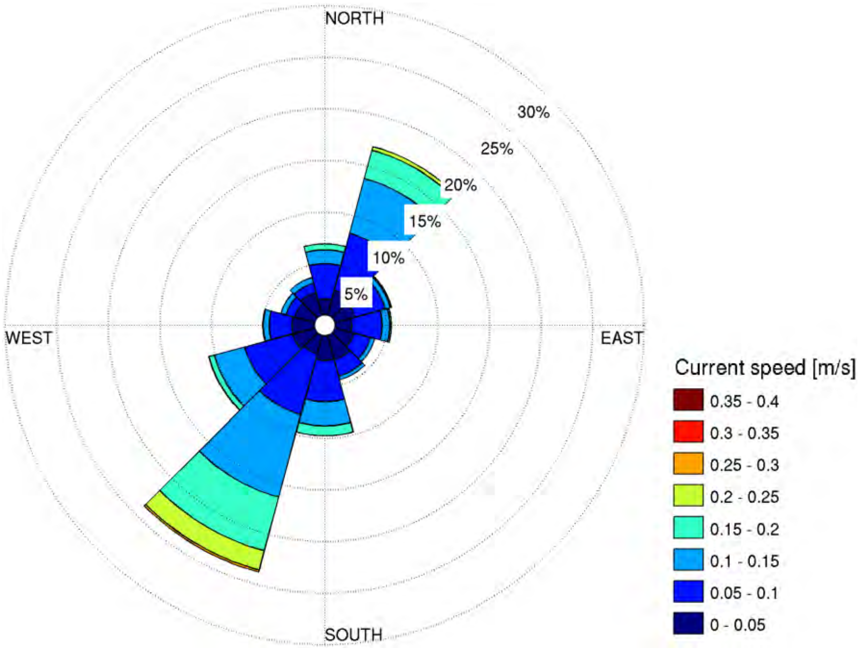
Positions	Description	Geographic coordinates (WGS 84 datum)	
		Longitude (East)	Latitude (North)
WS	Wind station location at Mardsen Point	174.48700	-35.84000
WRB	Wave measurement at tidal delta entrance	174.54830	-35.88310
w1	Wave measurement along Ruakaka Beach	174.46720	-35.90740
w2	Wave measurement along Ruakaka Beach	174.47050	-35.88930
w3	Wave measurement along Ruakaka Beach	174.48140	-35.86800
w4	Wave measurement along Ruakaka Beach	174.50110	-35.84930
ADCP1	Current profiler position in the Parry Channel	174.66077	-35.89648
ADCP2	Current profiler position at Disposal site 3.2	174.59075	-35.912833
ADCP3	Current profiler position at Disposal site 1.2	174.50742	-35.886233
ADCP4	Current profiler position at Disposal site 2.2	174.53307	-35.937559
K17	Water elevation measurement at Port Whangarei (near Hatea river)	174.35120	-35.75750
P10	Water elevation measurement near Portland	174.34890	-35.80330
Parua	Water elevation measurement at the Parua Bay entrance	174.37950	-35.77600
W2	Water elevation measurement between Tamaterau and Rat Island	174.45160	-35.79970

APPENDIX B – MEASURED CURRENTS

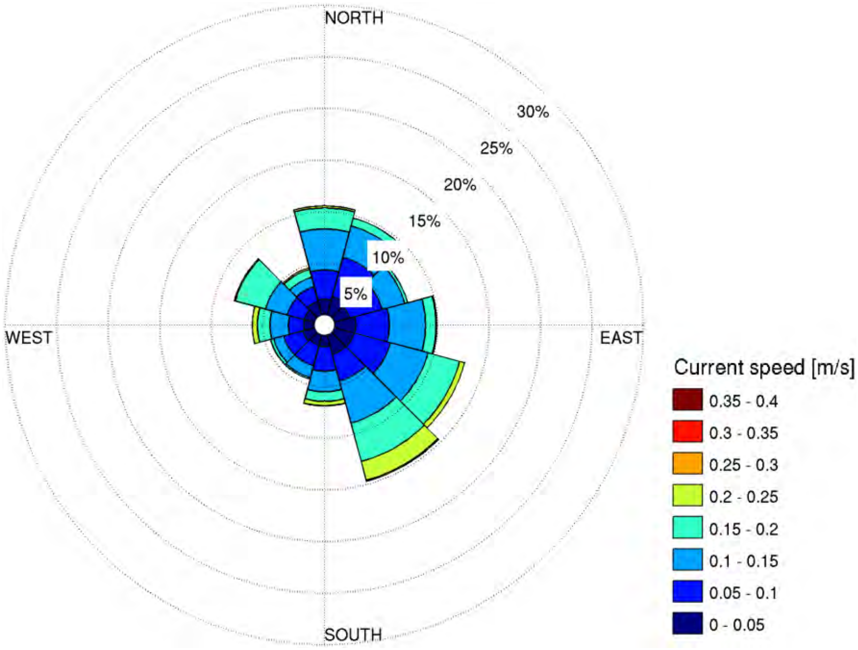
Time series and rose plots of the depth-averaged measured currents at sites ADCP1-4.



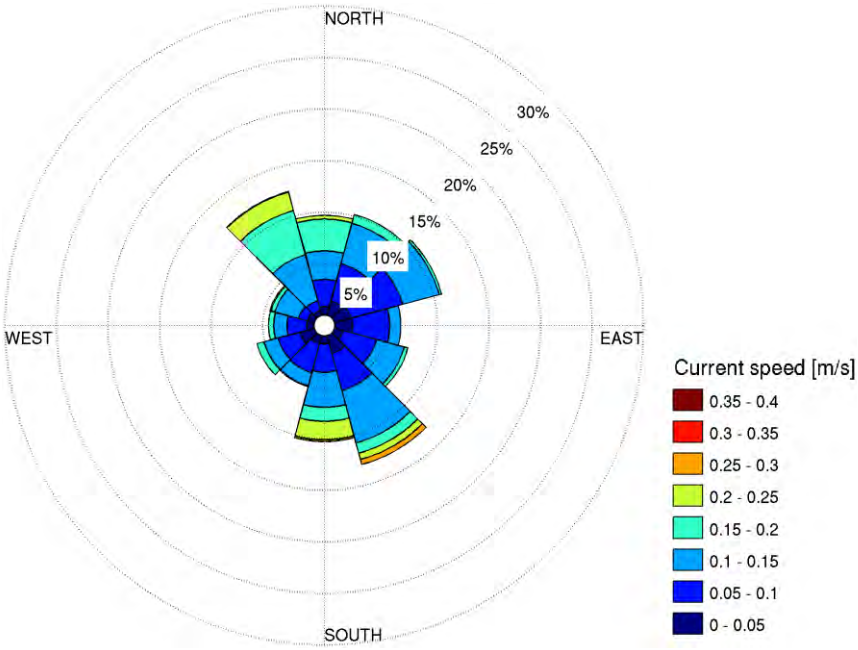
ADCP1



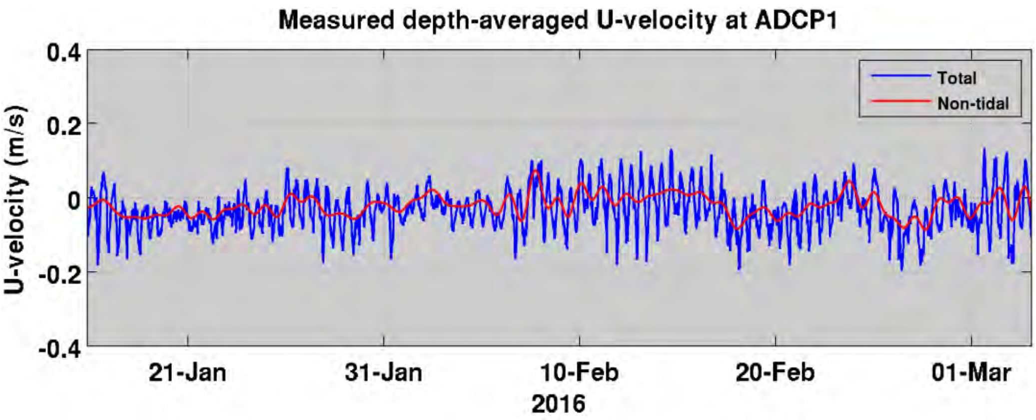
ADCP2

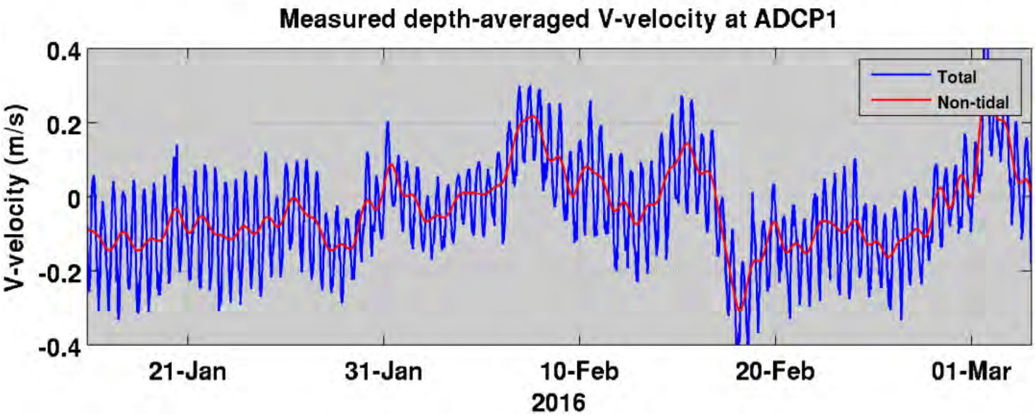

NORTH
30%
25%
20%
15%
10%
5%
WEST
EAST
SOUTH
Current speed [m/s]
0.35 - 0.4
0.3 - 0.35
0.25 - 0.3
0.2 - 0.25
0.15 - 0.2
0.1 - 0.15
0.05 - 0.1
0 - 0.05

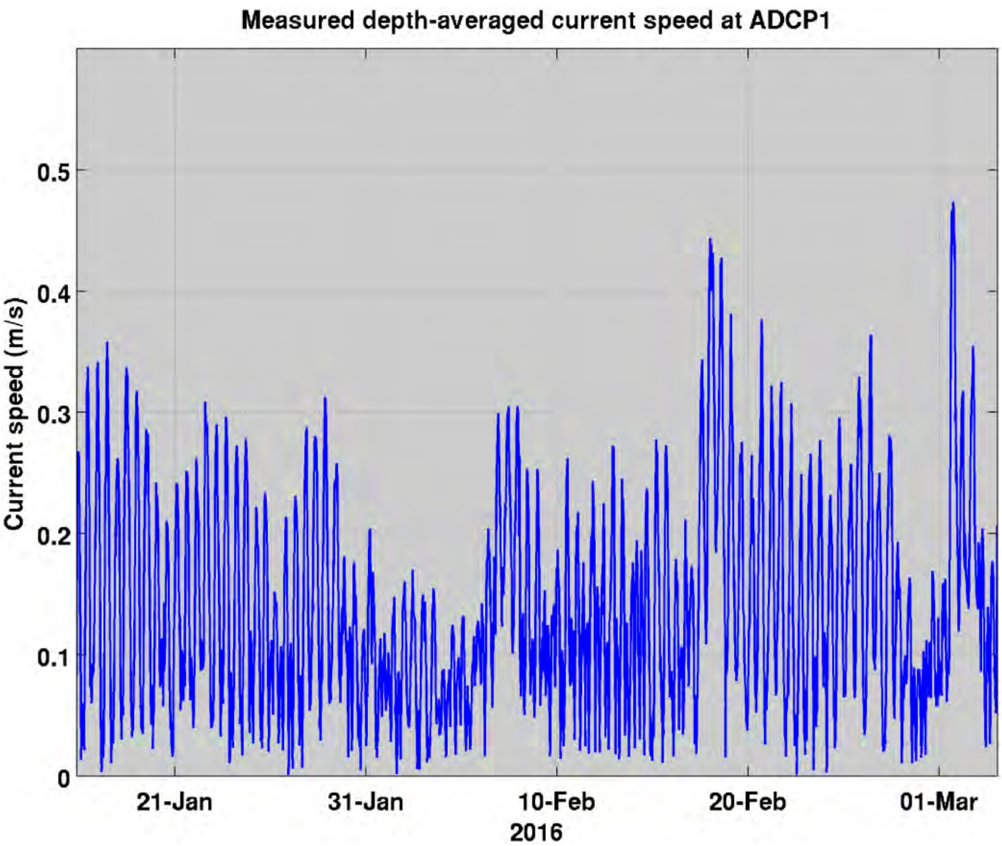
ADCP3

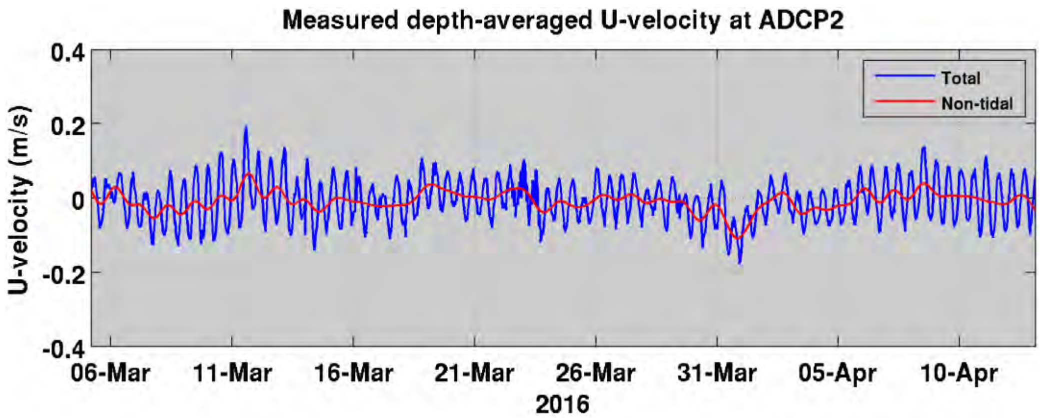

NORTH
30%
25%
20%
15%
10%
5%
WEST
EAST
SOUTH
Current speed [m/s]
0.35 - 0.4
0.3 - 0.35
0.25 - 0.3
0.2 - 0.25
0.15 - 0.2
0.1 - 0.15
0.05 - 0.1
0 - 0.05

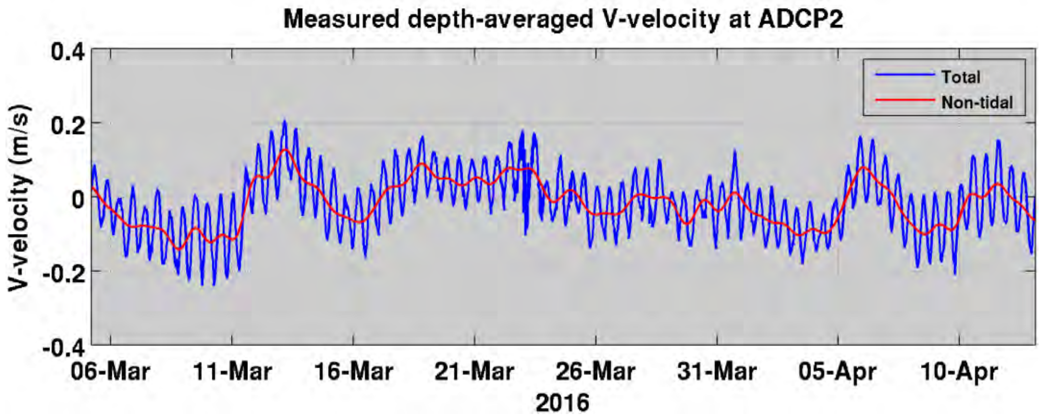
ADCP4

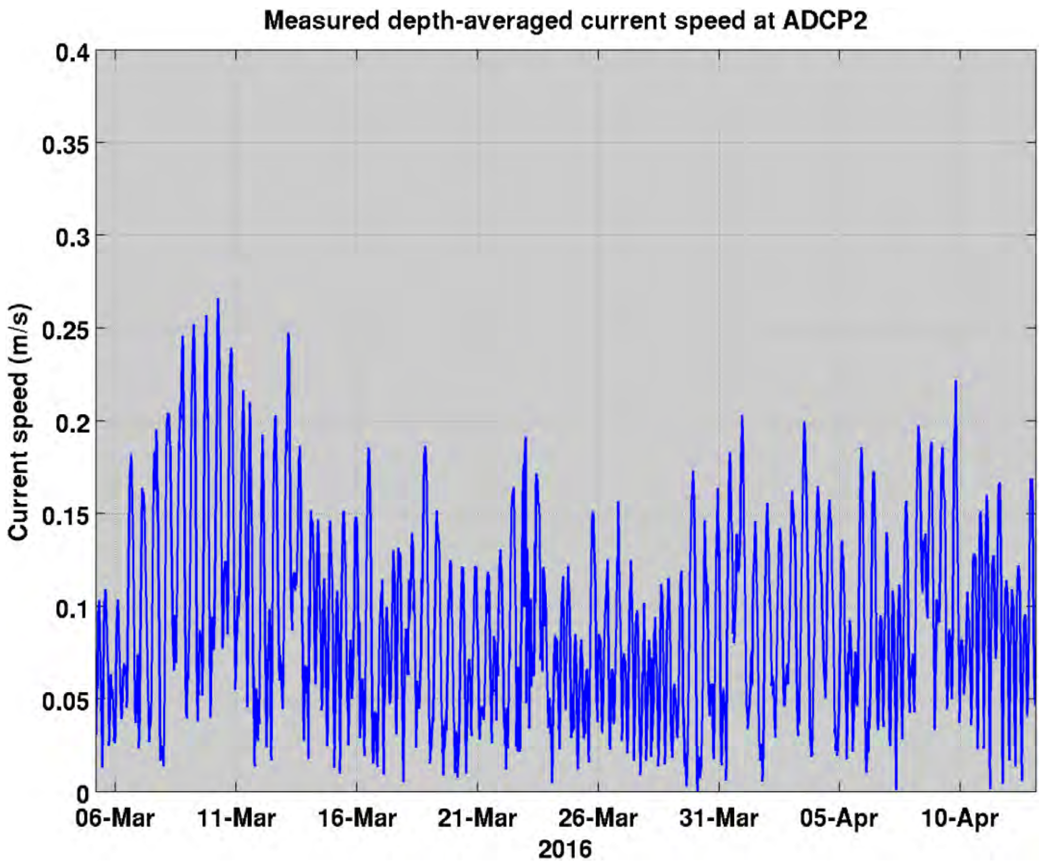

Measured depth-averaged U-velocity at ADCP1
U-velocity (m/s)
0.4
0.2
0
-0.2
-0.4
Total
Non-tidal
21-Jan
31-Jan
10-Feb
20-Feb
01-Mar
2016

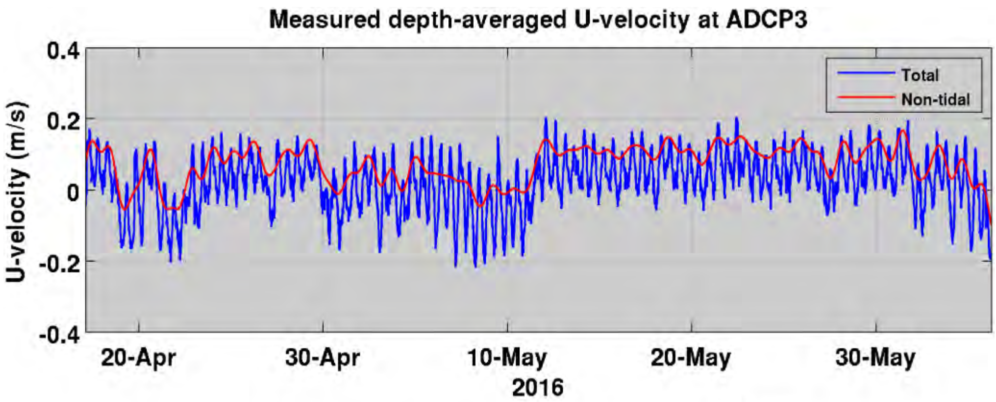

Measured depth-averaged V-velocity at ADCP1
V-velocity (m/s)
0.4
0.2
0
-0.2
-0.4
Total
Non-tidal
21-Jan
31-Jan
10-Feb
20-Feb
01-Mar
2016

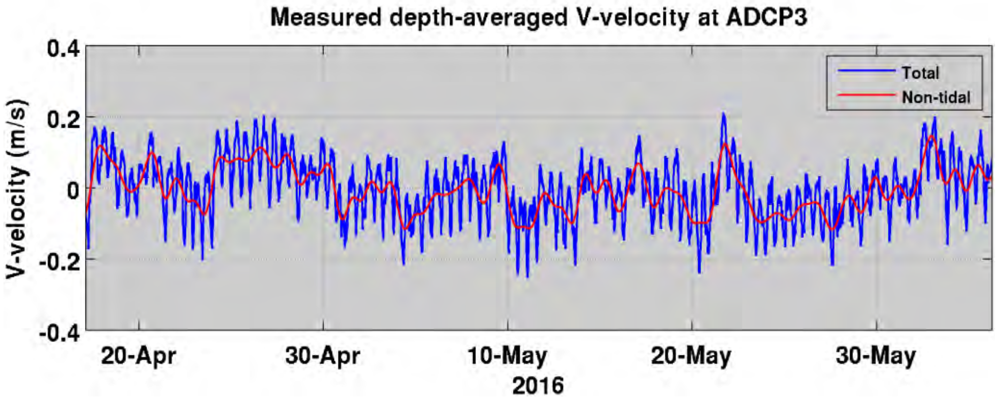

Measured depth-averaged current speed at ADCP1
Current speed (m/s)
0.5
0.4
0.3
0.2
0.1
0
21-Jan
31-Jan
10-Feb
20-Feb
01-Mar
2016

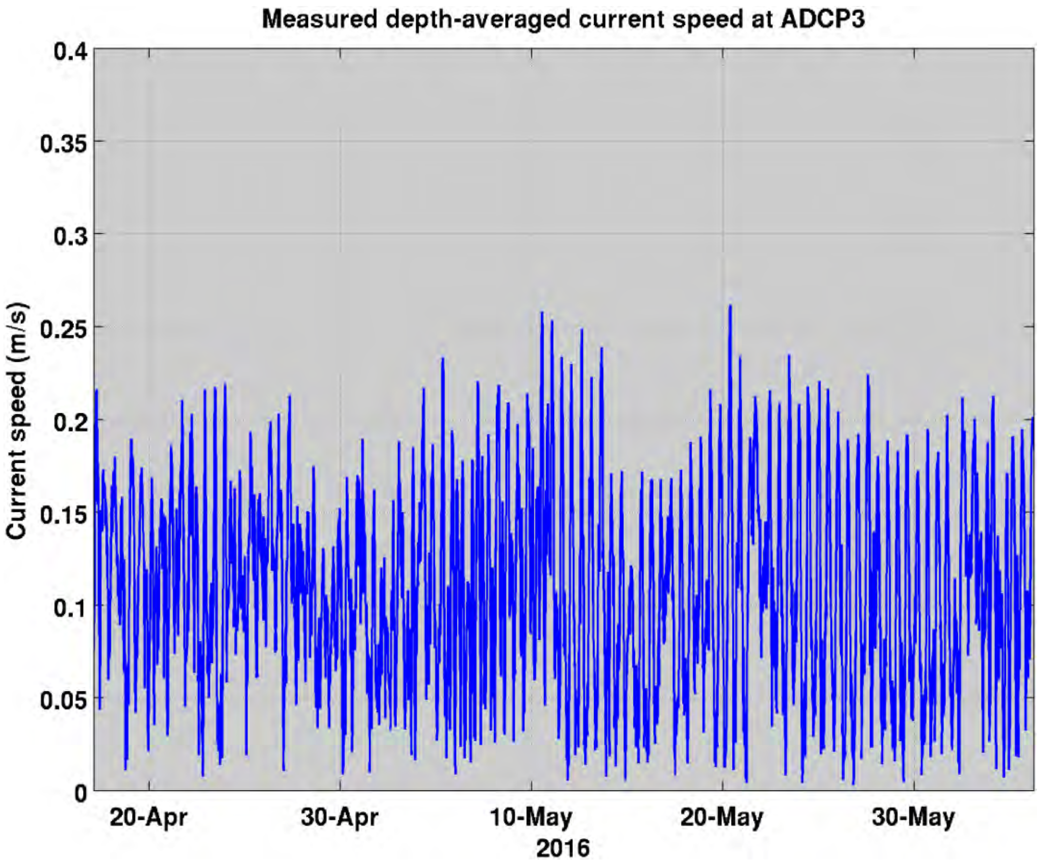

Measured depth-averaged U-velocity at ADCP2
U-velocity (m/s)
0.4
0.2
0
-0.2
-0.4
Total
Non-tidal
06-Mar
11-Mar
16-Mar
21-Mar
26-Mar
31-Mar
05-Apr
10-Apr
2016

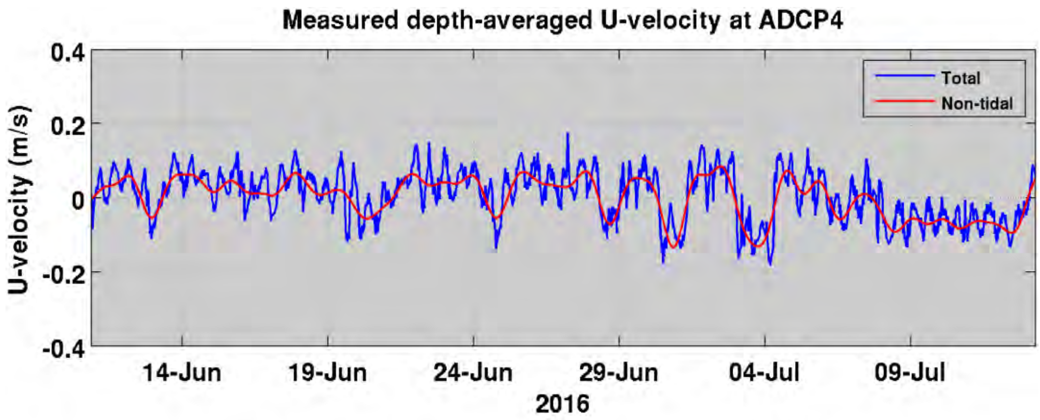

Measured depth-averaged V-velocity at ADCP2
V-velocity (m/s)
0.4
0.2
0
-0.2
-0.4
Total
Non-tidal
06-Mar
11-Mar
16-Mar
21-Mar
26-Mar
31-Mar
05-Apr
10-Apr
2016

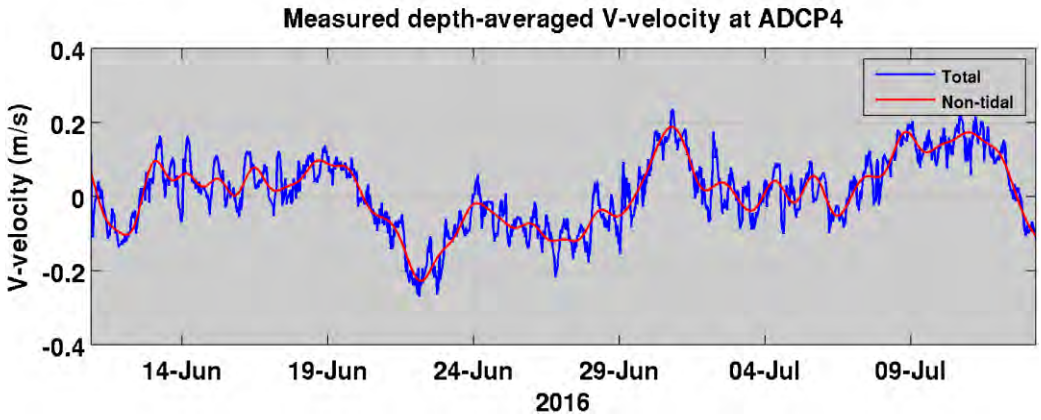

Measured depth-averaged current speed at ADCP2
Current speed (m/s)
0.4
0.35
0.3
0.25
0.2
0.15
0.1
0.05
0
06-Mar
11-Mar
16-Mar
21-Mar
26-Mar
31-Mar
05-Apr
10-Apr
2016

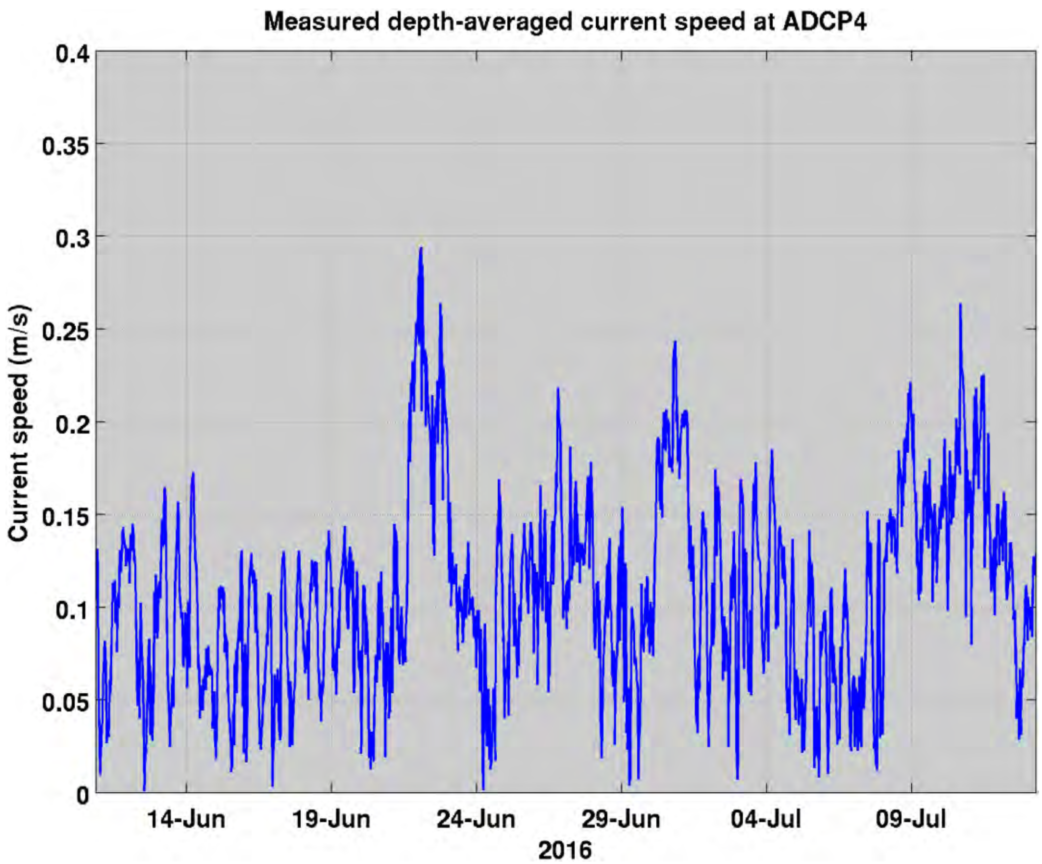

Measured depth-averaged U-velocity at ADCP3
Total
Non-tidal
U-velocity (m/s)
0.4
0.2
0
-0.2
-0.4
20-Apr
30-Apr
10-May
20-May
30-May
2016


Measured depth-averaged V-velocity at ADCP3
Total
Non-tidal
V-velocity (m/s)
0.4
0.2
0
-0.2
-0.4
20-Apr
30-Apr
10-May
20-May
30-May
2016


Measured depth-averaged current speed at ADCP3
Current speed (m/s)
0.4
0.35
0.3
0.25
0.2
0.15
0.1
0.05
0
20-Apr
30-Apr
10-May
20-May
30-May
2016


Measured depth-averaged U-velocity at ADCP4
Total
Non-tidal
U-velocity (m/s)
0.4
0.2
0
-0.2
-0.4
14-Jun
19-Jun
24-Jun
29-Jun
04-Jul
09-Jul
2016


Measured depth-averaged V-velocity at ADCP4
Total
Non-tidal
V-velocity (m/s)
0.4
0.2
0
-0.2
-0.4
14-Jun
19-Jun
24-Jun
29-Jun
04-Jul
09-Jul
2016


Measured depth-averaged current speed at ADCP4
Current speed (m/s)
0.4
0.35
0.3
0.25
0.2
0.15
0.1
0.05
0
14-Jun
19-Jun
24-Jun
29-Jun
04-Jul
09-Jul
2016

APPENDIX C – LOCATION OF RELEASE SITES

Geographic coordinates of release sites used for the dredging and the disposal plume modelling.

Positions	Geographic coordinates (WGS 84 datum)	
	Longitude (East)	Latitude (North)
R0	174.501963	-35.837500
R1	174.507890	-35.835210
R2	174.520148	-35.847333
R3	174.523247	-35.862960
R4	174.538100	-35.878500
R5	174.545600	-35.885700
R6	174.521125	-35.842327
PW	174.581275	-35.915609
PN	174.588669	-35.904212
PE	174.600443	-35.910711
PS	174.594556	-35.922250
ADCP	174.590750	-35.912833

Annexure Two: Technical Reports

b) **Predicted physical environmental effects from channel deepening and offshore disposal. MetOcean Solutions Limited. Peter McComb, Florian Monetti, Brett Beamsley and Sarah Gardiner. Dated 25th July 2017**

METOCEAN SOLUTIONS

Specialists in Oceanography and Meteorology

CRUDE SHIPPING PROJECT, WHANGAREI HARBOUR

Predicted physical environmental effects from channel deepening and offshore disposal

Report prepared for Chancery Green for Refining NZ

MetOcean Solutions Ltd: Report P0297-02

July 2017

Report status

Version	Date	Status	Approved by
RevA	19/06/2016	Draft for internal review	Monetti
RevB	21/06/2016	Draft for internal review	McComb
RevC	24/06/2016	Draft for client review	Gardiner
RevD	12/08/2016	Updated draft for internal review	Monetti
RevE	16/08/2016	Updated draft for internal review	McComb
RevF	23/08/2016	Updated draft for client review	Gardiner
RevG	20/10/2016	Updated draft for client review	Monetti
RevH	19/01/2017	Updated draft for client review	Monetti
Rev0	07/02/2017	Draft for public consultation	Monetti
Rev1	25/07/2017	Final version	Monetti

It is the responsibility of the reader to verify the currency of the version number of this report.

Acknowledgements

Thanks to Ross Sneddon from the Cawthron Institute for ADCP deployment and data collection.

Thanks to Ricky Eyre from Northland Regional Council for supplying LIDAR and single-beam data for Whangarei Harbour, Stuart Caie from LINZ for supplying offshore multi-beam data and historic survey data of Mair Bank and Jae Staite from Northport Ltd for supplying multi-beam survey data for main channel and multiple historic surveys of Mair Bank.

PO Box 441, New Plymouth, New Zealand
T: 64-6-7585035 E: enquiries@metocean.co.nz
www.metocean.co.nz

EXECUTIVE SUMMARY

Refining NZ is investigating options for the deepening and realignment of the shipping channel leading to the Marsden Point Refinery at the entrance to Whangarei Harbour.

Given the emphasis on preserving or enhancing the environment, one of the most critical aspects affecting the regulatory approval of such a project is the assessment of its impacts on the existing environment. MetOcean Solutions participation in the impact assessment for the project has involved an evaluation of the physical effects of the channel deepening on the wave, current and sediment dynamics of the harbour entrance, the effects of dredging and disposal on water quality, and the effects of sediment disposal on the receiving environment. This has been undertaken through the use of a suite of numerical model investigations supported by empirical data, observations and historical / contemporary measurements.

The study investigations are presented in two reports. The first report (MSL Report P0297-01) is a technical reference document that provides details on the establishment of numerical models for wind, wave, current and sediment dynamics, and the data collection programme that was undertaken to support the model establishment and to validate the numerical schemes. The present report (MSL Report P0297-02) summarises the existing physical environment and outlines the likely effects of the Crude Shipping Project on the wave, hydrodynamic and short- and long-term sediment dynamics. This is also a technical reference document.

The dominant physical processes at both regional and local scales have been replicated through the application of industry-standard numerical models based on published scientific methodologies and the background knowledge acquired from numerous previous numerical modelling studies. Several models were investigated and the most appropriate ones chosen for the domain of application. Wherever possible, models were validated using historical and contemporary oceanographic data sets. The models chosen are considered suitable for characterising the dominant physical processes in the region and also for identifying the potential physical effects arising from the Crude Shipping Project.

Bathymetry and sediment character

The surficial sediments within the main channel of Whangarei Harbour are a mix of sands and coarser material (likely to be shell) in varying proportions. Coring has shown that a minor fraction of silty material is also found at depth. The subtidal regions of the ebb tidal shoal are mainly made up of sandy material. This is true for the region south of Mair Bank as well as the edge of Mair Bank adjacent to the channel. The intertidal region of Mair Bank is covered with a shell substrate, mostly consisting of pipi shells, with deposits of fine sands in the lee of shell ridges. With increasing water depth the amount of sand interspersed with the shells increases down the edge of the bank. The results presented here support the assertions in previous literature that sediment reworking and biological activity are important processes on Mair Bank that govern its morphology. However, as a large scale ebb tide delta, it is relatively stable in position.

Based on the characterisation of the existing environment and extensive modelling of the wave, hydrodynamic and sediment dynamics, a summary of the predicted effects of the Crude Shipping Project is as follows.

Wave climate

The proposed channel modifications are not expected to fundamentally change the wave climate in the vicinity of the harbour entrance. However, there are areas where the wave climate will change slightly as a result of deepening the channel, with a different degree of significance depending on the location.

Outside the harbour entrance, the overall changes in the mean significant wave height fields are very subtle and do not exceed 2 cm. During infrequent storm events associated with offshore significant wave height of more than 5 m, the significant wave height may increase by 5 to 10% outside the harbour entrance, corresponding to a small increase of few centimetres (< 15 cm) of the significant wave height. The western edge of the channel entrance near Busby Head may occasionally experience an increase of the significant wave height up to 20% (~20 cm) during extreme events due to enhanced refraction. Such changes in the wave height fields are expected to be constrained to a limited area of the tidal delta shoal where bottom friction processes dissipate a large fraction of the incident wave energy. The increase of the wave energy during extreme storm events due to the dredging are thus predicted to be inconsequential for the adjacent beaches, sand banks, Marine 1 Management Areas or Marine Reserves.

The offshore extent of the deepened channel slightly modifies the refraction pattern of waves at the delta entrance. Enhanced refraction occurring along the eastern margin of the deepened channel is predicted to increase wave height at Busby Head and Smugglers Bay up to a maximum of 15 cm when offshore wave heights are around 5 m during storm events. Conversely, a minor decrease of wave height (-1 cm on average) is expected along sections of Ruakaka Beach. Note that modifications of the wave refraction at the distal margin of the channel may generate a zone to the north of the Ruakaka River mouth characterised by a slight increase in wave height (up to a 5 cm maximum during storms). Changes in wave height over Mair Bank are not expected to exceed 1 cm on average and 5 cm during extreme wave events. No consequences for recreational surfing activities along Ruakaka Beach are therefore expected.

Tidal hydrodynamics

The proposed channel modifications are not expected to change the overall tidal hydrodynamics of the harbour entrance, and the existing complex asymmetries induced by the ebb and flood tidal flows will be maintained after deepening. However, there are areas where the tidal hydrodynamics of Whangarei Harbour will be changed as a result of deepening the channel, with a different degree of significance depending on the location.

There will be a reduction in the peak tidal speed by up to 0.10 $m.s^{-1}$ in the main channel and an acceleration of up to 0.10 $m.s^{-1}$ in some areas adjacent to the channel. Removal of the lobe in the central channel (north of Mair Bank) is predicted to result in a localised decrease of up to 0.15 $m.s^{-1}$ (from 0.5 to 0.35 $m.s^{-1}$) while the current speed is expected to increase from 0.05 to 0.09$m.s^{-1}$ along the northern flank of the inlet channel between Motukaroro Island and High Island. The subtle realignment of the channel by removal of the toe on some of the bends has a localised influence on the tidal flows in the channel for both the ebb and the flood tidal stages. Both ebb and flood flows on the delta margin will be slightly reoriented by the dredged channel and exhibit areas of flow acceleration and deceleration - up to 0.02 ms^{-1}. The deepening is predicted to reduce the peak bed shear stress in the main channel by up to 20% in the area adjacent to Marsden Point and cause small localised increases and decreases up to 30% over areas of the delta during the flood tidal stage. The percentage of time the bed shear stress exceeds the critical threshold for entrainment of 200 μm sand is predicted to increase by approximately 10% over the eastern margin of the channel close to Busby Head at flood tides. This area currently features a slight bathymetric indentation, and it may be an area of active (and asymmetric) sediment transport.

Sediment transport

The proposed channel modifications are not expected to significantly change the governing sediment dynamics of the harbour entrance, and the existing complex asymmetries induced by the ebb and flood tidal flows will be maintained after deepening.

The morphodynamics of Mair Bank are largely influenced by the bio-stabilisation provided by live shellfish and their residual shell fragments. This bio-stabilisation is expected to play a more significant role on future evolution of the Bank than the effect of the proposed channel deepening. The studies undertaken here do not indicate that channel deepening will materially change the sedimentary outcomes on the Mair Bank.

The sedimentary stability of Ruakaka Beach is not expected to be influenced by the slight variation in the wave conditions caused by channel deepening. However, enhanced wave refraction along the eastern ridge of the channel on the delta may increase the bed shear stress around Busby Head somewhat and Smugglers Bay in a lesser extent, although this not anticipated to disturb the stability of the sea bed, which is largely composed of sandy and shelly gravel and already occasionally subjected to 4 m wave height during storms.

Sedimentation is expected to occur immediately adjacent to the Marsden Point jetty. Here, the tidal flows reduce and the tidal asymmetry is expected to promote infilling of the deepened areas over time at a relatively constant rate. While a reliable volumetric estimate is difficult to make with confidence, the likely evolution pattern will be of accretion from the southern shore. A degree of infilling at the toe of Mair Bank may occur where the channel has been realigned. These areas of sedimentation will require regular maintenance dredging to ensure on-going navigability.

Infilling of the main channel south of Busby Head toward the distal margin is expected, and a programme of maintenance dredging will also be required here for ongoing navigability. The deepened channel is exposed to diffusive infilling from wave action and there is a predicted change to the location and width of the ebb tide jet along with an increase in the sediment flux from the adjacent channel margins. The source of infilling material to the channel is the adjacent delta and the rate of accretion is expected to decrease over time until equilibrium is reached. The initial infilling of this part of the channel is calculated to be 86,000 m^3 per year, with a margin of error of ±36,000 m^3.

Dredging plumes

The plume dispersion associated with two different (large and small) trailing suction hopper dredgers (TSHD), one cutter suction dredger (CSD) and one Backhoe Dredger (BHD) was simulated in the present study. The sediment plumes associated with dredging, caused by the action of the drag head, are constrained within the lower water column, with negligible expression at mid-water and surface levels. In contrast, the sediment plumes associated with the overflow phase are spread across the entire water column. The resultant plumes from either source are predicted to follow the general channel alignment, consistent with the tidal currents. A SSC threshold of 12 mg/L was selected. This corresponds to the difference between the 15 NTU level Response Limit and the 3 NTU existing background level (Brian T. Coffey and Associates Limited, 2016a) considering a 1:1 relationship between SSC and Turbidity. This linear relationship was established by Stewart (2017) analysing vibro-core samples from the dredging footprint. The maximum excursion of any plume modelled did not exceed 1200 m with the maximum extension evident near the bottom of the channel. All plumes were confined to the channel. There is no evidence of the plume dispersing to the adjacent beaches, sand banks, Marine 1 Management Areas and Marine Reserves. The sensitivity analysis carried out based on more conservative configurations of the sediment release did not show any fundamental changes in the plume dispersion.

Of the two dredge vessels considered for this study, the large dredge vessel generates more extended and concentrated plumes than the smaller vessel. The overflow duration has a notable effect on the magnitude and extent of the plumes. Comparisons between plumes generated for the existing channel and the post-dredging scenario indicates that the plume excursions will decrease slightly as the channel becomes deeper due to the slightly reduced tidal velocities.

The SSC plumes associated with dredging operations using the CSD or the BHD at the Refining New Zealand (RNZ) jetty pocket were characterised by a lower horizontal extension, with no evidence of plume dispersion to the adjacent beaches, sand banks, Marine 1 Management Areas and Marine Reserves. In the case of the CSD, the sediment release was caused by the effect of the rotating cutter head and therefore constrained to the bottom water layer. The discharge of sediments using floating pipelines avoids any sediment discharges over the extent of the water column by overflow. The anticipated plume dispersion associated with the use of the CSD for the dredging operations is predicted to be within the plume range associated with the use of the TSHD. For this reason, the CSD plume modelling was not repeated at all the dredging locations over the proposed channel.

Simulations of dredging with the proposed BHD led to sediment discharges over the entire water column due to the excavation, hoisting and slewing phases. The relative low production rate of the BHD associated to the bucket limits the release of a large amount of sediment per hour and thus the SSC.

Disposal ground dynamics

Numerical testing of the proposed offshore disposal ground (Area 3.2) at 40-45 m depth in Bream Bay shows that the wave and current regime can occasionally mobilise sediments in this area. This will only occur during more energetic storm conditions, when sediments can be transported in suspension or by bedload processes. Following the outcomes from the consultations involving RNZ and the relevant experts, the study considered a conservative estimate of a 4 m high disposal mound over the 2 km^2 area of Disposal site 3.2, and area that can contain the capital dredge volume plus the placement of maintenance dredge volumes over 35 years. For this scenario, the percentage of erosion of the disposal mound after 1 year is not expected to exceed 5% (i.e. 400,000 m^3) of the total volume based on an 8 million m^3 disposal mound (conservative approach). The predicted rate of movement of sediment from the site is very low and essentially omni-directional, however there is a slight bias towards transport to the south. After one year, the extent of movement of sediment was predicted to be very limited, and modelled sediments did not reach any of the sensitive areas identified such as beaches, Marine Reserves, Marine 1 Management Areas or 3 Mile Reef. The predicted maximum changes to the nearshore wave climate caused by the presence of a disposal mound will be very minor and are not expected to exceed +/- 5 cm under the larger wave conditions. This is not expected to have any consequence for the beach or nearshore processes, including surf activities at any areas (including proximate to Ruakaka River).

The location of Disposal Site 1.2 on the flank of the ebb tidal delta for the disposal of 2.5 – 5% of the capital dredge volume and up to 100% of the maintenance dredge volume favours the replenishment of the delta and adjacent beach over years. The net transport from the disposal ground is directed onshore and recirculation back into the channel is not predicted. For an example mound of 0.6 m height, approximately 8% of the volume would be moved out of the site over the course of one year, from which it would contribute positively to the nourishment of the adjacent beach areas. The Disposal mound 1.2 is predicted to cause changes in the significant wave height fields which do not exceed a maximum of 5 cm and 10 cm (< 5%) along the shoreline and near the mound, respectively. These estimations are based on a highly conservative approach which includes the placement of the maintenance dredge volumes over 10 years without considering the reduction of the disposal mound due to erosion over years. In this context, surf conditions along Ruakaka Beach are not expected to be affected by the placement of dredge material at Disposal sites 1.2 and 3.2.

Disposal plumes

The plumes caused by the offshore disposal are short lived and not highly dispersive. They typically extend along a northeast – southwest axis, preserving the adjacent reef from settlement, and 99% of the plume material is predicted to settle to the seabed within 14 hours. The disposal plumes calculated from the measured current profiles have a lesser excursion than those determined from the long term environmental hindcast, and do not show incursion towards the adjacent 3 Mile Reef to the west of the proposed disposal ground.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

1. INTRODUCTION

Refining NZ (RNZ) is investigating options for the deepening and realignment of the shipping channel leading to the Marsden Point Refinery at the entrance to Whangarei Harbour. Increasing the navigable depth is necessary to allow vessels with increased draft to safely transit to the refinery. MetOcean Solutions Ltd (MSL) have been contracted to provide coastal oceanographic expertise and investigate the potential effects of channel deepening on the physical environment. The scope of work includes i) an evaluation of the wave, hydrodynamic and sediment dynamic regime throughout the Whangarei Harbour entrance region, ii) consideration of the effects of capital and maintenance dredging on this environment, iii) potential effects on the coastal sediment budgets, iv) the stability of the adjacent beaches and the sub-tidal delta, and v) the effects of dredging and disposal on water quality in the receiving environment. A flow chart of the study processes is shown in Figure 1.1, and a map of Whangarei Harbour with the different locations referred to in the study is presented in Figure 1.2. A map showing the proposed deepening is presented in Figure 1.3. The location of the proposed disposal grounds for the placement of capital and maintenance volumes is shown in Figure 1.4.

The study investigations are presented in two reports:

- The first report (MSL Report P0297-01) is a technical reference document that provides details on the establishment of numerical models for wind, wave, current and sediment dynamics, and the data collection programme that was undertaken to support the model establishment and to validate the numerical schemes.

- The present report (MSL Report P0297-02) first characterises the existing environment and then investigates the likely physical effects of the Crude Shipping Project. This is also a technical reference document.

1.1. Report structure

This report is structured as follows. The bathymetry sources and sediment sampling results used for the present study are presented in Section 2. The wind and wave climate is described in Sections 3 and 4, respectively. Section 4 also includes the predicted effects of the channel deepening on the wave climate. The regional hydrodynamic regime is described in Section 5. The nearshore hydrodynamic regime and the expected changes caused by the channel deepening are presented in Section 6. The existing sediment dynamics and predicted effects of the channel deepening are provided in Section 7. Results of the dredging plume modelling are provided in Section 8, while predictions of the disposal ground dynamics and the disposal plume dispersion are provided and discussed in Sections 9 and 10. The executive summary is presented at the beginning of the report.

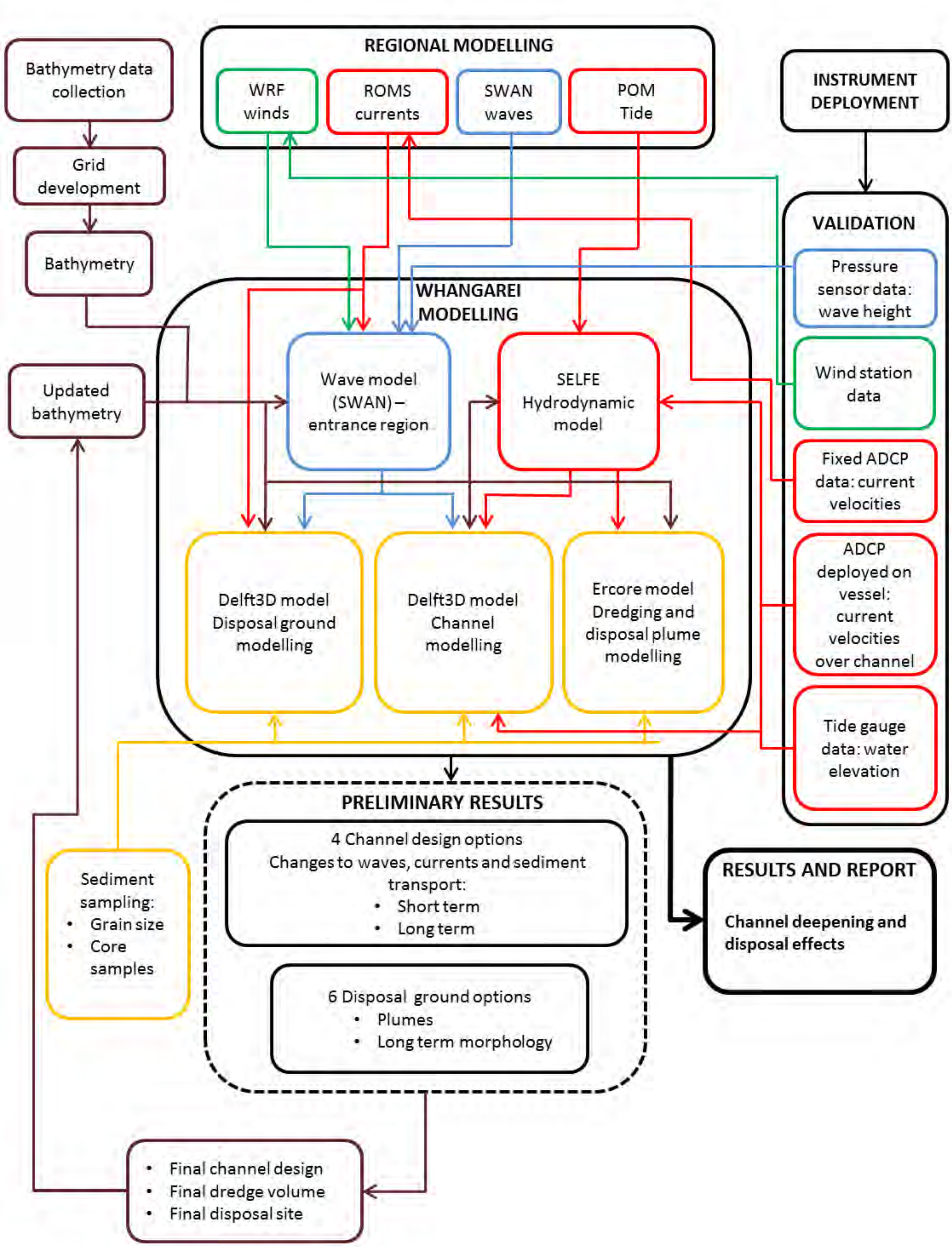


Figure 1.1 Flow chart showing the numerical modelling process for the study. Red lines indicate hydrodynamics; blue indicate waves; green indicate wind, brown indicate bathymetry and yellow lines indicate sediments / grain size.

1.2. Study Area

The different locations referred in the present report for the description of the effect of the deepening channel on the coastal dynamics at Whangarei Harbour are summarised in Figure 1.2.

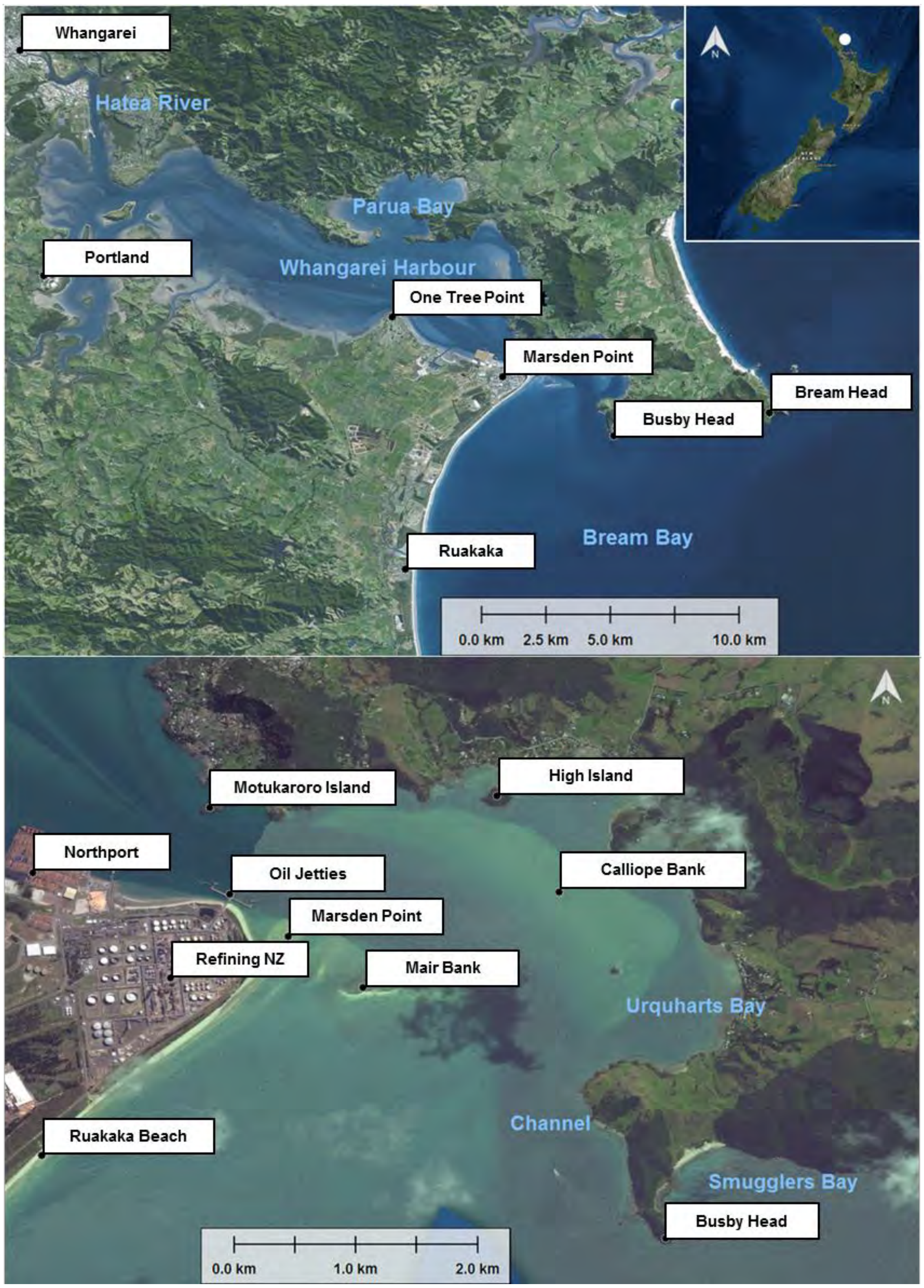


Figure 1.2 Maps of Whangarei Harbour (top) and its entrance (bottom) with the locations used in the present study for the establishment of the numerical models and the description of the effect of the channel deepening on the coastal dynamics.

1.3. Proposed channel deepening design

As part of the Crude Shipping Project, RNZ commissioned Royal Haskoning DHV (RHDHV) to define an optimal navigation channel design, including the associated dredging requirements, in order to provide high water access for vessels with increased draft to safely transit to the Crude Jetty.

Different options for the channel design (RHDHV Shipping Channel - Concept Design Report, Royal HaskoningDHV, 2016a) were provided and discussed with RNZ. An Under Keel Clearance study was completed by OMC in the OMC International (2016) - Marsden Point Channel Optimisation report, based on the channel designs provided by RHDHV and the long period wave analysis performed by MSL. Further assessment of the channel was undertaken from a navigation perspective (RHDHV Report - Desktop Simulation Study, Royal HaskoningDHV, 2015). The Option 4.2 was the stated preferred option from a channel design perspective and was confirmed via the alternatives assessment work presented in Tonkin and Taylor (2016a).

For the present study, Option 4.2 has been adopted as the design case for the numerical modelling. Details about the characteristics of the proposed channel and corresponding dredging requirements are described in Royal HaskoningDHV, 2016b, as part of the dredging methodology assessment provided by RHDHV to RNZ.

An overview of the proposed channel design (Option 4.2) and the resultant differences between existing and post-dredging bathymetries are shown in Figure 1.3 based on the depth datasets used by MSL to setup the model water depth.

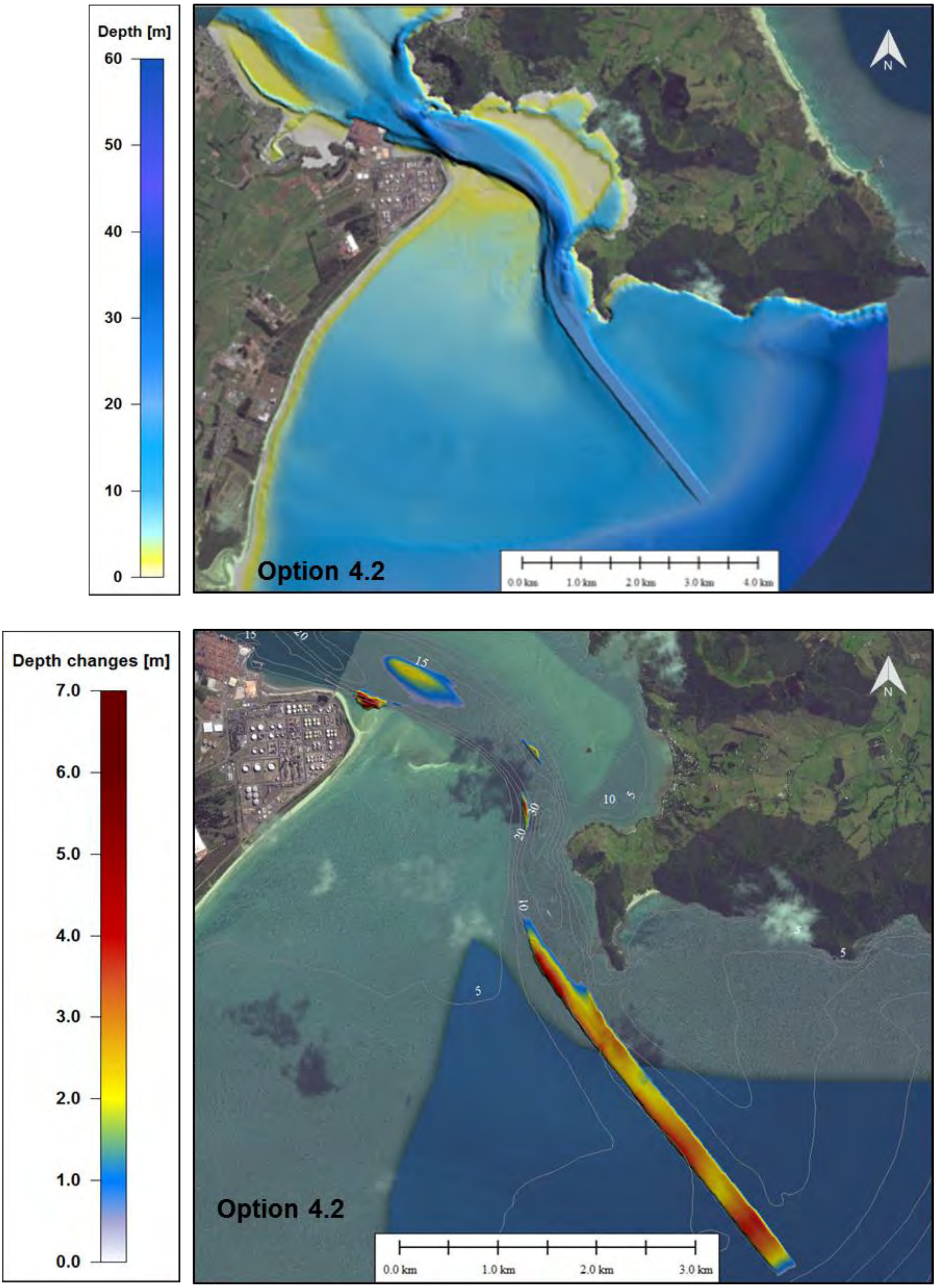


Figure 1.3 Depths (upper plot) and depth differences (lower plot) between the Option 4.2 channel design and the existing channel configuration. Positive amplitudes indicate a deepening of the channel.

1.4. Proposed disposal ground designs

A selection process was adopted to identify the preferred location to dispose the capital and maintenance volumes from the Crude Shipping Project. Two disposal sites are currently considered by RNZ (Tonkin and Taylor, 2016a) as potential options for the disposal of capital and maintenance dredge spoils volumes (see Figure 1.4):

- Disposal Site 1.2 (yellow polygon) is located over the south-western flank of the tidal delta where depths range between 2 and 10 m. Its distance from Ruakaka Beach and Busby Head is approximately 2 km and 1.6 km, respectively. This disposal site is considered by RNZ as an option for the placement of maintenance volume and up to 5% of the capital dredging volume and the site has therefore been investigated in the present study.

- Disposal Site 3.2 (red polygon) is an area measuring approximately 2 km^2, which ranges in depth from 41 to 48 m. This option for the disposal of capital volumes is located approximately 3.5 km south of Bream Head and 700 m east of 3 Mile Reef. Its distance from Busby Head and the inlet entrance is approximately 7 km. This disposal site is considered the preferred option for the placement of up to 95% of the capital volume and from up to 100% of the maintenance volume by RNZ and the area was therefore investigated in the present study.

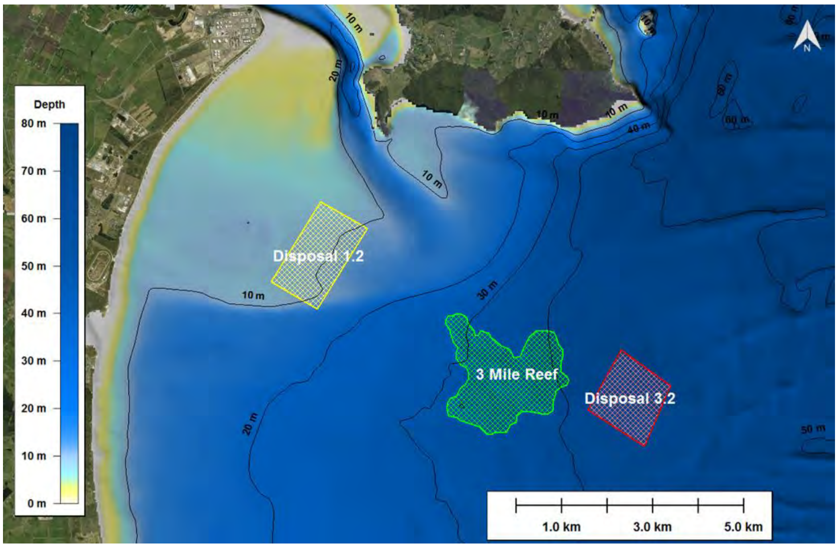


Figure 1.4 Location of sites 1.2, and 3.2 (indicated by coloured diagonal cross-hatch polygons) for the disposal of capital and maintenance volumes. 3 Mile Reef, indicated by a green polygon, is a sensitive reef because of its benthic encrusting communities.

2. BATHYMETRY AND SEABED CHARACTER

This section provides details on the bathymetry of Whangarei Harbour, and outlines the seabed analysis used as fundamental inputs to the numerical models.

2.1. Bathymetry

Bathymetry is an essential requirement for modelling. MSL has compiled an extensive national and regional bathymetric dataset from various sources, which have been used and validated in previous hydrodynamic studies. These datasets were updated with the latest Whangarei Harbour, main channel and offshore surveys. Specialist data manipulation tools have been developed in-house to allow the merging, interpolation and QA of raw bathymetric data when establishing numerical model domains. The bathymetry data and sources are shown in Figure 2.1.

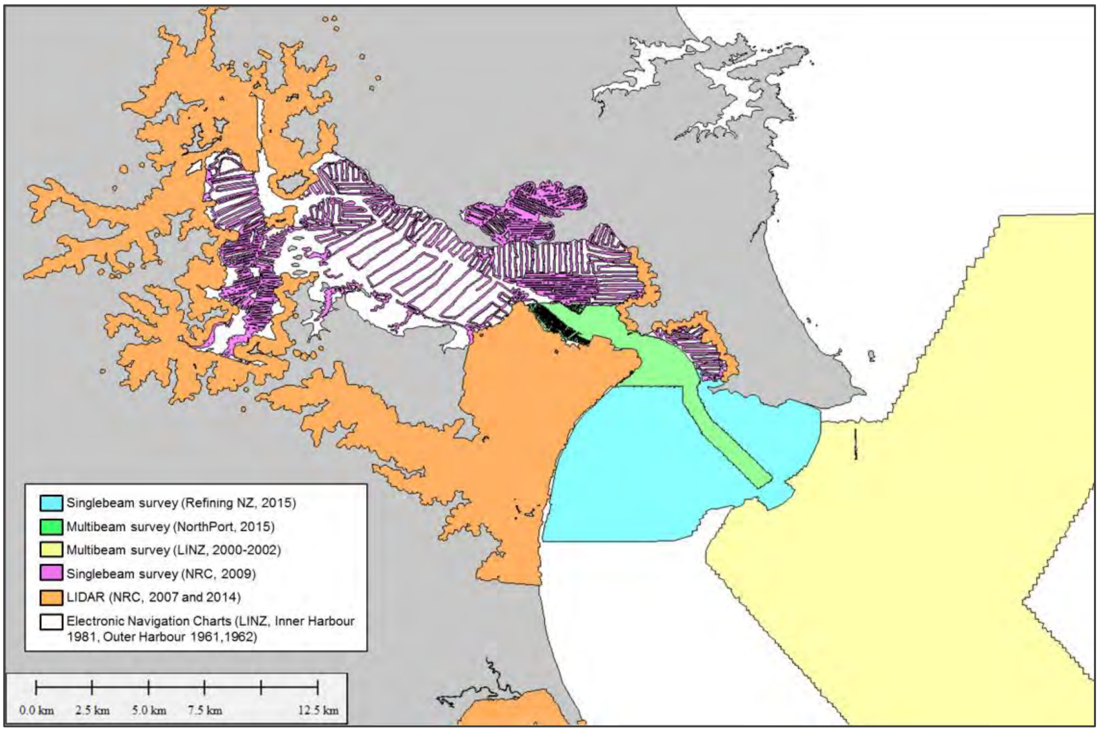


Figure 2.1 Sources of bathymetry data used in the study.

2.2. Sediment characteristics

2.2.1. Sediment sampling

A series of sediment sampling programmes were undertaken in the study area (Tonkin and Taylor, 2010) to provide information on the sediment grain size of the proposed dredge and disposal areas. This information was used as an input to both the morphological and plume models with representative sediment compositions in order to realistically predict the short- and long-term morphodynamics of the seabed pre- and post-dredging. Sediments were classed according to the Folk scale (Figure 2.2).

The sediment sampling programmes are described in detail in other reports, but in summary were as follows:

Firstly, surficial sediment sampling was undertaken, the sites and sediment class of which are shown in Figure 2.3 - Figure 2.6 . Sample sites were confined to the regions to be dredged within the main channel and areas identified initially as potential disposal areas. Limited fines (silts and clays) were identified in these surficial samples, with most sites exhibiting varying proportions of sand and gravel/coarse material.

Secondly, a total of 26 vibrocores were collected in 2016 for geotechnical and environmental testing (Tonkin and Taylor, 2016b). The core locations are shown in Figure 2.7 and Figure 2.8. Of particular interest are the cores at sites v10a,b,c and v11 at the edge of Mair Bank (Figure 2.9 to Figure 2.12, which indicate that this region is predominantly sandy and show no indication of shell armouring with depth.

Thirdly a diver survey was undertaken (Kerr, 2016) in order to visually inspect the subtidal habitat and sediment composition of Mair Bank. Photos were taken at locations along transects at the edge of Mair Bank, with amount of shell hash, bed composition and bed form noted (Figure 2.13 and Figure 2.14). A gradation of shell hash to sand was observed from the top of the Bank down into the subtidal on the channel walls, finally grading back to shell hash in the channel bed. In areas of sand on the channel edge, sand waves were observed, indicating active sediment transport in this region.

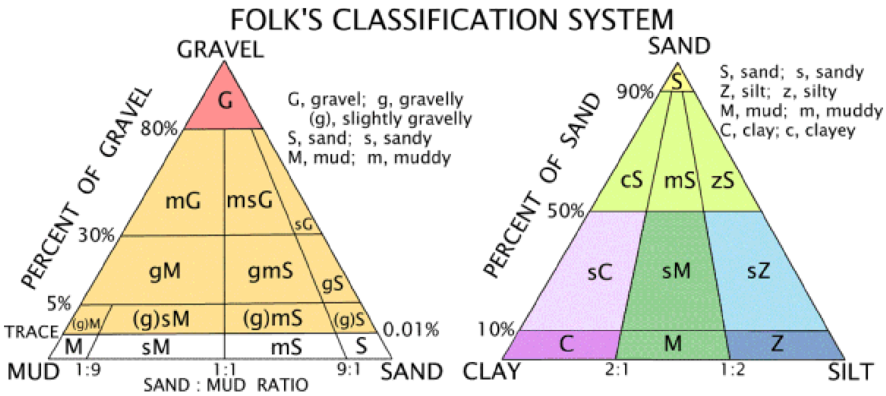


Figure 2.2 Folk classification system for sediments (Folk, 1954).

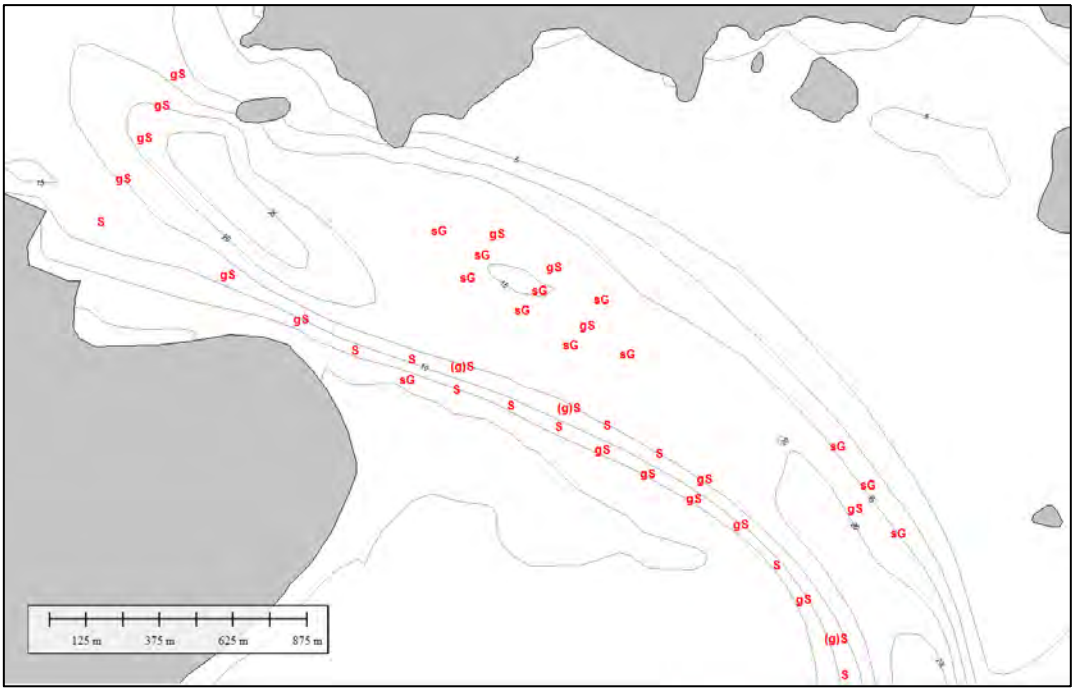


Figure 2.3 Whangarei Harbour inner channel sediment samples (sediment class according to the Folk scale).

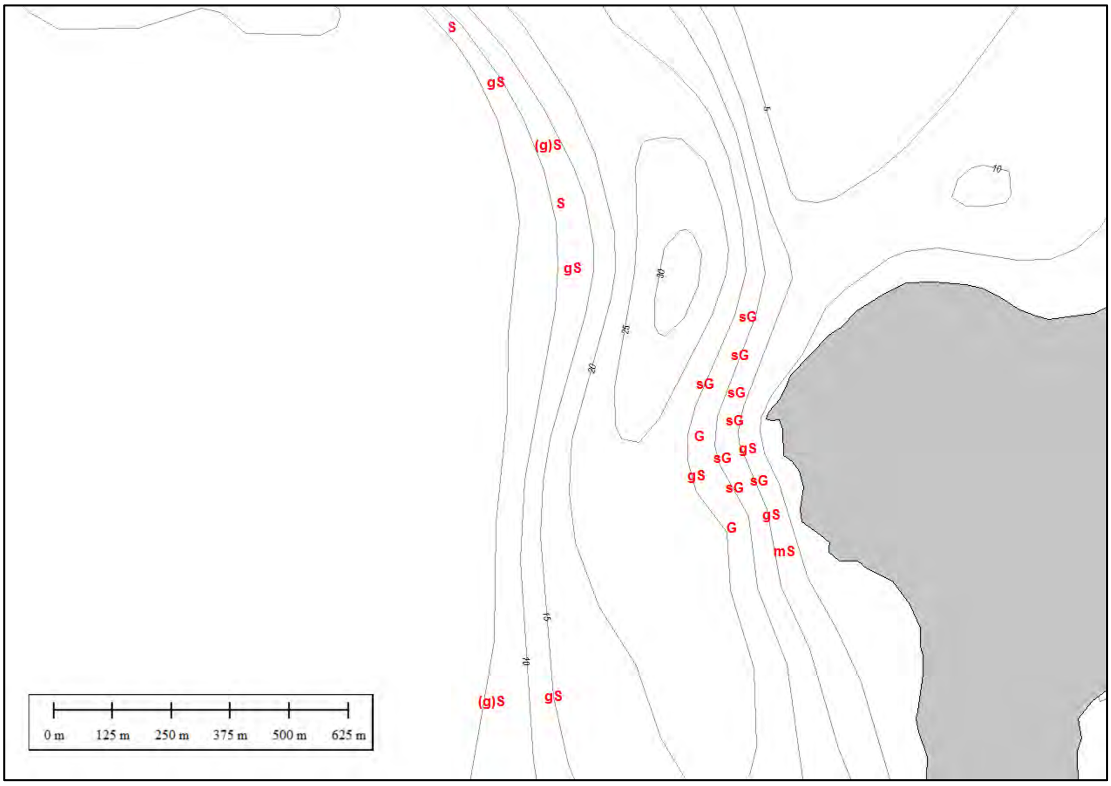


Figure 2.4 Whangarei Harbour mid channel sediment samples (sediment class according to the Folk scale).

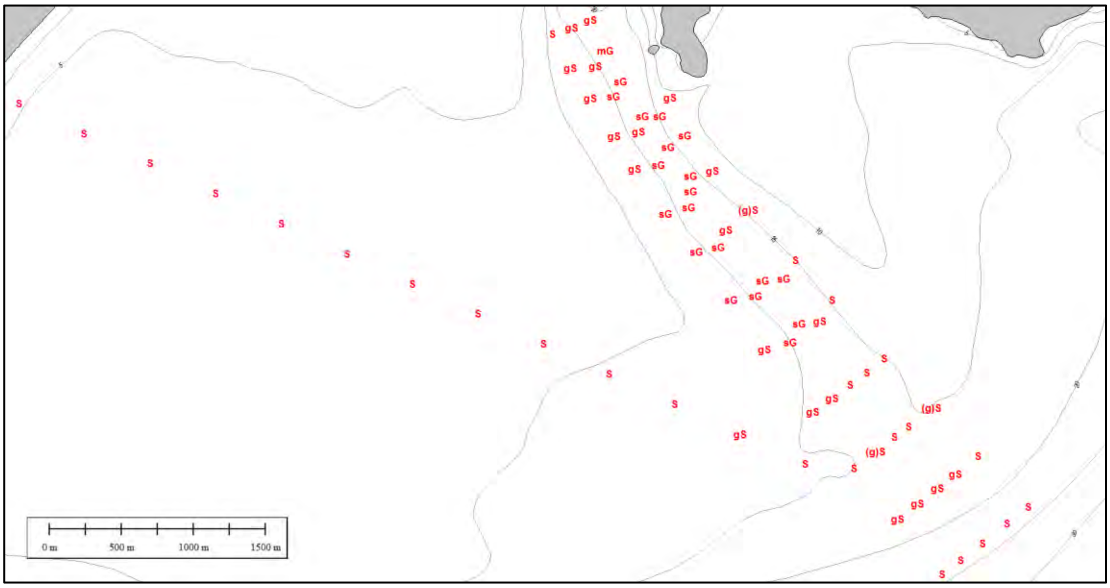


Figure 2.5 Whangarei Harbour outer channel and ebb tidal shoal sediment samples (sediment class according to the Folk scale).

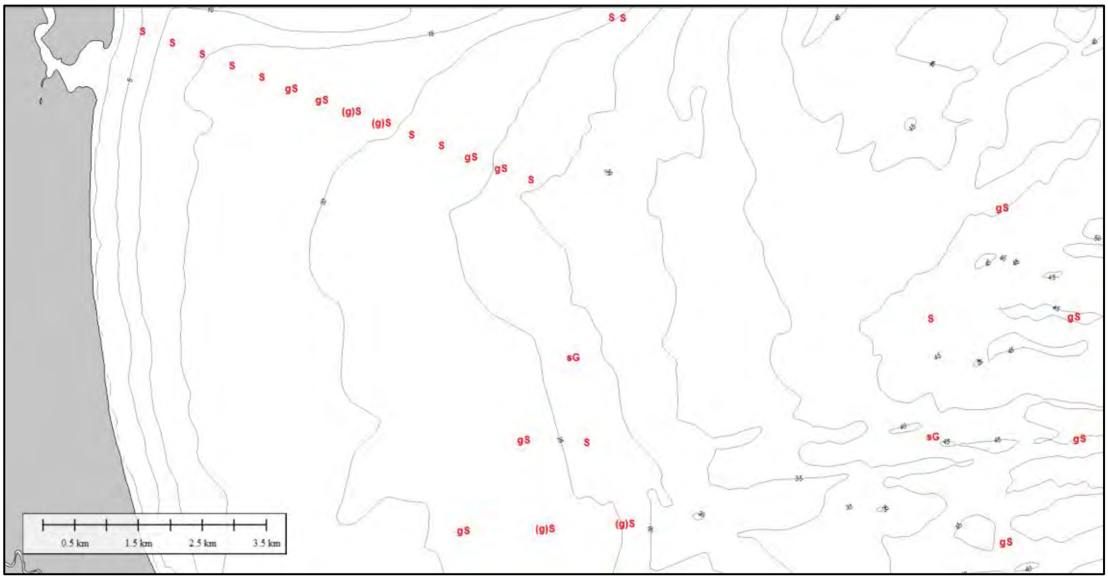


Figure 2.6 Wider Bream Bay sediment samples (sediment class according to the Folk scale).

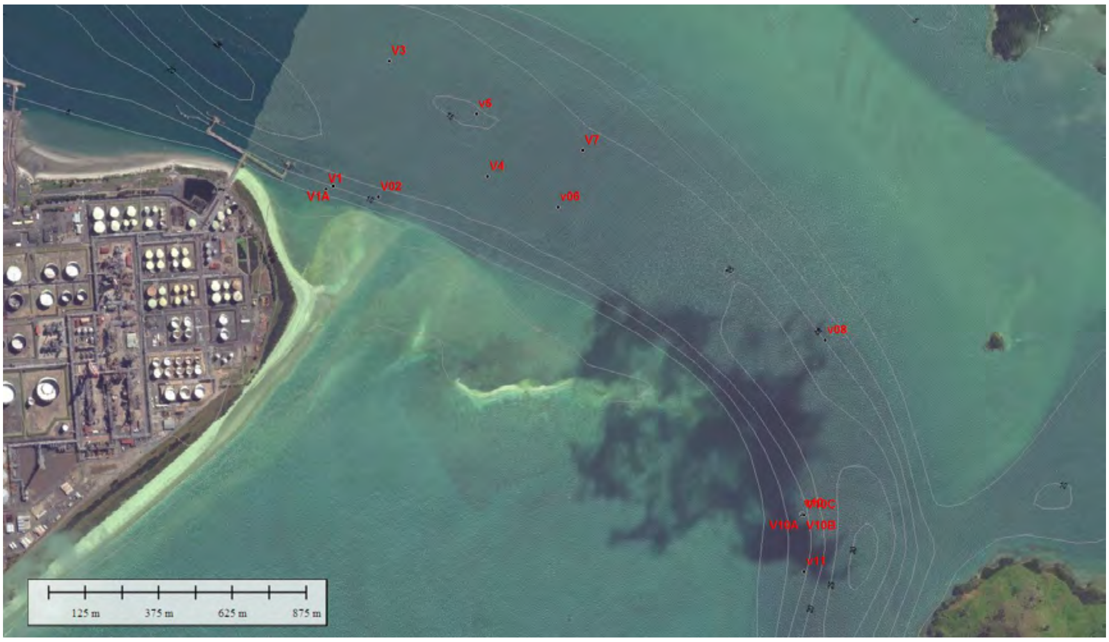


Figure 2.7 Whangarei Harbour inner channel vibrocore locations.

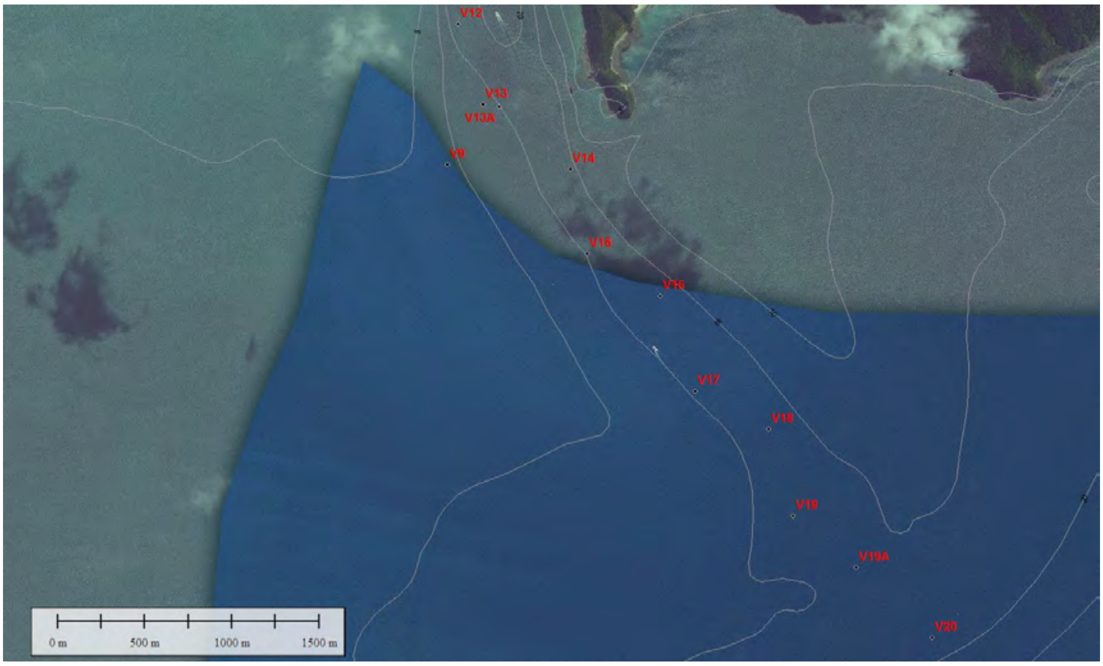


Figure 2.8 Whangarei Harbour outer channel vibrocore locations.

Figure 2.9 Vibrocore samples for site v10.

Figure 2.10 Vibrocore samples for site v10a.

Figure 2.11 Vibrocore samples for site v10b.

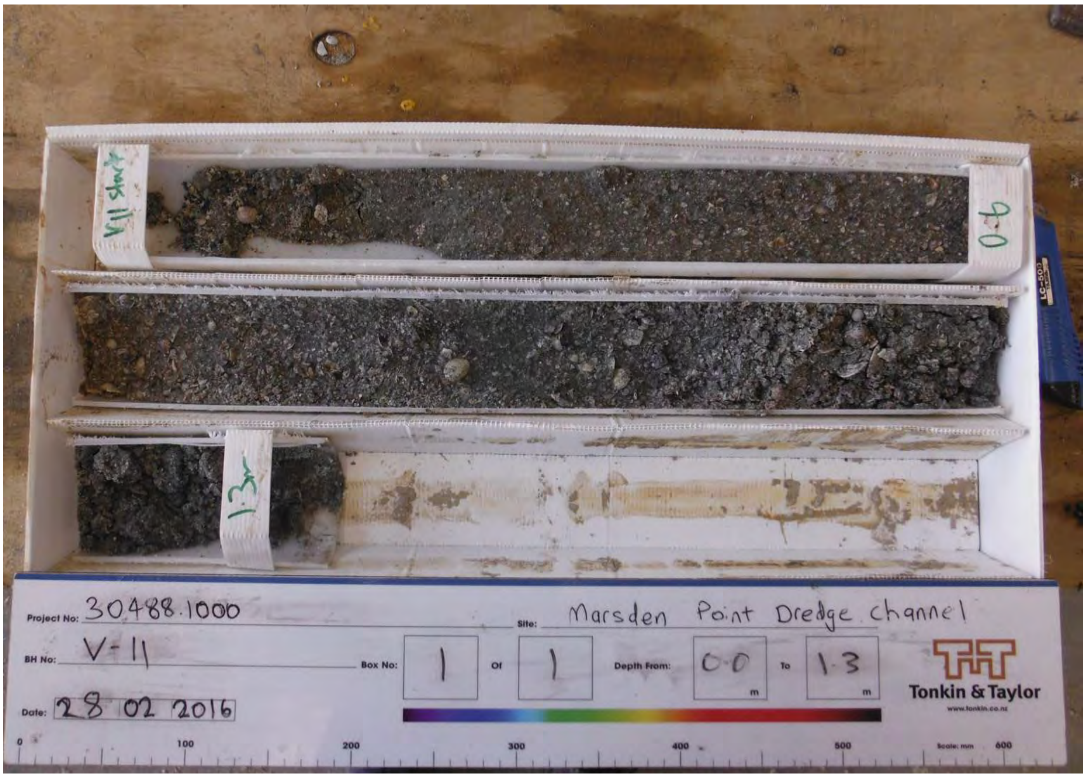


Figure 2.12 Vibrocore samples for site v11.

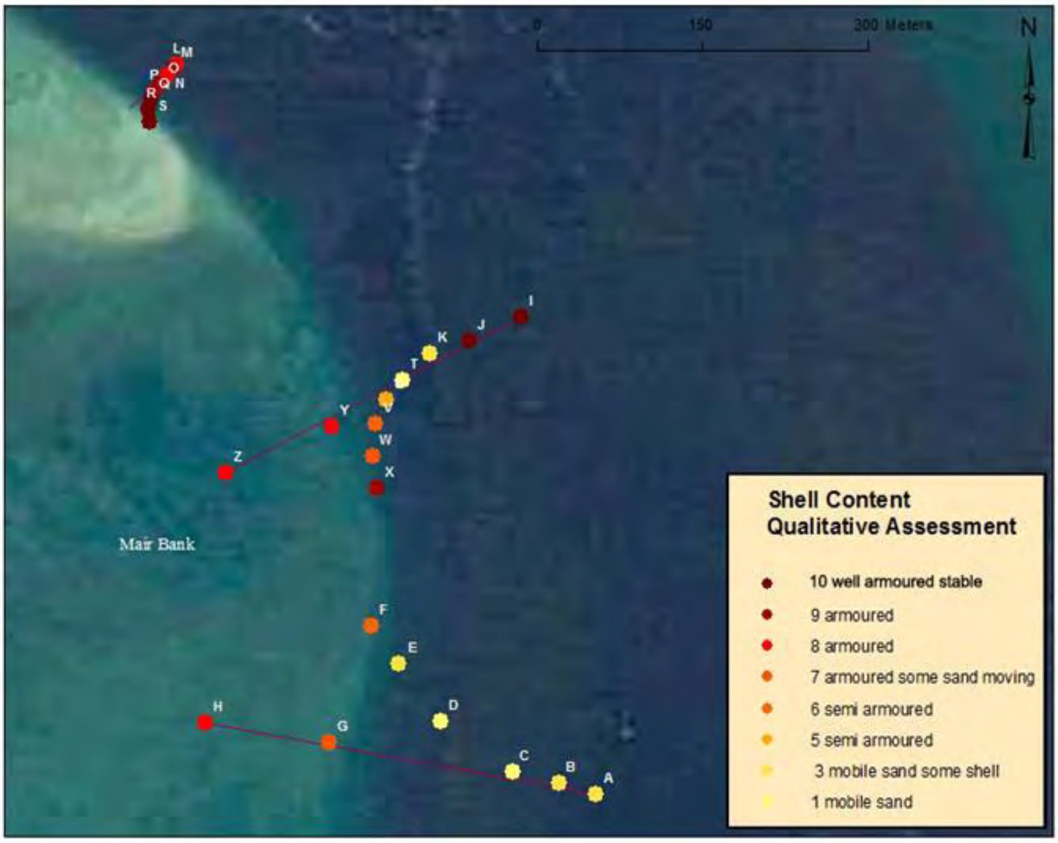


Figure 2.13 Results from channel edge diver survey carried out by Vince Kerr (Figure 2.15 in Kerr, 2016). Areas ranked qualitatively according to the amount of shell component.

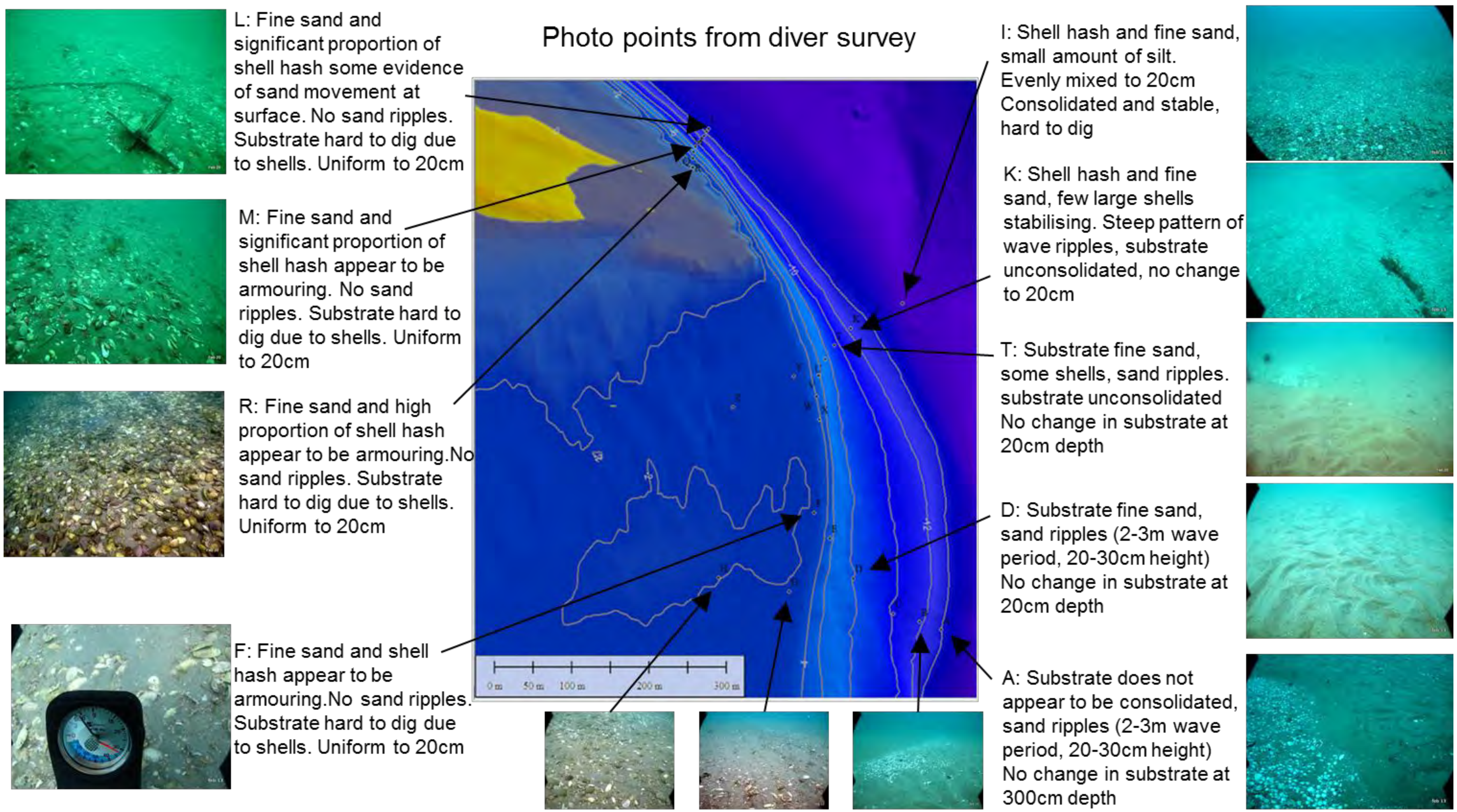


Figure 2.14 Selection of photos and locations from diver survey, illustrating the varied spatial nature of sediments and bedforms on the edge of Mair Bank. From Kerr (2016).

2.2.2. Mair Bank

A field trip to Mair Bank was undertaken on 23rd of January 2016 by MSL to observe sediment composition and structure of shell armouring in the intertidal.

Mair Bank consists of significant amounts of shell material, in the past this has mostly consisted of pipi and their shells (Figure 2.15 and Figure 2.16), however mussel colonies were also observed; contributing to the general consolidation of surficial sediments (Figure 2.17). To the lee of the shell ridges, fine sediment had been deposited. This suggests that sediment transport actively occurs across the bank as shown in Figure 2.18 and Figure 2.19. Such process may be due to the duration of submersion and positioning within the tidal stage as well as sand deposits in response to storm events.

Figure 2.15 Pipi shell bank.

Figure 2.16 Shell structure of pipi bank.

Figure 2.17 Mussel colony on Mair Bank.

Figure 2.18 Fine sand deposited to the lee (northern side) of the shell ridges.

Figure 2.19 More advanced stage of sand deposition with a greater proportion of sand overlaying the shell substrate.

3. WIND CLIMATE

The long-term wind climate at Whangarei required as inputs for the wave and hydrodynamic models was prepared using the regional scale WRF atmospheric numerical model. The model was validated using measured data provided by a local wind station (MSL Report P0297-01). Wind-wave and wind-driven circulation predictions depend upon the accuracy of the predicted wind field and the techniques used for hindcasting. The results of the validation process showed that the wind hindcast was suitable for providing wind forcing to the wave and hydrodynamic numerical models.

This section summarises the regional wind conditions in the vicinity of Whangarei extracted from the 36-year regional atmospheric hindcast carried out by MSL. These data are used, along with outputs from the ROMS hydrodynamic model (described in Section 5) to provide boundary conditions for the local wave modelling carried out for the study.

3.1. Characterising the wind climate

The wind rose calculated at the wave rider buoy (WRB) site (Figure 3.1) and presented in Figure 3.2 shows that the wind regime is dominated by south-westerly winds in frequency of occurrence (approximately 30%). However, the strongest wind intensities occur during easterly and north-easterly events related to local storms and extra-tropical cyclones.

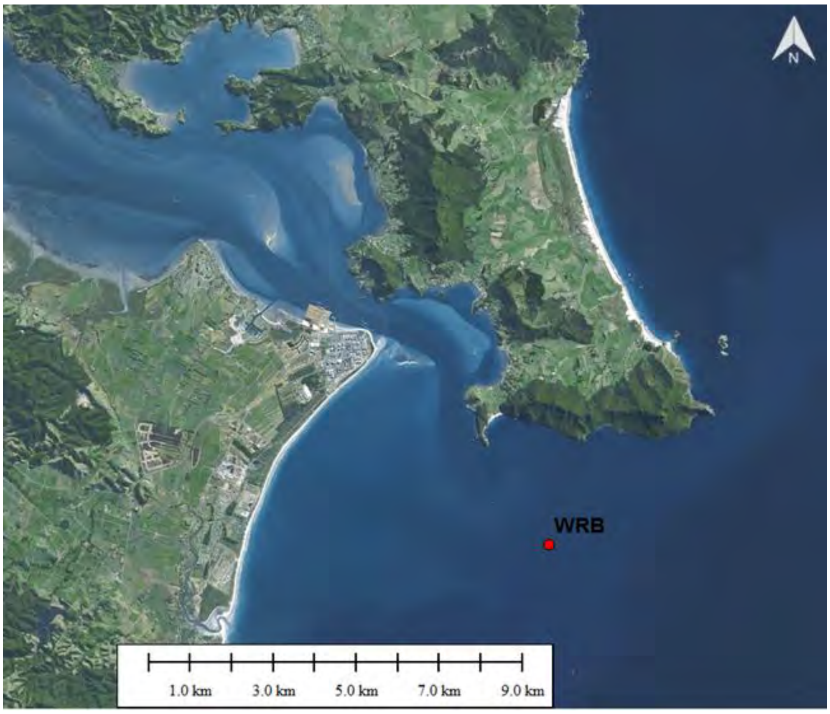


Figure 3.1 Locations of the WRB site used to extract the wind climate from the 36-year hindcast data.

The summary of the wind speed statistics (Appendix A – Wind statistics) indicates a mean speed of ~6 $m.s^{-1}$. The mean wind speed variability between winter and summer conditions is approximately 1 $m.s^{-1}$. The maximum wind speed observed over the hindcast period was 23.7 $m.s^{-1}$ corresponding to cyclone Bola in 1988. July and December are typically the months with the highest and lowest occurrence of strong wind events, respectively. The occurrence of easterly winds increases in summer and decreases in winter (Figure 3.3).

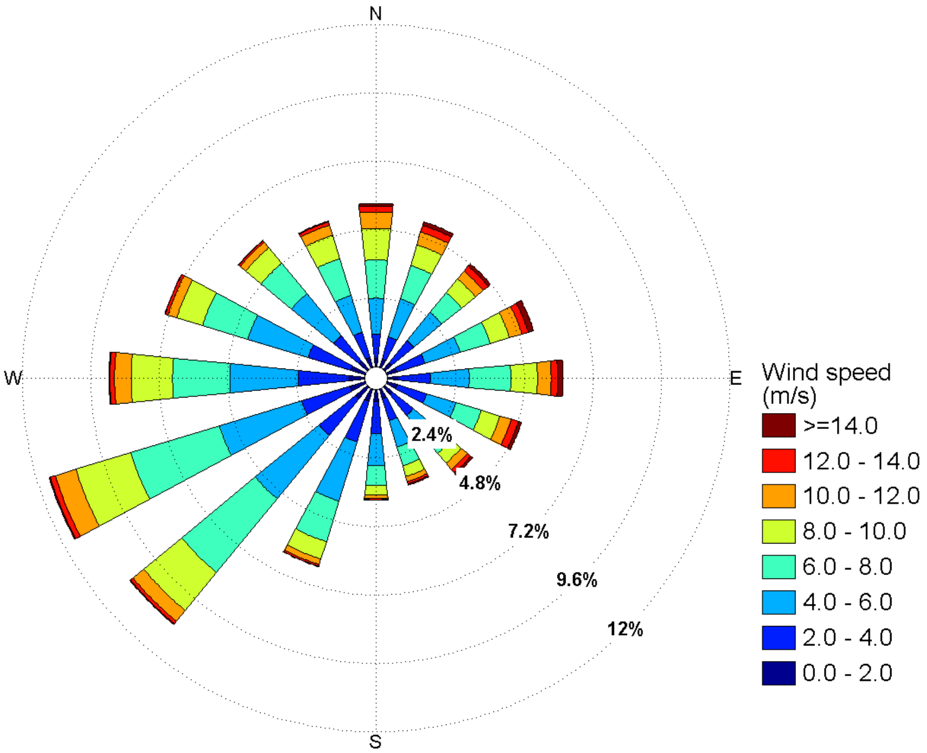


Figure 3.2 Annual wind rose plot at WRB. Sectors indicate the direction from which the wind is coming.

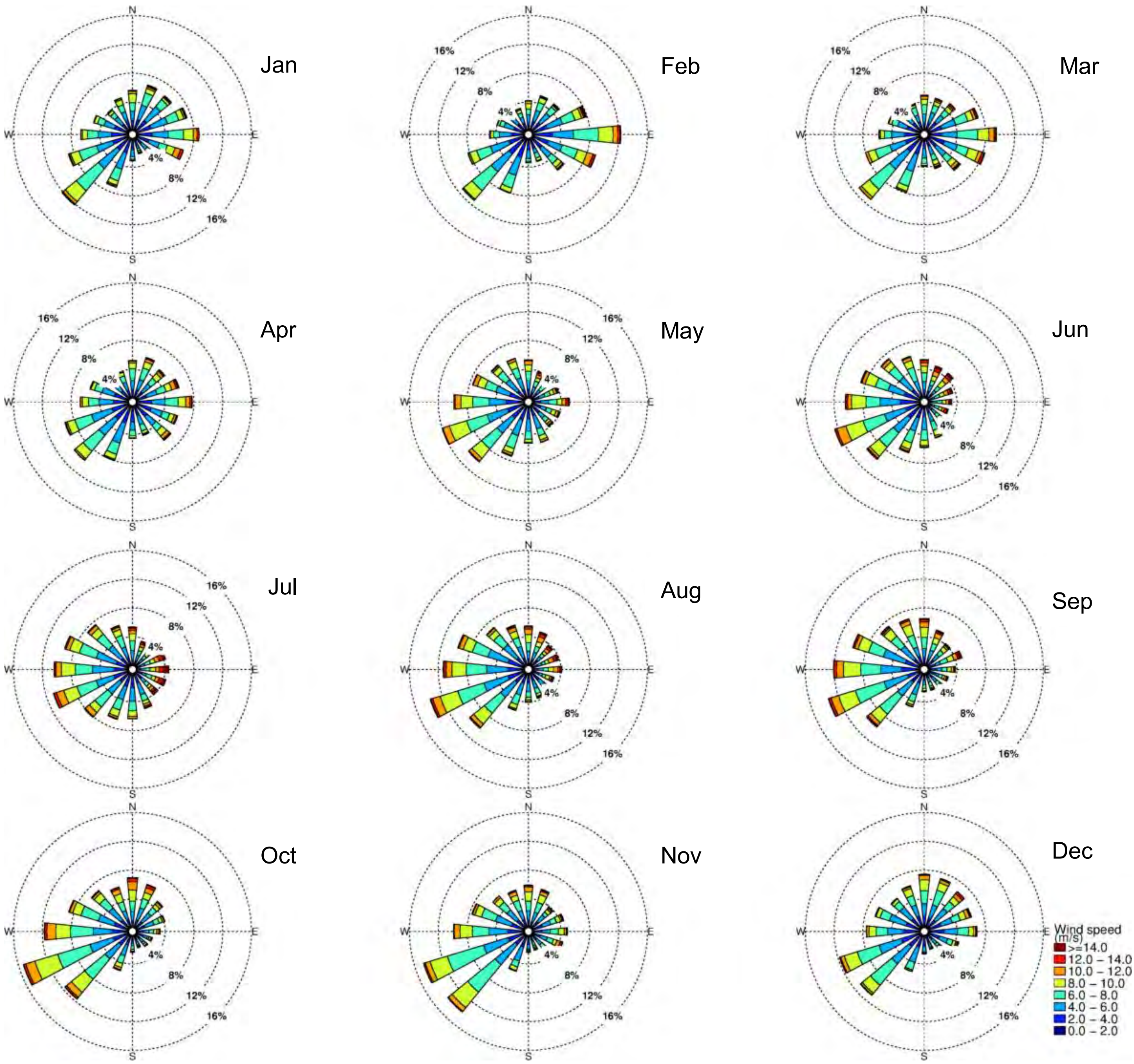


Figure 3.3 Monthly wind rose plots at WRB. Sectors indicate the direction from which the wind is coming.

4. WAVE CLIMATE

The SWAN model was used to hindcast the wave climate and further examines the wave transformation across the ebb tide delta based on a 3-level nested domain. This approach allowed the replication of the spectral wave transformations from offshore to the nearshore region occurring at different spatial scales. This model was validated with measurements from 5 locations (see MSL Report P0297-01 for details), and was shown to represent the wave climate at the entrance to Whangarei Harbour and along Ruakaka beach well, except for one site near the Ruakaka river mouth where wave heights were over-predicted by the model. The wave model did not fully capture the redistribution of wave energy to the south of the tidal delta largely controlled by refraction processes. The relative good agreement between the model and the measured data at the other locations close to Whangarei Harbour entrance confirms the model is suitable for the impact assessment over Whangarei Harbour entrance and the surroundings.

This section presents a detailed characterisation of the wave climate at the entrance to Whangarei Harbour and Bream Bay and the predicted effects of the channel deepening on the nearshore wave transformation processes. Potential changes in the wave field in coastal waters are of importance given that wave forcing is a significant contributor to both the morphodynamic and the navigability conditions through the access channel.

4.1. Characterising the wave climate

The wave climate in the northern region of Bream Bay at position WRB, shown in Figure 4.1, is characterised by a mean annual significant wave height of 0.80 m. The largest significant wave height modelled over the hindcast period was 5.86 m (cyclone Bola, 1988), while the annual 99th percentile non-exceedance level (P99) was 2.85 m (i.e. on an annual basis, for 99% of the time the total significant wave height is less than 2.85 m). On average the total significant wave heights are less than 1.0 m for durations of 36 hours and greater for some 73 % of the time. These statistics indicate a typically low energy wave environment that is occasionally affected by strong storms and cyclonic systems. Wave height maps for a range of wave conditions are provided in Figure 4.2 and Figure 4.3. Easterly sea states predominate (see Figure 4.4) and the monthly wave roses (Figure 4.5) do not suggest any strong seasonality in the wave height distribution.

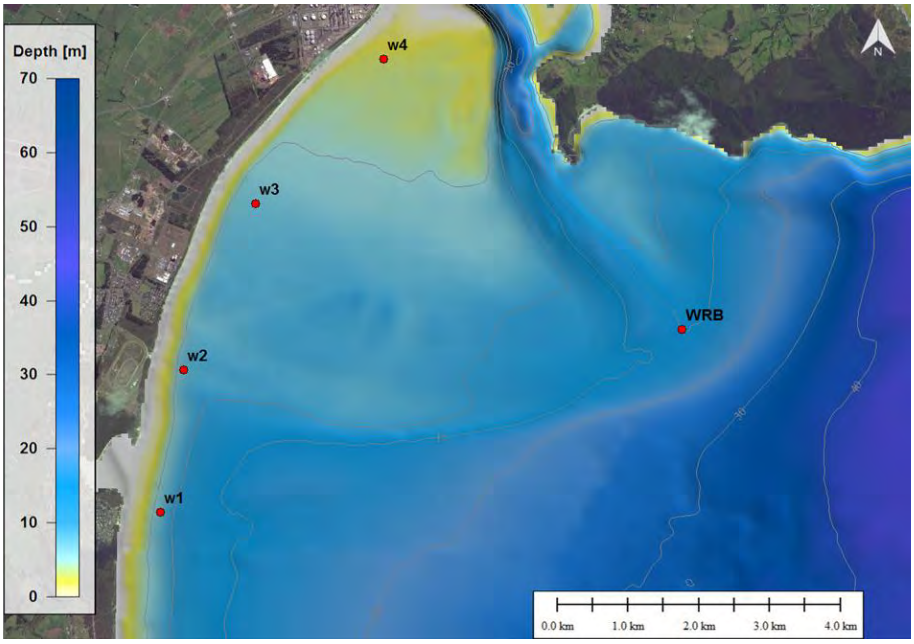


Figure 4.1 Locations of the wave gauges (red circles) along Ruakaka Beach and offshore of the harbour entrance.

A summary of the significant wave statistics for swell, wind-sea and total frequency bands at position WRB is provided in Appendix B – Wave statistics. This includes the monthly and annual significant wave height exceedance probabilities, the annual joint probability distribution of total significant wave height and mean wave direction at peak energy, the annual joint probability distribution of total significant wave height and peak spectral wave period, and the annual persistence non-exceedance probabilities for total significant wave height.

The seabed morphology of the ebb tide delta and adjacent headland plays an important role in the wave climate along Ruakaka Beach and at the harbour entrance (Figure 4.3), particularly in dictating the along shore variability of the wave field. Strong wave refraction patterns develop over the delta and near Busby Head. This typically leads to a shift in the wave direction from northeast to east at WRB and southeast, causing wave focusing along the eastern edge of the delta entrance toward Busby Head and the penetration of a fraction of wave energy through the entrance channel. Moreover, this mechanism of refraction increases the exposure of the southwestern flank of Mair Bank to waves during strong storm events. The extended and gradual bed slope of the western flank of the ebb-tidal delta largely dissipates the amount of refracted wave energy through bottom friction and wave breaking, which reduces the wave energy reaching Mair Bank, thereby contributing to its relative stability. During extreme wave events (e.g. cyclonic conditions), wave breaking and overwash can occur over Mair Bank, potentially leading to the formation of a non-permanent marginal channel between Marsden Bank and Mair Bank(. Note, however, that overwash mechanisms are not resolved by the SWAN model.

The configuration of the Whangarei Harbour entrance, which is characterised by an S-shaped access channel and sheltered by an extended cross-shore sandy/shelly bank, decreases the amount of wave energy propagating within the tidal inlet. For example, during ebb tide the opposing current induces a steepening of waves which decreases the wavelength and the apparent wave period and causes an increase of the whitecapping dissipation. Variations of tidal water elevation near

Mair Bank also result in a tidal modulation of wave height and period as observed at position W4 (see Figure 4.1). This tidal modulation effect is typically caused by variations in the vertical profile of roughness according to the water depth.

Effects of waves on currents is further discussed in Section 8 (Sediment Transport Modelling), in which a two-way fully coupled model was used to replicate the effect of wave-current interactions on the morphological dynamics at the entrance to Whangarei Harbour.

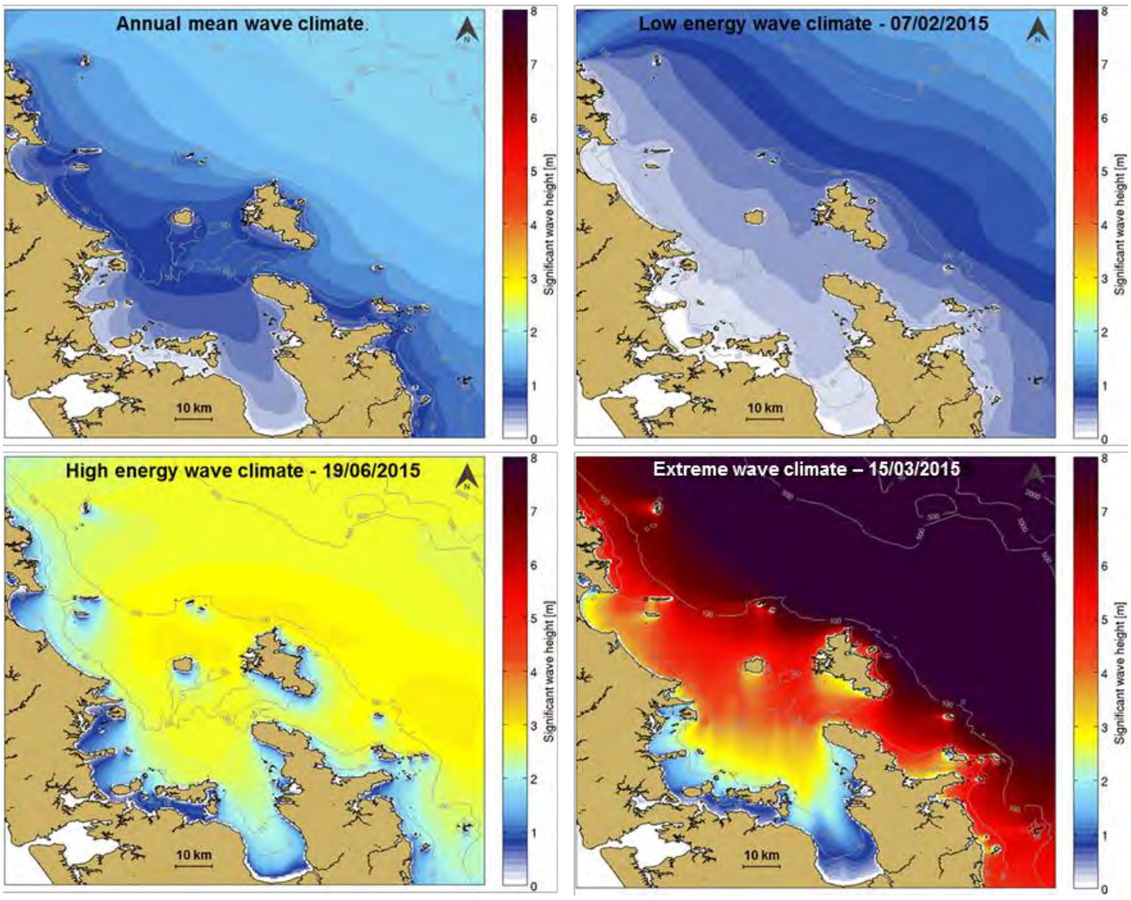


Figure 4.2 Annual mean and snapshots of modelled significant wave height over the regional SWAN parent domain for different weather events. The wave height annual mean was calculated for 2015.

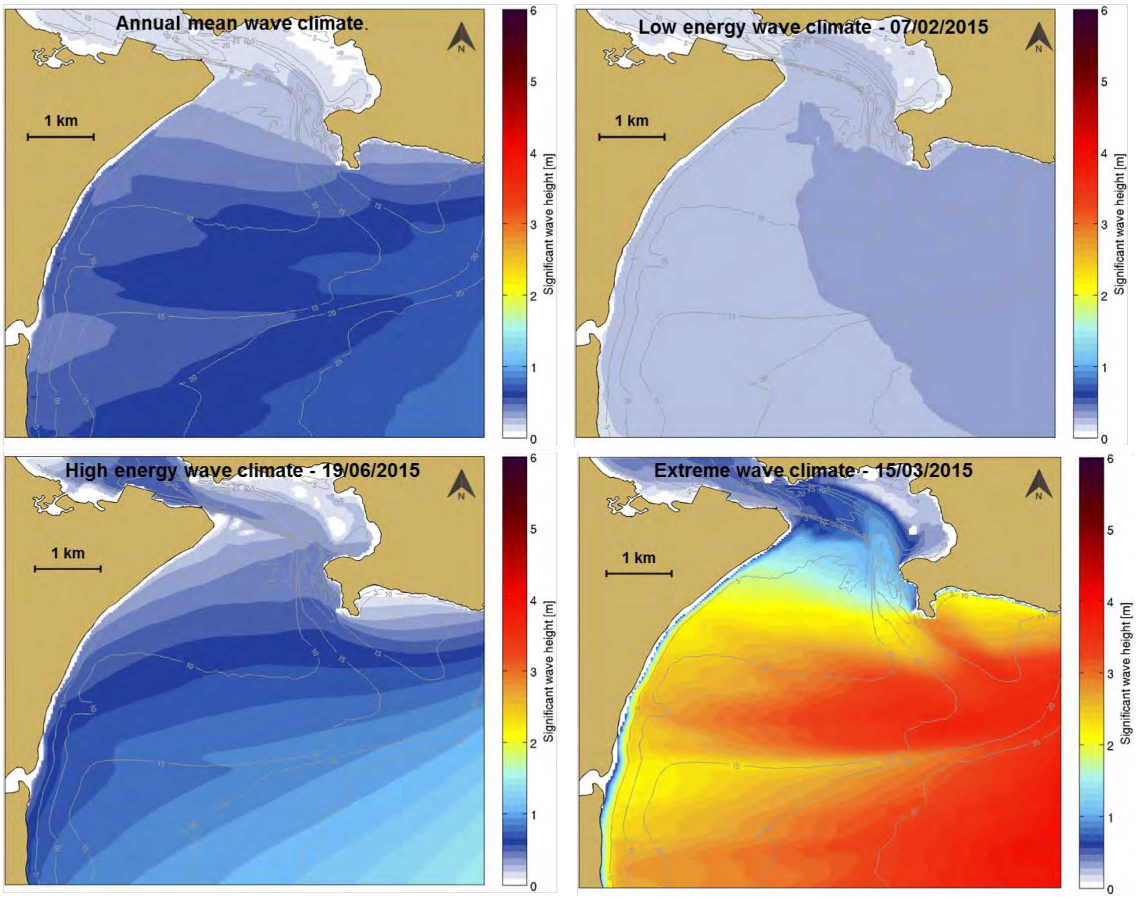


Figure 4.3 Annual mean and snapshots of modelled significant wave height over the local SWAN domain for different weather events. The wave height annual mean was calculated for 2015.

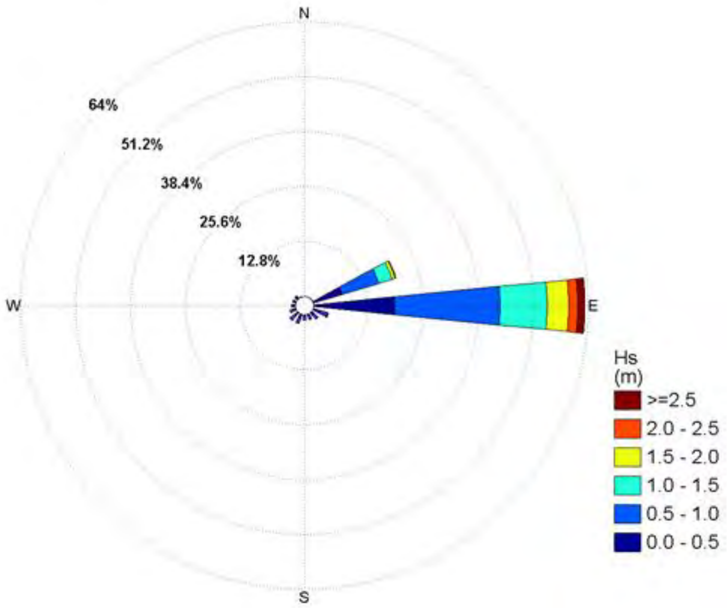


Figure 4.4 Annual wave rose plot for the total significant wave height at WRB. Sectors indicate the direction from which waves approach.

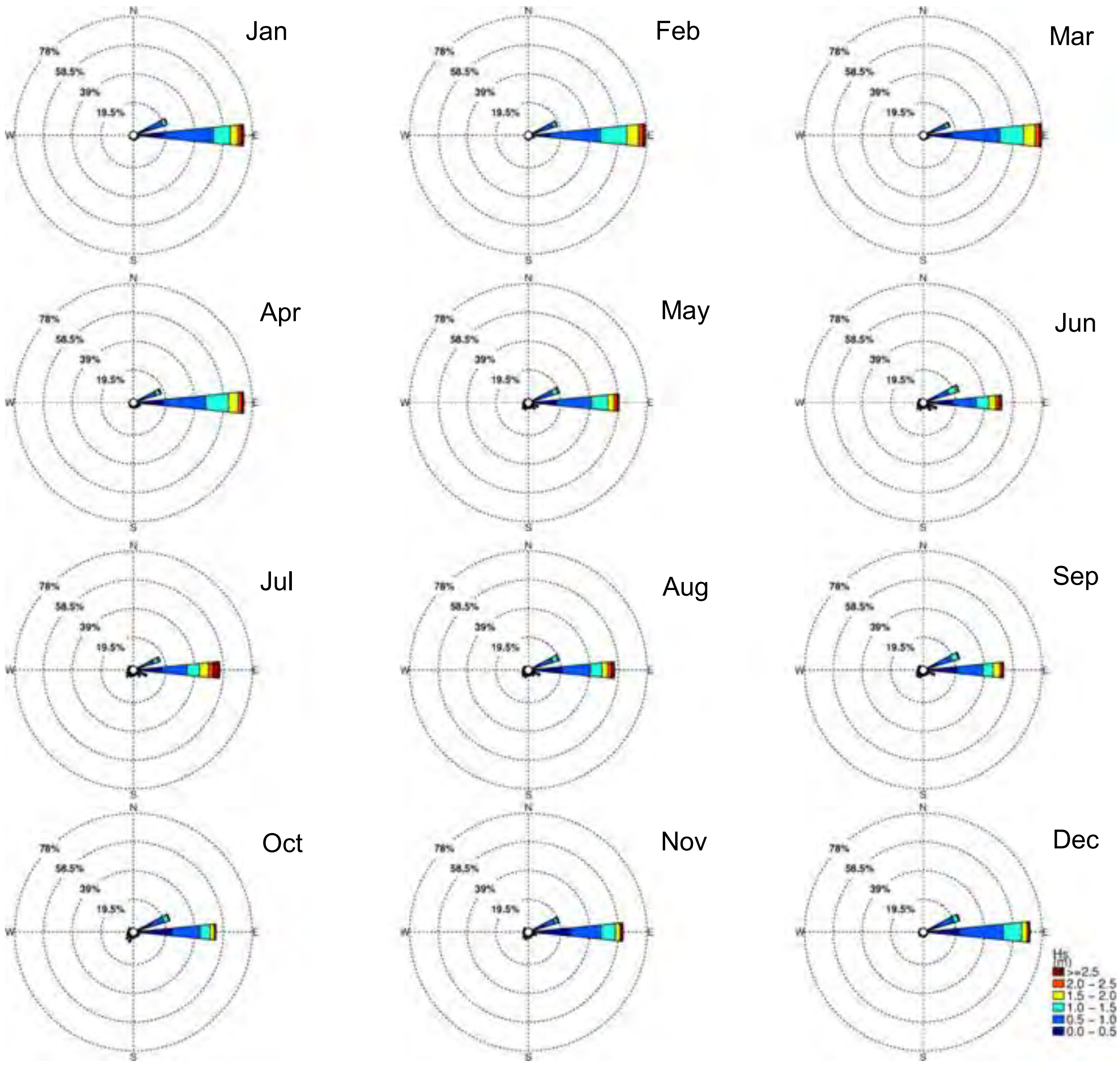


Figure 4.5 Monthly wave rose plots for the total significant wave height at WRB. Sectors indicate the direction from which waves approach.

4.2. Effects of channel deepening on the wave climate

The spectral wave model (SWAN) was applied to simulate the propagation of waves across the ebb tide delta and consider the effects of the channel deepening. These effects were assessed by modelling the existing harbour and a scenario with a deepened channel, in order to evaluate the changes in the wave climate through direct comparison of modelled outcomes. The wave modelling technique employed in this assessment is fully described in MSL Report P0297-01.

A one-year period (2015) covering the measuring periods was used to assess the changes, being duration sufficient to capture the full range of likely conditions. The wave model produced the spatial distribution of wave heights over the entire delta at hourly intervals. The mean absolute change to the significant wave height is presented in Figure 4.6. The predicted changes are very subtle; a slight increase (1 cm) east of the channel and zones of increase and decrease (~1 – 2 cm) west of the channel. The offshore extent of the deepened channel induces slight changes to the speed of the incoming swell waves, which results in a change to the wave refraction outcomes. The absolute magnitude of the changes is further illustrated with a series of 16 wave classes that represent the wave climate range (Figure 4.7 to Figure 4.10). Note that during a highly energetic storm (significant wave height of more than 5 m) the changes in significant wave height are predicted to be in the order of 20 cm.

Enhanced refraction occurs along the eastern margin of the dredged channel, directing energy toward the rocky point of Busby Head and Smugglers Bay. This leads to a slight increase in the mean and maximum wave height by 2 and 10 cm (~5%) at Busby Head and by 2 and 15 cm (~10%) at Smugglers Bay (Figure 4.7 to Figure 4.10), respectively. The limited impact of such changes in the wave propagation in terms of sediment dynamics for both Busby Head and Smugglers Bay are discussed in Section 7.4.

Conversely, there is a minor decrease in wave energy over a wide zone along Ruakaka Beach. Here, the reduction of wave height during storms will be as much as 10 cm. However modification of the wave refraction at the distal margin of the channel is expected to give rise to a zone of slightly increased values along the beach just north of the Ruakaka River, the increase predicted to be in the order of - up to maximum of around 5 cm in storm conditions. Over Mair Bank, the model results suggest a slight overall increase in wave heights (less than 1 cm on average).

The range of predicted changes to the significant wave height at the sites shown in Figure 4.11 are presented in Table 4.1.

The validation process of the wave model (detailed in MSL Report P0297-01) highlighted some disparities between modelled and measured data at sites W1 to W4, which suggest that the model cannot fully resolve the redistribution of wave energy along Ruakaka Beach. Thus, the effect of the channel deepening on the existing wave climate described previously may be slightly over-predicted at some locations and under-predicted at others. Based on the relative low effect of the channel deepening on the wave climate along Ruakaka Beach we consider that this poses no fundamental change the outcomes of the wave modelling stage along Ruakaka Beach and should not affect the recreational surfing activities over this area.

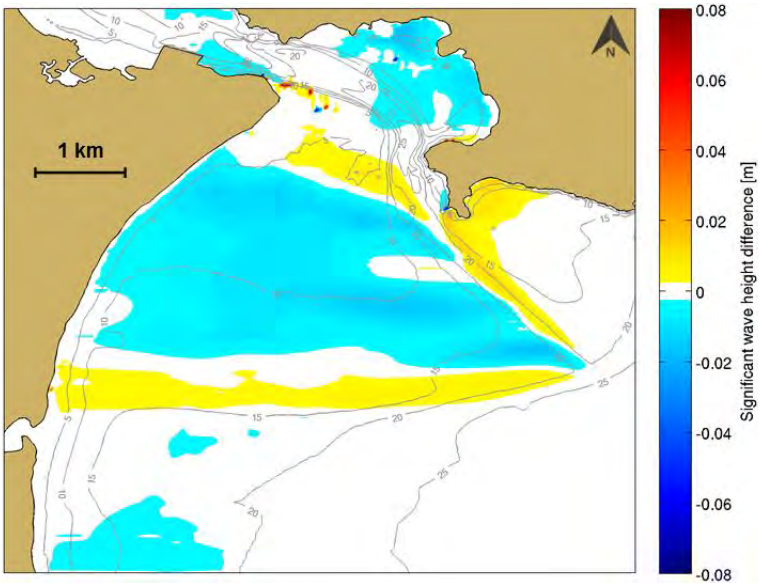


Figure 4.6 Average annual change in significant wave height due to the deepened channel. Positive amplitudes indicate areas with a predicted increase, negative areas a decrease.

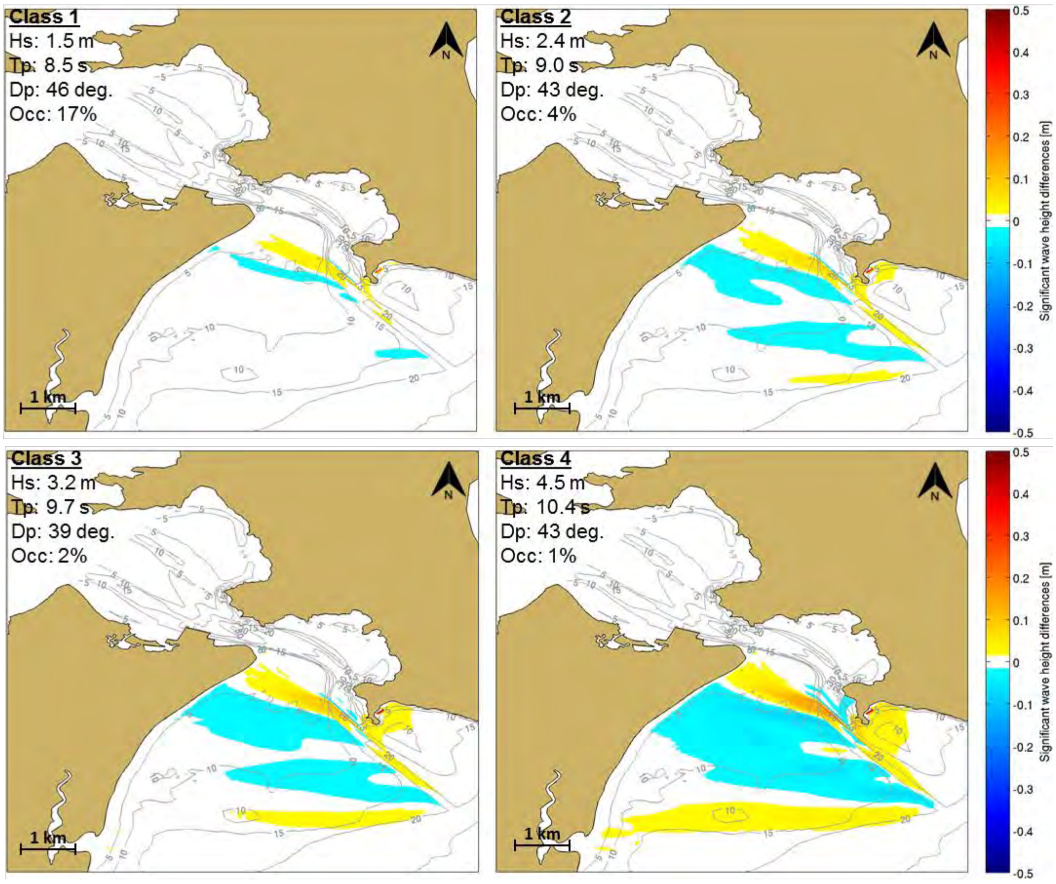


Figure 4.7 Significant wave height changes for wave classes 1 – 4 due to the deepened channel. Positive amplitudes indicate areas with a predicted increase, negative values a decrease.

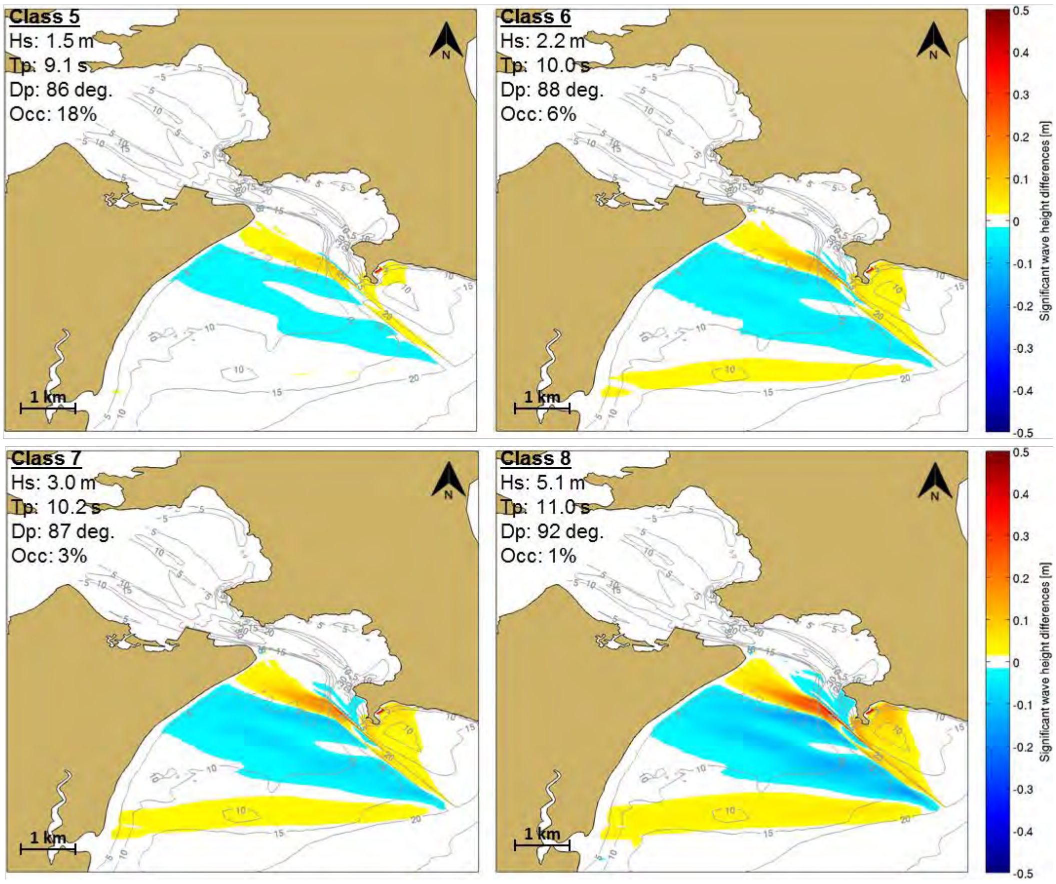


Figure 4.8 Significant wave height changes for wave classes 5 – 8 due to the deepened channel. Positive amplitudes indicate areas with a predicted increase, negative values a decrease.

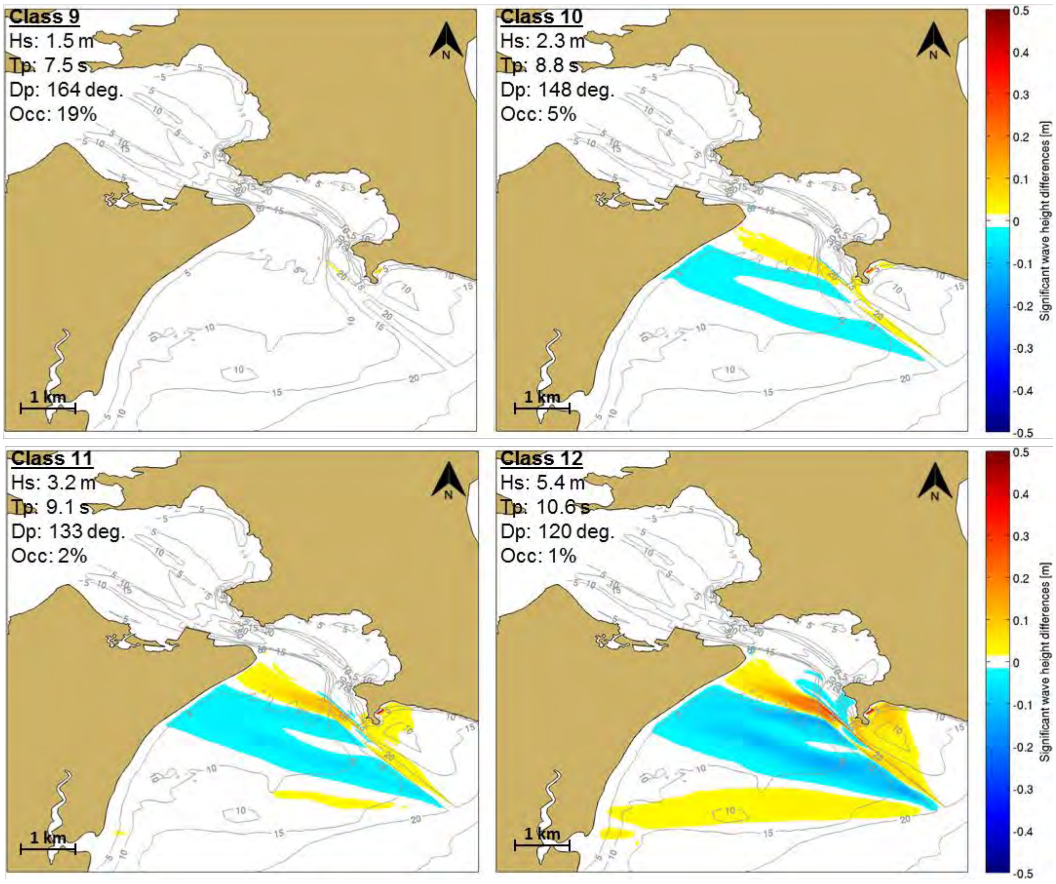


Figure 4.9 Significant wave height changes for wave classes 9 – 12 due to the deepened channel. Positive amplitudes indicate areas with a predicted increase, negative values a decrease.

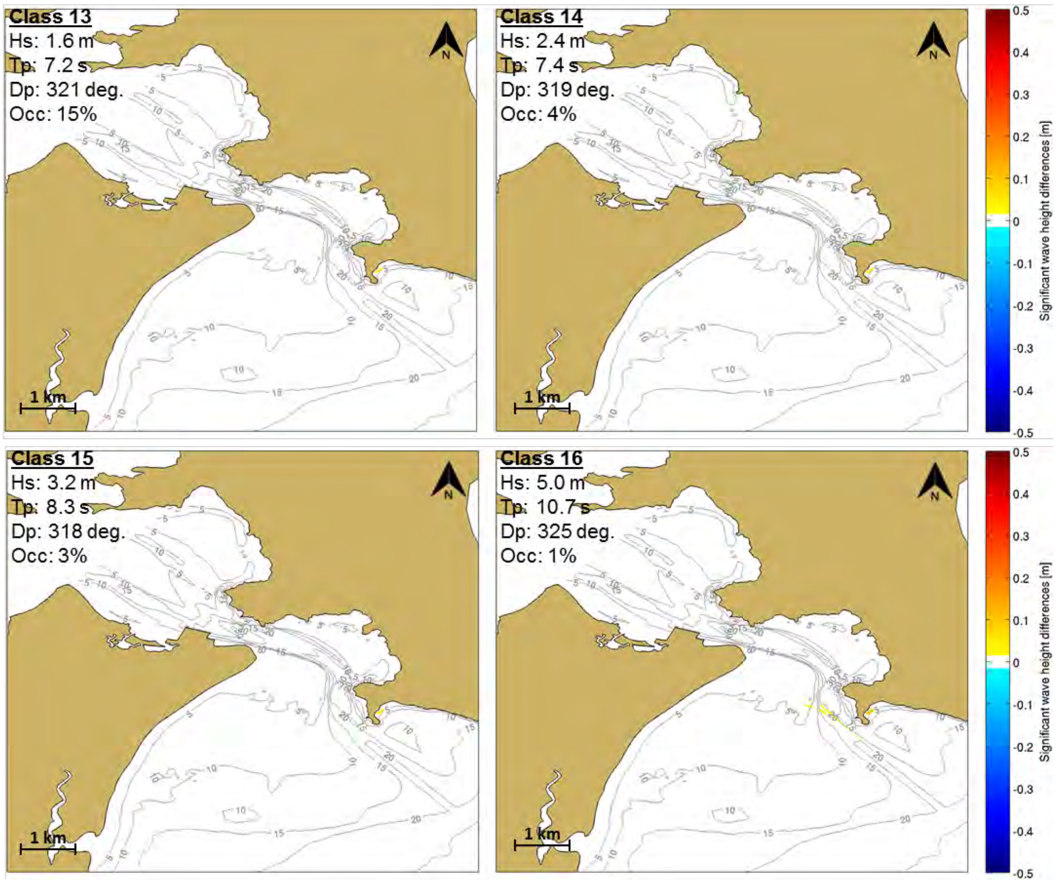


Figure 4.10 Significant wave height changes for wave classes 13 – 16 due to the deepened channel. Positive amplitudes indicate areas with a predicted increase, negative values a decrease.

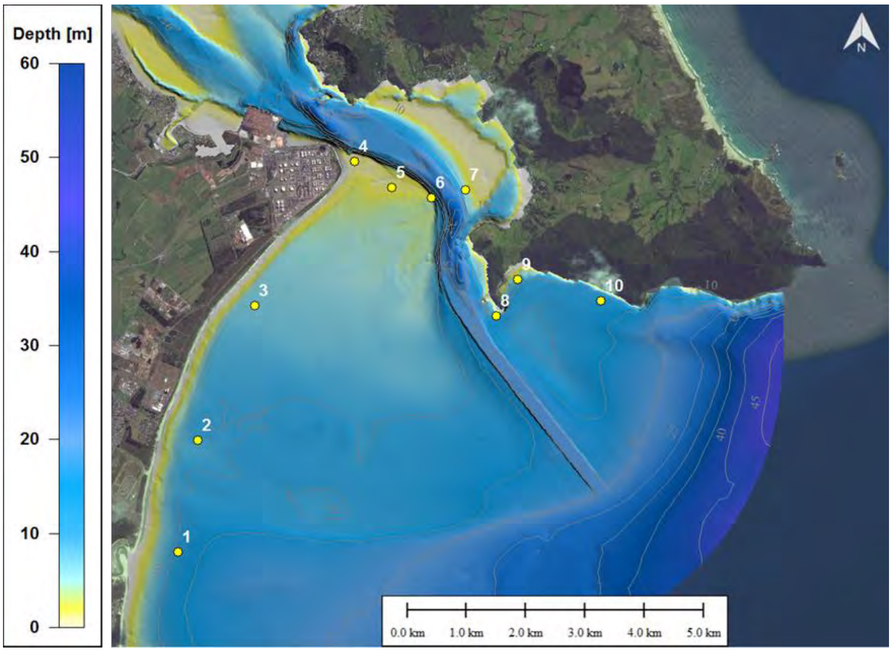


Figure 4.11 Locations used to calculate statistics of the difference in wave height due to channel deepening.

Table 4.1 Changes in mean and maximum significant wave height at positions 1 to 10 from 16 wave scenarios between the dredged channel and the existing configurations. Positive magnitude indicates a predicted increase of wave height due to the dredging.

Positions		Existing mean wave height* (m)	Changes in mean wave height* (cm)	Existing maximum wave height (m)	Changes in maximum wave height (cm)
1	Ruakaka Beach - river mouth	0.43	No changes	1.75	+2 cm
2	Ruakaka Beach	0.55	No changes	2.04	+1 cm
3	Ruakaka Beach – northern area	0.45	-1 cm	1.71	- 5 cm
4	Marsden - Mair Bank	0.11	+1 cm	0.29	+2 cm
5	Mair Bank - middle area	0.08	No changes	0.32	-1 cm
6	Mair Bank - eastern edge	0.03	No changes	0.11	-1 cm
7	Calliope Bank	0.02	No changes	0.06	No changes
8	Busby Head	0.42	+2 cm	1.92	+ 10 cm
9	Smugglers Bay – western area	0.26	+3 cm	1.23	+ 15 cm
10	Smugglers Bay – eastern area	0.27	No changes	1.21	No changes

* The mean wave height calculation included the percentage of occurrence of each wave event.

4.3. Summary of predicted effects of channel deepening on the wave climate

The methodology used to characterise the existing wave climate at Whangarei and to examine the effect of channel deepening is detailed in MSL Report P0297-01, including the validation of the model at 5 locations. The anticipated effects of the channel deepening on the wave climate are as follows:

- The effect on the mean significant wave height fields is likely to be very subtle and generally not exceed 2 cm. During storm events where offshore waves can reach more than 5 m, changes in the significant wave height fields generally should not exceed 10 cm (less than 10% changes), except over a limited area to the west of Busby Head where the significant wave height may increase by 20 cm (~20%) during extreme wave events.

- The offshore extent of the deepened channel modifies the refraction pattern of waves at the delta entrance. Enhanced refraction occurring along the eastern margin of the deepened channel is predicted to increase wave height at Busby Head and offshore of Smugglers Bay up to a maximum of 10 and 15 cm during storm conditions, respectively.

- Conversely, a minor increase of wave height (1 – 2 cm on average) is expected along sections of Ruakaka Beach. Note that modifications of the wave refraction at the distal margin of the channel may generate a zone to the north of the river mouth characterised by a slight increase of the wave height (up to a 5 cm maximum).

- Changes in wave height over Mair Bank are not expected to exceed 2 cm.

5. REGIONAL SCALE HYDRODYNAMICS

The characterisation of the circulation in the continental shelf waters adjacent to Whangarei Harbour is important when considering the local scale hydrodynamic and sediment transport processes, as they prescribe the boundary conditions for the nearshore and harbour entrance numerical modelling. The presence of strong along-shelf winds and offshore oceanic boundary currents year round can all play a role in forcing the circulation near the coast. A careful modelling strategy is required to reproduce the different spatial and temporal scales and circulation phenomena at the shelf and deep ocean environments and adequately feed the local scale models. This section describes the results of the modelling studies that were undertaken to characterise regional hydrodynamics. The modelling methodology is detailed in MSL Report P0297-01.

5.1. Characterising the regional hydrodynamics

The results from the regional scale modelling show that the mean flow patterns in the northern Hauraki Gulf area are oriented in the along-shore direction, due to open ocean currents and the predominant wind forcing (Figure 5.1). Offshore of Whangarei Harbour, channelling effects between the coast and the offshore islands intensify and steer the flow to a quasi-meridional orientation (Figure 5.1 and Figure 5.3).

The long term (10-year) net flow is oriented from north to south, and most of the strength and variability of the currents is observed in the along-shore direction (Figure 5.2). The high order hydrodynamics at the inner shelf and in the vicinity of Whangarei Harbour are mainly controlled by the tides and the interaction between the offshore flows and the local bathymetry (Figure 5.3). The residual circulation at Bream Bay is complex but normally responds to the shelf flow to the east of the bay (Figure 5.3).

The monthly analysis of hindcast current data at position WRB highlights a relative weak seasonal variability (Figure 5.4), with late winter and early spring showing the stronger current flows. Current fields exhibit much more strength and variability in the along-shore direction and the predominant flow direction is from north to south year round.

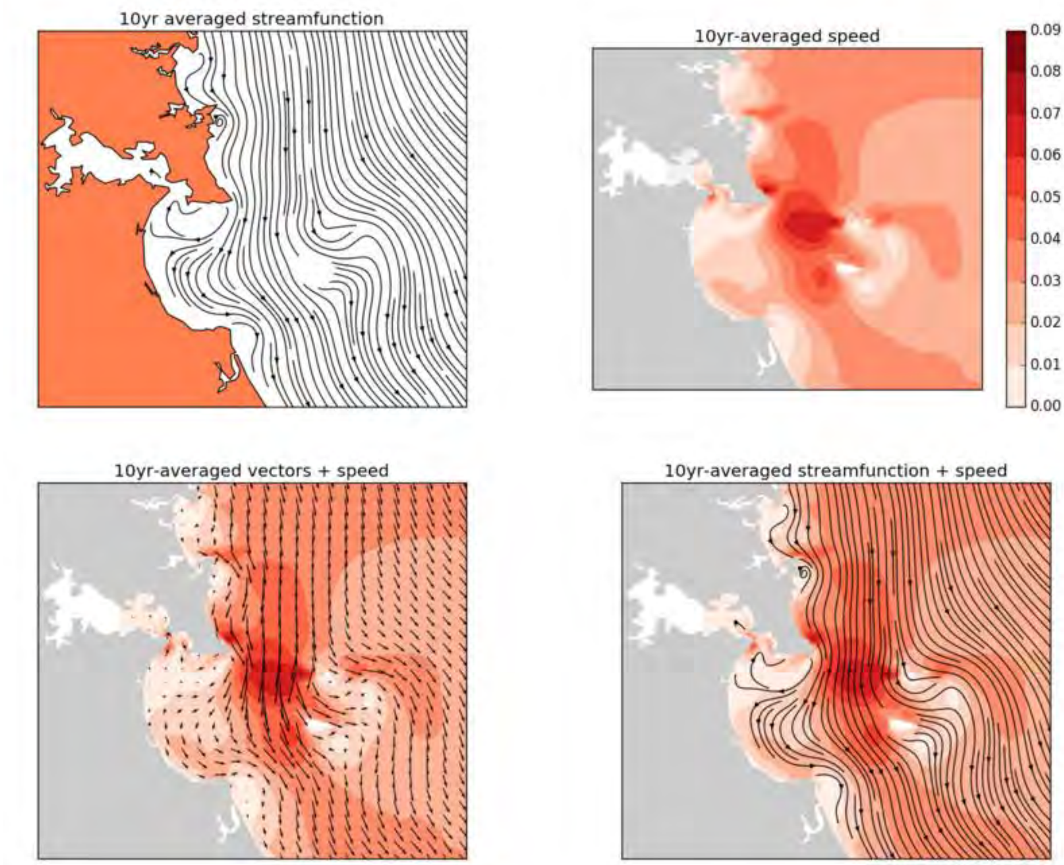


Figure 5.1 Climatological flow patterns offshore Whangarei Harbour based on mean current speeds computed off a 10 year (2000-2010) ROMS hindcast. Current speeds in red shades ($m.s^{-1}$).

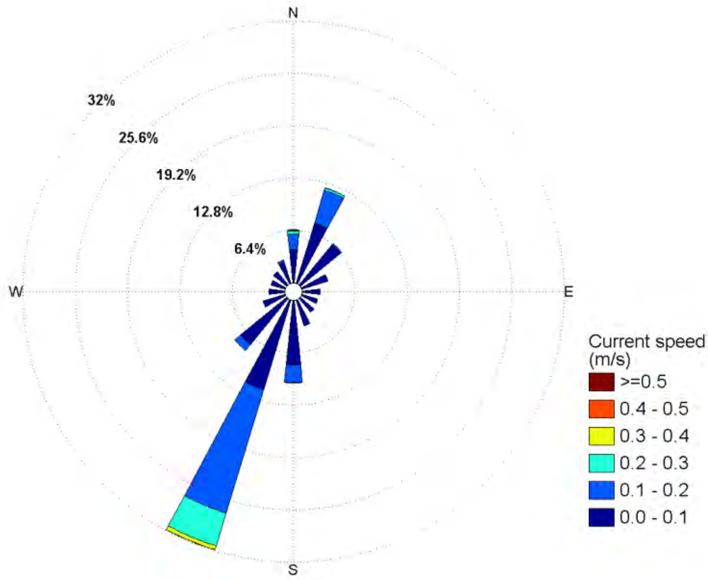


Figure 5.2 Long term current rose at the proposed offshore disposal ground. Current directions are represented as "going to".

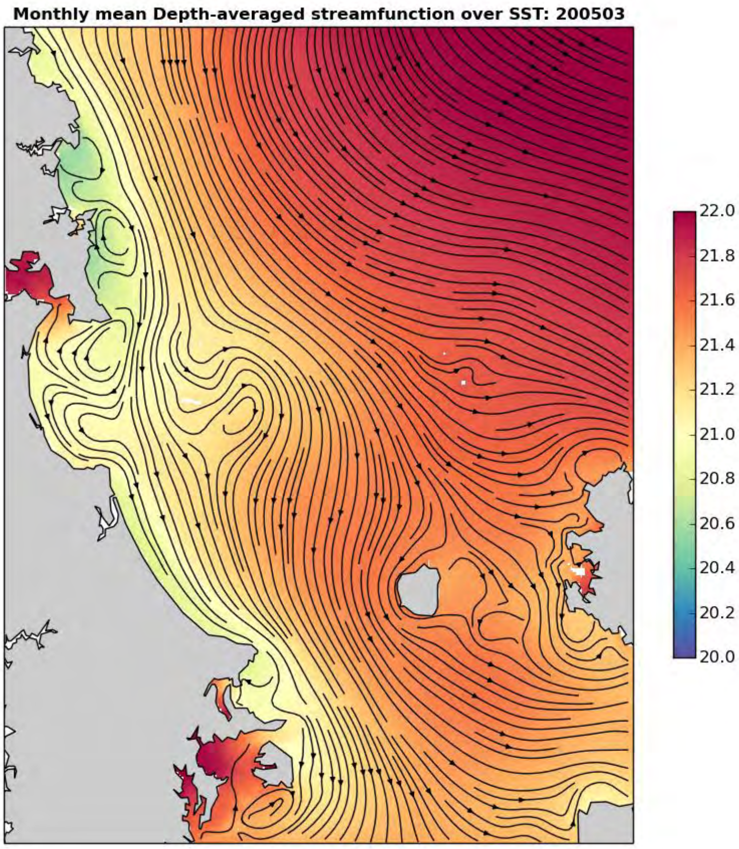


Figure 5.3 Monthly averaged flow for March 2005 as an example of the regional circulation. Note the interaction of the southward flow and the coastline geometry between Bream Bay and the offshore islands, generating coastal eddies and bifurcations.

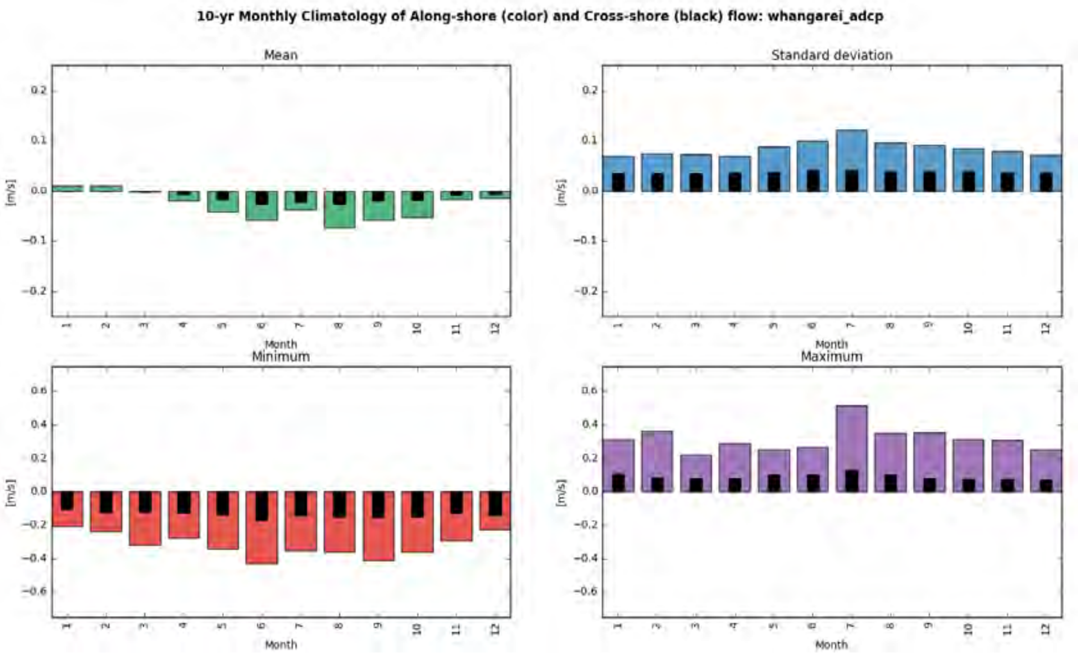


Figure 5.4 Monthly climatology of alongshore current at the proposed offshore disposal ground (site WRB).

6. NEARSHORE TIDAL HYDRODYNAMICS

The SELFE model was used to simulate the 2D tidal flows through the entire Whangarei Harbour to accurately replicate the tidal hydrodynamic in a very complex environment characterised by the presence of marginal channels, sand banks and small islands. The model was validated against water levels measured at four locations and current profiles measured over regions of the outer channel where dredging is proposed (see validation results in MSL Report P0297-01). The model was shown to replicate the governing hydrodynamic of the harbour, including the phase and amplitude of the tidal elevations and the spatially complex flows along the main shipping channel.

This section describes the existing tidal hydrodynamics of the Whangarei Harbour and examines the predicted effects of the channel deepening on the ebb and flood tidal flows. Changes in the bed shear stress fields are also presented and discussed.

6.1. Characterising the tidal dynamics

The modelled ebb and flood tidal flow patterns are shown in Figure 6.1 to Figure 6.4 for the spring and neap tidal regimes. Ebb flows gradually accelerate through the inlet with velocities ranging between 0.8 $m.s^{-1}$ near One Tree Point and increasing to 1.3 $m.s^{-1}$ through the narrow constriction of the channel during spring tides. During neap tide, ebb flow velocities range between 0.3 and 0.8 ms^{-1}. The south-southeast directed ebb-jet drives a velocity field on the ebb-tidal delta that extends up to 3.5 km into Bream Bay. On the western flank of the delta, the ebb-jet contributes to a clockwise tidal circulation along Ruakaka Beach and Mair Bank, with current velocities up to 0.35 $m.s^{-1}$ during the spring tide. The northern subtidal area of Mair Bank adjacent to the channel presents the highest exposure to strong currents (up to 1.4 $m.s^{-1}$). Interactions of the tidal flow and Mair Bank bathymetry result in accelerated and diverted flow velocities toward the inlet entrance. Between Marsden Point and Mair Bank, this acceleration occurs particularly over the southern edge of the channel where the depth exhibits steeper bed slopes. On the opposite flank, ebb flows do not exceed 0.8 $m.s^{-1}$ along Calliope Bank.

The hydrodynamic model results show that an approximate 0.5 to 1 hour phase lag in transition from flood to ebb flow between inlet and the open sea occurs, and it takes approximately 1 hour from the beginning of the ebb-tide to a complete current reversal.

At peak flood, the strongest velocities are located near Motukaroro Island and Marsden Point where the constriction of the channel accelerates the flows. Mair Bank is dominated by large uni-directional flood flow velocities ranging from1.2 $m.s^{-1}$ over the subtidal areas to 1.6 $m.s^{-1}$ over the intertidal area, which are directed from southwest to northeast. A weak counter current develops along Mair Bank to the southern flank of the channel. Within the harbour, segregation of flows due to marginal channels and bottom friction tends to reduce the flow velocities for both flood and neap tides leading to current speeds which do not exceed 0.9 $m.s^{-1}$.