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# **ENVIRONMENTAL MANAGEMENT AND MONITORING PLAN**



# Channel Deepening Project

## Draft Environmental Monitoring and Management Plan

**Prepared for**  
Lyttelton Port Company

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**Appendix A : Project Figures**

**Appendix B : Water quality monitoring methodology**

**Appendix C : Statistical approach for determination of trigger levels**

## Notes on the DRAFT Version

- This is a draft version and as such does refer to appendices or documents that are yet to be completed. Consequently there may be some references denoted 'XX'. These will be updated as the document and appendices are developed or finalised through the consenting process.

Draft



# 1 Introduction

## 1.1 Purpose

Lyttelton Port Company Limited (LPC) is planning a Channel Deepening Project (CDP) to deepen and extend the navigation channel and associated swing basin/berth pockets in Lyttelton Harbour/Whakaraupō. The channel will be widened, deepened and lengthened to accommodate larger vessels. The dredge spoil will be disposed of at a designated disposal ground, located offshore of the Harbour Heads.

This Draft Environmental Monitoring and Management Plan (EMMP) details the monitoring and management of the dredging and disposal activities associated with the CDP. The EMMP is a working document.

It is intended this EMMP will form part of the resource consent and seeks to manage the risk of the CDP resulting in unanticipated effects and, in particular, the risk of significant or irreversible effects. The Consent Holder (LPC) shall be responsible for ensuring all management and monitoring approaches outlined in the EMMP are followed.

## 1.2 Objectives

This EMMP outlines the monitoring and management proposed for the CDP, including the year prior and 1-5 years after the capital dredging. Primarily, it implements an adaptive management approach based on the results of real-time turbidity monitoring throughout Lyttelton Harbour/Whakaraupō and Port Levy/Koukourārata<sup>1</sup>. In addition, it outlines a monitoring regime (referred to as “assurance monitoring”) for the pre-dredging, dredging and post-dredging phases of the project. The assurance monitoring focuses on monitoring longer term effects on key ecological habitats and communities and the physical environment as well as quality control.

The primary purposes of the EMMP are to:

- Detail the framework for management of the dredging plumes which are the primary mechanism for potential effects.
- Detail the assurance monitoring to monitor longer timescale environmental responses
- Ensure the effects of the CDP on the coastal environment are within those predicted by modelling and the assessment of environmental effects.

In order to deliver in the above purposes, the objectives of the EMMP are to:

The primary objectives of this EMMP are to:

- Ensure dredging and disposal activities are managed to protect water quality, mahinga kai and other cultural values, and therefore recognises and provides for the relationship of Mana whenua with the coastal environment.
- Ensure dredging and disposal activities are managed to protect the commercial (aquaculture, finfish etc.) interests and the wider communities cultural and recreational interests
- Specify a framework for adaptive management of the dredging and disposal activities based on results of real-time turbidity monitoring in order to reduce the risk of unanticipated effects occurring.
- Detail a programme for appropriate and relevant monitoring of the physical, biological and ecological environments in Lyttelton Harbour/Whakaraupō and Port Levy/Koukourārata.

<sup>1</sup> Reference to Lyttelton Harbour/Whakaraupō and Port Levy/Koukourārata includes the waters off Northern Banks Peninsula in Pegasus Bay



- Ensure stakeholder engagement is ongoing through all phases of the CDP.

NOTE: The CDP will be undertaken in at least two stages. As such, it is proposed to undertake a formal review of the performance of the EMMP at the completion of each stage. Further details on the review process and outcomes are detailed in Section 7 – Reporting Requirements.

### 1.3 Regulatory requirements

This EMMP is designed to provide a framework for resource consent compliance and should be read in conjunction with the resource consent conditions for the following consents:

- CRCXXXXX - XXXXX

The consent conditions forming the resource consents above are issued and enforced by Canterbury Regional Council (CRC) as the regulator.

### 1.4 Environmental Monitoring and Management

Three types of monitoring and management approaches are proposed for the duration of the CDP:

- Adaptive Dredge Management - based on real-time turbidity monitoring
- Assurance Monitoring and Review – of physical and ecological environments
- Management Protocols –implemented during the dredging activity

#### 1.4.1 Adaptive Management

General adaptive management facilitates a continuous monitoring – evaluation – adjustment loop in which management responses are dictated by real-time monitoring and environmental conditions (refer Figure 1.1). The Central Dredging Association (CEDA) states

*“The need for integrating adaptive management into dredging projects is already becoming recognised but will probably increase in future, in reaction to an ever growing awareness of the need for protection of the environments as well as in connection to the ecosystem services approaches”* (CEDA, 2015)

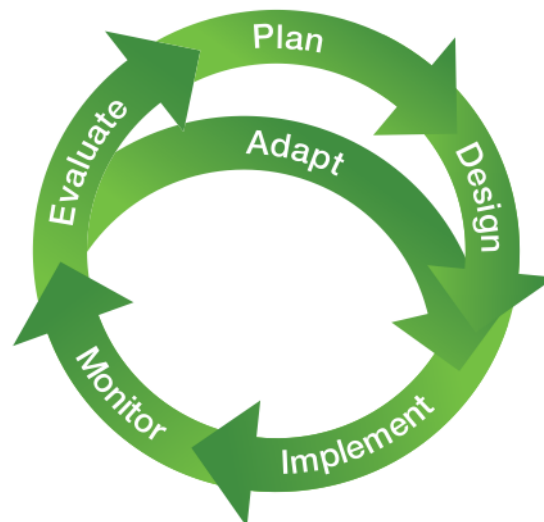


Figure 1.1: Adaptive management cycle (CEDA, 2015)

In the New Zealand context, adaptive management most usually refers to altering the overall scope of the project in response to measured effects i.e. limiting the footprint of the activity in response to

monitored effects. In the context of this project, the adaptations are proposed to be two-fold and based on two different timeframes:

- Adapting the operation in response to real time measurements of the mechanism of effect, rather than the effect itself
- Adaptation of the overall monitoring and management between the various stages of the project

This approach not only delivers the ‘typical’ adaption of the activity based on measured effects, but also places the adaptation process one step earlier to control the primary mechanism (sediment plumes) that may cause the effects.

This two phase adaptive management approach will ensure risks associated with the CDP are well managed as well as recognising the coastal system is complex and some uncertainty exists in the way predicted effects may manifest.

Adaptive management is identified by Te Hapū o Ngāti Wheke, Te Rūnanga o Koukourārata and Te Rūnanga o Ngāi Tahu as the key method to manage the potential effects of dredging activities on important rights, values and interests such as mahinga kai. A Cultural Impact Assessment prepared for the project (Jolly, 2016) recommends that:

*“LPC (must have the ability) to adapt the activity if adverse effects are observed. Integral to this is an adaptive and precautionary approach to managing potential effects; favouring the protection of water quality and mahinga kai habitat, sites and species, reflecting the limits to what we know, and the significance of potential impact if things go wrong.”*

Successful adaptive management for the CDP will rely on the following:

- Appropriate real-time water quality monitoring network
- Baseline monitoring of the existing environment undertaken for at least a year prior to commencement of dredging.
- Establishment of a tiered trigger level system, specified in the resource consent conditions, through a statistical approach. This shall be based on baseline monitoring of the background turbidity and an understanding of the existing environments<sup>2</sup> that could potentially be affected
- Guidelines for tiered management responses and reporting at each trigger tier to ensure appropriate responses to elevated turbidity levels.
  - The top tier trigger shall be a point of compliance under consent condition CRCXXXXXX section XX to ensure dredging is appropriately managed at higher levels of turbidity. The lower tier triggers are to inform management responses for the dredging operator.
- Involvement of key stakeholders throughout the project.

It is important to note that whilst the adaptive management framework will include possible management responses, prescriptive management actions for the dredge activities in response to trigger level exceedance are not being specified. The complexity of the coastal system means that a prescribed management response may be suitable one day (or in one current scenario) and not the next. Instead, the actual operational management measures implemented will be the responsibility of the Dredging Contractor in co-ordination with the Consent Holder. This will allow the

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<sup>2</sup> Refer to Chapter 5 (Existing Environments) of the Lyttelton Port Company Channel Deepening Project Assessment of Environmental Effects (LPC, 2016) for further information.

management measures to be flexible and adapt to the various conditions. It will also allow the dredging contractor to refine the management responses as the project progresses further reinforcing the 'learning by doing' approach of adaptive management.

#### **1.4.2 Assurance Monitoring**

The purpose of assurance monitoring is to measure potential effects which may manifest over longer timescales, ensure the effects are within anticipated levels and give confidence the adaptive management is achieving the objectives of the EMMP. It includes various monitoring methodologies to be undertaken on the physical, chemical and biological environments throughout Lyttelton Harbour/Whakaraupō and Port Levy/Koukourārata. This will be done for a year prior to the dredging, periodically during the dredging activities and post-completion of the channel deepening.

It is important to note that the time scales of assurance monitoring events (and the effect they are measuring) means day-to-day operational management of the dredging activity in response to assurance monitoring results is not possible. However, the frequency or nature of the assurance monitoring may be adjusted subject to advice from the Technical Advisory Group and/or Peer Review Group (refer Section 5.2 for further information). In addition the overall management of subsequent stages of the CDP may be adapted in relation to the assurance monitoring results from the previous stage.

#### **1.4.3 Other Management Protocols**

The EMMP also details management protocols to guide responses to marine mammal sightings, accidental discovery of archaeological significance and other incident – these protocols may also be included in the dredge management plan post procurement of the dredging operator.

### **1.5 Groups**

In order to ensure LPC receives ongoing advice from key stakeholders and the monitoring results and management actions are independently reviewed, two key groups are required. A Technical Advisory Group (TAG) and a Peer Review Group (PRG). The Consent Holder Project Team (CHPT) will liaise with these groups.

Defining each group's roles and responsibilities is crucial for the success of the adaptive management approach and ensuring monitoring is being appropriately undertaken and reported. The Consent Holder is responsible for ensuring open communication with key stakeholders throughout the project - in particular with Te Hapū o Ngāti Wheke, Te Rūnanga o Koukourārata and Te Rūnanga o Ngāi Tahu, given the importance of mahinga kai interests in the project area.

The following summarises the three groups and their roles in the project, full details are set out in Section 8:

- CHPT – responsible for the operational dredging activities, assessing real-time monitoring data as it is received and adapting dredge operations in order to prevent and/or respond to trigger level exceedance.
- TAG – responsible for providing advice to the Consent Holder on the monitoring results and methodology as well as advice on effectiveness of dredge management response. The group shall consist of technical experts with the relevant experience and knowledge on the project and the group shall meet regularly to discuss results of monitoring. This group will not provide advice on specific dredge management responses.
- PRG – responsible for providing high level independent peer review of the monitoring results (real-time and assurance) and effectiveness of dredge management decisions to provide confidence that the consent conditions and methods proposed in this EMMP are being adhered to. There will be specific peer review milestones associated with monitoring reports,

trigger level development etc. as well as 'as required' functions around unanticipated events i.e. extreme weather events etc.

In addition the Consent Holder will ensure open and continued engagement with other key stakeholders and the general community throughout the baseline, construction and post-completion phases of the project.

## 1.6 Key Contact Details

Table 1.1 summarises the key representatives on the CHPT and contact details for each.

**Table 1.1:** Summary of key contacts, roles and responsibilities of each throughout the dredging project (to be populated prior to commencement of baseline monitoring)

Name	Role/Responsibility	Organisation	Contact details
XX	Project Director	LPC	XX
XX	Project Manager	LPC	XX
XX	Project Environmental Advisor	LPC	
XX	Dredging Operator (TBC)	Dredging Company - TBC	XX
XX	Water quality monitoring and real-time data analysis	XX	XX
XX	Project Marine Ecologist	XX	XX
XX	Project Hydrodynamic Modeller	XX	XX
XX	Project Environmental Statistician	XX	XX

## 1.7 Report structure

This EMMP has been composed to set out the proposed monitoring and management plans for the duration of the CDP (including baseline and post-dredging) and is structured as follows:

- Section 2 describes the proposed works and location and setting of the project.
- Section 3 provides an overview of the sensitivity of the existing ecological, social, cultural and economic environments.
- Section 4 details the monitoring and management approaches for the implementation of the adaptive dredge management approach.
- Section 5 outlines the assurance monitoring.
- Section 6 outlines the additional environmental management protocols to be employed by the dredging company during the dredging activities.
- Section 7 outlines the reporting requirements for each stage of management.
- Section 8 summaries the group makeup, roles and responsibilities.

## 2 Description of the proposed works

### 2.1 Requirement of channel deepening

LPC plans to undertake a Channel Deepening Project (CDP) to deepen, enlarge and extend the main navigational channel and associated swing basin/berth pockets. Lyttelton Port (The Port) is currently New Zealand's third largest deep-water port and provides a vital link to international trade routes and a key role in the global transport network. However, the current channel does not have the draught to cope with the increasing vessel sizes/draught. Deepening the channel will allow the Port to keep up with international trade demand which is a key facilitator of the regional and national economy.

### 2.2 Location and extent of deepening works

The existing channel is maintained at approximately 11.9 metres (m) below chart datum, has a navigable width of 180 m and ends about one kilometre (km) inside the harbour heads (adjacent to Mechanics Bay). The channel enables a 12.5 m sailing draught across the high tide. LPC plan to allow vessels of up to 14.5 m draught access to the harbour in all tides. To achieve this, the existing navigation channel needs to be deepened (by approximately 5-6 m), widened (by 20 m) and lengthened, extending to approximately 4 km beyond the harbour heads as shown in Figure XX. This will involve the dredging of approximately 16.5 cubic metres (m<sup>3</sup>) sediment. In addition, a further approximately 1.5 million m<sup>3</sup> of material will be dredged as follows:

- Deepening of the ship-turning basin to allow vessels to manoeuvre into the future berth pockets at Te Awaparahi Bay;
- Deepening of the existing berth pockets at Cashin Quay;
- The creation of new pockets to serve the container terminal at Te Awaparahi Bay; and
- The deepening of the seabed located within the reclamation footprint, and in particular around the edges of the reclamation, as part of the construction methodology for the reclamation.

The existing navigation channel, as well as the Inner Harbour ship-turning basin and berthage areas, are regularly dredged (referred to as maintenance dredging) due to sediment in-fill which results from the movement of sediment by waves and currents. Currently, this is disposed of at the consented Godley Head disposal ground. However, recent modelling of sediment dynamics in Lyttelton Harbour/Whakaraupō has determined it likely that spoil disposed of at this location is being transported back into channel. Therefore, it is proposed to dispose the maintenance dredging from the deepened channel at a new dedicated maintenance disposal site, between Godley Heads and the capital dredging disposal ground. The site is approximately 1.6 km by 1.6 km and will receive anywhere from one to two times the current average annual maintenance dredging volume (between 0.45 and 0.9 million m<sup>3</sup> per year. Note that actual volume in a year may be higher or lower than this range of annual averages).

### 2.3 Dredging equipment and execution

Channel deepening will be primarily undertaken by a Trailer Suction Hopper Dredge (TSHD). TSHD's have a trailing suction pipe (or pipes) attached to a suction head that is capable of removing a lateral section of seabed. The seabed material is delivered into the hopper (hull) of the dredge. The size of the dredge has yet to be determined and the hopper capacity could range between 5,000 and 18,000 m<sup>3</sup>. The spoil will then be disposed of to sea at the proposed spoil disposal ground.

The TSHD is appropriate for the predominantly soft sediments found in the Lyttelton Harbour seabed. However, other types of dredges may need to be used, for example if areas of more

consolidated sediment are found a grab dredge or back hoe dredge may be required. In the highly unlikely event the sediment is highly consolidated, a cutter suction dredge will need to be used<sup>3</sup>

## 2.4 Timeframes

The CDP will be undertaken in at least two stages and involve dredging and disposal of approximately 18 million m<sup>3</sup> of sediment. An estimated 16.5 million m<sup>3</sup> of this will be dredged as part of the deepening of the channel, swing basin and berthage areas. A further estimated 1.5 million m<sup>3</sup> of material will be dredged to allow for reclamation and quay wharf construction and contingency.

The first stage will allow for tide-dependent access for container vessels with a sailing draught of 14.5 m. This stage is planned to commence in late 2017 and will dredge and dispose of approximately 6-12 million m<sup>3</sup> of sediment (depending on the extent of widening and deepening occurring in this stage). The remaining stage(s) will be undertaken at a later date to allow 14.5 m draught vessels access to the Port at all tides. It is anticipated each stage will take between nine and 14 months to complete.

A formal review of the performance of the EMMP will be undertaken upon completion of each stage and updates to monitoring frequencies, locations and other matters made as necessary (refer to Section 7.6 for further details).

<sup>3</sup> Further information on the types of dredges can be found in the Assessment of Environmental Effects, Chapter 2, Sections 2.46 – 2.51 (LPC, 2016).

### 3 Existing environment

The following gives a brief outline of the physical, ecological, biological, cultural and recreational environments of Lyttelton Harbour/Whakaraupō and Port Levy/Koukourārata. For further information refer to Chapter 3 and the appended technical reports of the LPC Channel Deepening Project Assessment of Environmental Effects (LPC, 2016).

#### 3.1 Physical environment

##### 3.1.1 Geography

Lyttelton Harbour/Whakaraupō is the eroded caldera remnant of an extinct volcano. The harbour has high marine cliffs at its entrance and along its sides. In its natural condition the harbour seabed is unusually flat and an almost constant gradient of 1:1000.

Pegasus Bay is a relatively shallow embayment north of Banks Peninsula and is part of the continental shelf. The bathymetry of the bay shows the continental shelf consists of two sections – a near shore steeply sloping zone which extends to the 10 m depth contour and has a relatively steep gradient of approximately 1:65 and an offshore gently sloping zone. Around the 35 m contour the gradient steepens to the Pegasus Canyon which reaches a maximum depth of 1600 m.

Both the Lyttelton Harbour/Whakaraupō and Port Levy/Koukourārata seabed are predominantly silt (60%), though there are slightly coarser sediments on the northern side of the harbour and exposed fine sands on the southern side of the harbour.

##### 3.1.2 Waves

Offshore of Banks Peninsula, in Pegasus Bay, the wave climate is largely dominated by southerly swell conditions mixed with infrequent northeast and southeast wave events. In comparison, the wave climate at the capital spoil disposal ground is predominantly from the east-northeast due to refraction of waves around Banks Peninsula. Wave height at this location is usually less than 2.0 m though rare wave events resulting in wave heights of over 3.5 m do occur.

In Lyttelton Harbour/Whakaraupō, mean wave height is at a maximum at the Harbour entrance and decreases towards the upper end of the harbour due to the effects of shoaling, refraction and friction. Mean wave height also reduces with distance from the Harbour entrance, from approximately 0.8 m, to 0.2 m at the centre of the harbour and then approximately 0.1 m in the Upper Harbour. Wave periods also decrease further into the Harbour, from nine seconds at the harbour entrance to seven seconds in Governor's Bay, due to the dissipation of swell waves.

##### 3.1.3 Tides/Currents

Oceanic currents are influenced by tides, wind and thermohaline conditions (temperature and salinity differences in the water). In Lyttelton Harbour/Whakaraupō, tidal conditions are the main influence on currents. The largest tidal currents occur in the shallow waters around the ends of the Cashin Quay and Naval Point breakwaters and around the Harbour Heads. Relatively large currents also occur at various places around Quail Island due to tidal dissipation.

##### 3.1.4 Meteorological

Coastal winds in Christchurch are mostly characterised by strong onshore north-easterlies during summer and slightly weaker south-westerlies in winter that blow off-shore. Low pressure systems pass through Pegasus Bay on average every six to seven days and are often dominated by strong southerly winds and high swells. Outside of the heads of Lyttelton Harbour/Whakaraupō, the ocean

is exposed to the prevailing oceanic swell; however, Banks Peninsula protects the Harbour from these strong weather events.

## 3.2 Ecological Habitats

Ecological habitats vary between the depth contours and physical environments of Lyttelton Harbour/Whakaraupō and Port Levy/Koukourārata.

### 3.2.1 Muddy bottom

The benthic habitats of Lyttelton Harbour/Whakaraupō and Port Levy/Koukourārata typically consist of relatively uniform semi-consolidated mud. As a consequence the communities living in these areas are comparatively sparse with a prevalence of marine worm organisms as well as taxa (populations of organisms) such as ostracods, crabs and small marine crustaceans. The area of the proposed channel has a lower abundance and range of fauna compared to the spoil disposal ground (Cawthron, 2016)

### 3.2.2 Sub-Tidal

The shallow sub-tidal reefs along the exposed coastline are dominated by a variety of kelp - including giant kelp (*Macrocystis spp*), common kelp (*Ecklonia spp*) and bull kelp (*Durvillaea spp*). A number of other taxa occur, including tunicate (*Urochordata*), and a rich understory of bryozoans, mussels, ascidians and sponges. Marine mollusc are also common, predominantly pāua (*Haliotis*), topshell (*Diloma aethiops*) and Cooks Turban snails (*Turbinidae*). The sea urchin (*E. chloroticus*) has been recorded at depths of three to five m (Cawthron, 2016).

### 3.2.3 Intertidal

Intertidal communities mainly consist of tubeworms and barnacles as well as periwinkles, limpets, chitons and cat's eye snails in the upper shoreline zone. In mid-shore zones species of mussels, oysters and algae become more prevalent. These communities are also evident at low-shore zones in addition to sponges and tunicates.

A variety of sea crustaceans are found around Banks Peninsula. These include, at varying extents of population and individual shell sizes, the following species: Tuatua/Bivalve Clam (*Paphies subtriangulata*), pipi (*Paphies australis*), tupaki/cockle kūtai (green lipped mussel), pāua, tio (oyster), kina (sea urchin) and pūpū (cat's eye (Cawthron, 2016).

## 3.3 Biological Environment

### 3.3.1 Fisheries

A range of fish species (both flattish and finfish) are supported in the relatively shallow and semi-sheltered waters of Lyttelton Harbour/Whakaraupō and Port Levy/Koukourārata. The waters support customary, commercial and recreational fisheries.



## Customary fisheries

There are 21 species of finfish important to mana whenua rights, values and interests (particularly customary fisheries and mahinga kai), in Lyttelton Harbour/Whakaraupō and Port Levy/Koukourārata. These include pātiki/flounder (*Rhombosolea retiaria*), hoka/ling (*Genypterus blacodes*), and pōke/rig (*M. antarcticus*) (refer Section 6.1 of the CIA (Jolly, 2016) for a full list of these species)). There is active customary fishing of these species in Lyttelton Harbour/Whakaraupō and Port Levy/Koukourārata (Cawthron, 2016).

There are Mātaitai reserves in both Lyttelton Harbour/Whakaraupō and Port Levy/Koukourārata, provided for under the Fisheries Act 1996. The Rāpaki Mātaitai Reserve was established in 1998 as the first Mātaitai in New Zealand. The Koukourārata Mātaitai Reserve, extending across the whole of the Harbour, was established in December 2000. Mātaitai Reserves recognise traditional fishing grounds that are important for customary food gathering, and are intended to protect, enhance and sustain the customary fishery for future generations (Jolly, 2016).

## Commercial Fisheries

There are 18 main commercially caught finfish species in the area including bluenose (*Hyperoglyphe antarctica*), NZ sole (*Peltorhamphus novaezeelandiae*), flatfish (various species), red cod (*Pseudophycis bachus*), terakihi (*Nemadactylus macropterus*), gurnard (*Chelidonichthys kumu*), common warehou (*Seriola lalandi*), barracouta (*Thyrsites atun*), giant stargazer (*Kathetostoma giganteum*), school shark (*Galeorhinus galeus*), blue moki (*Latridopsis ciliaris*), alfonsino (*Beryx splendens*), blue cod (*Parapercis colias*) and elephant fish (*Callorhinchus milii*). The Ministry of Primary Industries data extract for Pegasus Bay species records that flatfish is targeted inshore, with elephant fish (*C. milii*) and red gurnard (*Chelidonichthys kumu*) representing high value by-catch – especially in the area just offshore of Godley Heads (Cawthron, 2016).

### 3.3.2 Marine mammals

The footprint of the shipping channel extension and associated spoil disposal site are located within the boundaries of the Banks Peninsula Marine Mammal Sanctuary (BPMMS). The Sanctuary covers approximately 413,000 hectares and places restrictions on activities within its boundaries for the protection of fisheries and marine mammals (in particular the endangered Hector's dolphin/upokohue).

More than 25 cetacean (marine mammal) species have been sighted or stranded within the waters of Banks Peninsula. However, only the Hector's dolphin and New Zealand fur seal reside in the harbour year-round with the southern right whale often sighted offshore of Banks Peninsula.

Hector's dolphin/upokohue is endemic to New Zealand waters. Of the estimated 14,900 Hector's dolphins known to occur around the South Island, approximately 2,000–4,000 dolphins are found in the waters of Pegasus Bay year-round. The dolphins generally reside in the bays and harbours of Banks Peninsula in the summer and autumn months and move further offshore in the cooler months.

Several New Zealand Fur Seal breeding colonies are located throughout the more eastern and southern bays of Banks Peninsula (more than 20 km away from Lyttelton Harbour/Whakaraupō and the offshore disposal ground). However, New Zealand fur seals often cover large distances away from their breeding grounds and thus are commonly seen within Lyttelton Harbour/Whakaraupō and Port Levy/ Koukourārata and Pegasus Bay.

Regular sightings of southern right whales occur each year off Banks Peninsula, in particular in the northern bays and along the Lyttelton Harbour coastline, as whales migrate back to their traditional wintering and calving grounds around New Zealand. At the current sighting rate, at least one or two

southern right whales are expected to appear within or near Lyttelton Harbour each winter where they will remain for anywhere from a few days to several weeks (Cawthron, 2016).

### 3.3.3 Avifauna

Lyttelton Harbour/Whakaraupō, Port Levy/Koukourārata and the surrounding coastline provide diverse habitat locations for a number of marine birds to undertake nesting, roosting and foraging activities. The main avifauna habitats in the region include the inter-tidal rocky shoreline, the outer harbour wave-cut platforms, exposed reefs and sand beaches, the Inner Harbour inter-tidal mud-flats, the large conifers around the Harbour and coastal cliffs, Quail Island and the waters close to the seabed.

Assessment of avifauna in the region determined a total of 17 species which associate with the waters of Lyttelton Harbour/Whakaraupō, Port Levy/Koukourārata and offshore Banks Peninsula and have local breeding or wintering populations onshore of the area. These birds include (among others) penguins, fairy prion and sooty shearwater, tern, shag, gull and waders, and inhabit two major ecosystems; coastal (including the outer Lyttelton Harbour and the offshore area where dredged material will be disposed) and intertidal areas within the Lyttelton Harbour (Boffa Miskell, 2016).

### 3.3.4 Aquaculture

Commercially, a number of mussel farms have established along the bays and headlands of northern Banks Peninsula, from Port Levy/Koukourārata to Squally Bay. In total, there are 24 active consents, held by 6 different consent holders around the area. Consents have been issued to authorise the growing of a number of species, including green shell mussels (*Perna canaliculus*), blue shell mussels (*Mytilus galloprovincialis*), macroalgae (*Macrocystis pyrifera*, *Ecklonia radiata*, *Gracilaria spp.*, *Pterocladia lucida*, and *Undaria pinnatifida*), and for the collection of mussel spat. To date only green shell mussels are farmed along with the collection of green shell mussel spat (Ogilvie, 2016).

## 3.4 Cultural Environment/Mahinga Kai

The proposed channel dredging and spoil disposal grounds are located in the coastal marine area of the takiwā (traditional territories) of Te Hapū ō Ngāti Wheke (Rāpaki) and Te Rūnanga ō Koukourārata. The coastal marine area is known as Te Tai ō Mahaanui and is identified in the Ngāi Tahu Claims Settlement Act (NTCSA) 1998 as a Statutory Acknowledgement site, reflecting the particular cultural, and spiritual, historical and traditional associations of Ngāi Tahu to this area.

Te Hapū o Ngāti Wheke is the Ngāi Tahu Papatipu Rūnanga representing the hapū Ngāti Wheke, who hold mana whenua and mana moana (customary authority) over Whakaraupō. Te Rūnanga o Koukourārata is the Papatipu Rūnanga representing the hapū Ngāti Huikai, who hold mana whenua and mana moana over Koukourārata and the northern bays of Te Pātaka ō Rākaihautū (Banks Peninsula).

Lyttelton Harbour/Whakaraupō and Port Levy/Koukourārata are cultural landscapes with strong traditions of mahinga kai. Ngāi Tahu have lived and fished in the waters of both harbours and offshore for generations. There are numerous settlement sites, wāhi taonga (treasured places) and wāhi tapu (sacred sites) that hold the stories of Ngāi Tahu migration, settlement and resource use.

The rich resources of the harbour brought Ngāi Tahu to settle in the area, and mahinga kai continues to be an integral part of the relationship between mana whenua and the coastal environment. This includes customary food gathering and the establishment of Mātaitai Reserves, and the contemporary development of marine farms. The importance of the relationship of mana whenua with the coastal environment, including the kaitiaki (guardianship) role, is recognised by the RMA 1991 and the New Zealand Coastal Policy Statement 2010 (NZCPS).

As kaitiaki, Te Hapū o Ngāti Wheke and Te Rūnanga o Koukourārata are working to protect and restore the cultural and ecological health of the harbours and wider coastal environment. This includes the fundamental importance of water quality to sustaining mahinga kai which is abundant, diverse, and safe to eat, and the ability to access these resources. Fourteen types of shellfish and 21 species of finfish (Ogilvie, 2016) have been identified by the Te Hapū o Ngāti Wheke application for a mātaihai reserve (Te Hapū o Ngāti Wheke Incorporated, 2014), and by Te Hapū o Ngāti Wheke Tangata Tiaki.

Engagement with Te Hapū o Ngāti Wheke, Te Rūnanga o Koukourārata and Te Rūnanga o Ngāi Tahu is ongoing and will continue throughout the CDP to ensure protection of all values, rights and interests in the harbours before, during and after the dredging activities.

### **3.5 Recreational values**

The close proximity of Lyttelton Harbour/Whakaraupō to Christchurch City means it is a popular recreational destination for Christchurch and Canterbury locals as well as domestic and international tourists. In particular, the Harbour is valued for its fishing, swimming, biscuiting, water skiing, general boating, picnic locations and wake and knee boarding. Some diving and snorkelling occurs in and around the outer harbour and pāua, mussels and crayfish are found at specific sites. Swimming is popular at sites with relatively sandy beaches, such as at Cass and Corsair Bays, despite poor water clarity. The shoreline provides many on-land recreation opportunities, including walking, heritage and sightseeing opportunities at Godley and Adderley Head, Ripapa and Quail Islands, Diamond Harbour and the road-accessible bays stretching from Naval Point at Lyttelton to Camp Bay east of Purau.

In terms of recreational fishing, a wide variety of fish species has been reported in Lyttelton Harbour/Whakaraupō with most fishing taking place from boats in the Outer Harbour. The best recreational fishing is reported to be a long way further off the coast although Kingfish are reported to be caught off Taylors Mistake after Christmas (AEE, 2016). During summer the port area is frequented by juvenile fish of species such as red cod, yellow eyed muller, blue warehou, spiny dogfish and green pufferfish. Adult fish such as red cod and quinnat salmon have also been caught in the harbour (Rob Greenaway & Associates, 2016).

### **3.6 Archaeological Environment**

Human activity has been occurring in and around Lyttelton Harbour/Whakaraupō and Port Levy/Koukourārata for over 800 years. The first occupants of the area were Waitaha, followed by Ngāti Māmoë in the 16th century and Ngāi Tahu in the 18th century. For centuries, Lyttelton Harbour/Whakaraupō was a major travel route between Ngāi Tahu settlements and mahinga kai areas. Lyttelton Port itself was established by European settlers in 1850. There is still the potential for the accidental discoveries of taonga (treasures), kō iwi tangata (human skeletal remains) or European artefacts when dredging areas of previously undisturbed seabed.

### **3.7 Navigation and Navigational Aids**

The existing dredged channel extends to within approximately one nautical mile of the Heads, and is marked by the Governors Bay Precision Entrance Light (PEL). PEL Sector Lights indicate the vessel position in confined waterways by using sectors of colour to convey information about the location of the vessel with respect to the channel centreline.

A second PEL leading light is located on the headland between Diamond Harbour and Purau Bay. This sector light marks the outer (un-dredged) approach route aligned roughly 060-240°N(T) along the line between the pilot transfer station (approximately two nautical miles east north east of The Heads, outside the pilotage limit) and the outer (eastern) end of the dredged channel.

There is an existing turning area opposite the Cashin Quay container terminal area. This irregularly-shaped area is dredged to a maintained depth of -11.9 m CD, and is up to approximately 600 m wide (close to the Sticking Point breakwater structure), with extents of the dredged area marked by a series of transit marks.

Access to the inner basin (dredged to a maintained depth of -10.5 m CD) is through a relatively narrow entrance between the Z-Wharf and Naval Point Oil Wharf.

In addition to the two PEL sector lights the innermost navigation fairways are marked by a comprehensive system of transit marks. However, other than the Spoil Ground special buoy and the Parsons Rock beacon, navigation buoys and beacons are sparse in the approaches to the port.

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## 4 Adaptive dredge management

Two primary management methods will be employed throughout the operational phase of the project:

- Proactive Operational Management: utilises real time environmental information (i.e. tides, wind, waves etc.) to guide operational management decisions during dredging. Undertaken as part of common dredging practice.
- Adaptive Dredge Management: based on real-time turbidity monitoring - implements an adaptive management approach in response to predetermined trigger levels.

### 4.1 Proactive operational management

Proactive operational management of the dredge and disposal activities will be undertaken by the Dredging Operator. This will take into consideration the hydro-meteorological conditions, likely plume movement based on hindcast modelling (MetOcean Solutions Ltd, 2016) and the real-time water quality information (turbidity, waves and currents). The purpose of proactive operational management is to constantly assess the daily planned dredge operations to minimise the risk of a dredge-induced trigger exceedance. It is anticipated the Dredging Operator will increasingly incorporate past causes and management responses to trigger exceedances in a “learn as we go” approach. This type of dredge operation is considered routine best practice by Dredging Operators.

### 4.2 Adaptive dredge management monitoring

Adaptive management of the dredging operations will occur throughout the CDP (referred to as adaptive dredge management). Location of dredging and disposal points within the grounds will be adjusted based on the results of real-time turbidity monitoring collected at 14 locations throughout Lyttelton Harbour/Whakaraupō and Port Levy/Koukourārata. The results of the turbidity monitoring will be compared to tiered triggers. The triggers will be based on a robust statistical analysis of at least one year of baseline data and are likely to be a higher order percentile of background. If exceeded, the dredging operations must be modified to reduce the turbidity at the point of exceedance.

#### 4.2.1 Real-time turbidity monitoring

The objective of the real-time turbidity monitoring program is to provide continuous real-time information on turbidity levels at key locations throughout Lyttelton Harbour/Whakaraupō and Port Levy/Koukourārata. The dredge operations will be managed in real-time by comparing the turbidity data with pre-established trigger levels.

Dredging plumes are largely generated at the seafloor. However, due to either the water column being well mixed and/or a relationship existing between surface and benthic turbidity it is only proposed to measure real-time surface turbidity (benthic turbidity is measured, but not real-time). To validate this assumption it is important that the benthic-surface turbidity relationship and/or the well mixed nature of the water is demonstrated and documented. Determination of the relationship between benthic and subsurface turbidity is explained below.

#### 4.2.2 Establishment of the benthic – subsurface turbidity relationship

The relationship between the surface and benthic turbidity shall be established during the baseline monitoring (undertaken for at least one year). This will be determined by:

- Analysing the surface and benthic turbidity levels at the locations where these are both measured

- Analysing the monthly NTU depth profiling and TSS sampling at each monitoring site
- Analysing the an Acoustic Doppler Current Profiler (ADCP) backscatter readings (collected at 15 minute intervals) at the three spoil Ground monitoring sites.

#### 4.2.3 Locations of monitoring sites

In determining the locations of the monitoring instrumentation the broad objectives were to:

- Provide two lines of monitoring between the offshore ground and the shoreline,
- Encircle the channel works with monitoring instruments located between the channel and shoreline
- Have some reference sites on the outer coast away from predicted increases in turbidity

15 monitoring sites are proposed to achieve the above, 14 of which will have real-time subsurface turbidity loggers. Of these 13 are to be used as part of the tiered management approach, the 14<sup>th</sup> is a reference or control site. The locations have been chosen based on the above broad objectives, analysis of hydrodynamic models of predicted plume dispersion and locations of environmental and cultural significance. Each monitoring site (situated either inshore or offshore) consists of a buoy with a combination of instruments capable of monitoring combinations of different water quality parameters.

The real-time turbidity data shall be compared to pre-established triggers as part of the tiered management system approach. The remaining water quality and current/meteorological monitoring data will be used to establish the benthic-subsurface turbidity relationship, give an indication to the Dredging Operator of the MetOcean and physiochemical conditions and also form part of the assurance water quality monitoring (refer section 5.5).

Instrument locations have been separated into four zones as shown in Figure 3 (Appendix A) and detailed as follows:

- i Channel Zone
  - At least six real time surface turbidity monitoring locations situated throughout the harbour at locations close to ecological habitats and within locations of potentially increased turbidity from suspended sediment plumes (as informed by modelling undertaken by MetOcean Solutions Ltd.).
  - At least one of the sites shall have the ability to continuously self-log benthic turbidity.
- ii Offshore Zone
  - At least two real time surface turbidity monitoring sites in this zone to monitor turbidity between the spoil ground and receptors on the coast of Banks Peninsula.
  - At least one of the sites shall have the ability to continuously self-log benthic turbidity.
- iii Spoil Ground Zone:
  - At least three real time turbidity monitoring sites situated at suitable locations in order to detect turbidity plumes generated during spoil disposal which may migrate shorewards (as informed by modelling undertaken by MetOcean Solutions Ltd.).
- iv Inshore Zone
  - At least three real time subsurface turbidity monitoring sites. One of these sites shall be used as a control site during the monitoring programme.
  - All of the monitoring sites shall have the ability to continuously self-log benthic turbidity.
  - At least two locations shall continuously self-log benthic PAR

In addition there shall be an altimeter installed in Rāpaki Bay for the purposes of recording bed level changes in the bay throughout the baseline, dredging and post dredging monitoring period. This data will not be used to manage the dredging operations during a dredging stage.

The proposed monitoring locations are shown in Figure 4 (Appendix A). The scale of the dredging and disposal footprints means different monitoring locations may detect increased turbidity from the channel dredging, spoil disposal or both activities (Table 4.1).

**Table 4.1: Spoil activity related monitoring locations and channel deepening locations**

Measurement purpose	Sentinel monitoring sites
Turbidity plumes generated during disposal at spoil disposal ground and for informing dredge management procedures	SG1, SG2a, SG2b, OS5, OS6, OS3
Turbidity plumes generated from dredging in the channel and for informing dredge management procedures	UH1, UH2, CH1, CH2, OS1, OS2, OS5, OS6, OS7
Turbidity close to mussel farms and as reference location	OS6

#### 4.2.4 Instrument type

The instruments deployed at each location are dependent on the location, hydrodynamic and meteorological conditions and the predicted plume extents and locations. All locations (aside from UH3 at Rāpaki) have a surface telemetered real time turbidity setup. A number of locations also have self-logging benthic turbidity, benthic light and two also have self-logging bed level altimeters. Where turbidity is measured, dissolved oxygen, temperature, conductivity and pH are also measured.

Three locations (at the offshore ground) also measure the current profile, with one location also measuring wave height, direction and period as well as general meteorological data.

The details of what instrument are deployed at each location is set out in Table 4.2. More detail on the specific instruments is contained within the water quality monitoring report prepared by Vision Environment (Vision Environment, 2016).

#### 4.2.5 Adjusting monitoring locations post-deployment

Due to the complexity of the coastal environment it may be necessary to adjust the monitoring locations during the baseline or dredging periods.

**Table 4.2: Summary of instrumentation at each monitoring location**

Monitoring Site	Buoy type		Instrument					
	Off-shore	In-shore	Benthic self-logging data logger	Surface Turbidity Data Logger	Self-Logging Benthic PAR	Self-logging Benthic Altimeter	ADCP	Watch keeper
UH1		✓		✓				
UH2		✓		✓				
UH3 – reference site		✓				✓		
CH1		✓		✓				
CH2		✓		✓				
CH3		✓		✓				
SG1	✓			✓			✓	
SG2a	✓							✓
SG2b	✓			✓				
SG3	✓			✓			✓	
OS1	✓		✓	✓				
OS2	✓		✓	✓	✓	✓		
OS3	✓		✓	✓	✓			
OS4 -control site	✓		✓	✓				
OS5	✓			✓				
OS6	✓		✓	✓				



### 4.2.6 Data processing

Data processing of the real-time turbidity monitoring data will be required in order to ensure the gathered data is appropriate for analytical purposes (refer Figure 4.2). For more information on each of the processes refer to Appendix C (Fox D. R., 2016).

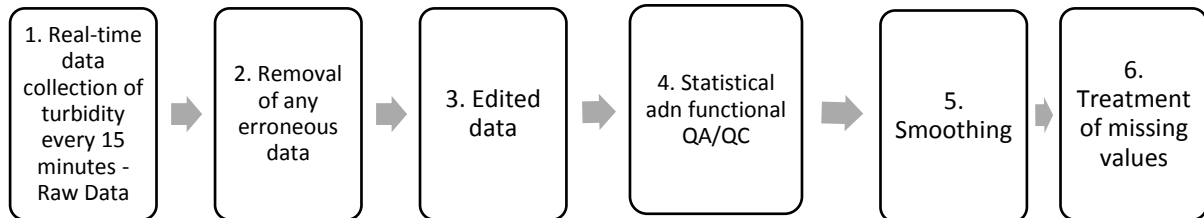


Figure 4.1: Example data processing flow chart (Fox D. R., 2016)

### 4.3 Tiered trigger system

Adaptive dredge management will be implemented through a system of triggers which require management responses. This system is based upon comparing the real time monitoring information collected against pre-established and agreed trigger levels to ascertain the degree of management required. An overview of the trigger levels is shown below in Figure 4.3.

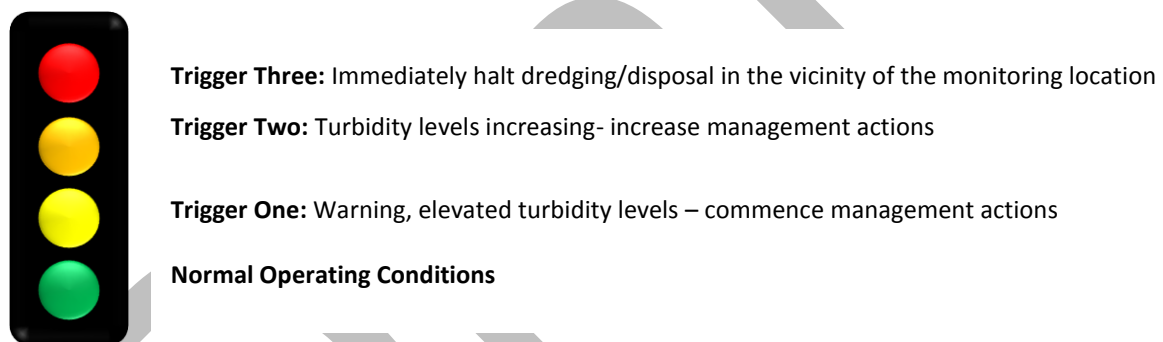


Figure 4.2: Proposed approach for trigger level management.

Each stage shall have broad management and reporting requirements in order to determine the cause of the trigger level exceedance and, where appropriate, take measures to reduce the exceedance and/or prevent turbidity from increasing. Reporting requirements are detailed further in Section 7 and group roles and responsibilities in Section 8.

Thirteen of the fourteen real-time monitoring sites will be assigned turbidity trigger levels (the control site will not have triggers values). Throughout the dredging activities the surface telemetered turbidity data recorded at these locations will be continuously assessed against the trigger limits.

#### 4.3.1 Establishing the trigger levels

##### 4.3.1.1 Background

Two approaches have been considered for establishing the trigger levels, based on:

- Tolerance of present species to turbidity; and
- Existing natural turbidity levels.

Developing species-tolerance based trigger levels requires robust information on how the species of concern react to increases in turbidity. This is particularly challenging when the actual effect of turbidity may be through some other mechanism, e.g. reduced light due to increased turbidity, rather than the turbidity itself. Detailed information on how species within Lyttelton Harbour/Whakaraupō and Port Levy/Koukourārata react to increased turbidity does not currently exist for all potentially affected ecological communities.

The second approach considered is based on maintaining existing natural turbidity levels and the assumption that ecological communities present in Lyttelton Harbour/ Whakaraupō and Port Levy/Koukourārata are tolerant and adapted to existing turbidity levels. This includes periods of naturally elevated turbidity, both short term high turbidity and longer term low level elevations.

Robust long term baseline information is critical to a 'background' based approach. Baseline monitoring needs to be undertaken for a sufficient period (at least 12 months) to establish the existing turbidity conditions at each monitoring site. The natural variation of turbidity throughout the waters of the Harbour and offshore mean the actual turbidity trigger levels will vary significantly between monitoring site locations.

#### 4.3.1.2 Proposed Methodology

A preliminary method for establishing the trigger levels has been proposed, based on a modified Intensity – Duration – Frequency (IDF) approach (Fox D. R., 2016). The methodology for establishing the trigger levels forms part of resource consent compliance under condition XX of CRC XXXXXX. Outputs from, and any amendments to the methodology, will be reviewed by the current Technical Advisory Group (TAG).

The modified IDF approach establishes that for any given exceedance there is only one combination of average duration of exceedance and average frequency that correspond to that exceedance rate (Fox D. R., 2016). This approach will be used to establish numerical trigger values which have a turbidity limit and corresponding permissible number of exceedances and maximum average duration of exceedance.

The trigger limits will be set based on the XX<sup>th</sup>, XX<sup>th</sup> and XX<sup>th</sup> percentiles of data. The data may incorporate dredge related turbidity increases, where predicted by modelling i.e. at monitoring points around the offshore ground.

#### 4.3.2 Trigger levels

**Table 4.3: Percentile/duration/frequency associated with each trigger level**

Trigger Level	Intensity Percentile	Duration	Frequency
One	XX <sup>th</sup>	TBC	TBC
Two	XX <sup>th</sup>	TBC	TBC
Three	XX <sup>th</sup>	TBC	TBC

Upon confirming the trigger level method, appropriate background percentile, and once all background data has been received, Table 4.4 shall be populated detailing the trigger level at each monitoring location.

**Table 4.4: Defined trigger levels at each monitoring location**

Monitoring Site	Trigger One			Trigger Two			Trigger Two		
	I (NTU)	D (hrs)	F (no.)	I (NTU)	D (hrs)	F (no.)	I (NTU)	D (hrs)	F (no.)
UH1									
UH2									
CH1									
CH2									
CH3									
SG1									
SG2a									
SG2b									
SG4									
OS1									
OS2									
OS3									
OS5									
OS6									

#### 4.4 Tiered Management Approach

Figure 4.4 indicates the levels at which each management group will be involved in the management of the dredge.

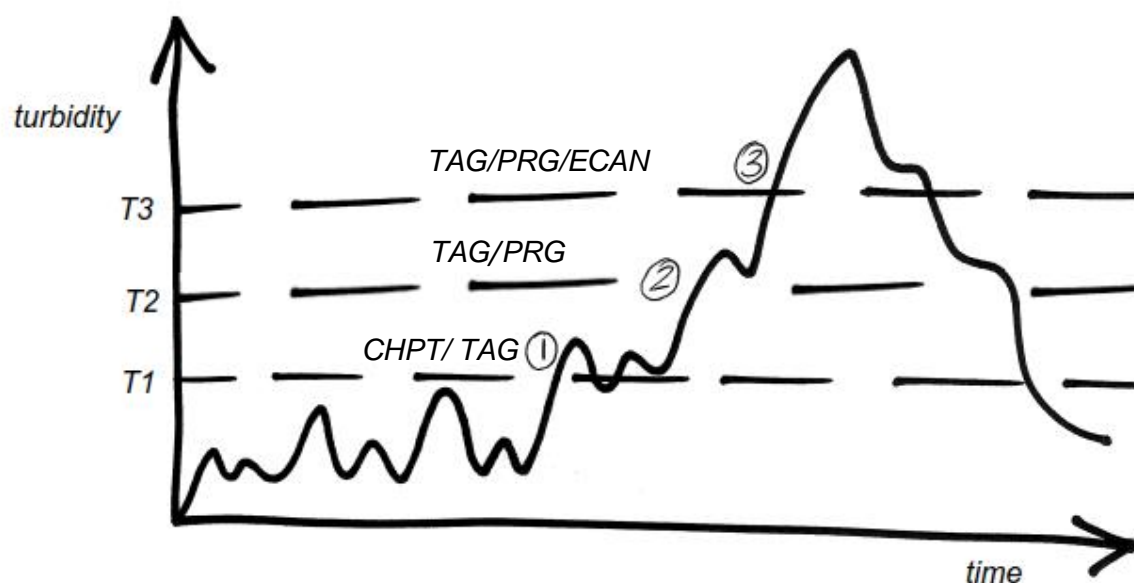


Figure 4.3: Schematic of trigger responses and group involvements

#### 4.4.1 Normal operating conditions

- Turbidity levels within normal limits and below the defined triggers levels
- Dredging operator, in conjunction with the rest of the CHPT, responsible for applying a proactive management response, taking into consideration hydro-meteorological conditions, modelling, real-time monitoring etc. to guide location of dredging and spoil disposal locations.

#### 4.4.2 Trigger One

Percentile: XX<sup>th</sup>

Duration: TBC

Frequency: TBC

Trigger One is an internal trigger to alert the Consent Holder Project Team (CHPT), in particular the Dredging Operator, that the surface turbidity at a monitoring site has increased beyond the xx<sup>th</sup> percentile of background. The Dredging Operator will then have the time associated with the duration component to respond to the exceedance.

The following steps shall be undertaken by the CHPT:

- Notify the TAG of the exceedance via automated email.
- An investigation into the following:
  - Examine the monitoring equipment for any faults/defects that may have influenced data collection
  - Analyse and compare the results against:
    - o Background turbidity levels
    - o Recent meteorological and current/wave/tide conditions (particularly due to any extreme events)
    - o Turbidity levels and trends at all monitoring sites for at least 48 hours prior to exceedance
  - Consider sediment transport patterns in Lyttelton Harbour/Whakaraupō, Port Levy/Koukourārata and wider Banks Peninsula using aerials/satellite imagery
  - Where possible, examine the monitoring site to ensure no natural processes (e.g. landslips, seaweed build up etc.) are contributing to the elevated turbidity level.
  - Consider whether any significant rainfall events (resulting in increased surface runoff or river sedimentation outfall)
  - Consider the proposed dredge locations in the two days preceding exceedance

Based on the above, the investigation shall determine the likelihood of the alert exceedance being due to the dredging activities in order to analyse how and why the alert was triggered. If it is determined at all likely that the dredging activities have contributed to the increased turbidity level, the dredging operator shall, within XXX days, adjust the dredging operations in order to prevent turbidity further increasing at the location. Where the extent to which the dredging has contributed to the exceedance is uncertain, a precautionary approach shall be taken assuming the dredge has contributed to the exceedance.

Dredging operation modification to reduce plume extent/concentration may include the following (based on the discretion of the dredging operator and advice from other members of CHPT:

- Change of disposal location within spoil grounds
- Change the dredging location

- Alteration of overflow regime
- Reduction of the dredge load
- Alteration of vessel speed during dumping
- Modification of dredge phase with respect to tide phase

A monitoring location shall be deemed no longer in exceedance of Trigger One immediately upon the turbidity levels reducing to below Trigger One levels.

Records shall be kept of the incidence of Trigger One level exceedance and associated investigations or actions.

#### **4.4.3 Trigger Two**

If the management responses undertaken in response to the Trigger One trigger do not reduce the turbidity levels at the monitoring location, the second management tier, Trigger Two, may be reached.

In the event of a Trigger Two exceedance, the following steps shall be undertaken by the CHPT:

- Notify the PRG and the TAG of the trigger level exceedance (can be automated email).
  - Dredging operator is to increase the management measures in order to further reduce the turbidity levels at the location of exceedance.
  - Undertake further review of the monitoring data and environmental factors which may be causing a natural increase in turbidity (as set out for Trigger One).
  - If deemed necessary undertake additional monitoring in the area of exceedance to further investigate the turbidity plumes.

A monitoring location shall be deemed to be below Trigger Two immediately upon the turbidity levels dropping below the Trigger Two levels.

A brief trigger level exceedance report detailing the investigation processes, results and responses (if any) shall be completed within XX days of the exceedance and made available to the TAG at the next meeting (for further details refer to Section 7).

#### **4.4.4 Trigger Three (compliance level)**

Trigger three is a compliance trigger as specified in Consent Conditions Clause XX. The Dredging Operator should take all practicable steps to avoid the dredge plumes reaching Trigger Three. However if Trigger Three is reached, at any of the monitoring locations, the CHPT must undertake the following:

- Immediate notification of exceedance to the Canterbury Regional Council, PRG, TAG.
- Undertaken immediate action to halt dredging and/or disposal in the vicinity of the monitoring location. The distance at which the dredge is no longer within the vicinity of the monitoring location is determined by the CHPT and should take into consideration the likely suspended sediment plume extent from the dredging and/or disposal activities as well as the current and forecast MetOcean conditions.
- Undertake an investigation into the likely cause of exceedance. This should include all points covered in the Tier One trigger exceedance.
  - If the reason for exceedance is determined to be due to an unusual natural event and not dredging related, dredging may be able to continue. The regulator must be notified of the decision to continue dredging and they may review this decision and disagree. If

the Canterbury Regional Council does not agree that exceedance is due to natural events, enforcement action may result.

- An unusual event is defined as one which is due to natural causes or completely out of the control of the CHPT e.g. flooding of the Waimakariri River.

A monitoring location shall be deemed no longer in exceedance once the turbidity results drop to below Trigger Three. Immediate notification post-exceedance shall be provided to the CRC, PRG and TAG and a trigger level exceedance report shall be prepared, and provided to the CRC, PRG and TAG within XX days (refer Section 7 for further information on reporting requirements).

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## 5 Assurance monitoring

The purpose of assurance monitoring is to provide confidence that the adaptive management approach is achieving the objectives of the EMMP i.e. to ensure that any effects of the CDP are not beyond anticipated and provide protection to the various cultural, physical and ecological environments present in Lyttelton Harbour/Whakaraupō and Port Levy/Koukourārata.

Methods for bathymetrical surveys, physical shoreline surveys, sediment sampling, water quality sampling, and mussel monitoring are outlined below. It is anticipated this monitoring will be undertaken prior to, during and post-completion of the CDP in order to provide assurance that the compliance monitoring and tiered management approach is achieving the objectives of the EMMP. In addition, the results of the assurance monitoring will be used to assess how the different environments are responding to the dredging activities both during and in the five year period post dredging.

The assurance monitoring is not intended to provide within-dredging-stage adaptive management as that is implemented through the real-time turbidity monitoring. However, it is anticipated that the results of the assurance monitoring will be used to adapt and improve (as required) this EMMP and the management and monitoring approaches between dredging stages. The assessment of the need for this longer term adaption shall be reviewed and detailed as part of the Dredging Stage Completion Report (refer Section 7.6).

### 5.1 Bathymetrical surveys

**Objective:** give an indication of the sediment erosion and deposition at the offshore disposal ground during dredging and post completion of each stage. This will be compared to predicted sediment dynamics from numerical modelling (MetOcean Solutions Ltd, 2016) as part of model validation and to give assurance that sediment dispersion is occurring as predicted.

**Methodology (tbc):**

The bathymetrical surveys shall be taken at the following locations (these will be determined with the Dredging Operator):

- Perpendicular transects down the navigation channel at spacing of XX m.
- At the swing basin
- At the spoil disposal ground
- At the frequencies given in Table XX below

**Table 5.1: Bathymetrical monitoring frequencies**

Project Phase	Frequency
Construction	Undertaken as part of the dredging operator normal operations – reported monthly
First year post-completion of a dredging stage	Monthly
2-5 years post-completion of a dredging stage (or until consolidation occurs)	Quarterly (TBC)

## 5.2 Ecological monitoring (subtidal, intertidal and benthic – soft shore/rocky reef)

**Objective:** identify any changes to soft shore and rocky reef communities' that could potentially be attributed to the CDP dredging and disposal activities. In particular, the time scales of ecological response to elevated turbidity are relatively long, therefore this monitoring will aim to give assurance that the ecological communities have not been impacted by the CDP over time.

Upon completion of the ecological monitoring, the results shall be recorded and reported as part of the four monthly ecological monitoring report (refer Section 7.4).

### 5.2.1 Subtidal rocky shoreline

Surveys of the communities at the subtidal rocky shoreline at no fewer than six locations shall be undertaken at a frequency to provide at least two surveys in the baseline phase, 4-monthly during the dredging phase and at least one survey post dredging. Due to the surveys being weather dependent the frequencies are approximate only.

The methodology of each survey will cover the following (full detailed methodology is included in Appendix XX):

- Dive surveys along three subtidal transect lines, parallel to the shore and at the following depth ranges (refer Figure XX):
  - Deep transect
    - o between 6 – 8 m depth and 30 m in length
    - o running near maximum extent of non-coralline macroalgae
  - Shallow transect
    - o between 3 – 5 m depth and 30 m in length
    - o within kelp forest habitats
  - littoral fringe transect
    - o between 0-1 m depth (relative to chart datum) and 50 m long
    - o within the shallow subtidal
- Eight quadrats (measuring 1 square metre (m<sup>2</sup>)) at each shallow/deep depth transect with the following recorded at each quadrat:
  - Water depth
  - An estimate of the percentage cover of substrate type
  - An estimate of the percentage cover of canopy forming and understory algae
  - Estimates of percentage cover of encrusting invertebrates (e.g. sponges, ascidians, mussels)
  - Counts of solitary epifauna (e.g. snails, sea urchins, sea stars)
- A count and measure of the number of large invertebrate and mahinga kai species within a one m band (i.e. 50 m<sup>2</sup> area) at each littoral fringe transect.

### 5.2.2 Intertidal rocky shoreline

Intertidal biological communities will be surveyed at four (tbc) locations throughout Lyttelton Harbour/Whakaraupō (refer Figure XX). Surveys shall be undertaken at a frequency to provide at least one survey in the baseline phase, 4-monthly during the dredging phase and at least two survey post dredging. Due to the surveys being weather dependent the frequencies are approximate only.



The methodology of each survey will cover the following (full detailed methodology is included in Appendix XX):

- Survey of 50 m shoreline at each site
- Recording of substrate characteristics
- Recording of zonation patterns of intertidal fauna and flora at high, mid, low and tidal pools using a categorical scale.
- Representative photos of habitats and taxa were also obtained.
- Taxonomic nomenclature based on the World Register of Marine Species (WoRMS Editorial Board 2016).

### 5.2.3 Benthic (soft sediments)

Benthic sampling shall be undertaken to record the physical, chemical and biological nature of benthic habitats. Two groups of sites are to be sampled, a set of 14 sites for the dredging phase and a further 5 sites for the pre and post dredging phases. The sites should be sampled at the same frequency as the subtidal survey work.

The methodology of each survey will cover the following (full detailed methodology is included in Appendix XX):

- Sediments will be collected using a 0.1m<sup>2</sup> stainless steel Van Veen grab from 19 samples at the locations shown in Figure XX.
- The collected sediment samples shall be analysed for:
  - Sediment chemistry, in particular indicative metal contaminants
  - Sediment grain size distribution and organic content
  - Sediment-dwelling macroinvertebrate communities (infauna)
- Triplicate grabs will be conducted at each station and at each, the grab contents will be sub-sampled for the sediment and infauna analyses.

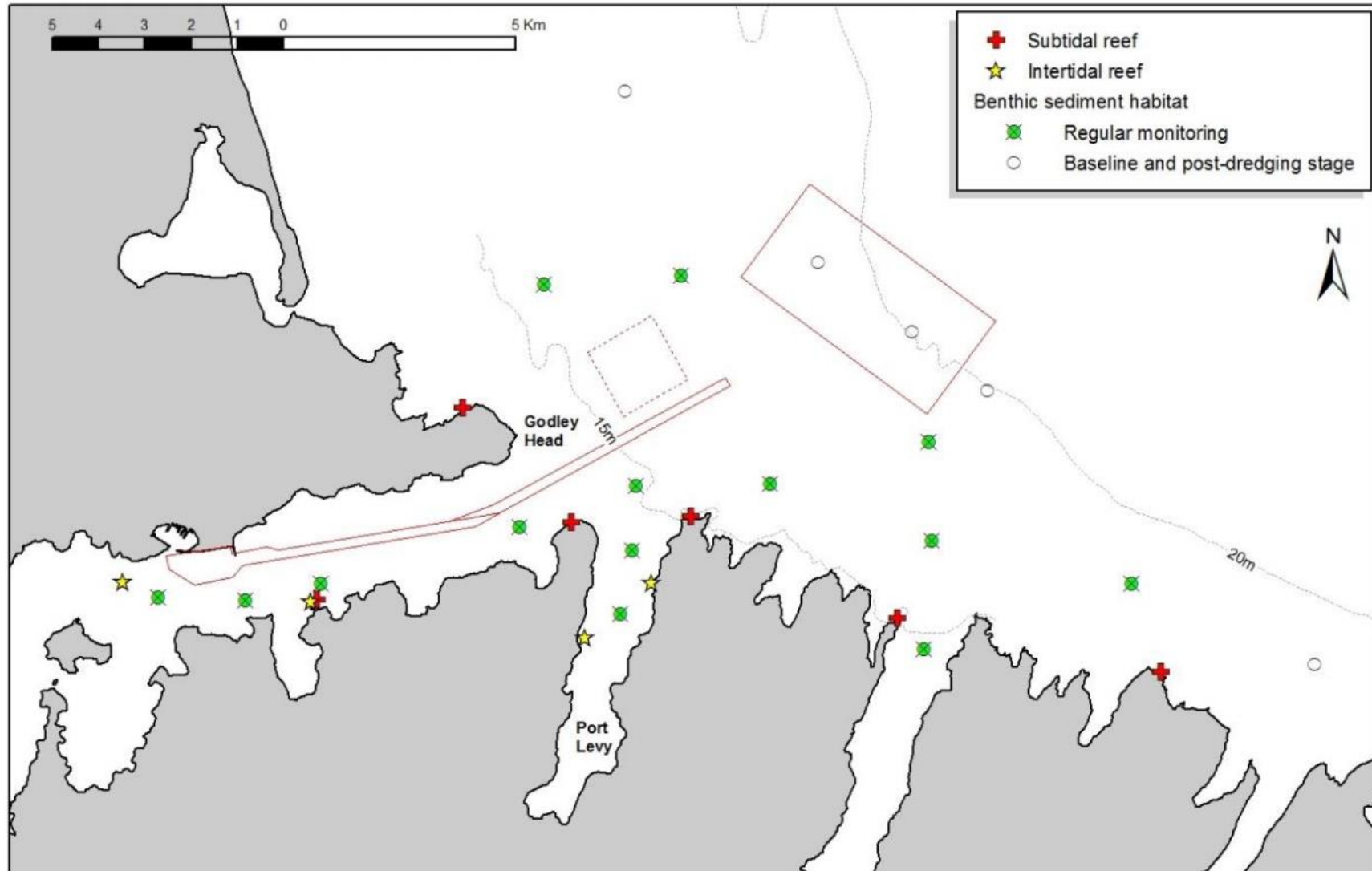


Figure 5.1: Proposed benthic, subtidal and intertidal monitoring locations – MAP SUBJECT TO CHANGE

### 5.3 Physical shoreline surveys

**Objective:** of physical shoreline surveys is to monitor and assess any changes on the rocky and soft shores of Banks Peninsula.

**Monitoring methodology:**

The following physical shoreline monitoring will be taken at the locations shown in Figure 5, Appendix A:

- Fixed photo-point monitoring to visually assess beach level changes or fine sediment deposition.
  - Fixed position photography at the same location.
  - Collected 3-monthly during baseline monitoring, during dredging and for a period of 2 years post-dredging then 6 monthly for the years 3-5 post-dredging.
- Sediment texture (PSD) of soft shore areas incl. fines <63 micron.
  - Collect surface sample from intertidal beach face
  - 6 monthly throughout the baseline, dredging and two years post-dredging, then annually for the 3-7 years post-dredging
- Beach profile survey from established benchmark (note there are some already existing Sumner and Brighton). This can be done using staff and level, total station or real time kinematic satellite navigation.
  - Spring low tide, pick up all changes in grade
  - Required horizontal accuracy +/- 0.1m, vertical accuracy +/- 0.05m
  - 6 monthly throughout the baseline, dredging and five years post-dredging.
- Shoreline analysis
  - Initially derive historic shoreline positions of Lyttelton Harbour monitoring beaches (not including Sumner/New Brighton beaches as there are already records at these areas)
  - Annually for five years as additional aerial photographs/Satellite imagery become available

It is noted that beaches around Avon-Heathcote estuary mouth may be affected by changes in the flow regime resulting from bed-level shifts occurring during the Christchurch earthquakes. This should be taken into consideration when interpreting results (though may be impossible to differentiate).

### 5.4 Dredge hopper validation samples

**Objective:** provide assurance that the dredged spoil does not contain levels of contaminants or toxins beyond expected.

**Monitoring methodology:**

Grab samples shall be collected from the dredge hopper into laboratory supplied containers. The samples shall be collected following a representative dredge run for the period (i.e. location in channel, depth dredged etc.). The samples shall be labelled with the hopper load number and the approximately dredge location shall be recorded alongside a unique sample identifier.

Samples shall be collected in a manner which ensures samples are taken at different locations throughout the dredging footprint.

- Samples shall be couriered, under chain of custody documentation and on ice, to the laboratory.

- Samples shall be tested by an IANZ credited laboratory for the following determinants:
  - Organic content
  - Trace metals (As, Cu, Cr, Cd, Ni, Hg, Zn)
  - Grain size
- Results shall be tabulated and compared to the ANZECC ISQG-low guidelines
- If unexpected results are noted, the consent holder shall be notified within 12 hours of receiving results.

## 5.5 Marine water quality monitoring

**Objective:** monitor any changes in water quality throughout Lyttelton Harbour/Whakaraupō and Port Levy/Koukourārata that could potentially be attributed to the dredging activities and provide a mechanism to determine the benthic-subsurface turbidity relationship

Water quality monitoring (both real-time and self-logging) shall be undertaken at each of the monitoring locations described in Section 4.

In addition, samples shall be collected from the subsurface with total suspended solids (TSS) also collected at mid-column and benthic at sites with increased water depth. Refer to Table 4.2 for a summary of proposed monitoring at each station and Appendix B (Vision Environment Environmental Monitoring Report) for further information.

### 5.5.1 Water sampling

Monthly water quality sampling shall be undertaken for the following sampling:

- Total Suspended Solids (TSS)
- Nutrients (Total phosphorous, orthophosphate, total nitrogen, ammonia, nitrate, total Kjeldahl nitrogen)
- Chlorophyll
- Total and Dissolved Metals (Aluminium, arsenic, cadmium, chromium, cobalt, copper, iron, lead, manganese, molybdenum, nickel, selenium, silver, tin, vanadium and zinc)

Biannual water quality sampling will also be undertaken for:

- 22 individual acid herbicides
- 179 individual multiresidue pesticides
- Total petroleum hydrocarbons and BTEX

Duplicate water samples for all parameters will be collected at 10% of sites as per established protocols, with a field and laboratory blank collected per sampling day. Samples will be undertaken and analysed in accordance with standard protocols derived from worldwide authorities, including Australian and New Zealand Standards for water quality sampling (ANZECC).

**Table 5.2: Summary of discrete grab sampling approach (Vision Environment, 2016)**

Sites	Depth profiling	Sub-surface metals & nutrients	Sub-surface organics	Sub-surface TSS	Mid-column & benthic TSS
SG1 SG2 SG3; OS1 OS2 OS3 OS4 OS5 OS6 OS7	Monthly	Monthly	Biannually	Monthly	Monthly
CH1 CH2 UH1 UH2 UH3	Monthly	Monthly	Biannually	Monthly	-

## 5.6 Mussel size and conditioning

STILL IN DISCUSSIONS - To be confirmed by industry/TAG at a later date.

## 5.7 Marine Mammal Monitoring

**Objective:** to provide assurance that the CDP is not effecting the dolphins (in particular the Hector's Dolphin/upokohue) in the waters of Lyttelton Harbour/Whakaraupō and offshore Banks Peninsula. Marine mammals are important

**Methodology:** Under development – likely to involve:

- Deployment of four self-logging C-PODs at four locations in order to collect echo-location activity. These will be located at the following monitoring sites:
  - TBC (channel zone)
  - TBC (channel zone)
  - TBC
  - TBC
- Monthly collection of self-logging data and maintenance
- Four-monthly reporting of monitoring data and results
- Final reports detailing the reporting results, consideration of the echolocation recorded in context to the dredging and disposal activities and investigation of any echolocation-activity

## 5.8 Monitoring frequency

**Table 5.3: Summary of monitoring frequencies and group meetings**

	Month (during dredging stage)											
Item	1	2	3	4	5	6	7	8	9	10	11	12
Water quality monitoring	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Sediment quality reporting	✓✓	✓✓	✓✓	✓✓	✓✓	✓✓	✓✓	✓✓	✓✓	✓✓	✓✓	✓✓
Bathymetrical monitoring	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Ecological monitoring				✓				✓				✓
Physical shoreline			✓			✓			✓			✓
Mussel size and conditioning (TBC)												
Marine mammal monitoring (TBC)				✓				✓				✓
TAG meeting	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
PRG meeting				✓				✓				✓

## 6 Other management protocols

In addition to the dredge management monitoring and responses detailed above, appropriate management of effects to marine mammals, accidental discoveries, incident and complaint reporting and fatalities will be required throughout the construction period. Specific protocol outlined by the dredging company is included in the attached dredge management plan (Appendix XX).

### 6.1 Dredge management plan

In addition to the effects management plans, the dredging company will prepare a Dredge Management Plan (DMP). A copy of the DMP shall be provided to Tangata Whenua. The purpose of the DMP is to set out the procedures and management measures associated with the operation of the dredge vessel. This shall include:

- Number and type of dredgers to be used
- Methodology and operation of the dredge(s)
- Details of spatial control and recording for dredging and disposal activities
- Biofouling and invasive species management
- Proposed dredging and disposal program
- Overflow management
- Waste management
- Discharge of black and greywater
- Refuelling procedures
- Storage and handling of hazardous substances
- Maintenance of equipment and systems
- Details of night lighting mitigation to manage bird strike risk

### 6.2 Marine mammal management plan (MMMP)

As the project location is within marine mammal habitats (specifically Hector's Dolphins), a marine mammal management plan (MMMP) has been prepared to set out management responses in relation to marine mammals. A copy of the MMMP shall be provided to Tangata Whenua. The purpose of this plan is to both minimise potential marine mammal collisions and collect relevant information.

The MMMP shall include:

- Requirements for a regular crew member on the dredge to be a designated marine mammal observer. The designated observer shall receive training from a suitably qualified marine mammal expert
- Record keeping requirements
- Avoidance measures for sightings of Southern Right Whales (as recommended in the assessment of marine mammals, Clement 2016)
- Vessel speed management measures
- Information protocols with the Department of Conservation to help anticipate potential seasonal interactions with whale species

The MMMP shall be prepared by a suitably qualified marine mammal expert who is experienced in managing potential effects on marine mammals.

### 6.3 Marine-based Accidental Discovery Protocol (ADP)

As detailed in Section 3.6, there is a long history of activity in Lyttelton Harbour/Whakaraupō and there is potential for the dredging activity to disturb sites of archaeological significance. An accidental discovery protocol (ADP) is currently in development to address this issue.

### 6.4 Biosecurity Management Plan (BMP)

The consent holder shall provide a biosecurity management plan (BMP) to the CRC one month prior to the arrival of the dredge vessel in New Zealand. A copy of the BMP shall be provided to Tangata Whenua. The purpose of the BMP is to reduce the risk of a biosecurity incursion.

The BMP shall include the following:

- Description of the dredge vessel and its attributes that affect risk (eg voyage speed, maintenance history, prior inspection, voyage history since last dry-docking and antifouling);
- Description of the key sources of potential marine biosecurity risk from ballast water, sediments and biofouling;
- Findings from previous inspections;
- A description of the risk mitigation taken prior to arrival in New Zealand;
- The nature and extent of pre-border inspection that will be undertaken to verify compliance with Import Health Standard (IHS) and Craft Risk Management Standard (CRMS);
- Record keeping and documentation of all mitigation undertaken to enable border verification if requested by Ministry of Primary Industries and to facilitate final clearance.

The BMP shall be prepared by a suitably qualified person who is experienced in managing the risk of biosecurity incursions.

### 6.5 Complaints

Records shall be maintained by the Consent Holder of any complaints lodged relating to the CDP activities. The records shall cover the following:

- The location of the reported nuisance or effect;
- The date and time of the complaint;
- A description of the weather conditions at the time of complaint, if relevant;
- Any possible cause of the nuisance or effect;
- Any management actions undertaken to address the cause of the complaint, and the name of the complainant, if offered.

LPC shall follow LPC's standard complaint response protocol to ensure these are adequately responded to.

The record of complaints shall be provided to the CRC every 4 months, or on request.

An aggregated summary of complaints received for each month shall be provided to the TAG no later than the end of the following month.

### 6.6 Incidents

In the event of a spill or leak of oil, fuel or other hazardous substance to water Te Rūnanga ō Ngāi Tahu, Te Hapū o Ngāti Wheke and Te Rūnanga o Koukourārata shall be notified to inform whanau who may use the area for mahinga kai.



## 6.7 Fatalities

The following are to be notified in the event of an on-site accident resulting in a fatality

- Te Hapū o Ngāti Wheke if the incident is in Whakaraupō
- Both Te Hapū o Ngāti Wheke and Te Rūnanga o Koukourārata if the incident is offshore. As mana whenua, Ngā Rūnanga are responsible to ensure that correct tikanga is followed in such an event.

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## **7 Reporting requirements**

### **7.1 Baseline Monitoring Report**

At the end of the baseline monitoring period, a report shall be prepared summarising the following:

- Methodology and frequency of monitoring (and any changed from those outlined in Section 5).
- Evaluation of results by technical experts as appropriate.
- Analysis of real-time turbidity monitoring including review of locations.
- Recommended changes to the EMMP, including to monitoring equipment/locations to better achieve the purpose and objectives of the EMMP.

The report shall be provided to the TAG, the PRG and the CRC as the regulating authority, at least 2 months prior to the first commencement of dredging.

### **7.2 Normal communications**

During all stages of the project the following reporting will occur:

- Fulltime public access to:
  - Summarised real-time monitoring data.
  - Monthly monitoring reports.
  - Four-monthly monitoring reports.
  - The DMP, MMMP, BMP and EMMP or amendments thereof.
  - All written reports and reviews prepared by the TAG or PRG under their consent obligations via online portal/website.
- Weekly (tbd) summary emails from real-time monitoring company
- Prior, during and post-completion meetings with stakeholders on the project

### **7.3 Monthly Monitoring Reports**

A monthly report shall be prepared by the consent holder during and after a Dredging Stage and made available for review and comment to the TAG. The report shall consist of a summary and evaluation of water quality assurance monitoring undertaken over the period.

The report shall be prepared and made available to the TAG one week prior to the monthly meeting/correspondence. Due to lab analysis timeframes the report will be available 14 days after the sampling is undertaken. This may mean the TAG review the previous month's report at each meeting. Advice on the monitoring and report shall be provided by the TAG in writing to the CHPT within one week following the meeting (or via meeting minutes).

### **7.4 Four-monthly monitoring reports**

A four-monthly report shall be prepared by the consent holder during and after a Dredging Stage and made available for comment to the TAG and to the PRG for review. The report shall consist of a compilation of the following:

- Assurance monitoring undertaken over the period.
- Monthly monitoring reports prepared and reviewed over the four month period, including any comments or recommendations from the TAG in writing.
- Tiered trigger exceedance reports over the four month period.

The report shall be prepared and made available to the PRG one week prior to the four-monthly meeting and the TAG once it is completed. Due to lab analysis timeframes the report will be available approximately two to three weeks after the sampling is undertaken. This may mean the PRG review the report a month after the end of the four month monitoring period. The report shall be reviewed by the PRG and submitted to the regulator with comments on whether the monitoring methodology, results and management responses are in accordance with the EMMP.

It is noted that due to the weather constraints of undertaking ecological monitoring there may be an additional time lag associated with the ecological monitoring reporting. It is recommended that a window of time over which the monitoring must take place is adopted depending on forecast tide and weather conditions.

## 7.5 Trigger Exceedance Reports

In the event of an exceedance of any trigger level, a Trigger Exceedance Report shall be prepared by the CHPT including the following:

- Results of investigations occurring as part of the management responses detailed in Section 4.4.
- Determination of whether the event was likely to be dredge related or not.
- Management actions taken in response to the exceedance and the results of the action i.e. changes in location of the dredge and turbidity levels as a result of this.
- Graph summarising the turbidity at the exceedance location over the monitoring period.

The report shall be submitted to the following:

- TAG – for any exceedance.
- The regulator (CRC) and the PRG – for a tier three trigger exceedance only.

Where trigger level three is exceeded, and the consent holder wishes to continue dredging in that locality, the consent holder must provide to the CRC a written report which demonstrates that the elevated turbidity is not attributable to Dredging. A copy of this report must be provided to the TAG and PRG, and must also be published on the consent holder's website.

## 7.6 Dredging Stage Completion Report

Within a year of completing a stage of dredging, a Dredging Stage Completion report shall be prepared with advice from the TAG. The report shall contain a summary or collation of the following:

- Dredging activities
- Final bathymetry survey results and analysis
- Monitoring undertaken during the period and a comparison of results to the baseline monitoring
- Trigger exceedances, investigation results and management responses
- Evaluation of the performance of the general performance of the EMMP including:
  - Evaluation of the adaptive management approach and management responses undertaken by the EMMP and whether or not the objectives and purpose of the plan were met
  - Evaluation of the monitoring methodology and results
  - Recommendations for improving the EMMP, monitoring and/or management responses

The PRG shall review the report and may provide recommendations to the regulator on potential improvements the EMMP.

If LPC makes any amendments to the EMMP in response to PRG comments, the updated EMMP shall be submitted to CRC for certification prior to commencing the next stage of dredging.

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## 7.7 Summary

**Table 7.1: Summary of CDP reporting requirements (note TAG = Technical Advisory Group, PRG=Peer Review Group, CRC=Canterbury Regional Council)**

Event	Report	Contents	Frequency	Recipient
Completion of 12 months of baseline monitoring	Baseline Monitoring Completion Report	Collation of monitoring results (including real-time water quality and assurance monitoring)	At the end of the pre-Stage One baseline monitoring	TAG for comment PRG for review CRC for certification
Normal operating conditions	Online portal allowing public access to summarised real-time monitoring data	Real time reporting of turbidity and hydrological conditions at 14 monitoring sites	As received from instruments and including statistical averaging windows.	Fulltime public access to summarised data via online portal/website. Complete access to all data for CHPT
	Online portal also allows public access to: monthly monitoring reports; four-monthly monitoring reports; the DMP, MMMP, BMP and EMMP or amendments thereof; and all written reports and reviews prepared by the TAG or PRG under their consent obligations	Relevant reports, and updated versions of relevant plans	Provided within reasonable time-frame as documents become available	Fulltime public access vial online portal/website.
	Project information meeting	Forum to discuss project and allow stakeholders to raise any concerns	At the beginning, middle and completion of a dredging stage (tbc)	Interested stakeholders and the Consent Holder
One week prior to TAG meeting	Monthly Monitoring Report	Refer Section 87.3	Monthly	TAG - Comments and advice to be forwarded to Consent Holder.
One week prior to PRG meeting	Four-monthly monitoring report	Refer Section 7.4	Four-monthly	TAG - Comments and advice to be forwarded to Consent Holder. PRG for review prior to passing on to CRC for certification.
Exceedance of a tiered trigger level	Automatic exceedance notification email	Detail of exceedance location, time, and charts showing data for 48 hours prior to exceedance.  Trigger three only: brief statement of anticipated dredge response and potential reason for exceedance	Immediately upon exceedance of a trigger level.	Trigger One: TAG Trigger Two: TAG Trigger Three: TAG, PRG and CRC
Post Trigger Two or Three Level Exceedance	Short report summarising trigger level exceedance period	Details of exceedance and management actions and future recommendations.	Three working days post alert	Issued to TAG for review at monthly meeting and PRG as part of four-monthly monitoring report.
	Notification email informing monitoring location is no longer in exceedance	Automatic email once turbidity levels at a monitoring site are no longer exceeding.	Immediately once monitoring site is no longer in exceedance.	Trigger One: TAG Trigger Two: TAG and PRG Trigger Three: TAG, PRG and CRC
End of a stage of dredging	Dredging Stage Completion Report	Collation of all monitoring data, exceedances, actions taken. Recommendations for improvement and analysis of performance of EMMP.	Upon completion of a dredging stage	Undertaken by the Consent Holder. Reviewed by TAG (for comment/advise) and PRG (to pass on to CRC for certification)

## 8 Group roles and responsibilities

Successful dredge management relies on good communication, liaison and input from a number of key parties throughout the monitoring and management stages. To ensure all relevant technical experts and stakeholders are appropriately involved in the dredge management process the following groups shall be established and implemented through consent conditions CRCXXX XXX:

- Consent Holder Project Team (CHPT)
- Technical Advisory Group (TAG)
- Peer Review Group (PRG)

All groups shall be established at least XX months prior to commencement of dredging activities.

### 8.1 Consent Holder Project Team

The CHPT will be established by the Consent holder and may include the any expertise that the Consent Holder deems necessary. However at a minimum, the Consent Holder shall ensure the CHPT includes employees, or persons engaged by LPC, with at least the following expertise:

- An assigned (contractor or employee) project manager for LPC
- Dredging operator
- Hydrodynamic modeller
- Water quality
- Statistician

The roles of the CHPT will include:

- Daily operations and proactive management of the dredge taking into consideration:
  - Real-time turbidity monitoring
  - Water quality monitoring
  - MetOcean conditions and forecasts
- Preparation of the 1-monthly and 4-monthly monitoring reports and circulation to the TAG and the PRG and the Canterbury Regional Council, as required (refer Section 7)
- Continually examine the monitoring data to ensure the appropriate information is being gathered;
- Ensure the dredge contractor has the required monitoring information and the appropriate management responses are completed in a timely manner

### 8.2 Technical Advisory Group (TAG)

This purpose for this group is to give technical advice to the CHPT on matters of individual member expertise. The group shall consist of no more than 10 members as follows (as per CRCXX Condition XX Section XX):

- Up to three members from Te Hapū o Ngāti Wheke, Te Rūnanga o Koukourārata and Te Rūnanga ō Ngāi Tahu with the expertise on the following:
  - Mahinga kai
  - Marine ecology and/or water quality
  - Tikanga Māori
- A representative from the local marine farms with direct experience in marine farm operation and is a current operator or manager of a marine farm in Banks Peninsula

- Up to six members from the Consent Holder (including two from the CHPT) covering the following expertise:
  - Marine ecology
  - Marine environmental monitoring
  - Hydrodynamic modelling
  - Statistician with experience in natural resource management

The role of the TAG is to (as per CRCXX Condition XX Section XX):

- Review the 1-monthly and 4-monthly reports and, as required, give the Consent Holder advice on the results and methodology of the assurance monitoring.
- Review any exceedances of the trigger values and, as required, provide advice on whether the monitoring programme detailed in Section 5 (assurance monitoring) requires amendment.
- The TAG will not direct the nature or specifics of dredge management responses.
- LPC shall comment back to the group the reasoning for rejecting or accepting the advice.
- Where the TAG does not have the expertise in any of the areas it is required to report on, it may engage the services of an appropriate expert on a relevant matter to the TAG.

The consent holder shall provide any administrative support necessary for the TAG to carry out its functions.

The consent holder shall establish the TAG at least 3 months prior to the first commencement of dredging.

### 8.3 Peer Review Group (PRG)

The purpose of this group is for independent review of documentation and decisions to provide confidence to the CRC that the project is in compliance with the consent conditions and the EMMP.

The group shall consist of not more than three scientists who shall be independent of the consent holder, and who collectively are recognised by their peers as having satisfactory experience, knowledge and skill in the following (as per CRCXX Condition XX Section XX) areas:

- Marine Ecology
- Hydrodynamic modelling
- Coastal processes

The members of the PRG must be approved in writing by the CRC before they commence their oversight and review functions.

The PRG must be established at least 2 months prior to the commencement of dredging.

Note the PRG may engage the services of an appropriate expert to add comment on matters outside their expertise (at the discretion of the Consent Holder).

This group is responsible for:

- Reviewing the EMMP and any amendments undertaken to the plan
- Reviewing the following reports for the CHPT and providing advice to CRC on whether these have been prepared in accordance with the EMMP:
  - Baseline monitoring report
  - 4-monthly monitoring reports

- Pre-dredging stage report where any subsequent dredging stage is to commence five or more years after the completion of the final 4-monthly monitoring report prepared for the previous dredging stage
- Post-stage dredging report/review
- Trigger Three Exceedance report
- Reviewing tier three trigger responses – in particular the decision by the CHPT to continue dredging in an unusual event (for example a storm surge or flood of the Waimakariri River).

## 8.4 Stakeholder Communication

Effective communication to key stakeholders will be an important part of dredging management. LPC has undertaken early engagement with a wide range of stakeholders who have interests in the project. Engagement with these stakeholders will continue throughout the works alongside normal day to day communication strategies currently in place by LPC. It is anticipated the following groups will have particular interest in communication from LPC:

- Department of Conservation (DOC)
- Te Hapū o Ngāti Wheke
- Te Rūnanga ō Kōkourārata
- Te Rūnanga ō Ngai Tahu
- Banks Peninsula/Pegasus Bay Mussel Farmers
- Recreational user groups
- Community groups
- Interested environmental groups



## 8.5 Summary of group involvement

**Table 8.1: Summary of group involvement and responsibilities at each operational level**

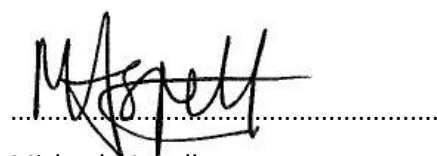
Operational Level	Groups Involved	Responsibilities
Normal operating conditions	Consent Holder Project Management Team	Daily proactive management of dredge activities and implementation of assurance monitoring
Tier One (post-trigger one exceedance)	Consent Holder Project Management Team	Dredge management in response to elevated turbidity Investigation into exceedance and brief reporting on outcome
	Technical Advisory Group	Notified of exceedance
Tier Two (post-trigger two exceedance)	Consent Holder Project Management Team	Dredge management in response to elevated turbidity Investigation into exceedance and preparation of trigger exceedance report
	Technical Advisory Group	Notification of exceedance Technical advice on turbidity exceedance in relation to ecological environment (if required)
	Peer Review Group	Notification of exceedance
Tier Three (post-trigger three exceedance)	Consent Holder Project Management Team	Dredge management in response to elevated turbidity Investigation into exceedance and preparation of trigger exceedance report
	Technical Advisory Group	Notified of exceedance Technical advice on turbidity exceedance in relation to ecological environment (if required)
	Peer Review Group	Notified of exceedance. Review of management responses (if required)

## 9 Applicability

This draft report has been prepared for the exclusive use of our client Lyttelton Port Company, with respect to the particular brief given to us and it may not be relied upon in other contexts or for any other purpose, or by any person other than our client, without our prior written agreement.

Tonkin & Taylor Ltd

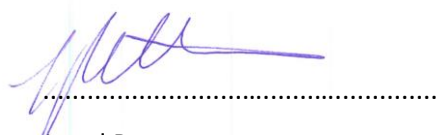
Report prepared by:

A handwritten signature in black ink, appearing to read 'M Aspell', written over a horizontal dotted line.

Michaela Aspell

Environmental Engineer

Report prepared by:

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Jared Pettersson

Project Manager

Authorised for Tonkin & Taylor Ltd by:

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Peter Cochrane

Project Director

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## Appendix A: Project Figures

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- **Figure 1: Overall site map**
- **Figure 2: Maintenance spoil ground location**
- **Figure 3: Instrumentation Zones**
- **Figure 4: Water Quality Monitoring Sites**
- **Figure 5: Ecological Monitoring**
- **Figure 6: Physical shoreline monitoring**

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## **Appendix B: Water quality monitoring methodology**

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- **Lyttelton Port Company Channel Deepening Project Environmental Monitoring (Vision Environment, 2016)**

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## **Appendix C: Statistical approach for determination of trigger levels**

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- Recommended Data Processing and Trigger-Value Methods for the LPC CDP (Fox D. R., 2016)

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