Appendix Q Coastal Processes Assessment

REPORT

Effects on Coastal Processes

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Taharoa Ironsands Limited
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Executive summary

Purpose

The purpose of this report is to assess potential effects on coastal processes and landforms related to Taharoa Ironsands Ltd's (TIL) application for all necessary resource consents to continue operating the Central and Southern blocks of the Taharoa Ironsand Mine under the Fast-Track Approvals Act 2024.

Relevant application information

TIL is seeking the necessary resource consents to continue its land-based sand extraction and export operation, which includes transporting iron sand from land as slurry through a 3 km long pipeline to an offshore mooring buoy and into the hold of awaiting export ships. The buoy and surrounding waters are legally defined as the Port of Taharoa.

TIL is seeking resource consent for the following two activities that relate to the coastal marine environment (CMA):

1 **Discharge of sediment to the CMA:**

a) Consent is being sought to discharge up to 75,000 m^3 of turbid ship loading water or '*de-watering fluid*' per day, to a maximum of 7,500,000 m^3/year.

b) Consent is being sought to discharge up to 32,600 m^3 of turbid '*stormwater and process water*' per day to the CMA at the mooring buoy, to manage stormwater levels on site by preventing pond overflow.

2 **Structures in the coastal marine environment:**

a) Occupation and maintenance of the existing pipelines and mooring buoy infrastructure and associated dewatering and diversion of coastal waters, bed disturbance and vehicle use.

b) Re-construction and replacement of pipeline and mooring infrastructure.

TIL currently undertakes up to 20 ship loading events per annum and it proposes to increase this to up to 35 ship loading events per annum over the life of the consents that are sought. Although TIL is proposing to undertake a greater number of shiploading events, it is not seeking to increase the volume of ship loading water (or stormwater and process water) that it is already authorised to discharge under its existing resource consents. This is taken into account in the modelling of the plume dispersion and settlement which was undertaken by MetOcean Solutions Ltd and forms the basis of this assessment.

Coastal environment

This assessment considers how the proposed activities could potentially impact coastal processes and landforms on the open coast environment at Taharoa and on nearby harbour environments at Kawhia and Aotea.

Taharoa is located on the west coast of the southern Waikato Region, and is a high energy coastal environment, characterised by large waves, coastal storms, and dynamic coastal landforms. The coast is part of a littoral drift corridor, where sediment is transported north from the Taranaki volcanic region up the north island west coast. This historic and ongoing sediment supply has produced the iron sand deposits at Taharoa, and the coastline remains in a state of accretion (seaward movement of the dune toe) due to this ongoing supply.

The combination of large waves and natural sediment transport creates a typically turbid environment on the Waikato west coast. Calculations of gross longshore transport indicate that around one million cubic meters of sediment is moved by waves each year (with some 620,000 m^3/year to the north, 440,000 m^3/year to the south). The Waikato west coast also receives

large volumes of sediment from land catchments, with an estimated yield of around 1.3 million tonnes of sediment delivered to the coast per year from harbours and rivers within 100 km of Taharoa. The baseline environment is naturally turbid and in constant flux and is therefore not geomorphically sensitive to a sediment plume or plume deposition.

Assessment of effects

A qualitative effects assessment framework is used to determine the level of effect associated with different proposed activities on coastal processes and landforms on the open coast and adjacent harbours.

Key findings from the effects assessment undertaken by T+T in respect of the application are:

- The volume of sediment released by the de-watering plume is orders of magnitude below the natural yield from nearby catchments and is orders of magnitude below the capacity for wave driven alongshore sediment transport.
- The de-watering plume was numerically modelled by MetOcean (2025) which shows some settlement in Aotea and Kawhia Harbours, with deposition less than 0.05 mm per year for 1 % of the harbour area. No settlement is modelled on the open coast.
- The overall effect of potential deposition from the de-watering plume is negligible on coastal processes and landforms on the open coast and adjacent harbours.
- The release of sediment during stormwater management is also considered negligible, as the sediment type is mostly consistent with seabed sediments and would become part of the littoral system. The volume released is orders of magnitude below the capacity for wave driven alongshore sediment transport.
- The occupation of the seabed by the coastal and marine structures at Taharoa has a low footprint on the seabed with a negligible effect on coastal processes and landforms.
- Installation, maintenance and renewal of the coastal and marine structures (export pipeline and buoy) could have a temporary effect on the foreshore, which can be mitigated by undertaking the dune and beach-based work during calm conditions and reinstating any excavated dune sediment and re-planting any disturbed vegetation.

The overall level of effect across all proposed activities is negligible in terms of coastal processes and landforms. This is based on the small magnitude of deposition from plumes and capacity of the Waikato west coast to accommodate and move sediment.

1 Introduction

1.1 Scope and purpose

Taharoa Ironsands Ltd (TIL) commissioned Tonkin & Taylor Ltd (T+T) to undertake an assessment of potential effects on coastal processes related to a resource consent application for all necessary resource consents to continue undertaking its sand mining and export operation at Taharoa.

The scope of this assessment relates to physical coastal processes and landforms. Coastal processes include waves, currents, tides, water levels, and sediment transport. Coastal landforms include features such as the shoreface, beach, sand dunes, and estuaries.

This assessment is focused on two elements of the Taharoa Ironsands operation including the release of turbid water to the coastal marine area (CMA) and the occupation and reconstruction of coastal marine structures.

1.2 Summary of relevant operations

TIL load iron sand into vessels using an export pipeline that is connected from land to a single buoy mooring (SBM) system located 3.2 km offshore, at a depth of 35 m. The export pipeline is buried under the sand dunes and beach, then sits on the seabed before connecting to the surface at the mooring buoy. Iron sand is loaded into vessels moored at the SBM as a turbid slurry of sand and water. Before the sand slurry is passed through the pipeline, the vessel hold is partially filled with water to prevent abrasion. During the loading process, the vessel hold is de-watered using a decanting system. This releases a mix of water and very fine sediment to the CMA and creates a visible plume during loading operations.

1.3 General assessment approach

The coastal assessment in this report is informed by a combination of literature review, other reports commissioned by TIL for the application[1], available data on coastal change, and land information from national databases. Findings of this report are used by other technical specialists to inform their effects assessments.

An overview of the application features that are relevant to the coastal environment are summarised in Section 2. A review of relevant background information to the coastal environment is presented in Section 3 to understand the receiving environment, which places the proposed activity in the context of natural variability. The effects assessment framework is presented 4.1 and results are summarised in 4.6.

The assessment considers the potential nearfield effect of the proposal on the Taharoa open coast and the potential effect at distant coastal environments of Aotea and Kawhia Harbour, which are located up-drift of the site under prevailing hydrodynamic conditions.

[1] A draft version (v0.2 14/03/2025) of the MetOcean Solutions Ltd report, with associated model output data was reviewed to inform this assessment. MetOcean. 2025. *Discharge Dispersion Modelling*. Prepared for Taharoa Ironsands Ltd.

2 Relevant elements of the application

2.1 Release of sediment to the CMA

2.1.1 Plume settlement from vessel loading and de-watering

The ship loading process for exporting iron sand at Taharoa involves a stage of de-watering of the vessel hold, which releases turbid water into the CMA. Consent is being sought by TIL to release up to 75,000 m^3 of de-watering fluid per day, to a maximum of 7,500,000 m^3/year.

The de-watering fluid comprises a combination of water and very fine sediment and has a total suspended sediment (TSS) concentration of approximately one kilogram of sediment per cubic meter of water (1 kg/m^3). Therefore, the weight of sediment released would be a maximum of 7,500,000 kg in one year (7,500 tonne). A typical loading event is 2-4 days, releasing approximately 150,000 m^3 of de-watering fluid, and therefore 150,000 kg of very fine sediment, into the CMA. The representative grain size of the plume is 10 microns (0.01 mm) with a settling velocity of 0.02 m/s (MetOcean, 2025).

The annual maximum release of 7,500,000 m^3/year de-watering fluid would input a sediment volume of approximately 5,250 m^3 into the CMA each year based on a conservative sediment density of 2,000 kg/m^3 and porosity of 0.4. This lower density is estimated and compared to a more typical density of 2,700 kg/m^3 that represents the sand size sediments typical of the beach and dune.

This report considers the potential effects of sediment from the discharge plume settling on the seabed. The analysis is based on an interpretation of the MetOcean (2025) model results for sediment plume dispersion, dilution and settlement. This assessment considers potential effects on coastal processes and landforms associated with plume deposition on the open coast offshore of Taharoa, and in adjacent harbours (Kawhia and Aotea), that are sites of deposition in the MetOcean model.

2.1.2 Sedimentation associated with stormwater discharge

TIL have '*process water*' ponds on site that have potential to overflow during high rainfall events. To manage water levels in these ponds, TIL undertake a controlled discharge of water from the process ponds to the CMA, through the export pipeline. TIL is seeking a resource consent to discharge up to 32,600 m^3 per day of *process water* to the CMA for stormwater management purposes.

A review undertaken by T+T (2020) indicates that discharge of process water / stormwater to the CMA is infrequent, with monthly totals up to 7,615 m^3 which is notably below the consented daily limit. However, it is reasonable to anticipate larger volumes being required in the future to manage effects of extreme events and climate change. If the water released from site to the CMA is turbid, there is potential for plumes and sedimentation to occur.

To inform this assessment, process water is assumed to be highly turbid with similar suspended sediment concentrations to the de-watering plume (e.g., 1 kg/m^3). Therefore, the daily discharge as assessed in 2020 would result in a sediment weight of 7,615 kg or sediment volume of approximately 5.5 m^3, however, it could be up to 32,600 kg. This would result in a sediment volume of approximately 23 m^3. The grain size characteristics of the discharged sediment would likely be more mixed than the de-watering plume, with a combination of sand and silt sizes, whereas the de-watering plume is mostly silt-sized grains.

2.2 Coastal marine structures

2.2.1 Occupation of structures in the CMA

The existing operation has the following infrastructure that occupies the CMA:

- The export pipeline that is buried under the sand dunes and surf zone but emerges on the seabed offshore before connecting to the SBM using a floating hose (Photograph 2.1 and Figure 2.1). The pipeline comprises twin 318 mm diameter pipes. There is also a secondary pipeline as shown in Figure 2.1.
- The SBM has a diameter of 11 m, an overall height of 7 m and a draft of 3 m. The buoy is anchored using six catenary anchor leg mooring chains, each 350 m long with 9 tonne Mark 11 Bruce anchors on each.

This assessment considers how the occupation, installation and maintenance of these structures in the CMA could impact coastal processes and landforms.

Photograph 2.1: Photos of the land side and marine side infrastructure (source: New Zealand Steel presentation 2010).

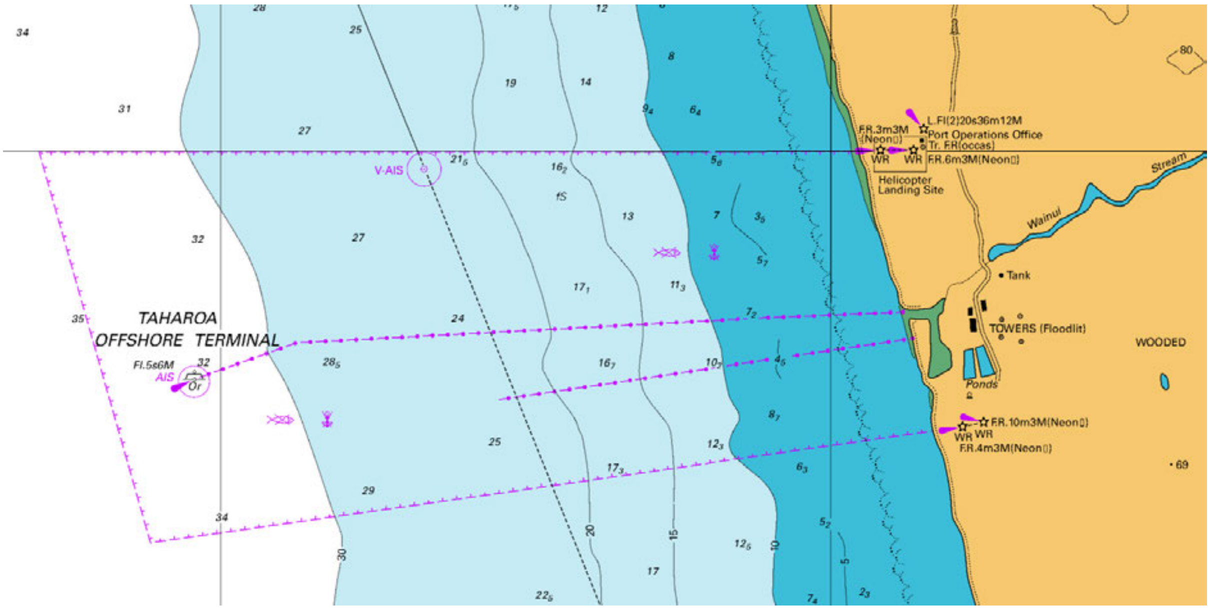

Figure 2.1: Nautical chart showiong the SBM location (source Wetmaps.co.nz).

2.2.2 Re-construction and maintenance of structures in the CMA

The existing physical environment at Taharoa includes the SBM and pipeline. However, for the purpose of this consent application, the existing environment is treated as if the structures are removed. Therefore, effects of installing and maintaining CMA infrastructure are addressed in terms of the construction phase effect on coastal processes and landforms. This assessment considers the potential effects associated with the installation of the CMA infrastructure and provides recommendations for avoiding or mitigating these effects.

3 Coastal environment

3.1 Overview

Taharoa is located on the west coast of the Waikato Region, which is known to be an energetic and dynamic coastal environment, characterised by large waves, storms, and frequently changing coastal landforms. An overview of the site location is presented in Figure 3.1, highlighting the location of Taharoa in the context of nearby rivers and harbours, with the bathymetry contours and coastal features that are discussed below.

This section of the report introduces the baseline landforms and processes that comprise the open coast environment at Taharoa, the nearby harbour environments at Kawhia and Aotea, and nearby rivers that discharge sediment to the CMA.

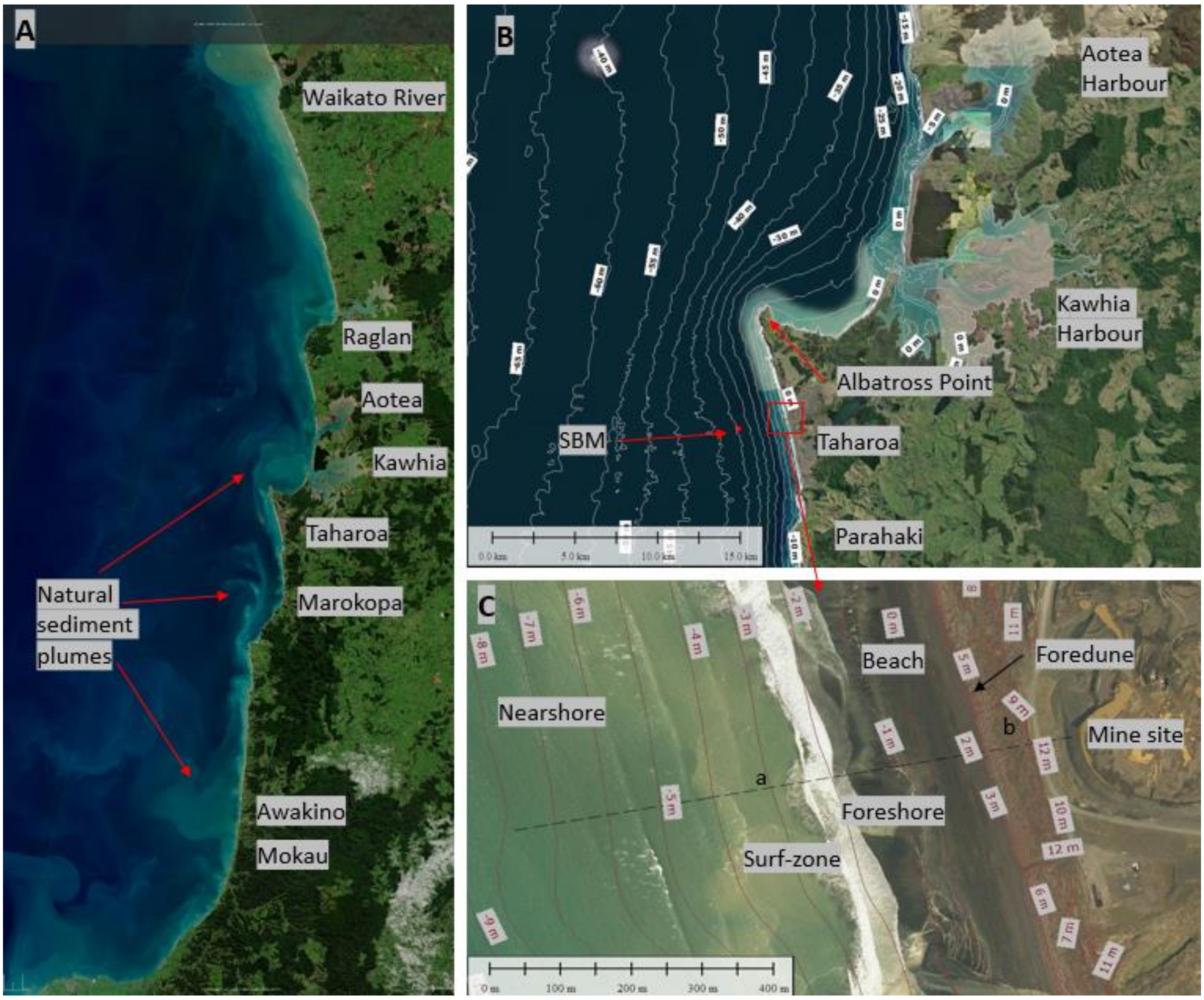

Figure 3.1: Site location and coastal setting. A) Sentinal-2 satellite image (7 June 2023) showing the location of Taharoa in context of nearby sediment plumes from rivers and harbours. B) Nearshore contours from the MetOcean model (converted to New Zealand Vertical Datum 2016) and aerial images from LINZ (2023) with the ship loading (SBM) location. C) Aerial images from LINZ (2023) and topographic contours from LINZ LiDAR (2015) in New Zealand Vertical Datum 2016.

3.2 Tides and water levels

Tides on the Waikato west coast have a spring tide range of 3.4 m. The mean high-water spring (MHWS) level is 1.43 m with regards to New Zealand Vertical datum (NZVD) which is used the reduced level (RL) in this report (Table 3.1). During storm conditions, low atmospheric pressure and onshore wind can increase sea level. For the Taharoa coast, the storm tide level is estimated to be up to 2.8 mRL based on the Waikato Coastal Inundation tool.

Table 3.1: Tidal and storm tide levels for different vertical datums

	Chart Datum (m)	MVD 1953 (m)	NZVD 2016 (m)
Storm tide upper	5.07	3.1	2.80
Storm tide lower	4.27	2.3	2.00
MHWS	3.70	1.73	1.43
MHWN	2.90	0.93	0.63
MSL	2.10	0.13	-0.18
MLWN	1.20	-0.77	-1.08
MLWS	0.30	-1.67	-1.98

3.3 Open coast environment at Taharoa

3.3.1 Coastal morphology

Bathymetry for the coast is presented in the MetOcean (2025) report, and the data was made available for this coastal assessment. The average shoreface slope for the Taharoa open coast is 1(V):88(H) indicating a gently sloping transition from deep water offshore towards the beach (Figure 3.2). TIL's single buoy mooring (SBM) site is located at a depth of 35.5 m, 3.2 km seaward of the beach. This is expected to be a location where waves are shoaling (wavelength reduces and wave height increases) prior to breaking. In this zone, wave orbital velocities likely mobilise sediment on the seabed and through the water column.

An intertidal beach area is located landward of the surf-zone, which has highly dynamic sedimentary features such as rip channels and bars. A subaerial beach exists between the mean high water spring mark and the dune toe, and a sand dune is present along most of the coast. Beach width is expected to be variable depending on sea conditions and storm event. The beach morphology is typical of a high energy west coast beach and has a well-established sand dune system (Figure 3.2). The foredune is the most seaward part of the sand dune system and has a crest approximately 10 mRL based on available LiDAR from 2015 (LINZ), and vegetation is evident in aerial images (LINZ). The sand dunes are likely dynamic, with periods of erosion due to coastal storms, followed by recovery during periods of low wave energy. Small streams are present along the beach and periodically interrupt the dune system. Wainui Stream outflows to the coast near the TIL export pipeline and locally prevents sand dunes establishing where the stream meanders around dynamically across the beach.

Sediment samples were collected from the nearshore SBM site by marine ecology consultants from SLR on 9-10 November 2021 as part of their Marine Assessment (4Sight, 2023). Samples were identified as being iron sand with grain size in the fine sand (e.g., 0.125 – 0.25 mm) and very fine sand class (e.g., 0.063 – 0.124 mm) (4Sight, 2023). The marine samples appear to be consistent with the character of iron sand being extracted by TIL, which ranges in grain size from 0.090 – 0.212 mm (fine to very fine sand) (Tonkin + Taylor, 2010).

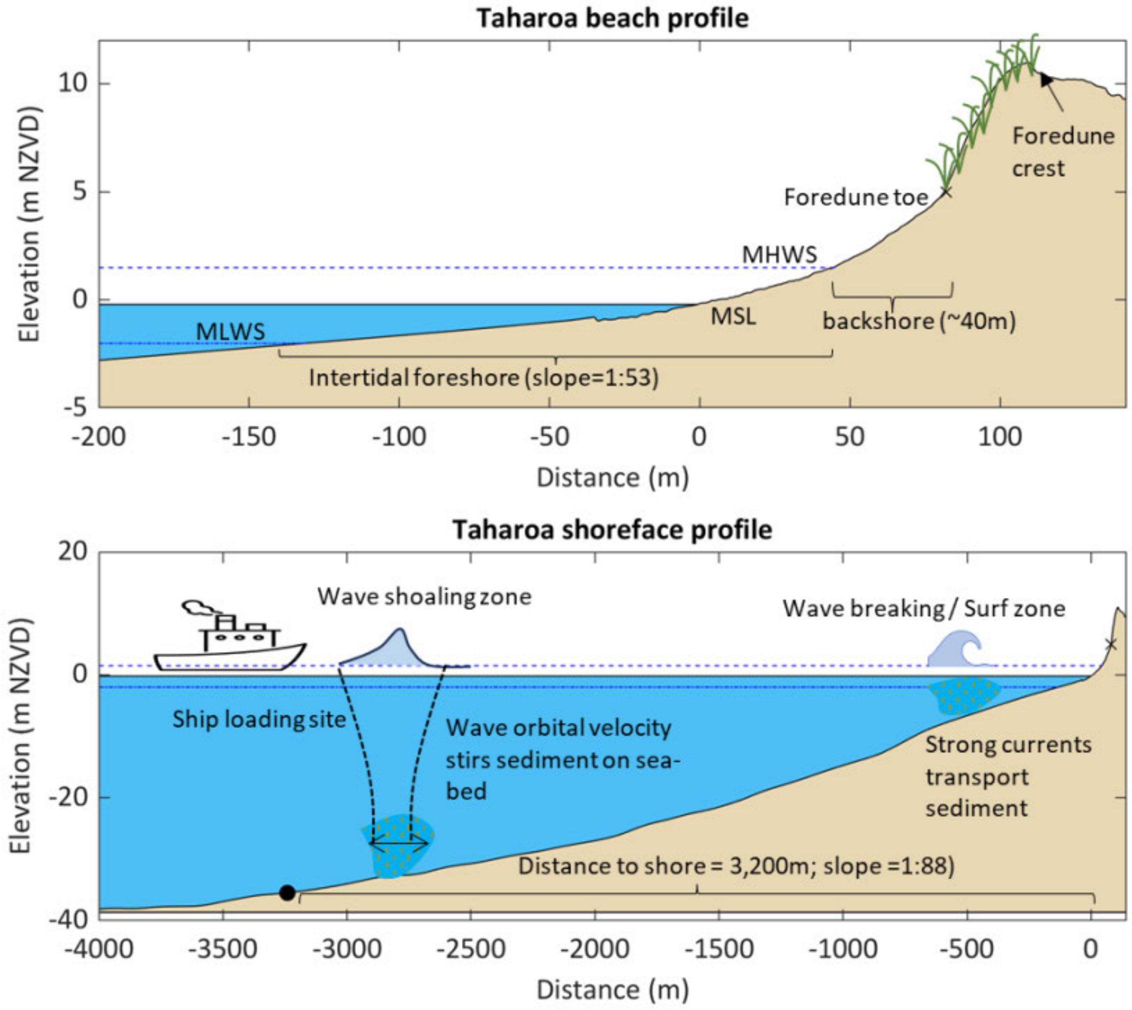

Figure 3.2: Beach and shoreface profiles showing key features at Taharoa. Profile location is presented in Figure 3.1.

3.3.2 Wave climate

The open coast at Taharoa coast faces west south-west (252°) and is exposed to high energy wave conditions. Wave exposure at the site is described by MetOcean (2025), identifying a mean significant wave height (Hs) of 1.93 m at the SBM ship loading site. Calculations of extreme wave heights using the same data from MetOcean (2025) identify a 1-year return period wave height of approximately 6 m, and a 10-year return period wave height of around 7 m. Significant wave height at the SBM exceed 1.5 m for 240 days per year and exceed 2.5 m for 70 days per year. Waves typically approach the site from the west south-west, with a median wave direction from 249 degrees (Figure 3.3). Wave periods range from 5-20 seconds, indicating that the site is exposed to swell waves from distant sources, and waves generated by regional wind processes.

Waves shoal from the nearshore to the surf zone and the average breaking wave height at Taharoa is approximately 2.5 m based on shoaling calculations. Wave breaking occurs at a critical water depth, which results in a mean wave breaking depth of 4.3 m which is ~300 m offshore of the beach (Van Rijn, 2014). During extreme wave conditions, waves at the site could break at a depth of 10-12 m which is approximately 800 m offshore of the beach.

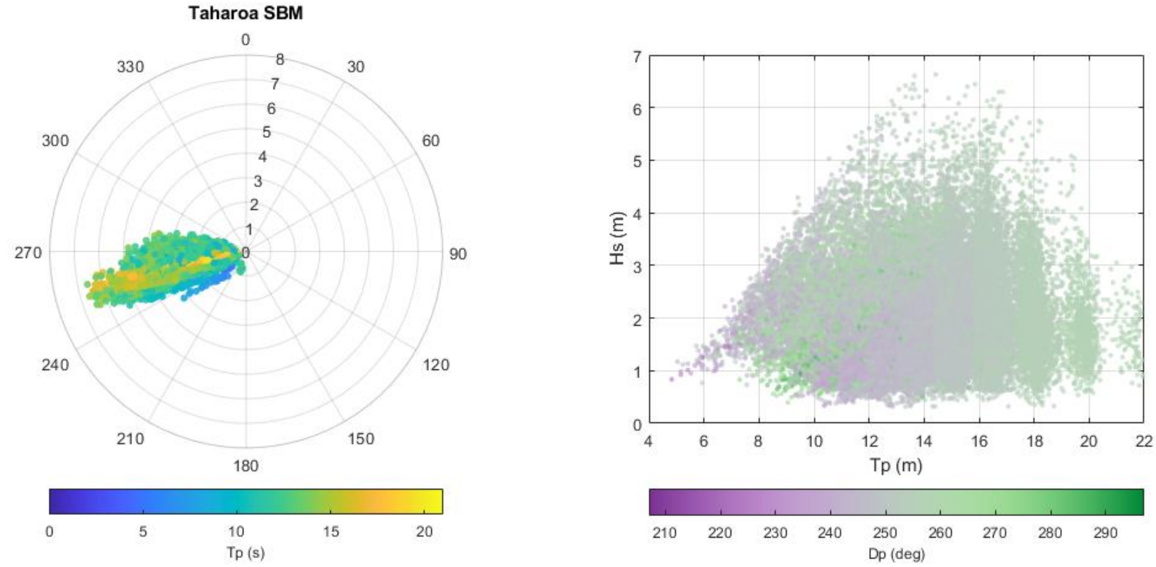

Figure 3.3: Summary of wave height (radial axis), direction and period at the SBM based on the MetOcean hindcast 1994 – 2016.

3.3.3 Alongshore transport

Waves typically approach the coast at an angle. A dynamic surf zone is located between the shoreface and beach, where waves break and dissipate as white water. Wave-generated currents and turbulence in the surf zone transport large volumes of sediment in alongshore and across-shore directions.

Alongshore transport was calculated using the MetOcean wave hindcast (1994 – 2016) and Kamphius (1991) and van Rijn (2014) methods. Results indicate that waves transport approximately 620,000 m^3 of sand to the north per year, and around 440,000 m^3 of sand to the south per year (Figure 3.4). The resulting gross annual alongshore transport of approximately 1,000,000 m^3/year in the surf zone by wave action. The net annual transport is 180,000 m^3/year to the north.

The rates of alongshore transport calculated by wave properties at Taharoa are consistent with existing literature on sediment transport along the North Islands West coast, where iron sand is originated in the Taranaki volcanic region and transported north (e.g., Hart and Bryan, 2008).

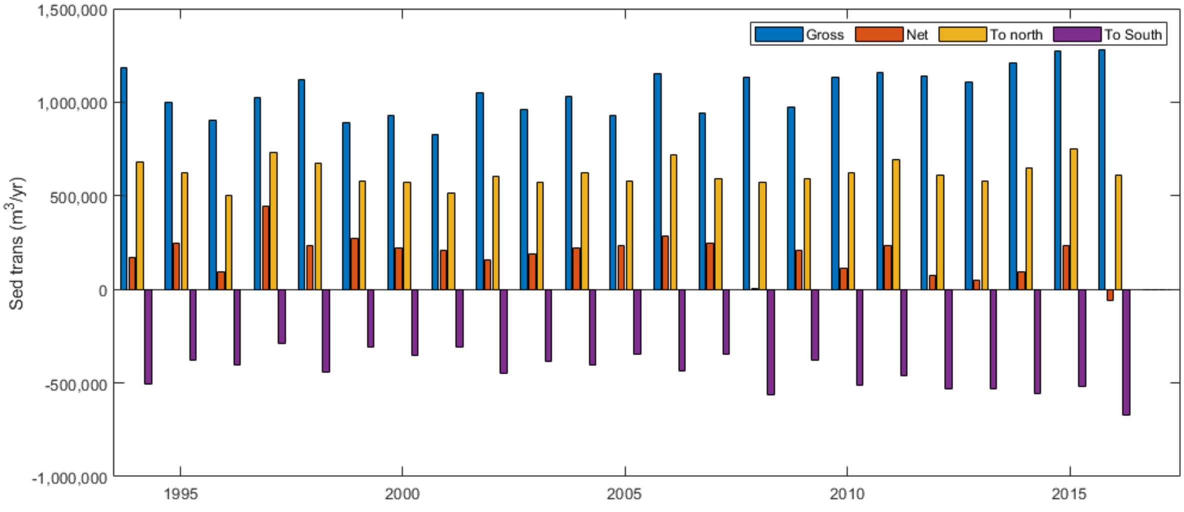

Figure 3.4: Summary of alongshore sediment calculations based on the MetOcean wave climate at the SBM 1994 – 2016.

3.3.4 Shoreline change

Historic shoreline change at Taharoa was investigated using the recently published 'Aotearoa's Coastal Change dataset' created by the University of Auckland (UoA) as part of a National Science Challenge (UoA, 2024). The coastal change dataset is based on georeferencing historic and recent aerial images, then digitising the shoreline position at the seaward edge of dune vegetation. The analysis includes historic images at Taharoa between 1944 and 2022, a span of 77 years. Due to the partial cover of some older aerial images, the number of shorelines mapped over this time ranged between 5-7. Historic shorelines for Taharoa are presented in Figure 3.5, with the newer shorelines in blue and older in red.

Key variables from the UoA analysis are the rate of shoreline change, which is based on the 'weighted linear regression (WLR)' of the trend line that tracks the change in shoreline position over time. The other useful metric is the 'net shoreline movement' which measures the net change in shoreline position over the 77 years.

Averaged over the full Taharoa coast, the net trend is accretion over the last 77 years, and at average rate of 0.5 m/year. The greatest rates of accretion occur away from river outlets, with some sections showing accretion of 1 m/year (90 percentile across site). The relationship between net shoreline movement and the rate of shoreline change is shown in Figure 3.6. All of the open coast dune sections that are not influenced by stream outflow have a long-term trend for accretion. Since 1944 the shoreline has moved seaward by an average distance of 40 m, with a 90 percentile change in shoreline position of 82 m. This historic trend of accretion is likely explained by the ongoing supply of sand from the Taranaki volcanic area that is transported north by longshore drift.

The long-term trend of dune accretion is likely to be periodically interrupted by storm events that can cause temporary erosion of the dune, where the dune would present as a vertical scarp and with the toe eroding back in the order of 10-15 m.

Climate change will likely alter the frequency and intensity of coastal storms around New Zealand, however there is uncertainty around this. Future wave climate projections indicate a general increase in the mean and extreme wave height on the west coast of New Zealand by around 5 % (Albuquerque et al., 2024). This could result in more erosion events cutting into the sand dunes. The beach will also likely adjust to higher sea levels in the next several decades to centuries as a result of climate change, with a landward migration. Over a long enough time (several decades), this may offset or overwhelm the historic accretion trend.

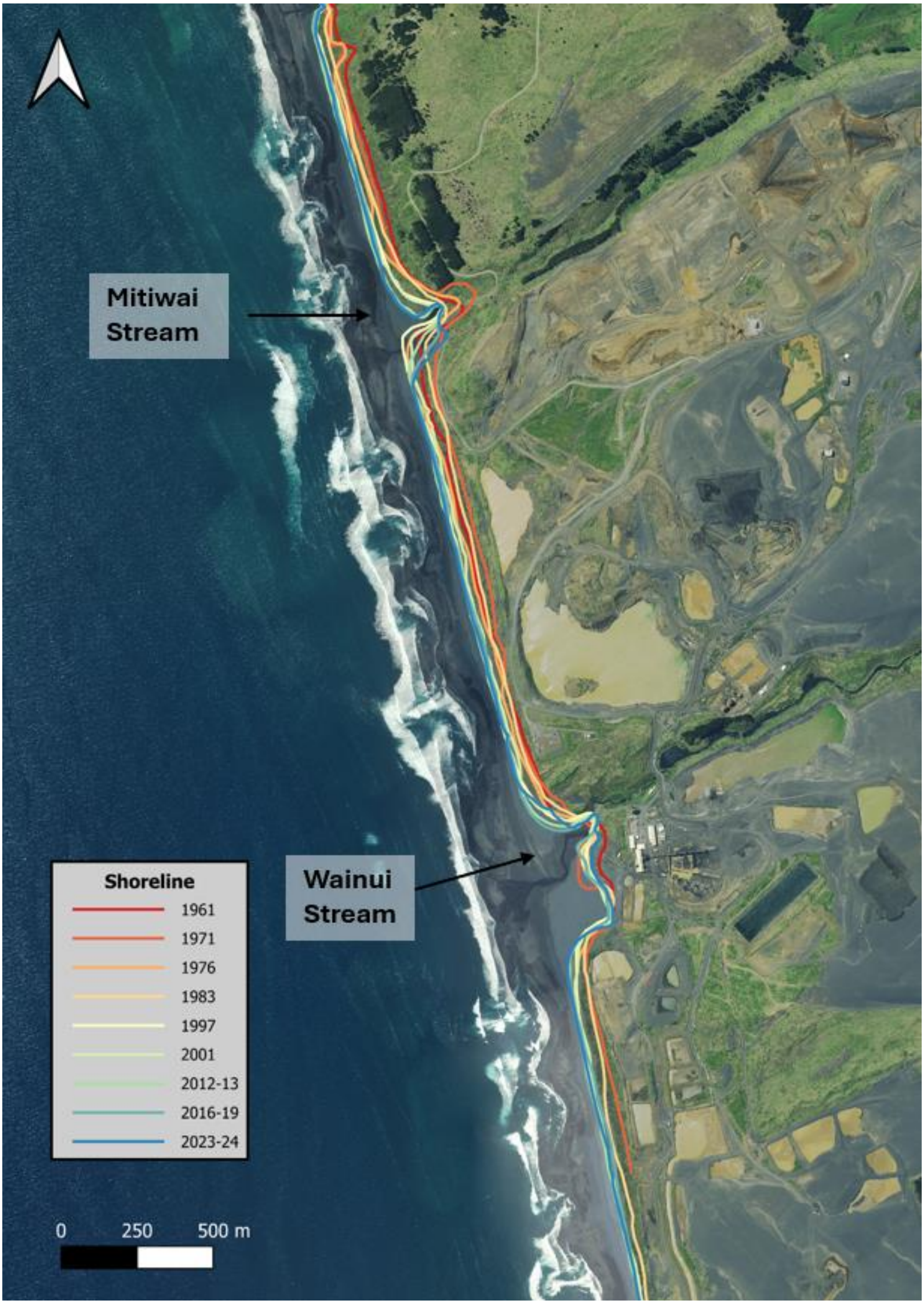

Figure 3.5: Historic shoreline position along the Taharoa coast (source UoA Coastal Change).

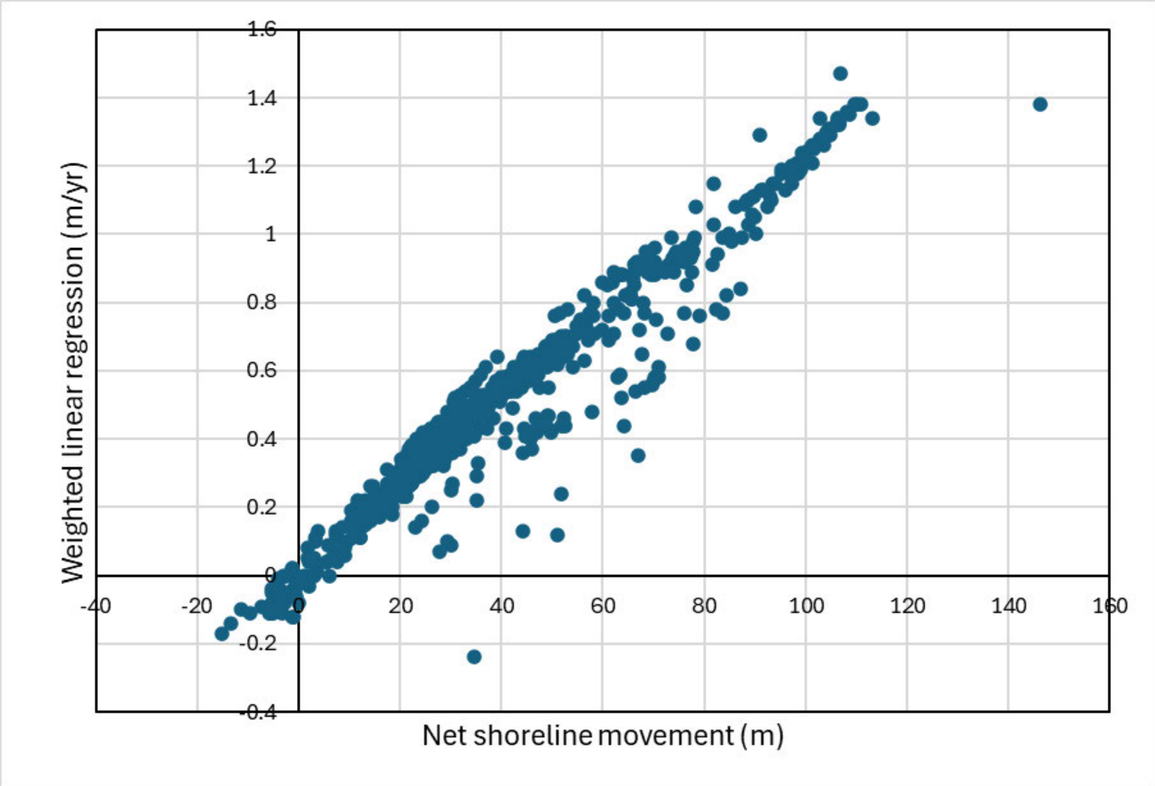

Figure 3.6: Historic shoreline position alogn the Taharoa coast (source UoA Coastal Change).

3.4 Local stream outlets

The outlets of Wainui Stream and Mitiwai Stream disrupt the sand dune system along the Taharoa coast. This locally prevents dune formation, and the trend of accretion observed on the open coast is not present where the stream outlets meander through the dune and beach.

A review of available historic images was undertaken to understand how stream outflow through the beach varies over time (Figure 3.7). Tracking stream outline position through the beach since 1944 indicates that both streams vary over time as water meanders through the beach. The outlet at Mitiwai has a small envelop of migration to the north, compared to a larger envelop of migration to north and south at Wainui. Meandering stream outlets explain the absence of dune accretion in these locations.

Sediment delivery to the coast at Taharoa is from northerly littoral transport from the Taranaki volcanic zone, with negligible sediment delivery to the coast from either stream in terms of influencing coastal processes and sediment budgets.

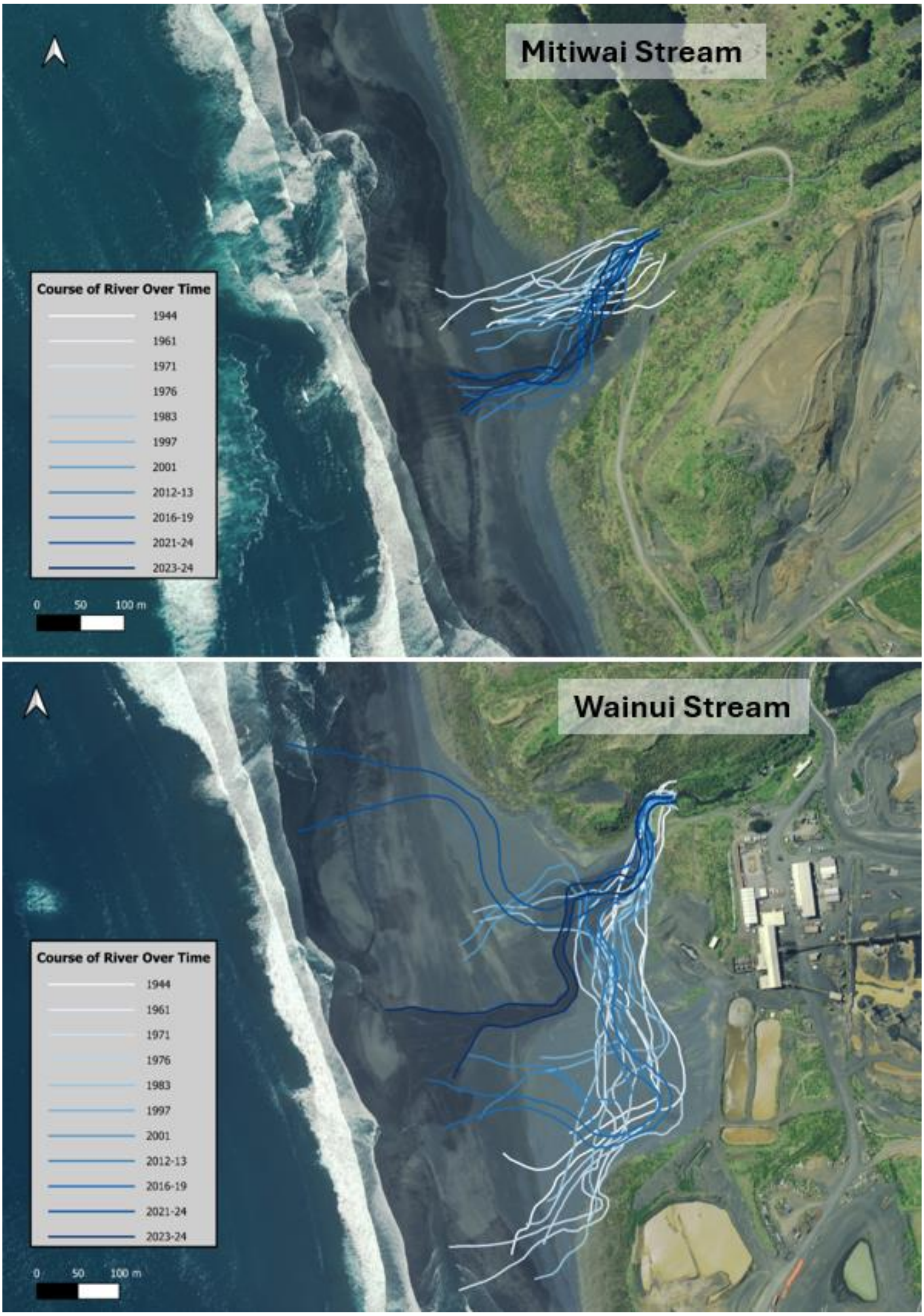

Figure 3.7. Variability in stream position at Mitiwai and Wainui between 1944 and 2024 (basemap LINZ Aerial 2023-2024). Note each time period has a line for both sites of the river.

3.5 Nearby harbours and rivers

The Taharoa coast is part of a large littoral drift zone that is influenced by sediment delivery to the CMA from four major rivers (Mokau, Awakino, Marokopa, Waikato) and three major harbours (Kawhia, Aotea, Raglan) within 100 km of the site.

3.5.1 Sediment yield

An overview of sediment delivery to the coast is presented in Table 3.2. For the estuary locations, the marine area of the estuary, defined as having an elevation below mean high water spring is also presented for normalising the sediment yield to a per unit area of the harbour. This is a potential indicator of relative sedimentation rates for harbour infilling.

The combined yield of sediment delivery to the coast from the Mokau, Awakino, Marokopa, and Waikato Rivers is 1.1 million tonnes per year (t/yr) (Mead & Moores, 2004; Hicks et al., 2011. Sediment yield from harbours (Kawhia, Raglan, and Aotea) is approximately 250,000 t/yr (Mead & Moores, 2004). These estimates are now 20 years old, and catchment conditions may have changed. More recent data for Raglan Harbour, as reported in Hunt (2023), indicates a lower rate of sediment yield at 60,424 t/yr, which is approximately half that reported in 2004. Therefore, sediment yield rates are considered a best estimate and should be interpreted with accuracy of ±50 %.

Table 3.2: Summary of sediment yield from rivers and harbours on Waikato West Coast

Location	Sediment yield (tonnes/year)	Area at high tide (m^2)	Yield per area ($kg/m^2/yr$)
Mokau River	654,419		
Awakino River	105,189		
Marokopa River	168.449		
Kawhia Harbour	98,353	67,000,000	1.5
Aotea Harbour	33,409	36,000,000	0.9
Raglan Harbour	122,927	24,000,000	5.1
Port Waikato	370,000		

Note: Values from Mead and Moores (2004).

3.5.2 Sedimentation

Harbour infilling and sedimentation is partly a function of supply to the coast, and tidal flushing, with sediment re-suspension by local wave processes also influencing long term settlement if re-suspended sediments are transported out of the harbour by tidal flushing. Research from estuary sites within Raglan Harbour suggests that locally generated wind waves can provide an important control on sedimentation and estuary morphology on the Waikato west coast (Hunt et al., 2017). However, rates of sedimentation and infilling for Waikato west coast estuaries are not well understood. A best estimate from the review by Mead and Moores (2004) suggested a rate of infilling for Kawhia Harbour of <1 mm/year. However, up to date and site-specific data are not available to confirm this estimate.

The combination of suspended sediment from river and estuary sources, and re-suspension by high energy waves results in a generally turbid coastal marine area on the Waikato west coast. Background levels of total suspended sediment are not well described for the Waikato west coast. Satellite monitoring of total suspended sediment (TSS) at a New Zealand scale has been undertaken by NIWA (2022), where monthly average suspended sediment values are in the order of 1 – 10 g/m^3 offshore of Taharoa when averaged over 500 square meters (Pinkerton et al., 2022). Samples of suspended sediment at Ocean Beach Kawhia indicate background levels of 4 – 29 g/m^3 are present on the Waikato west coast (Tonkin + Taylor, 2020). Another reference is the average suspended sediment measured from 23 Waikato rivers (Waikato Regional Council, 2008) which ranges from 5 – 100 g/m^3 across 22 sampling location over the region. The only west coast sample site is the Waingaro River, at the upper reaches of Raglan Harbour where mean suspended sediment was around 25 g/m^3 between 2002 – 2007. Episodic high flow events could produce suspended sediment concentration in the order of 100 – 1,000 m^3/year based on the relationship between river flow rate and suspended sediment concentrations (Waikato Regional Council, 2008).

4 Coastal effects assessment

4.1 Assessment framework

The criteria for assessing the level of effect on coastal processes and landforms for different application activities is outlined in Table 4.1. This framework has been developed by T+T and applied to various coastal process effects assessments, including for Northport and the proposed iReX terminal in Wellington.

Table 4.1: Qualitative definition for levels of effect on the physical coastal environment

Significance	Criteria: Coastal Processes
Very High/severe	Total loss of, or very major alteration to, key elements/features of the existing baseline condition such that the post-development character, composition and/or attributes will be fundamentally lost. This includes irreversible changes to tides, currents, waves and/or sand transport causing adverse impacts on significant parts of the shoreline, causing increased erosion and/or significant environmental habitat values. Substantial changes to the seabed morphology such that: • The majority of the regional distribution of a habitat type for nationally protected ecological communities is lost or substantially depleted; or such that. • The sediment pathway for sand flow to other areas is permanently intercepted.
High (Significant)	Major loss or alteration to key elements/features of the existing baseline condition such that the post-development character, composition and/or attributes will be fundamentally changed. In particular, extensive or acute disturbance (major impact) occurring to the shorelines, causing increased erosion and/or significant environmental habitat values. Also, substantial changes to the seabed morphology such that: • The majority of the regional distribution of a habitat type for regionally protected ecological communities is lost or substantially depleted; or such that. • The sediment pathway for sand flow to other areas is temporarily intercepted.
Moderate/medium (More than minor)	Loss or alternation to one or more key features of the existing baseline conditions such that the post-development character, composition and/or attributes will be fundamentally changed. Changes to tides, currents, waves and/or sand transport affecting parts of the shorelines bordering the site, causing: • Short term increased erosion that would affect communities or habitat values, such that natural recovery or mitigation measures would alleviate adverse impacts. Also, • Substantial changes to the seabed morphology such that the local distribution of a locally valued seabed habitat type is permanently lost or substantially depleted.
Low (minor)	Minor shift away from existing baseline conditions. Changes arising will be discernible, but attributes of the existing baseline condition will be similar to pre-development circumstances or patterns. Changes to tide levels, currents, waves and/or sand transport processes causing changes in shoreline stability of limited or temporary nature. Changes to the seabed morphology would be of local spatial extent with no impacts elsewhere.
Negligible (Less than minor)	Very slight changes from the existing baseline conditions. No perceptible impacts on regional hydrodynamics beyond the immediate works area. Local hydrodynamic changes that have no consequent adverse impacts elsewhere. Little or no changes to water level, current, wave or sand transport processes at shorelines such that any impacts to shoreline stability would be imperceptible. Changes to the seabed morphology would be temporary with only local spatial extents and no impact elsewhere.
No effect	No detectable change in physical parameters.

Significance	Criteria: Coastal Processes
Beneficial	Any effects or measures that are expected to result in reduced shoreline erosion where that is presently a problem, or design features or management activities that would make a positive contribution to shoreline amenity or coastal environmental values.

4.2 Plume deposition

In general, deposition of sediment in the CMA has the potential to influence coastal processes if sediment accumulates in a consistent location over time, causing a localised change in seabed level over and above natural variability, resulting in a change to coastal landforms (e.g., bars and channels) or processes (e.g., waves and currents). However, if the plume is dispersed widely and diluted before settling, deposition is not likely to have a discernible effect on the seabed level or coastal processes.

The potential effects of deposition from the de-watering plume should be assessed in the context of baseline processes in the coastal environment, including natural sediment transported by waves, and sediment delivered to the coast by rivers and harbours.

The application seeks the equivalent of discharging up to 7,500 tonnes of sediment per year from the de-watering plume (Section 2.1.1). This is several orders of magnitude below the combined sediment yield from nearby rivers and harbours of approximately 1,300,000 tonnes per year (Table 3.2). When converted to a potential sediment volume, the application is associated with inputting approximately 5,250 m^3 of sediment to the CMA via the de-watering plume over one year. This is also several orders of magnitude below the estimate of gross alongshore sediment transport attributed to waves at Taharoa of 1,000,000 m^3/year (Section 3.3.3). Therefore, when compared to the natural sediment inputs and transport processes, the plume is negligible in terms of sediment budget processes and baseline dynamics of the receiving environment. Based on the high yield and natural sediment transport, the receiving geomorphic environment is likely not sensitive to inputs of sediment from the de-watering activity.

However, the plume is visible during calm conditions because of the high initial concentration during regular loading events. The high concentration makes the plume visible in Sentinel 2 satellite imagery sourced from Copernicus Data Space (10 m pixel size), when a vessel is also present at the mooring buoy (e.g., Figure 4.1). These images show that the plume associated with vessel loading is clearly visible but small compared to the natural plumes associated with river and estuary locations. A vessel plume can be seen on 7 June 2023, but it is not visible five days later, on 12 June 2023, after a period of dispersion, sinking, and dilution would have occurred (Figure 4.1). A vessel plume is also visible on 22 July 2023 and can be compared with the natural turbidity from river and harbour sources a month later, on 21 August. The natural turbidity plumes in the satellite imagery area are associated with river discharge, wave re-suspension and alongshore transport. These natural plumes appear to be much larger than the de-watering plume but likely have lower suspended sediment concentration.

Figure 4.1: Satellite images from Copernicus Data Space (sentinal 2) showing the vessel loading plume in context of naturally occurring plumes up and down the coast.

Numerical modelling of the plume dispersion and settlement was undertaken by MetOcean Solutions Ltd and is presented in a specific report as part of TIL's Fast Track consent application (MetOcean, 2025). A draft report (v0.2 13/03/2025) was utilised for this assessment, along with geospatial model output files showing the location and thickness of sediment deposition associated with two model runs:

- Representative three months during winter conditions with 12.5 de-watering events (each event being 15,000 m^3 over 48 hours) totalling 1,875,000 m^3 turbid water input to the CMA (a quarter of the total annual consent for a quarter of a year).
- Same as above for a representative three-month summer period.

To understand the potential annual deposition associated with the de-watering plume, the results from the three-month winter and three-month summer simulations were added together and doubled to represent 12 months. The resulting plume deposition map is presented in Figure 4.2 below for Aotea and Kawhia Harbours.

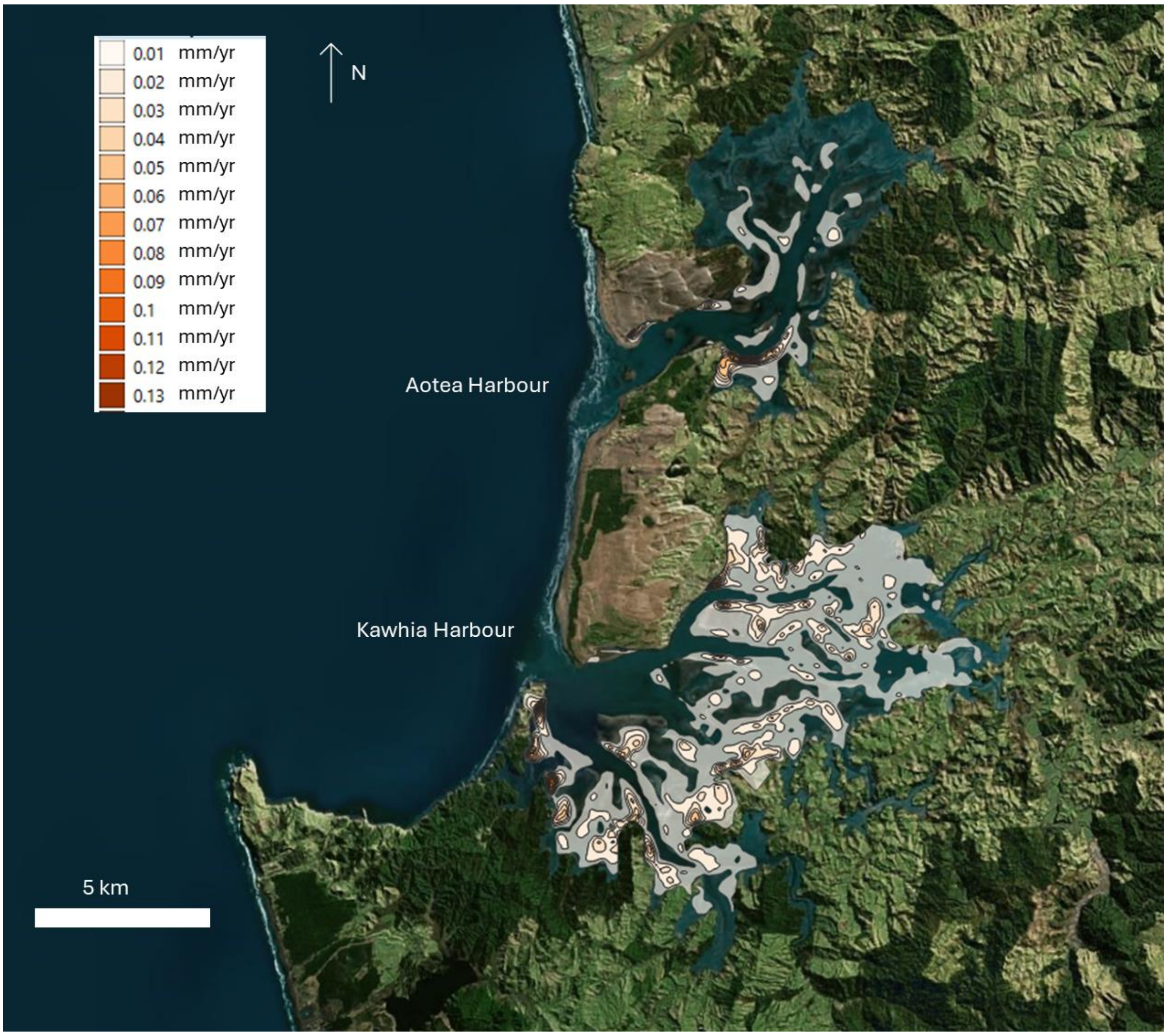

Figure 4.2: Plume deposition model results scaled up to represent 1 year (adapted from MetOcean model results).

Results from the numerical modelling show that sediment deposition of up to 0.01 mm (1 grain of 10-micron sediment) could occur in 40 % of Kawhia Harbour, and 13 % of Aotea Harbour (Figure 4.2; Table 4.2).

This appears to be a large area, but the thickness is so small that this would be unmeasurable and indiscernible. Sediment deposition above 0.05 mm (in the order of 5 grains high) is limited to less than 1 % of the harbour areas. Deposition over 0.1 mm/year (in the order of 10 grains high) is localised to very small areas (0.01 % of Kawhia Harbour). In terms of model deposition volume, the modelled deposition in Kawhia Harbour is approximately 500 – 550 m^3 or 10 % of the released plume sediment volume over one year. Modelled deposition volume in Aotea Harbour is approximately 80 m^3, or <2 % of the released plume sediment in one year.

The numerical model is a useful guide for understanding the fate of plume sediments, however it is a simplification of the complex natural world and provides a numerical level of precision that is beyond what is possible to measure and observe. The model resolves tidal currents, wave, re-suspension, and flushing in the harbours, but is limited by grid resolution (100 m grid spacing) for resolving small scale hydrodynamics that occur in harbour tidal banks and channels. It is likely that fine scale processes would re-suspend some of the deposited grains, allowing some flushing that is not resolved in the model. Regardless of this simplification, the numerical results show that deposition is limited to a very thin layer of accumulation which would have negligible effect on tides, currents, and the morphological evolution of the harbours.

No deposition was modelled on the on open coast at Taharoa, although some thin deposition (<0.01 mm) was modelled near Albatross Point. This is likely a numerical artifact of the dispersion model and is not expected to represent actual deposition on the complex coast in this location.

From a coastal process perspective, the release of fine sediment from the plume has a negligible effect on coastal processes and landforms for the open coast and adjacent harbour environment. This is based on the undiscernible magnitude of deposition when compared to the natural baseline of sediment yield and alongshore transport.

Table 4.2: Areas of de-watering plume deposition based on MetOcean model results

	Kawhia Harbour (67,000,000 m^2)		Aotea Harbour (36,000,000 m^2)	
Deposition	Area (m^2)	Percent of harbour	Area (m^2)	Percent of harbour
> 0.01 mm/yr	27,160,524	40.5 %	4,781,529	13 %
> 0.02 mm/yr	8,247,636	12.3 %	551,401	2 %
> 0.03 mm/yr	2,617,442	3.9 %	201,856	1 %
> 0.04 mm/yr	737,007	1.1 %	174,239	0 %
> 0.05 mm/yr	264,957	0.4 %	163,175	0 %
> 0.06 mm/yr	73,465	0.1 %	87,316	0 %

4.3 Discharge of stormwater and process water

As introduced in Section 2.1.2, TIL is seeking a resource consent to discharge up to 32,600 m^3 per day of *process water* and stormwater to the CMA for stormwater management. Process water is a turbid fluid made up of fresh water and sediment. This water receives treatment via a series of settlement ponds before being reused as process water, or if the quantities are too high, discharged via the export pipeline. Typically, this discharge comes from the K1000 pond which has low levels of suspended sediment – approximately 8-50mg/l (based on seven months of monthly testing by TIL in 2025). However, during times of excessive wet weather the suspended sediment concentration could be higher. To be conservative this assessment assumes this fluid is turbid, with a similar concentration to the plume discharge (suspended sediment concentration of 1 kg/m^3). Another assumption is that the sediment is a combination of sand and silts, compared to the plume which is primarily silts that leak out through decanting. Based on these assumptions, the daily discharge limit would be associated with a sediment weight of 32,600 kg or sediment volume of 23 m^3. In terms of capacity for local wave processes to disperse this volume, the daily averaged net alongshore transport capacity is 2,700 m^3/year which is orders of magnitude above the volume of sediment being released.

In terms of deposition, the coarser sand grains would settle out closer to the SBM, becoming part of the dynamic nearshore environment with similar characteristics the natural sediment (dune and nearshore sediments are similar). The finer grains would likely disperse in a similar pattern to the de-watering plume model results from MetOcean, likely drifting a north dominant direction and dispersing below background concentration levels.

Process water discharge to the CMA through the export pipeline only occurs infrequently where necessary to manage water levels in on-shore storage devices and during heavy and/or prolonged rainfall events.

The combination of low occurrence, and the capacity sediment to be mobilised by alongshore transport make this a negligible effect on coastal processes and landforms.

The potential cumulative effect of process water discharge and plume de-watering is also negligible on based on the small magnitude of deposition from both processes.

4.4 Occupation of coastal and marine structures

The SBM is 11 m in diameter with a draft of ~3 m and freeboard of ~2 m. The SBM is moored using six sets of 350 m long chains and anchors, with an anchor radius of ~330 m. The anchors provide a stable and low impact mooring design that has a negligible effect on coastal processes. This is especially true when compared to typical harbours that have breakwaters and port basins that can become a barrier to alongshore transport. The Taharoa mooring system has no discernible influence on waves, currents, or sediment transport processes because these structures are relatively small compared to the scale of physical processes at the site. The marine structures are not obtrusive to the flow of waves, currents, and the movement of sediment.

The pipelines resting on the seabed (seaward of surf zone) will have negligible effect on hydrodynamic and sediment transport processes due to the small diameter pipes (318 mm) and dynamic nature of the seabed. Some small, localised, and periodic scour may occur around the pipeline, but the structure is not expected to be obtrusive to natural sediment movements along and across the shoreface.

The pipelines are buried under the beach and surf zone so does not influence coastal processes while it is buried. However, if any pipe was exposed on the beach, this could create small areas of localised scour on the down-drift side and deposition the up-drift side.

4.5 Installing and maintenance of coastal marine structures

The existing pipelines, mooring anchors and buoy are already in place. However, for consenting assessment purposes we have considered the effects of installing or maintaining new CMA structures. Once installed with like-for-like infrastructure, the occupation effect on coastal processes would be consistent with the above assessment of negligible.

Any construction works to install or maintain consented marine structures would cause a temporary disturbance that may temporally entrain seabed sediments. However, relative to the scale of natural sediment transport in the coastal zone any construction disturbance is expected to be temporary and undiscernible once the works are complete. Construction works to install the pipeline underneath the sand dunes and beach may require temporary excavation to install the pipe. This would be a localised and temporary disturbance, and effects on coastal processes would be minimal if works were undertaken when the land is dry (e.g., low tide, small wave conditions). Any temporary excavation or disturbance of the dune and beach to install a new pipeline should require re-shaping of the dune with any removed sand, and re-planting of any disturbed dune vegetation.

4.6 Effects summary

Table 4.3: Effects summary for discharge related activities

Activity	Coastal Process / landform	Description of effect	Level of effect
De-watering plume deposition	Open coast landforms	Plume sediment is dispersed before settling on the seabed on the open coast. Any settlement is temporary and not detected in the MetOcean modelling in a way that shows any change to the sea-bed elevation over time.	No effect
	Open coast processes	Waves and currents on the open coast have an influence on the plume dispersion but are not influenced by the plume or associated deposition.	No effect
	Harbour landforms	Modelling shows plume deposition in Aotea and Kawhia Harbours is possible, but only exceeds 0.05 mm/yr for <1 % of the harbour areas.	Negligible (unmeasurable magnitude)
	Harbour processes	The magnitude of possible deposition is insufficient to influence harbour sedimentation, tidal currents, or wave processes.	Negligible (unmeasurable magnitude)
Stormwater discharge	Open coast landforms	Emergency stormwater discharge through the SBM pipeline can discharge some sediment to the CMA. Coarser sand size grains are expected to settle on the local open coast seabed and become part of the active sediment system. This magnitude of sediment input is geomorphological insignificant compared to the natural sediment flux on the Waikato west coast.	Negligible (undetectable compared to background sediment flux)
	Open coast processes	No influence is expected on open coastal processes (which disperse the added sediment), as there is no expected influence on the discharge on sediment level on the seabed.	No effect
	Harbour landforms	It is possible that a small plume could travel north to Aotea or Kawhia Harbours. This would likely be orders of magnitude lower than the de-watering plume and is therefore negligible as a single or cumulative effect.	Negligible (unmeasurable magnitude)
	Harbour processes	No sedimentation is expected to a level that could alter tidal, wave or current processes in the adjacent harbours.	Negligible (unmeasurable magnitude)

Table 4.4: Effects summary for structure related activities

Activity	Coastal Process / landform	Description of effect	Level of effect
Occupation by Coastal marine structures	Open coast processes	The single buoy mooring and associated pipeline occupy a small structural footprint and are not expected to alter waves, sediment transport or currents on the open coast.	Negligible (undetectable compared to natural variability).
	Open coast landforms	The land-side in structure is buried and therefore has no influence on the dune and beach. The submerged pipeline and mooring anchors may locally and temporally create sand ripples on the seabed, but this would not affect natural processes occurring.	Negligible (small scale, localised and ephemeral).
	Harbour landforms	Occupation footprint is distant from Aotea and Kawhia harbours.	No effect
	Harbour processes	Occupation footprint is distant from Aotea and Kawhia harbours.	No effect
Installation of Coastal marine structures	Open coast landforms	Temporary disturbance to local sand dunes and beach during construction. To be mitigated by undertaking works during low energy days at low tide. The temporarily excavated sediment would need to be replaced and planted with suitable dune vegetation.	Negligible (small scale, localised and temporary) managed by re-instating dunes and beach if disturbed.
	Open coast processes	No expected to alter waves, currents or sediment transport processes during construction.	No effect
	Harbour landforms	Construction footprint is distant from Aotea and Kawhia harbours.	No effect
	Harbour processes	Occupation footprint is distant from Aotea and Kawhia harbours.	No effect

5 Summary

The overall effect of TIL's application on coastal processes and landforms is negligible due to the small magnitude of deposition related to discharge activities and low impact footprint of the coastal marine structures. The natural coastal environment is dynamic, high energy and turbid making it geomorphically insensitive to the volumes of sediment associated with the de-watering plume and storm water discharge.

6 Applicability

This report has been prepared for the exclusive use of our client Taharoa Ironsands Limited, 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.

We understand and agree that our client will submit this report as part of an application under the Fast-track Approvals Act 2024 and that an Expert Panel as the consenting authority will use this report for the purpose of assessing that application. We understand and agree that this report will be used by the Expert Panel in undertaking its regulatory functions.

Compliance with the Environment Court Practice Note 2023

I confirm that, in my capacity as author of this report, I have read and abided by the Environment Court of New Zealand's Code of Conduct for Expert Witnesses contained in the Practice Note 2023.

I am a Senior Coastal Geomorphologist at Tonkin & Taylor Ltd (T+T), where I specialise in modelling and coastal processes. I have worked at T+T since 2019. Prior to joining T+T, I was a Research Fellow at the University of Auckland (2016 – 2018), and a PhD candidate (2012 – 2015).

I have 11 years' experience in coastal modelling, coastal process, and coastal geomorphology, as a researcher and consultant. I am a Member of the New Zealand Coastal Society.

Recent relevant projects and services that I have been involved with include:

(a) Expert witness on coastal processes for the Department of Conservation regarding three sand extraction applications that were heard in the Environment Court in 2023;

(b) Lead author on a coastal process effects assessment for a resource consent application for a new Interislander ferry terminal at Kaiwharawhara in Wellington Harbour;

(c) Lead author on a surf break risk assessment for Eastland Port for a resource consent application for capital maintenance dredging of a port entrance channel; and

(d) Technical reviewer for a coastal process effects assessment for Northport's port expansion.

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