APPENDIX R

NAPIER PORT DRAFT WATER QUALITY MANAGEMENT PLAN

NAPIER PORT

DRAFT Water Quality Management Plan
Proposed Wharf and Dredging Project

November 2017

Revision History

Version	Description	Date	Prepared By	Approved
0	**DRAFT**	17/7/2017	Michel de Vos	
1	**DRAFT for Application**	16/11/2017	Michel de Vos	Michel de Vos

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Contents

This Draft Water Quality Management Plan has been prepared to indicate the approach and method for a plan which will be developed to achieve Draft Conditions 5 and 6 of the applications for coastal permits for dredging and disposal of dredged material [Applications 2 to 5 for Coastal permits to Hawke's Bay Regional Council]. At this stage it is indicative only and it will be further developed for certification by the Regional Council prior to commencement of the Project.

List of Abbreviations

ADM	Adaptive Dredge Management
BHD	Backhoe Dredger
EWMA	Exponentially Weighted Moving Average
HBRC	Hawkes Bay Regional Council
NTU	Nephelometric Turbidity Units
PAR	Photosynthetically active radiation
QA	Quality Assurance
QC	Quality Control
SSC	Suspended Sediment Concentration
TSHD	Trailing Suction Hopper Dredger
TSS	Total Suspended Solids
WQMP	Water Quality Management Plan

1. Introduction

This Water Quality Management Plan (WQMP) has been developed for Napier Port's Proposed Wharf and Dredging Project (The Project) to manage the impacts of turbidity generated by the Project dredging activities, in particular at Pania Reef which Napier Port recognises as being both environmentally and culturally significant to the local region.

This WQMP covers the dredging and disposal activities, specifically:

- The dredging associated with creation of the berth pocket and swing basin
- The dredging associated with the widening and lengthening of the approach channel.
- Approximately 3.2 Mm^3 of dredge material will be dredged from the Project area.
- Disposal of dredge material at the offshore disposal area, approximately 5km east of the port.

1.1. Project Area and Location

Figure 1 shows the dredge footprint for all stages of the Project. Figure 2 shows the offshore disposal area for the Project.

1.2. Purpose of WQMP

The purpose of the WQMP is to manage the potential ecological and water quality impacts of the dredging and disposal of approximately 3.2 Mm^3 of material associated with the Project.

This Plan also has the aim of limiting and managing the impact of turbidity on sensitive receptors in particular at Pania Reef.

The Plan will also act as a reference, to guide and benchmark environmental performance and outcomes for the Port's Project Management Team and Contractors working on dredging and offshore disposal activities for the Project.

1.3. Objectives

The objectives of this Plan are to:

- Manage the impacts of dredging activities on water quality.
- Implement an integrated plan which incorporates ongoing research and monitoring programs for the management of water quality impacts, due to dredging and disposal activities
- Develop and implement a monitoring program for dredging and disposal activities that includes the health of Pania Reef.

1.4. Performance Objectives

The performance objectives of this Plan include:

- No exceedance of environmental limits as a result of suspended sediment from the disposal of dredge spoil associated with dredging activities above the increases predicted by the dredge plume modelling.
- Assurance that significant ecological effects attributable to the activity are not occurring on Pania Reef

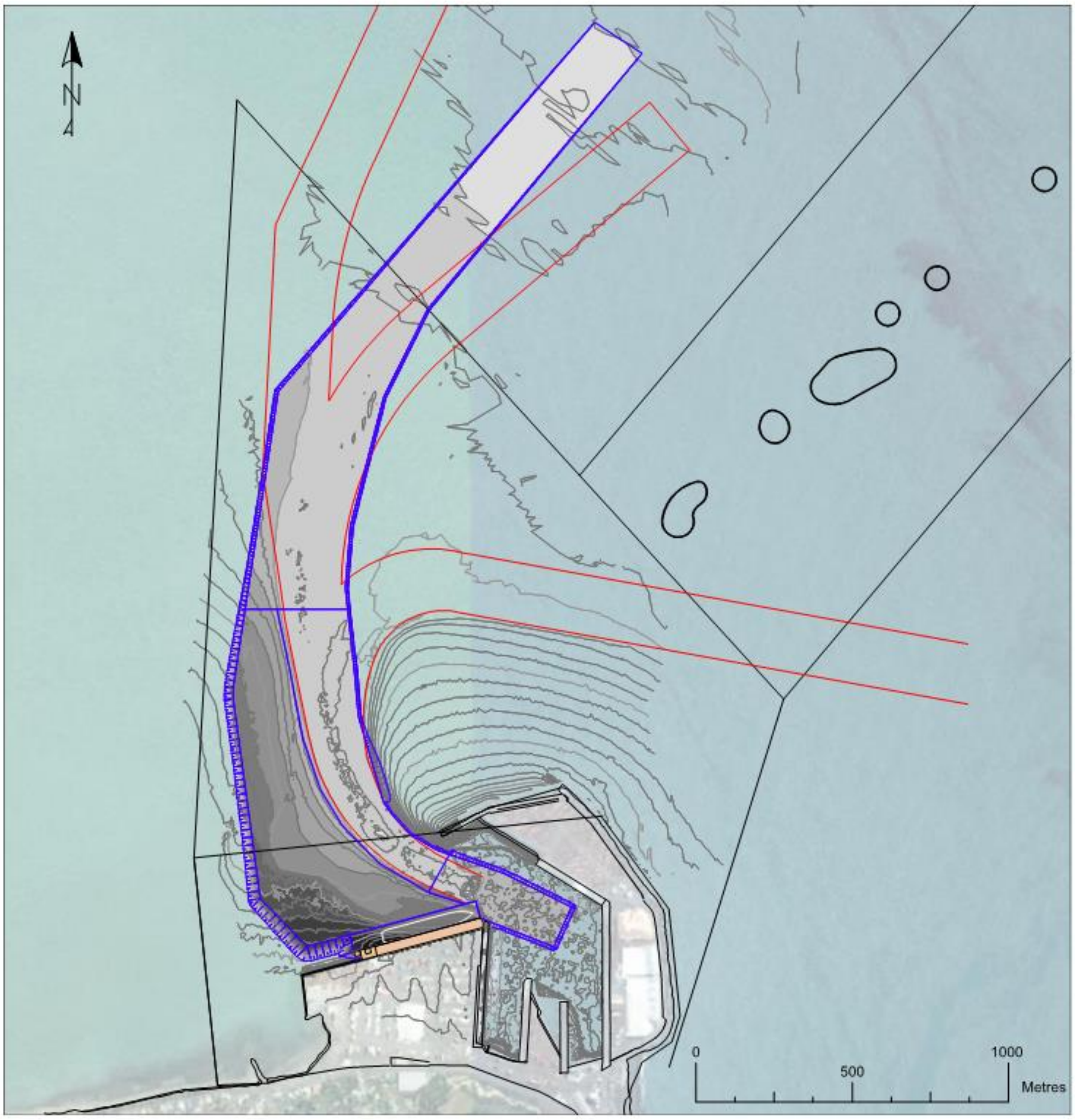

Figure 1 - Project Location

Figure 2 Offshore Disposal Area

2. Key Sensitive Receptors

2.1. Pania Reef

Pania Reef has been identified as the key marine ecological receptor due to proximity, high ecological, cultural and amenity values and the very limited occurrence and extent of such habitats in southern Hawke Bay. The importance of the reef is supported through its identification as a Special Conservation Area.

While the key marine ecological receptor in the vicinity of the proposed project is Pania Reef, shoreline reef areas are also potentially vulnerable by virtue of proximity to plume propagation paths (Town Reef) or limited flushing characteristics (the embayment immediately west of the Port reclamation). While no soft sediment benthic habitats have been identified as being unique or limited in the wider area, these are potentially locally important as foraging grounds for recreationally and/or commercially targeted fisheries species. (Cawthron 2017).

Cawthron (2017) describes the potential impacts of elevated turbidity at the Reef:

> Impacts to reef communities can result when sediment deposition occurs to the extent of covering over encrusting, sedentary or less-mobile biota. The amount of deposition required to lead to significant adverse effects will vary with the specific habitat and community assemblage. However, such smothering impacts generally do not occur in areas of high wave energy.
>
> Pania Reef communities are accustomed to periodically elevated turbidity, but the exposure of the Reef to persistent wave action also ensures that sediments tend to remain in suspension until settlement can occur in quiescent zones in deeper waters. Even where silt veneers deposit on Reef surfaces during periods of high turbidity and calm conditions, these will be easily resuspended and removed by subsequent wave events hence variable silt conditions are part of the natural conditions of the Reef. This mechanism will prevent or limit the build-up of settled silt even under increased sediment loading from dredging plumes. At peak levels of suspended solids (from all sources), silt veneers may be more prevalent at lower energy sites on the Reef, but these will still be rapidly resuspended and dispersed by swell events.
>
> High turbidity reduces light levels (as photosynthetically active radiation – PAR) reaching the seabed. When this is sustained, photosynthetic organisms can be adversely affected. On reefs, a reduction in PAR may affect structurally and trophically important seaweeds.
>
> Reef-dwelling suspension feeders vary in their tolerance to suspended inorganic particulates based on their ability to selectively remove organic food particles to maintain growth. The predominant filter feeders observed on Pania Reef were green-lipped mussels (Perna canaliculus), ascidians and sponges, most of which are relatively tolerant of elevated concentrations of inorganic particulates.
>
> All filter feeding bivalves are affected by the quality and quantity of seston. Mussels are relatively tolerant of high levels of suspended particulates, but feeding efficiency will be affected if the proportion of useable organic particulates relative to the inorganic fraction drops below a certain level.
>
> Negative effects from sedimentation on the abundance of gastropod grazers have been documented in numerous observational and manipulative studies. Deposited sediment can impair the movement and attachment of grazers. The reduction in grazing activity by

sedimentation has been postulated as one of the mechanisms through which sedimentation controls algal structure on rocky shores.

Sedimentation plays a significant role in structuring rocky reef communities, both intertidal and subtidal. However, it is important to recognise that gradients in sedimentation rates and water turbidity are a natural feature of coastal systems. Specific areas of the New Zealand coast feature naturally large sediment loads (e.g. South Canterbury) and, increasingly, natural inputs are augmented by those associated with catchment modification.

Advisian (2017) reports that only isolated peaks of SSC above background of 1 mg/L are predicted to occur for the project with the predicted SSC above background remaining less than 5 mg/L for Stage 1 works and less than 7 mg/L above background for subsequent stages.

Cawthron (2017) observes that background concentrations of 10 mg/L may be reasonably typical of Reef waters, and this level may be considerably exceeded during swell or run off events and remain elevated for several days.

Cawthron (2017) also report that natural sediment deposition may be significant, especially at deeper points of the inshore Reef sections, and the project plumes predicted by Advisian (2017) are likely to add only incrementally to existing background deposition. The amount of sedimentation occurring naturally on the Reef will furthermore be in equilibrium from episodic events that lift and disperse material that has settled in calm periods. This mechanism will prevent or limit the build-up of settled silt even under increased sediment loading from dredging plumes. (Cawthron 2017).

2.2. Town Reef

Cawthron (2017) describes the potential impacts of elevated turbidity on Town Reef:

Town Reef is located adjacent to the base of the main Port breakwater at the northern end of Marine Parade Beach. It is approximately 2 km to the south of the proposed Fairway dredging operations and represents a well-flushed, high-energy environment due to considerable exposure to both wave action and along-shore currents. While not surveyed for this assessment, the ecological communities it supports are expected to be well-adapted to highly turbid conditions. Natural sediment transport processes operating at this exposed location are expected to be significant, with considerable volumes of shoreline and near-shore sediments likely to move through the area.

The orientation of the currents identified in the vicinity of the Port Fairway makes inshore areas more likely to experience elevated turbidity from the proposed dredging than Pania Reef, and this is a notable feature of the modelling outputs. However, Town Reef is at sufficient distance from the proposed dredging and spoil disposal operations that the SSC exceedance envelopes show potential exposure which is unlikely to be ecologically significant relative to expected background levels for this location.

The shoreline morphology at this location indicates no potential for sediment plumes to be entrained and trapped within the area of Town Reef and its shallow, wave-exposed nature is expected to preclude the accumulation of settled fine sediments.

2.3. Others

Cawthron (2017) identified the Western Embayment as being potentially affected by elevated turbidity, however, it does not receive complete shelter from wave energy and would experience periodic flushing and disturbance as a result of storm and swell events. For this reason, while there is potential for short-term adverse ecological effects from increased fine sediment deposition to these areas if such conditions are sustained, shifts in community structure are unlikely to exceed those associated with natural perturbations and recovery is likely to occur within seasonal timeframes.

Rangitira Reef was similarly identified as being potentially affected, although Plume modelling conducted by Advisian indicated that this location would be unlikely to be exposed to SSC exceeding 10 mg/L above background and it is likely to be resilient to any sediment plume effects arising from the project.

3. Baseline Monitoring

3.1. Pania Reef Turbidity Monitoring

Two fixed monitoring buoys have been deployed at Pania Reef as per table 1 below. These buoys have been deployed to assist in:

- Establishing the long term trends in turbidity.
- Establishing an understanding of drivers for fluctuations in turbidity.
- Establishing seasonal trends (if any).
- Establishing differences between the northern and southern portion of the reef.
- Establishing an appropriate set of trigger levels to inform operational response during dredging.

These buoys are planned to remain in place and will continue to be monitored to provide additional baseline data, in particular to determine the full range of natural occurring turbidity (additional to what may have been a mild 2016 in Hawke's Bay).

Data collection from each of the buoy-mounted sensors is on a fifteen minute schedule with turbidity being an average of 30 readings collected at one Hertz. Water quality and buoy performance data (i.e. solar recharge, battery level, position, leak alarm etc.) are logged internally and telemetered back to shore every 15 minutes via cellular communications. (Cawthron 2017).

Cawthon (2017) reports:

- Generally low turbidity (<10NTU)
- High turbidity events of up to 30NTU
- Analysis of the turbidity and salinity data from the Pania West Buoy following these events demonstrates clearly the influence on background water clarity from riverine inputs and terrestrial runoff as well as sediment resuspension via waves.
- The turbidity readings from each buoy can be seen to track one another reasonably well.

Buoy	Location (Approx.)	Parameters
Pania East	**39° 27' 17.03"S** **176° 55' 48.12"E**	Turbidity (NTU), Salinity, Sea Temperature, Conductivity
Pania West	**39° 27.0' S** **176° 57.0' E**	Turbidity (NTU), Salinity, Sea Temperature, Conductivity

Table 1 - Monitoring Buoys

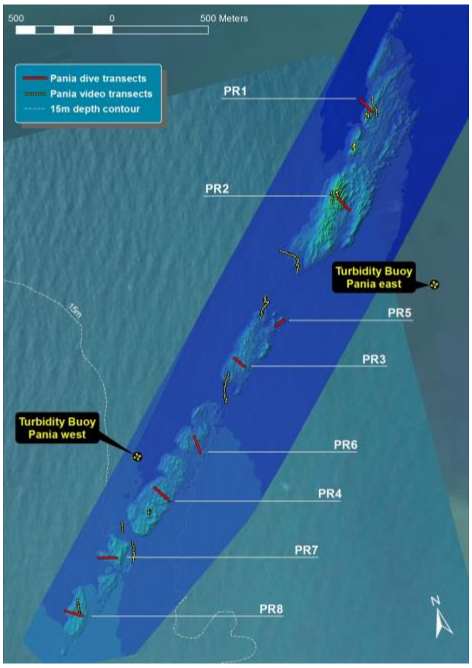

Figure 3 - Monitoring Locations (Cawthron 2017)

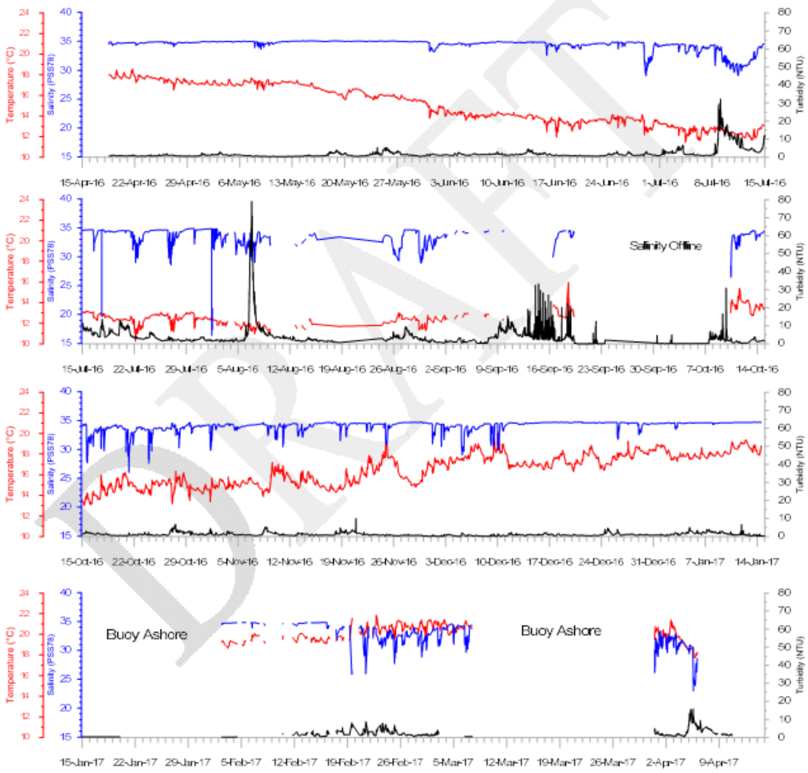

Figure 4 - Time series plot of key parameters April 2016 to April 2017.

4. Adaptive Dredge Management

Adaptive Dredge Management (ADM) will be used throughout the operational phases of the project to ensure that water quality - in particular turbidity related to the dredging and disposal - do not exceed that modelled and hence meet the environmental effects predicted by Cawthron (2017). The existing water quality monitoring buoys East and West of Pania Reef will be utilised during the project for Adaptive Dredge Management through a tiered response system.

4.1. Tiered Trigger System

Adaptive Dredge Management will be implemented through a system of triggers with management responses depending on the trigger level. The establishment of these trigger levels is based on the baseline data and ecological investigations undertaken as part of the development. The approach recognises that Pania Reef is exposed to and is resilient to periods of high natural turbidity and is based on maintaining the existing natural turbidity patterns and ensuring that dredge related turbidity effects do not result in large elevated turbidity levels or long periods of elevated turbidity. This is described further by Cawthron (2017).

The Trigger Levels are set based on the application of a 6 hourly Exponentially Weighted Moving Average (EWMA) to the raw turbidity data from the buoys, which is current industry best practice for the smoothing of the raw data[1], being applied to projects throughout Australia and more recently in New Zealand. The 6 Hour EWMA is calculated by using a 60:40 weighting system, where the current EWMA (Z_i) is computed by adding 60% of the mean turbidity readings during the preceding 6 hours (X_i) to 40% of the preceding 6 hour EWMA value (Z_{i-1}). Mathematically, 6-hourly values of the EWMA statistic are computed using the following equation:

$$Z_i = 0.6 X_i + 0.4 Z_{i-1}$$

Where *i* is the mean of the data for the ith period (in this case, the current 6-hour period).

4.2. Real-time Turbidity Monitoring

Both monitoring buoys provide real time water quality data at 15 minute intervals and a system will be developed to provide the Project Management Team and the Contractor with both real time turbidity and the rolling 6 Hourly EWMA. This data will allow the monitoring of trends and the effectiveness of changes in dredging practices or prevailing metrological conditions driving natural background turbidity. As this data is live, it will not have undergone any QA/QC procedures to provide a validated dataset, and as such is not suitable for direct comparison against Trigger Levels.

The 6 Hourly EWMA will be calculated and reported at 6 hourly intervals (00:00, 06:00, 12:00 and 18:00) after undergoing QA/QC through an automated system or by an independent third party.

Although proven reliable, failures of the monitoring equipment may and can occur. Repairs of monitoring equipment may be delayed due to weather conditions and associated safety concerns. A 95% availability rate of data is to be achieved for each monitoring buoy, this will be achieved through the holding of strategic spares to minimise any loss of each continuous dataset during the project

During instances where a monitoring buoy is not able to provide data in real time, alternative options to provide data include:

[1] Turbidity data measured continuously *in situ* is typically highly variable over small time-scales and must be smoothed to allow useful interpretation and comparability.

- Utilisation of the data from the alternate buoy.
- The use of hand held turbidity measurements (although not at 15 minute intervals) to confirm readings at the sensitive receptor.
- Daily visual observations of any turbidity plume created by dredging.

4.3. Trigger Levels

Table 2 below provides the proposed Trigger Levels based on the advice of Cawthron (2017). Trigger Levels are reached when the relevant 6 Hourly EWMA are exceeded for the respective duration.

The Trigger Level ceases to be in place once the 6 Hourly EWMA drops below the respective turbidity level for any 6 hourly reporting period. As the 6 Hourly EWMA uses data for the past 12 hours, with a weighting towards the most recent 6 hours, this 'smoothing' can be considered conservative and cessation of a Trigger Level will be associated with a long term trend rather than a short term lowering.

Trigger Level	Turbidity (NTU) (6 Hourly EWMA)	Duration
Normal	<10 NTU	
Response Level 1	10 NTU	24 Hours
Response Level 2	14 NTU	12 Hours
Environmental Response Level	17 NTU	6 Hours

Table 2 - Trigger Levels

4.4. Dredge Related Effects

The turbidity levels associated with the Trigger Levels and responses are, based on available baseline data, expected to be exceeded naturally under certain conditions. Analysis performed by the port and by Cawthron (2017) indicate that swell and riverine run-off associated with high rainfall are two principal drivers for elevated turbidity, at times significantly higher than normal ambient conditions.

When a Trigger Level is reached, an analysis shall be undertaken to determine if the exceedance is dredge related or non-dredge related. Sources of information for the analysis may include:

- Port supplied meteorological data
- Metservice sourced meteorological data
- Port supplied wave and current data
- HBRC supplied river level and flow data
- HBRC supplied water quality data (HAWQi)
- Satellite imagery
- Dredge location and activities

Various methods may be developed to assist in determining the likely natural background turbidity during an exceedance and hence the level of dredge-related effects:

- Statistical models that correlate elevation in natural background turbidity to key drivers such as, but not limited to wind, swell or riverine flows.
- The use of one or more 'reference sites' which are outside the predicted area of influence from dredging, and through analysis of background data is shown to have a good correlation with the monitoring sites; and
- Hand held turbidity sensor to confirm water quality of any additional inputs into the harbour at predetermined locations

4.5. Reporting

Exceedance of the relevant Trigger Levels will require reporting in accordance with Table 3 below. For Response Level 2 and above, notification to the Consent Authority will be required within 24 hours after data validation processes are confirmed and will include a determination of whether the exceedance is dredge-related.

In the case that the exceedance is determined to be dredge-related, the notification shall include details of management measures that have been, or will be, implemented to decrease the turbidity levels at the exceedance location.

Trigger Level	Internal	Notify Consent Authority	Exceedance Report (if dredge related)
Normal			
Response Level 1	√		
Response Level 2	√	√ (within 24 hours)	
Environmental Response Level	√	√ (within 24 hours)	√ (within 1 month)

Table 3 - Trigger Level Reporting

4.6. Management Measures

In response to an exceedance of Response Level 2 or Environmental Response Level Trigger Values, management measures shall be implemented. The management measures will depend on many factors and may include, but will not be limited to, the following:

- Reduction in the rate of dredging and disposal.
- If practical, relocation of the dredge to a different area with more coarse material.
- Disposal in an alternative part of the offshore disposal area.
- Utilisation of the existing consented inshore disposal area (R and Rext), subject to meeting the consent conditions.

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5. Assurance Monitoring

The purpose of assurance monitoring is to ensure that the underlying assumptions and ongoing management of the project is achieving the objectives of the Water Quality Plan, in particular to ensure that the effects of the project are no greater than anticipated and to provide protection to the physical, ecological and cultural environment.

The assurance monitoring is not intended to underpin management actions which are implemented through the Adaptive Dredge Management portion of this Water Quality Plan; rather it is intended to adapt and, if required, improve aspects of the Adaptive Dredge Management plan between stages of the project.

5.1. Plume Modelling Validation

The predicted dredge-related impact is based on extensive numerical modelling and material analysis. The purpose of the plume modelling validation is to ensure that the resulting plume intensity and spatial distribution are generally in accordance with that predicted by the model.

Plume modelling validation shall be performed for the following situations, within 3 months of commencement.

- BHD dredging – Stage 1
- Barge disposal at Offshore Disposal Area – Stage 1
- TSHD dredging – Stage 1[2]
- TSHD disposal at Offshore Disposal Area – Stage 1

5.2. NTU – TSS Relationship

As there is a disconnect between the modelling performed in Total Suspended Solids (TSS) and the physical measurement being performed in NTU, a relationship is required to be established so that the predicted effects can be verified in the field.

Through a programme of sampling at the Pania West Buoy Cawthron (2017) has determined the relationship to be:

$$TTS = 1.63(NTU) + 1.01$$
$$r^2 = 0.936$$

The data-set will continue to be expanded through additional sampling so that the correlation can be extended to higher values of turbidity, and will be supplemented with tank testing by Cawthron using dredge sediments.

Within one month of commencement of each Stage for both the BHD and TSHD, additional samples of the dredged material will be taken to confirm the TSS-NTU relationship.

[2] If the opportunity arises, plume verification for the TSHD dredging may be conducted prior to the works through routine maintenance dredging activities.

5.3. Bathymetric Surveys

Bathymetric surveys of the offshore disposal ground will be undertaken in accordance with Table 4. The purpose of the surveys are to compare them against the predicted sediment dynamics from the sediment transport modelling.

Stage	Interval	Coverage
During Execution	6 Monthly	Areas of disposal +50m
Stage Completion	Within 3 Months	100% + 50m
Between Stages	Annually	100% + 50m
Post Development	5 Yearly	100% + 50m

Table 4 - Bathymetric Surveys

5.4. Pania Reef Dive Surveys

Surveys of the communities at Pania Reef shall be undertaken by way of dive surveys by suitably qualified scientists at the following intervals:

- Annually up to the commencement of Stage 1
- Within 3 months after the completion of Stage 1
- 1 year after the completion of Stage 1
- Prior to commencement of subsequent stages
- 1 year after the completion of each subsequent stage.

Depending on the actual timing of the stages, it may be necessary to slightly adjust the timing of surveys so that the results remain comparable over time. Such variations in timing will be determined on the advice of the scientists involved, and will be advised to Hawke's Bay Regional Council.

The surveys shall be generally conducted in accordance with the 2016 survey as reported by Cawthron (2017), in particular the surveys shall be conducted on the same transects PR1 to PR8 (Figure 27, Cawthron 2017).

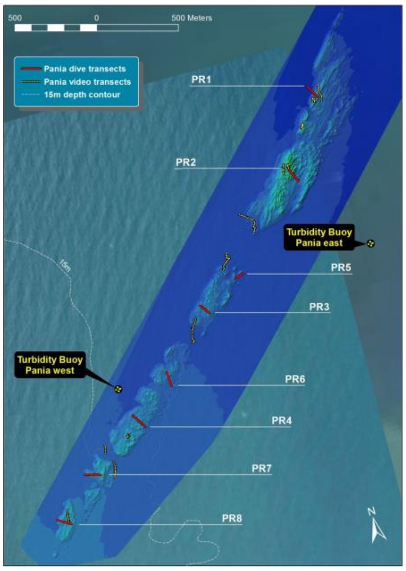

Figure 5 - Dive Transect Locations (after Cawthron 2017)

It is noted that natural background turbidity and diving conditions have in the past made it difficult to obtain suitable conditions to conduct the surveys, and hence the times are approximate. Similarly it is also recognised that natural fluctuations occur at the Reef due to varying ambient conditions, storms and the like.

5.1. Benthic Surveys

Benthic surveys to determine the biological nature of the benthic habits at the offshore disposal area shall be conducted at 5 yearly intervals following completion of Stage 1, and shall consist of:

- No less than 20 infauna cores or grab samples within the designated disposal area boundary.
- No less than 8 infauna cores or grab samples at a distance of 50-100m from each boundary.
- No less than 5 epifauna dredge trawls, each covering a distance of no less than 400m and distributed evenly across the disposal area.

References

1. Sneddon R, Dunmore R, Berthelsen A, Barter B 2017. Assesement of Effects on Benthic Ecology and Fisheries Resources from Proposed Dredging and Dredge Spoil Disposal for Napier Port, Cawthron Report No. 2895.