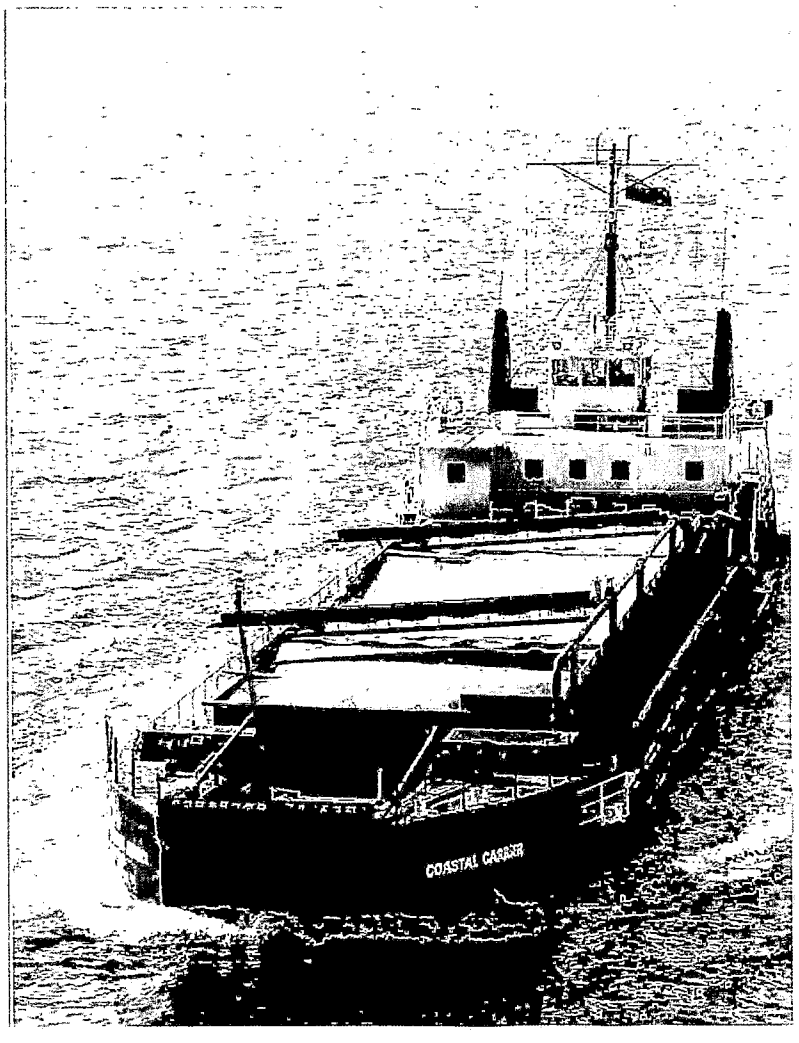
Auckland Offshore Sand Extraction Site - Review of Coastal Processes Effects

Prepared for Kaipara Ltd
Prepared by Beca Limited

15 July 2019



Contents

Appendices

Revision History

Revision N°	Prepared By	Description	Date
A	**Ian Goss**	Draft for Discussion	20 March 2019
B	**Ian Goss**	Draft Issue	15 May 2019
B	**Ian Goss**	Final Draft	11 July 2019
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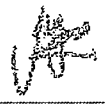
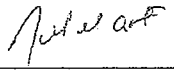
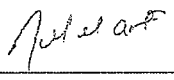
Document Acceptance

Action	Name	Signed	Date
Prepared by	**Ian Goss**		11 July 2019
Reviewed by	**Jennifer Hart**		14 July 2019
Approved by			15 July 2019
on behalf of	Beca Limited		

Executive Summary

This report provides a review of the monitored effects of offshore sand extraction undertaken by Kaipara Limited (Kaipara) from the Auckland Offshore Sand Extraction Site, offshore of the Mangawhai-Pakiri Embayment. The extraction operation is carried out under Auckland Regional Council Consent Permit No 20795 (RCAN 0621). The current consent was issued in 2003 for a period of 20 years, and Kaipara wishes to apply for renewal of the consent to extract from a much reduced area confined to 25 to 40 m water depth.

Sand extraction from this depth range has been accepted as seaward of the 25 m Depth of Closure beyond which by definition effective interchange of seabed sediments between nearshore beach processes and the inner continental shelf is minimal. This means that extraction of sand from this offshore site is effectively independent of the nearshore processes.

Review and comparison of the monitoring work undertaken over the consent period in terms of the consent requirements concludes that the effects of extraction of approximately 1,500,000 m^3 from the monitored areas between 2003 and 2019 are not significant based on the information provided:

- Surveys indicate, subject to the levels of accuracy inherent in the survey process, bathymetric changes indicated on comparison of profiles over time show maximum change in the order of 0.5 m in localised areas of recent extraction and the indicative contours of bed change between surveys suggest that effects of extraction will be well distributed.
- Bedforms and grain size distributions have been shown to vary over time but monitoring of undisturbed control areas shows that changes have been consistent over both extraction and control areas i.e. changes appear to be due to natural processes and rather than the extraction process.

The above is consistent with the findings of studies and expert witness evidence between the mid-1990s and 2005 including:

- Establishment of the Depth of Closure at 25 m depth
- Suggestion of limited sediment transport processes and sediment budget inputs seaward of this depth
- No identified evidence of effects of nearshore sand extraction

The proposed area defined for ongoing extraction has been selected to ensure material is only recovered from beyond the accepted Depth of Closure, and a significantly more detailed and refined management and monitoring approach is proposed (as set out in the draft Environmental Monitoring Management Plan included with the consent application) to allow an adaptive approach to mitigate short term effects on the environment. On the basis of these effects and findings, combined with this mitigation and monitoring, it is concluded that continued extraction of sand from seaward of the 25 m depth contour will provide a regional resource that does not appear likely to result in significant effect on coastal processes.

1 Introduction

1.1 Scope of Report

Kaipara Limited (Kaipara) presently holds resource consent to remove up to 2,000,000 m^3 of sand over a 20 year period from an extraction area located offshore in the Outer Hauraki Gulf. The consented zone covers an area totalling 636 km^2. Kaipara has been operating the current consent since February 2003. The consent provides for an extraction rate of 150,000m^3/year from between the western boundary of the zone and the 30 metre isobath. The consent also provides for the extraction of additional volumes of sand to be extracted in any one year provided the sand is taken from beyond the 30 metre isobath and does not exceed the 2,000,000m^3 total permitted volume. To allow practical monitoring of effects, sand extraction carried out under this consent has been confined to two designated deepwater areas off the Mangawhai-Pakiri coast with a combined total area of 21 km^2.

The reference to deepwater or offshore extraction distinguishes the extraction area as being in water deeper than 25 m, which is seaward of the Depth of Closure under most conditions at this location. Depth of Closure is an indicator of the outer extent of significant seabed sediment movement beyond which there is limited sediment interchange between the nearshore beach processes and the inner continental shelf. In other words, extraction from seaward of the 25 m depth as undertaken under this consent is effectively independent of the nearshore processes i.e. by definition it will not significantly affect nearshore and beach processes. More detailed definition of this boundary and the establishment of its site-specific location in the Mangawhai-Pakiri embayment is provided in Section 2.1.4.

Kaipara wishes to renew the existing consent for a much reduced portion of the existing consented zone for a further period of 20-years that provides for the continuation of offshore sand extraction under the same overall terms and conditions as the existing resource consent. Kaipara has engaged Beca Ltd (Beca) to provide technical coastal engineering assistance to prepare a review of the sand extraction and monitoring carried out to date under the existing consent and of previous studies to support the preparation of a resource consent application. This report is intended to be read in combination with Bioresearches' ecological report, which includes information on seabed sediment and bedforms.

1.2 Limitations

This report is based on a desktop study of information provided to Beca by Kaipara, and sourced by Beca from NIWA, Auckland Council and on-line literature searches. The context and conclusions of this report are dependent on this information and Beca accepts no responsibility for the accuracy or completeness of the information reviewed. This approach was accepted by Auckland Council at pre-lodgement discussions with Kaipara in 2018.

Scientific interpretation of the coastal marine environment of the Mangawhai-Pakiri embayment is the subject of a large body of investigation and research work accumulated over many years, including specific studies undertaken in relation to the formalisation of the current extraction regime and consents, and expert and judicial opinion presented in the appeals proceedings for the inshore extraction consents. This report is not intended to supplant any of this material, but to provide a summary of conclusions presented to date, and context regarding the offshore extraction consent application.

1.3 Resource Consent Sought

Kaipara currently holds a resource consent for the extraction of 150,000 m³/year of sand between the western boundary of the consented zone and the 30 m isobath and additional annual volume is available beyond the 30 m isobath if required. The sand is used as a key ingredient by the Auckland construction industry, particularly in the manufacture of concrete. The current resource consent will expire in 2023 and Kaipara intends to replace this with a new resource consent for the extraction of sand under the same terms and conditions as the existing consent. Kaipara has successfully operated the consent for the past 16 years. The new consent will be confined to a much reduced area tailored to provide adequate area to extract this volume with limited predicted effect on the resource and the environment, while effectively managing and monitoring the extraction site in the process. Kaipara proposes to continue extracting sand at depths between 25m and 40m using conventional suction dredging equipment and a self-propelled vessel.

The proposed extents of the offshore extraction site are outlined in **Figure 1** below. Boundaries have been established on the basis of providing access to recover material from between the 25 and 40 m depth contours.

Co-ordinates for the vertices of the proposed area and presented in both New Zealand Transverse Mercator Projection (m) and World Geodetic System 1984 (G1762) (Degrees and decimal degrees) format are:

Point	NZTM Projection		WGS84 Projection	
	Easting (m)	Northing (m)	Latitude (D.D)	Longitude (D.D)
1	1758084.670	5990925.300	-36.21360013	174.75868134
2	1756328.790	5989464.690	-36.22704777	174.73944691
3	1751721.200	5994126.250	-36.18577335	174.68729716
4	1748945.940	5998824.360	-36.14386535	174.65555434
5	1747812.500	6000863.220	-36.12566455	174.64257762
6	1746958.060	6002961.330	-36.10688598	174.63269451
7	1748380.440	6004086.890	-36.09652603	174.64827925

Drawing Plotted: 16 Jul 2019 1:40 p.m.

NORTHLAND REGION

AUCKLAND REGION

COUNCIL AREA BOUNDARY

PROPOSED EXTRACTION CONSENT AREA BASED ON WATER DEPTH 25m - 40m

COORDINATES		
	LATITUDE WGS84_DD	LONGITUDE WGS84_DD
1	-36.21360013	174.75868134
2	-36.22704777	174.73944691
3	-36.18577335	174.68729716
4	-36.14386535	174.65555434
5	-36.12566455	174.64257762
6	-36.10688598	174.63269451
7	-36.09652603	174.64827925

LEGEND	
	PROPOSED BOUNDARY

NOTES:

1. DRAWING BASE PLAN TAKEN FROM AUCKLAND COUNCIL WEBSITE, UNITARY PLAN (OPERATIVE 15 NOV 2016) MAP
2. LOCATIONS AND DISTANCE ARE APPROXIMATE ONLY
3. CABLE PROTECTION AREA IS APPROXIMATELY 15KM EAST OF PROPOSED EXTRACTION POINT 1.
4. THIS WORK IS BASED ON/INCLUDES LINZ'S DATA WHICH ARE LICENSED BY LAND INFORMATION NEW ZEALAND (LINZ) FOR RE-USE UNDER THE CREATIVE COMMONS ATTRIBUTION 4.0 INTERNATIONALLICENCE.

LEGEND

- OUTSTANDING NATURAL LANDSCAPES OVERLAY
- SIGNIFICANT ECOLOGICAL AREAS OVERLAY (MARINE 1)
- SIGNIFICANT ECOLOGICAL AREAS OVERLAY (MARINE 2)

Sentinel Rock

Fl.5s16m4M

Te Arai Point

Red Hill

Pakiri

Cape Rodney

Mu(4)20s53m8M

Marine Reserve (see Note)

Sandhills 40 - 50m high (continuous)

TRUE NORTH

19°05'E 2014 (0'E)

NZ 5219

NZ 5227

JELLICOE CHANNEL

ODAS

FIGURE 1 - PROPOSED EXTENTS OF NEW OFFSHORE EXTRACTION SITE

1:100,000 (A3) 0 2km 4km 6km

FOR INFORMATION
NOT FOR CONSTRUCTION

No.	Revision	By	Chk	Appd	Date
A	FOR INFORMATION	RS	IG	JH	

Drawing Originator: Beca

Original Scale (A1) 1:50,000	Design	IG	07.19	Approved For Construction*
Reduced Scale (A3) 1:100,000	Drawn	RS	07.19	
	Dsg Verifier			
	Dwg Check	JH		Date

* Refer to Revision 1 for Original Signature

Client: KAIPARA LTD

Project: AUCKLAND OFFSHORE SAND EXTRACTION SITE

Title: PROPOSED EXTRACTION CONSENT AREA

Discipline: CIVIL ENGINEERING

Drawing No.: 3233103-CA-010

Rev.: A

DO NOT SCALE

IF IN DOUBT ASK.

Document No.: 3233103-CA-010.DWG

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1.4 Previous Investigations

1.4.1 Studies

Over the past 3 decades, several studies have been carried out in relation to the Mangawhai-Pakiri Embayment. The focus of investigation for these studies has been the assessment of sustainable sand extraction quantities and rates from the nearshore (less than 25 m depth), although many of them provide descriptions and characteristics of the offshore area between the 25 and 40 m depth contours which is the area covered by the Kaipara consent. A number of these have been reviewed as outlined below:

- Process of sedimentation on the shoreface and continental shelf and the development of facies, Pakiri, New Zealand (Unpublished Doctoral Thesis of M.J. Hilton)(1990).
- Sediment facies of an embayed coastal sand body, Pakiri, New Zealand (1995).
- Determining the limits of beach-nearshore sand systems and the impact of offshore coastal sand mining (1996).
- Mangawhai-Pakiri Sand Study Modules 1- 4 and 6 (1996 – 1999). This study was commissioned to investigate and report on the overall extent of the Managwhai-Pakiri sand resource out to the 40 m isobath, and the sustainable level of nearshore (less than 25 m depth) extraction of sand from the Managwhai-Pakiri embayment. The project team, headed by NIWA, comprised Auckland UniServices Ltd (Department of Geography, University of Auckland), MarineGeosciences Group (Department of Earth Sciences, The University of Waikato), and the Victorian Institute of Marine Sciences (VIMS, Melbourne). The findings of this study have been assumed as the basis of scientific knowledge of the embayment.
- Sediment facies and pathways of sand transport about a large deep-water headland, Cape Rodney, New Zealand (2000).
- Sidescan Sonar Mapping of Surficial Sea Floor Sediments in the Outer Hauraki Gulf – Thesis for MSc – Bronwen Beth Riddle (2000). The work undertaken for this thesis was specifically related to the identification of seabed types and potential bed movement indicators in the offshore areas under the supervision of Professor Healy.
- Sand volume change and cross-shore sand transfer, Mangawhai Beach, New Zealand (2002).
- Application for Renewal of Coastal Permits to Extract Sand Offshore at Mangawhai-Pakiri: Assessment of Environmental Effects (2003) including clarification and interpretation of the Sand Study findings by Professor Terry Healy. Professor Healy was involved in the investigations and reporting for the Sand Study, and his input to the AEE referred specifically to the effects of sand extraction from the offshore (beyond 25 m depth) area relevant to the Kaipara consents.
- NIWA 2004 Report Pakiri Interpretation (2004).
- Environment Court Decision No A066/2006 March 2006 related to inshore extraction consents which traversed the earlier investigations and findings related to the overall Mangawhai-Pakiri sand resource as well as expert evidence presented in relation to that application. The Court confirmed the Depth of Closure as 25 m, and established the sand budget for the embayment as a whole.

1.4.2 Surveys

- Beach Profiles

In 1978, following a severe storm that affected the shoreline, a series of beach profiling sites were established by Auckland Regional Water Board along the Mangawhai - Pakiri embayment to monitor the recovery of the beach. The initial 6 monitoring sites were established in 1978 and have been surveyed most frequently. A number of other survey lines have subsequently been established. A total of 13 shore perpendicular inshore survey lines have been established between 1978 and 2016 to investigate the changes in the cross-shore profile of the beach and nearshore. The time span of profile

surveys varies from site to site. These profile surveys have been focussed on the nearshore changes, and are not expected to be affected by sand extraction from beyond the Closure Depth.

- Seabed Surveys

Since 1962 several hydrographic surveys of the embayment have been carried out by a variety of organisations. Between 1962 and 1964 the Royal New Zealand Navy conducted intensive hydrographic surveys of the embayment. A further survey of 8 shore normal profiles (along the same alignment as some of the beach profiles) was carried out in 1978 to depths of 45m. These 8 surveys were repeated in 1990 with a number of additional profiles added. Further surveys of the seabed were carried out in 1995 as part of a seismic survey. NIWA completed a number of other surveys along the embayment between 1995 and 1997.

Since the granting of resource consent to commercial sand extractors in 2003 and 2006, further more regular bathymetric surveys and cross shore profile surveys have been carried out. Kaipara is required to complete a survey of their offshore extraction areas at intervals aligned with the extraction of 500,000 m^3 of sand. The 500,000m^3 and 1,000,000 m^3 Kaipara survey reports, surveys of adjacent land and inshore areas, and further 2018 Kaipara survey data completed in anticipation of further consent application and as the total volume extracted from the offshore area approaches 1,500,000 m^3, have been reviewed.

2 Existing Environment

The following brief description of the existing environment is compiled from the studies and surveys listed in Section 1.4.

The Mangawhai-Pakiri embayment is a sandy, semi-exposed beach system on the East Coast, backed by an extensive dune complex extending 350 to 1200m inshore of the active beach and 40 to 50m high. The seaward extent of the active sediment movement processes, and the source and transport rates of the sand supply to this system have been traversed in some detail through extensive scientific study and evidence submitted for consent hearings. While there was no definitive consensus on these matters, the Depth of Closure, or general outer limit of sediment movement between the continental shelf and the nearshore beach system under all but extreme sea conditions was established as 25m depth below mean sea level (MSL).

In granting the current inshore extraction consents (from 5 to 10m depth) the Environment Court traversed a significant amount of expert evidence presented on behalf of both the inshore and offshore consent applicants and objectors and accepted that the Depth of Closure is 25 m, and concluded that there was a total input of sediment to the nearshore system of the Mangawhai-Pakiri embayment as a whole of 150,000 m^3 per year, with the total sand resource estimated at 1.7 to 3.0 billion m^3.

2.1 Morphology and Geomorphology Context of the Mangawhai-Pakiri Embayment

The Mangawhai-Pakiri Sand Study identified that in periods of moderate to high wave activity there are very large amounts of sand mobilised and in re-circulation in the embayment during storms. Module 3 of the Sand Study looked at the morphodynamics of the sediment body within the embayment with the key points outlined below.

2.1.1 General Geomorphology

The Mangawhai-Pakiri embayment morphologic components include inland dunes, foredunes, foreshore, surf zone, nearshore, inner shoreface, inner continental shelf and middle continental shelf. These are as illustrated in Figure 2 below.

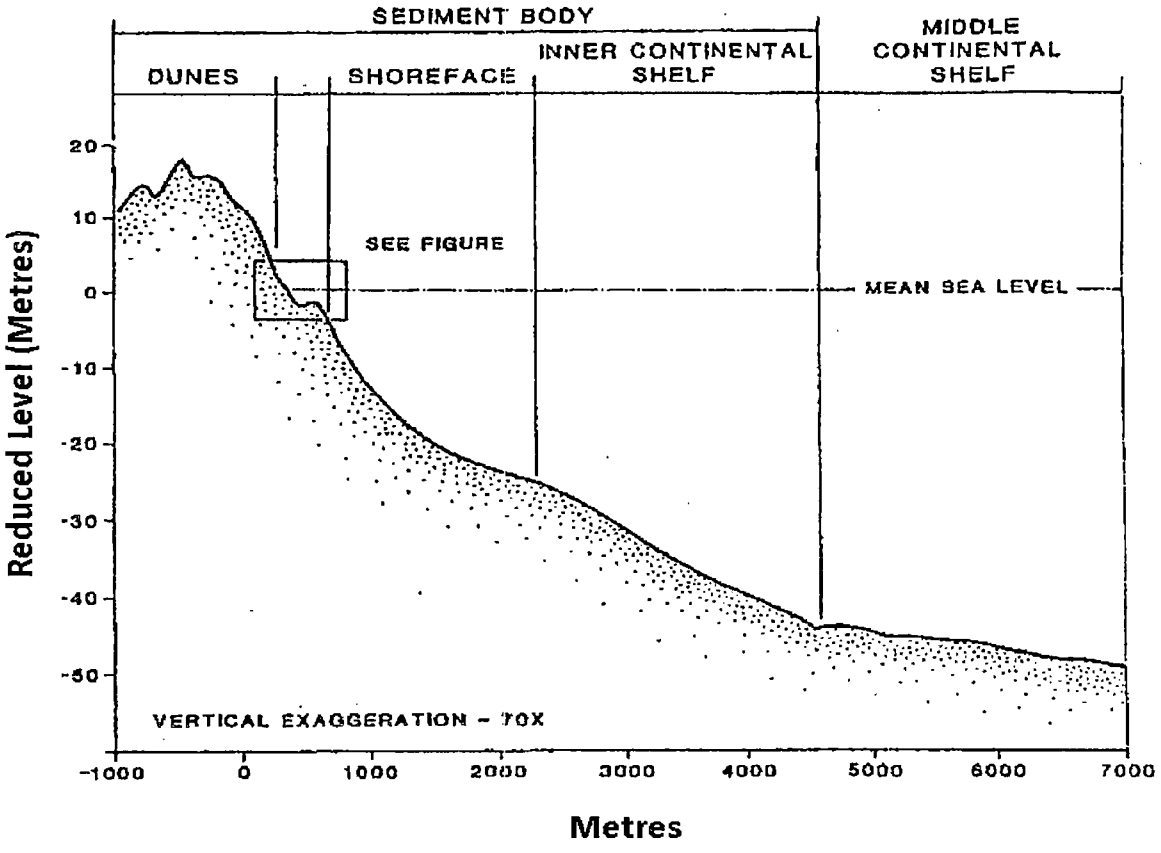


Figure 2 - Morphological components of the Mangawhai-Pakiri Embayment (Hilton, 1990, p.9)

The sand body in the embayment is generally a wedge of sediment comprising the dunes, beach and seabed sands extending seaward to approximately 40m depth contour. This wedge comprises of recent or modern (Holocene) sands that overlie older iron-stained consolidated Pleistocene sands that are similar in texture to the Holocene sand body. The Sand Study considers that the band of sediment that lies on the inner shelf in 25 – 40 m water depth is now largely disconnected from the beach in terms of sediment transfer. This material comprises coarser sediments that are residual lag resulting from the winnowing and shoreward transport of finer material over centuries to supply the beach with sand. The Sand Study indicated that the wedge of Holocene sand is in the order of 1.0 m thick at the 25 m depth contour, and tapers out to the 40 m depth contour. The wedge is underlain by older sands of similar texture but red stained.

The driving forces for sediment transport processes comprise wind as an important force in the construction of the dunes, whereas waves and associated turbulence and currents, and tidal currents are the dominant forces causing erosion or accretion of the beach and foreshore.

2.1.2 Coastal Dunes

There is a huge volume of Holocene sand (estimated between 92 and 552 million m^3) stored in the inland dune field as a cap over older Pleistocene sediments. Much of the surface of the dunes is

covered in pine forest and farmland, effectively locking away the sediment from the present day sediment budget. The foredunes south of Te Arai Point have pro-graded over the last 6000 years by between 150 to 200m. Sand losses from the beach into the foredunes is estimated to be in the region of 27,000m^3 per year.

2.1.3 Beach foreshore and inshore

Beaches at Mangawhai-Pakari embayment are most frequently of the 'intermediate' type and therefore would be expected to have the following traits:

- Have a flat to concave cross shore profile
- Change in appearance under different wave conditions
- Exhibit considerable exchange of sand between beach and any nearshore bar system for considerable distances along the length of the beach
- Store 40% of the sand in the foreshore (dunes to low-water), 40% in the surf zone and 20% in nearshore bars.

Each of these characteristics relates to areas inshore of the offshore extraction consent boundaries, and the implication from the above definitions is that the scale of potential seabed changes there is secondary to that of the bar and foreshore system.

2.1.4 Shoreface and the continental shelf

The shoreface, inner and middle continental shelves are zones where different combinations of processes occur. The issue of possible volumes and rates of exchange of sand between the beach, shoreface and inner shelf is difficult to quantify. For sandy coastlines such as the Mangawhai-Pakiri embayment, research on identification of the outer boundary of nearshore sediment exchange between inner shelf and nearshore environments seabed has provided methods for establishing the *Depth of Closure which is defined "for a given or characteristic time interval is the most landward depth seaward of which there is no significant change in bottom elevation and no significant net sediment transport between the nearshore and the offshore." (Krauss et al 1998).*

Specific investigation of the extent of the limits of the beach-nearshore sand systems in relation to the impact of offshore sand mining was carried out by Hilton and Hesp (1996) with specific reference to Pakiri-Mangawhai. Detailed investigation of bedforms, sub-tidal facies, historic morphodynamics and theoretical estimates indicate that the nearshore-inner shelf boundary approximates the 25 m isobath at Pakiri. The paper notes that "*Sediment exchange between the inner shelf and nearshore environments in the Pakiri region (across the 25 m isobath) is unlikely and almost certainly insignificant over timescales of tens to hundreds of years.*" This being said, the paper also comments "*that sediment disturbance of the inner shelf to water depths of at least 40 m may occur during infrequent storm events.*" These conditions allow the sorting and redistribution of seabed sediments in this area without necessarily mobilising mass transport processes.

In accordance with these definitions the offshore extraction consents (current and applied for) considered by Kaipara are confined to the inner continental shelf as illustrated in Figure 2, and seaward of the Depth of Closure.

2.1.5 Headlands

Investigations of the headlands to the north and south of the embayment by the NIWA Sand Study identified coarse sediments and shell hash which would indicate little by-passing of sediment. It was proposed in the NIWA Sand Study that sand appears to be leaking from the southern end of the embayment where eddies transport small amounts of sediment into the deep water of the Jellicoe Channel. There is also potential for a small amount of sand by-pass to the north, contributing to the

Bream Bay sand system. A subsequent study (Hume, Oldman and Black, 2000) to identify and quantify such changes was inconclusive but suggests that there may be a small loss.

2.1.6 Sediment Texture and Mineralogy

Sands in the embayment are generally quartzo-feldspathic with carbonate, as a fine shell material, making up approximately 10% of the total sediment. The mineral component is identified to have been supplied by the Waikato River when it discharged at Thames and supplied sediment to the East Coast.

In the embayment, sand is of good quality for engineering purposes in terms of grading, mineral characteristics, and limited fines content with generally less than 1% of silt size or smaller. The median grain size in the inshore bar and beach zones is in the order of 0.25 mm, and becomes coarser with depth to be in the range of 0.3 to 0.8 mm in the 25 to 40 m depth range which is the zone covered by the offshore extraction site. The grain size variations and gradings are the result of sorting by the transportation processes, and are shown by the monitoring work to vary seasonally.

2.1.7 Inlet and stream mouths

Inlet and stream mouths interrupt the coastal sediment transport by trapping sand both temporarily and permanently. This is a nearshore process, independent of the offshore consent areas.

2.2 Wave Climate

For the Sand Study, wave climate was recorded by a wave buoy deployment for 17 months with results showing significant wave height ranged from 0.1 to 5.3 m with a mean value over the period of 0.71 m. Significant wave period values ranged from 3 to 11 seconds. Hindcast records for extraction Area 1 were generated by MetOcean as part of the 2011 monitoring review, and showed values for mean significant wave height H_s of 1.08 m, and approximate values for H_{s90} of 2.0 m and H_{s99} of 3.75 m.

The wave climate information established is relevant to and has been applied in relation to the site specific assessment of Depth of Closure as part of the Sand Study.

2.3 Current Velocities

Currents in the Mangawhai-Pakiri embayment are generated by two separate means, both periodic tides and non-tidal forces. Non-tidal forces are generated by a complex combination of components including winds, coastally-trapped long waves, seiches, wave setup in the surf zone, vertical density variations and upwelling oceanic intrusions. As part of the Mangawhai-Pakiri Sand Study Module 4, a study of currents was carried out over a sufficiently long period to quantify the magnitude and frequency of current speeds and directions and establish causal forcing mechanisms which generate the measured currents.

The study identified that the mean sea currents are relatively low, at less than 22cm/s for 90% of the time, rising above this only during storm events. This is particularly noticeable in the nearshore zone. The near bed current measurements at 15m depth show the current speeds close to the seabed are generally low and less than 10cm/s. This low current velocity means that there is insufficient energy to entrain sediment from the seabed in the absence of wave forces.

In contrast, the wave orbital velocities in 15m depth of water range from 5 – 40cm/s during non-stormy days. This increases to between 40 – 70cm/s during storm events. The contrast is even greater further inshore where orbital velocities reached up to 120cm/s during severe storms.

The wave induced current velocities identified in the nearshore zone have a significant impact on the mobilisation of sediment and, hence, the variability on the cross-shore profiles of the beach and nearshore. During periods of prolonged calm weather, it would be expected that accretion would be

observed, and any offshore bars would tend to migrate towards the beach. Conversely, during periods of prolonged storms, the beach would be observed to erode with bars migrating offshore.

The wave induced currents in deeper waters at seabed level are relatively low and during normal sea state conditions do not surpass the threshold velocities to mobilise the predominantly coarse grained sands at these locations. The sediments at these locations are only moved by the largest storms. This situation applies in the areas covered by the offshore extraction consent which is confined to depths in excess of 25 m.

2.4 Other Sediment Transport Considerations

2.4.1 Cross shore profile and bathymetric analysis

The comparison of bathymetric surveys of offshore consent areas beyond the closure depth seaward of Pakiri Beach carried out as part of the Kaipara consent requirements in 2003, 2011, 2015, and 2018, do not show significant variability in the seabed levels outside the immediate extraction area as a direct result of offshore sand extraction, noting the comments in section 2.5.1. This is also consistent with a review of beach and nearshore profiles from 2007 through to 2013, which indicate considerable variability in the profiles. The monitoring data and subsequent analysis presented for these inshore areas does not show any discernible effects on the sediment system as a result of the offshore sediment extraction. The fluctuations in the beach profiles are suggested as representative of normal winter-summer sediment movement processes and variability.

2.4.2 Sediment Budget

Sediment budgets are a coastal management tool used to analyse and describe the different sediment inputs (sources) and outputs (sinks) on coastal compartments. They can be used to identify areas of overall sediment accumulation or deficit provided the individual components can be quantified adequately, and in turn to predict potential morphological change in coastal compartment over time. The Mangawhai-Pakiri Sand Study presents a diagrammatic representation of the contributory components to the overall sediment budget for the embayment which is included as Figure 3 below.

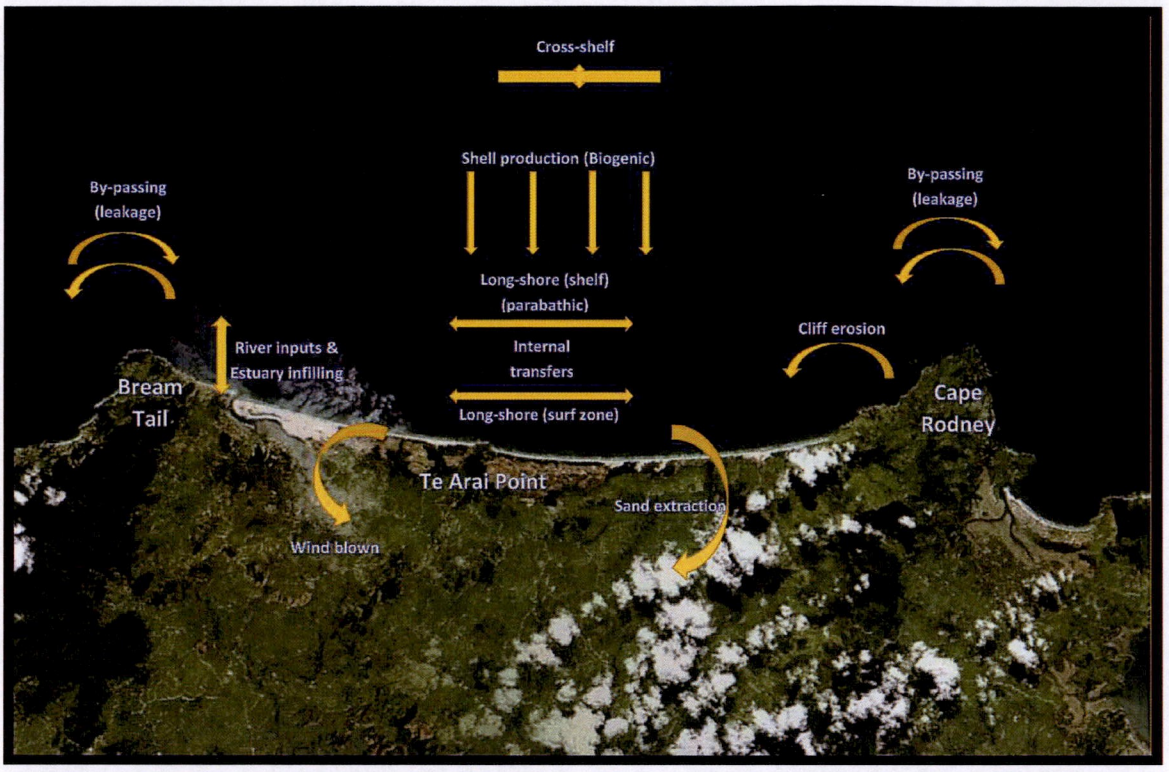


Figure 3 - Diagrammatic representation of the Mangawhai-Pakiri embayment sediment budget (adapted from Mangawhai-Pakiri Sand Study Module 6, p.58)

a. Budget Inputs and Outputs

As outlined in sections 2.1-2.4 and Figure 3 above, there are a number of inputs to and outputs from the overall sediment budget at Mangawhai-Pakiri embayment. These include:

Inputs

- Long-shore transport into the area
- River sediment inputs
- Sea cliff erosion from Bream Tail and Cape Rodney
- Onshore cross-shelf transport
- In-situ shell (biogenic) production
- Wind transportation onto the beach from the dunes

Outputs

- Estuary infilling
- Long-shore transport out of the area
- Offshore transport
- Wind transport away from the beach
- Deposition in canyons
- Solution and abrasion
- Sand extraction

Extensive research into the rates of sediment transport has been carried out in the past as part of the Mangawhai-Pakiri Sand Study and the results of these studies have provided approximate and variable quantities of sediment input and output to the system from the above sources. Expert evidence presented at consent hearings for the nearshore extraction consents (Barnett 2005) proposed different values for several of the budget components. Comparison of the estimated inputs to and outputs from the system are summarised in **Table 1** below illustrating the variability and range of values:

Table 1 - Estimated annual sediment budget inputs and outputs

Source	Quantity Based on Mangawhai-Pakiri Sand Study (1999) updated with current consented extraction	Quantity Based on Barnett Evidence (2005) updated with current consented extraction
Long-shore transport into/out of the area	loss of 2000 m^3 /year	Credit of >100,000m^3 /year from north
River inputs	credit of 2000m^3 /year	Credit of 10,000m^3 – 20,000m^3/year from Pakiri Stream only
Estuary infilling	loss of 3000m^3 /year	Irrelevant
Windblown transport into/out of the area	loss of 2000m^3 /year	Loss of 2000m^3 /year
Cliff erosion	credit of 6000m^3 /year	Credit of 5700m^3 /year
Cross shelf transport into/out of the area	credit of between 200m^3 and 64,000m^3 /year (12,000 best est)	Not considered
Sand extraction	loss of between 81,000m^3 and 226,000m^3 /year	Loss of between 81,000m^3 and 226,000m^3 /year
Biogenic production	Accounted for in Cross Shelf transport	Credit of 90,000m^3 /year

Based on the above figures from the Sand Study, there is a net annual deficit of sediment within the overall system. Based on the Barnett evidence provided to the inshore consent proceedings, there is either a net loss or credit to the system of between 25,300m^3 and 129,700m^3 per year. The largest single source of variability in the sediment budget is the rate of biogenic sand production. Further assessment of the rate of biogenic sand productions is required to establish the magnitude of this contribution, but there is clearly significant variability in the sediment budgets presented. The High Court Judgement (The Friends of Pakiri Beach v Auckland Regional Council CIV-2006-404-3544 [26 March 2009]) on the appeal against the continued nearshore extraction confirmed the earlier Environment Court decision that shell contribution to the system growth through biogenic sand production occurs within the 25 m closure depth and is thus confined within the nearshore system.

Another potentially large sediment transport component within the system is the by-passing of sediment around the headlands to the north and south of the embayment. While the Sand Study indicated minor overall losses to the system through this mechanism, the Barnett evidence suggests otherwise. With two conflicting opinions of the effects of headland by-passing on the sediment budget, this is an aspect that has not been determined. The Barnett evidence was preferred by the court.

b. Relevance of Sediment Budget to the Offshore Extraction Zone

The location of the offshore consent zone has been confined to water deeper than 25 m which is beyond the Depth of Closure, or the depth that interaction and transfer of bed material between the beach and nearshore system shore-wards and the shelf system seawards is unlikely to occur under ambient wave conditions. The significance of this is that the existing offshore extraction zone is more stable and directly exposed only to the cross shelf transport component and potentially to a degree of the biogenic production component of the sand budget as listed in Table 1 above. The predicted rates of cross shelf transport are minimal in the context of the sediment budget of the whole embayment

3 Sand Extraction

3.1 Total Extraction from the Mangawhai-Pakiri Embayment

3.1.1 Historical Extraction

Sand extracted from the Mangawhai–Pakiri embayment has long been a source of material for construction in the Auckland/Northland region as there are few fluvial sediment sources in the area. The total volume of sediment extracted from the Mangawhai–Pakiri embayment to date is unknown as there is little record of volumes prior to 1966.

An overview of historical extraction volumes between 1966 and 2019 is outlined in Table A.1 in Appendix A. The volumes in Appendix A are based on a number of sources including the Mangawhai-Pakiri Sand Study Modules 3 & 6, the July 2003 application for renewal of coastal permits H8209 and H8230 and the February 2014 Pakiri beach monitoring report, as well as the current consent monitoring records.

3.1.2 Average for Last 5 Years

Over the last 5 years, the total exact rate of extraction from the Mangawhai-Pakiri embayment is unknown as figures for the inshore areas are yet to be made available. Kaipara has averaged approximately 135,000m^3 of sand extraction per year from beyond the 25 m water depth. This is within the annual limit of 150,000 m^3 imposed by the offshore resource consent.

3.1.3 Total Quantities Extracted Since 1966

Since records started in 1966, data suggests there has been approximately 4,400,000m^3 of sand extracted from the embayment, excluding historic extraction from the dune system by land-based mining operations.

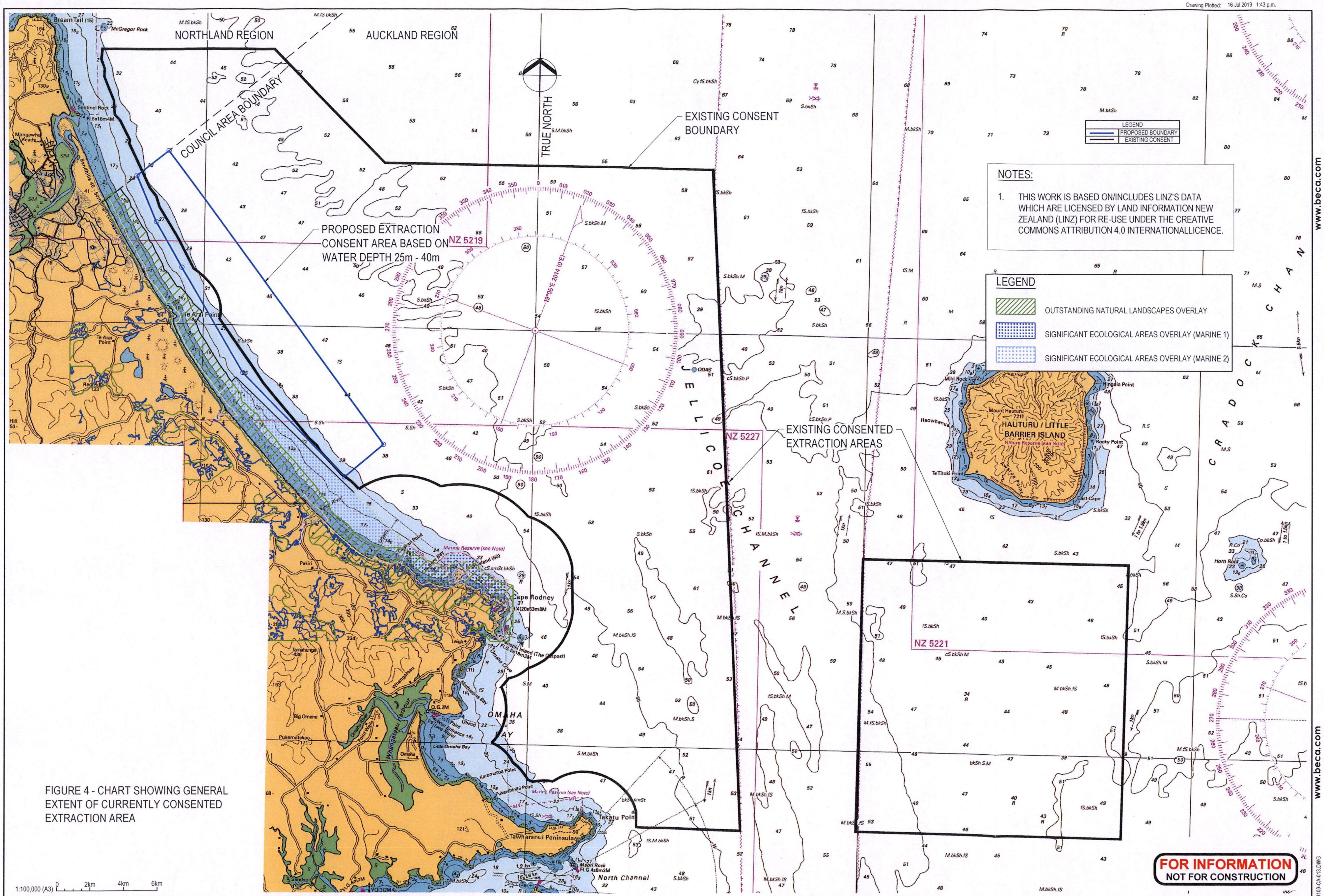
3.2 Offshore Sand Extraction

This section refers specifically to sand extraction from beyond the 25 m depth contour (the Depth of Closure) where the Kaipara consent is defined.

3.2.1 Offshore Extraction Areas

Kaipara operates the offshore extraction operation under Auckland Regional Council Consent Permit No 20795 (RCAN 0621) to undertake this restricted coastal activity granted by the Minister of Conservation on 13 February 2003. The full extents of the combined extraction areas identified in the consent comprises some 636 km^2 as shown in Figure 4 below.

Drawing Plotted: 16 Jul 2019 1:43 p.m.



NORTHLAND REGION
AUCKLAND REGION
COUNCIL AREA BOUNDARY
TRUE NORTH
EXISTING CONSENT BOUNDARY
PROPOSED EXTRACTION CONSENT AREA BASED ON WATER DEPTH 25m - 40m
NZ 5219
NZ 5227
NZ 5221
EXISTING CONSENTED EXTRACTION AREAS
JELLICOE CHANNEL
CRADOCK CHANNEL
HAUTURU / LITTLE BARRIER ISLAND
Cape Rodney
OMAHA BAY
Tawharanui Peninsula
North Channel
LEGEND
PROPOSED BOUNDARY
EXISTING CONSENT
NOTES:
1. THIS WORK IS BASED ON/INCLUDES LINZ'S DATA WHICH ARE LICENSED BY LAND INFORMATION NEW ZEALAND (LINZ) FOR RE-USE UNDER THE CREATIVE COMMONS ATTRIBUTION 4.0 INTERNATIONALLICENCE.
LEGEND
OUTSTANDING NATURAL LANDSCAPES OVERLAY
SIGNIFICANT ECOLOGICAL AREAS OVERLAY (MARINE 1)
SIGNIFICANT ECOLOGICAL AREAS OVERLAY (MARINE 2)
1:100,000 (A3) 0 2km 4km 6km
FOR INFORMATION
NOT FOR CONSTRUCTION

FIGURE 4 - CHART SHOWING GENERAL EXTENT OF CURRENTLY CONSENTED EXTRACTION AREA

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No.	Revision	By	Chk	Appd	Date
A	FOR INFORMATION	RS	IG	JH	

Drawing Originator: Beca

Original Scale (A1) 1:75,000 — Reduced Scale (A3) 1:150,000

Design: IG 07.19 — Drawn: RS 07.09 — Dsg Verifier — Dwg Check: JH — Approved For Construction* — Date

* Refer to Revision 1 for Original Signature

Client: KAIPARA LTD

Project: AUCKLAND OFFSHORE SAND EXTRACTION SITE

Title: EXISTING AND NEW CONSENTED EXTRACTION AREA

Discipline: CIVIL ENGINEERING

Drawing No. 3233103-CA-013 — Rev. A

Document No. 3233103-CA-013.DWG

DO NOT SCALE

IF IN DOUBT ASK.

Drawing Plotted: 16 Jul 2019 1:47 p.m.

NORTHLAND REGION

AUCKLAND REGION

COUNCIL AREA BOUNDARY

PROPOSED NORTHERN CONTROL AREA

CURRENT AREA 2

PROPOSED EXTRACTION CONSENT AREA BASED ON WATER DEPTH 25m - 40m

CURRENT AREA 1

PROPOSED SOUTHERN CONTROL AREA

EXISTING CONTROL AREA

COORDINATES		
	LATITUDE WGS84_DD	LONGITUDE WGS84_DD
1	-36.21360013	174.75868134
2	-36.22704777	174.73944691
3	-36.18577335	174.68729716
4	-36.14386535	174.65555434
5	-36.12566455	174.64257762
6	-36.10688598	174.63269451
7	-36.09652603	174.64827925

LEGEND	
	PROPOSED BOUNDARIES
	EXISTING AREAS

NOTES:

1. DRAWING BASE PLAN TAKEN FROM AUCKLAND COUNCIL WEBSITE, UNITARY PLAN (OPERATIVE 15 NOV 2016) MAP
2. LOCATIONS AND DISTANCE ARE APPROXIMATE ONLY
3. CABLE PROTECTION AREA IS APPROXIMATELY 15KM EAST OF PROPOSED EXTRACTION POINT 1.
4. THIS WORK IS BASED ON/INCLUDES LINZ'S DATA WHICH ARE LICENSED BY LAND INFORMATION NEW ZEALAND (LINZ) FOR RE-USE UNDER THE CREATIVE COMMONS ATTRIBUTION 4.0 INTERNATIONALLICENCE.

LEGEND

- OUTSTANDING NATURAL LANDSCAPES OVERLAY
- SIGNIFICANT ECOLOGICAL AREAS OVERLAY (MARINE 1)
- SIGNIFICANT ECOLOGICAL AREAS OVERLAY (MARINE 2)

FIGURE 5 - NOMINATED EXTRACTION AREAS DEFINED BY KAIPARA UNDER EXISTING OFFSHORE CONSENT, AND PROPOSED FOR NEW CONSENT

1:100,000 (A3) 0 2km 4km 6km

No.	Revision	By	Chk	Appd	Date
A	FOR INFORMATION	RS	IG	JH	

Drawing Originator: Beca

Original Scale (A1)	1:50,000	Design	IG	07.19	Approved For Construction*
Reduced Scale (A3)	1:100,000	Drawn	RS	07.09	
		Dsg Verifier			
		Dwg Check	JH		Date

* Refer to Revision 1 for Original Signature

Client: KAIPARA LTD

Project: AUCKLAND OFFSHORE SAND EXTRACTION SITE

Title: EXISTING AND PROPOSED NEW OPERATING AREAS

Discipline: CIVIL ENGINEERING

Drawing No.: 3233103-CA-012

Rev.: A

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To provide practical limits for establishing pre-extraction baseline and ongoing effects monitoring, two much smaller areas, Areas 1 and 2 totalling 21 km^2 were defined for extraction within the Mangawhai-Pakiri embayment, comprising a strip approximately 1.1 km wide extending from 19.5 km from the Pakiri River in the south to just south of Mangawhai Heads in the north as plotted on the marine chart extract included as Figure 5. Dredging for extraction from the existing offshore consent has been confined to these areas which generally cover a 25 to 40 m depth range.

The proposed boundaries for the new consent are also shown on **Figure 5**, illustrating the much reduced extent applied for, and selected on the basis of being within the 25 to 40 m depth range. This depth range is selected as being beyond the depth of closure, and as such in line with the definition of Depth of Closure practically unlikely to have any significant influence on the nearshore beach system and foreshore processes.

3.2.2 Offshore Extraction Volumes

Annual sand extraction volumes from the existing offshore consent zone, as provided by Kaipara from the commencement of extraction in 2004 to 28 February 2019, are as shown in **Table A.2** of Appendix A. This gives a total of just under 1.5 million m³ extracted over the life of the current consent.

Comparative annual extraction rates over time are plotted in Figure 6 below, noting that the value plotted for 2005 also includes most of 2004 but the data for each year is not individually identified. Clearly the data for 2019 is for part year only.

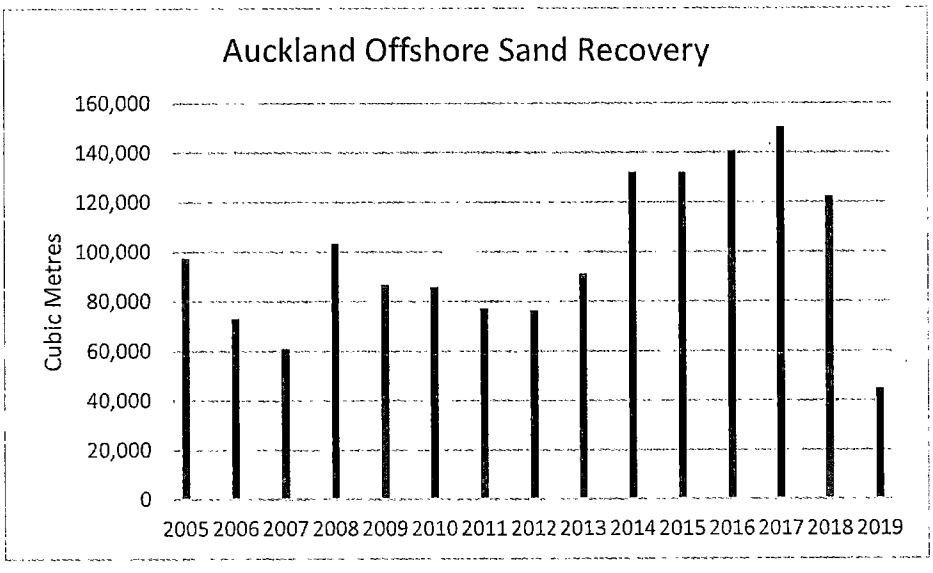

Figure 6 - Annual extraction volumes over existing offshore consent period

3.2.3 Extraction Locations

Dredge tracks from the extraction are recorded on the dredge vessel navigation system using the DGPS system and have been provided by Kaipara. Tracks are saved as a screen plot for each completed day's dredging and stored. Additional data from Marine Traffic confirms this information.

Review of these plots covering the period Feb 2010 to Feb 2019 has been undertaken. This period covers the production of just over 1 million m³ of sand, and is in agreement with the annual extraction records presented above.

The source of sand over this period was predominantly Area 1 with comparatively smaller volumes recovered from Area 2.

Sand extraction locations prior to 2010 have not been provided, but as the Environmental Monitoring Management Plan (EMMP) for Area 2 was not submitted until 2011 it is assumed that sand recovered before that time (approximately 500,000 m³) was solely from Area 1.

On the basis of this assumption the quantities recovered up to 2019 under the offshore consent are approximately 1,450,000 m³ from Area 1 and 75,000 m³ from Area 2.

3.3 Effects of Current Offshore Sand Extraction on Coastal Processes

Monitoring of aspects of the defined extraction zone is required under the existing consent conditions with specific surveys to be carried out following extraction of each 500,000 m³ of sand. In accordance with this process, reports providing comparison with pre-extraction baseline surveys, or with previous

monitoring surveys, have been prepared and submitted in relation to multibeam hydrographic surveys, sediment texture and ecological sampling and interpretation. The following sections summarise the findings and interpretation of the monitoring results.

3.3.1 Bathymetric Comparisons

Bathymetric surveys have been undertaken by different hydrographic survey contractors over the life of the consent, and attempts to provide realistic interpretation of changes over time have been problematic. Sources of error inherent in the survey process are quoted in the survey reports, and are significantly greater than the changes in bed height indicated between surveys. There is also the requirement to apply manual adjustments to raw data to smooth anomalies to provide realistic surface replication. Small errors in the scale of cm in depth change when applied over the approximately 10 km² of identified extraction area (Area 1) result very large volumetric errors in seabed material changes. For this reason, the use of bathymetric survey to provide quantitative comparison for the interpretation of quantities extracted or to imply the magnitude of sediment budget components is considered unrealistic.

Direct comparison of surveyed profiles, and contour difference plots from survey to survey provide an indication of the changes that result from sand extraction. The most recent (2018) survey of Area 1 when compared with the 2011 survey suggests that the removal of 1,000,000 m³ of sand has resulted in small areas of cut to a maximum of about 0.5 m depth and the remainder of the Area showing reasonably evenly distributed cut and fill depths of less than 0.5 m.

The interpretation that can be made on the basis of the information provided is that the extraction of sand is reflected in the progressive overall lowering of the seabed in the specific areas dredged, and that neither the identification nor quantification of the effects of natural sediment transport, either input or loss, can be established from the survey results.

3.3.2 Seabed Characteristics and Sediment Texture Changes

Monitoring of the extraction area has included assessment of seabed characteristics and sediment texture (grain size) information obtained by observation and sampling between 2003 and 2011. These surveys, summarised and compared with the latest round of investigations carried out in 2017, are presented in the 2019 Bioresearches report, Assessment of Ecological Effects . Section 4.1 of the Bioresearches report sets outs the seabed types (fine/medium rippled sand; coarse sand with larger ripples and shell lag deposits) as identified by the 2003 – 2017 monitoring. Results presented have been reviewed by Beca in relation to morphodynamics and coastal processes. This review confirms the conclusions presented in terms of seabed type that these have not changed significantly over the 2003-2017 extraction period.

In relation to sediment characteristics, extensive and repeated sampling and analysis of sediment texture has shown near-surface sediment to have become slightly coarser over the 2003 to 2011 period when 500,000 m³ of sand was extracted, and then slightly finer over the subsequent 2011 to 2017 period when 1,000,000 m³ was extracted (Bioresearches, 2019). These changes in grain size were observed over both extraction and control areas, and were thus not attributed to the effects of extraction, rather to seasonal and annual wave climate variations.

4 Effects of Proposed Extraction on Coastal Processes

4.1 Introduction

Extensive sources of authoritative background information and monitoring reports prepared in relation to the existing consent have been reviewed to establish an understanding of the effects of sand extraction under Kaipara's current existing offshore extraction consent. The following sections set out an assessment of the likely effects of the proposed future sand extraction for the period 2020 to 2040 on the relevant components of coastal processes.

4.2 Bathymetric Changes

Assessments of the Depth of Closure for the Mangawhai-Pakiri embayment using both specific observation of physical characteristics, and theoretical methods based on wave climate and sediment grainsize, identify an offshore limit of exchange between inner shelf and nearshore of 25 m water depth. The significance of targeting sand from seaward of this location-specific depth contour is that extraction seaward of this depth will not affect nearshore beach and coastal processes through the transfer of sediment from or to the active nearshore system which is much more mobile and responsive to swell and current conditions.

Monitoring of changes in bathymetry following extraction under the present consent shows lowering of seabed level occurs roughly in proportion to the volumes extracted. Extraction to date has been managed largely by the dredging operator which resulted in the recovery of sand from limited source areas resulting in short term localised depressions evident in the bathymetric survey results, which are gradually restored by natural wave induced effects to a uniform bed level. The longer term effect is a small distributed lowering of the bed over a large area approximately equivalent to the volume extracted.

It is proposed to establish a defined plan for the management of extraction areas under the EMMP which will, in conjunction with the use of GPS control of the dredge operation, provide for more even distribution of the sand extraction. Source areas will be monitored, and the extraction programme planned to minimise these local effects. The area of the proposed extraction site is approximately 44.2 km^2 and the recovery of 2,000,000m^3 of sand is the equivalent of a distributed increase of less than 100mm of depth assuming only half of the area proves appropriate for extraction due to the presence of fine material or ecological restrictions. The proposed establishment of a system of management cells as set out in the draft EMMP for programming extraction and monitoring of effects will allow the control of extraction volumes from selected areas to limit localised short term depth increases. These effects are not expected to have any observable influence on coastal processes.

4.3 Seabed Types

Monitoring of bed types and characteristics (e.g. coarse sand with larger ripples and shell lag deposits) in the extraction area has to date shown little change over time in the physical distribution of bed types. The types of seabed characteristics and their distribution observed prior to commencement of extraction in 2003 are still present. These features are considered to be formed and maintained as a result of the combination of wave action and water depth, and are expected to reform following temporary disturbance caused by extraction.

4.4 Sediment Texture

Seabed sampling and analysis of sand gradings over the monitoring period have shown measurable changes in grain size grading. Grading changes were observed that were common to both extraction and un-dredged (Control) areas sampled, and showed mean grain size changes from the pre-extraction baseline sampling to coarser, and then back to finer within the 2003 to 2019 period. There was shown to be no

statistical difference between the changes between the monitored extraction area and the control area. These variations are considered to result from seasonal winnowing and redistribution of the finer fractions with changes in wave conditions. Such processes may not represent a measurable bedload transport as much as temporary sorting and redistribution, and such a mechanism will assist in the gradual redistribution of sand to repair minor depressions resulting from extraction as discussed above.

These changes can be expected to continue, and are considered to be independent of the extraction processes.

4.5 Overall Sediment Processes and Budget

Components of the sediment transport processes and sediment budget for the embayment which may be active in the offshore areas include cross shelf transport and biogenic sand production. The establishment of transport rates for these components has not been conclusive. Cross shelf transport may occur occasionally as the result of storm wave conditions and has been considered in the sand budget as irrelevant or a minor contributor, and biogenic sand production which may have a significant part in total input but is identified as occurring predominantly inshore of the Depth of Closure and thus isolated from the offshore site. These inputs to the sediment budget are considered to be secondary and episodic, and unlikely to be affected by sand extraction from the offshore area.

4.6 Mitigation of Effects

Experience gained from the operation of the existing consent has provided a good understanding of the offshore extraction process, and a number of measures are proposed to increase the efficiency of the process and to mitigate the effects. These arise largely from advances in technology in relation to dredging control, position control, bathymetric survey, and sampling and analysis.

Proposed mitigation measures to be implemented include:

- significantly reduced extraction area
- extraction to remain seaward of Depth of Closure
- management of extraction to distribute effects in response to monitoring
- progressive extraction programme to provide even distribution of sand extraction
- fine real time control of the dredge tracks with GPS system
- more consistent bathymetric survey results through technology advances
- detailed EMMP to summarise these issues and monitoring and reporting procedures.

5 Conclusions

Based on the information available and within the limitations outlined in Section 1.2, it is concluded that:

- The location of the offshore extraction zone established under Auckland Regional Council Consent Permit No 20795 (RCAN 0621) are such that they are largely independent of coastal sediment transport pathways identified for the Mangawhai-Pakiri embayment, and thus not likely to affect nearshore and beach processes.
- The current consent conditions provide for regular monitoring based on extracted volume milestones of; bathymetry, seabed features, sediment characteristics. Monitoring over the current consent has not conclusively identified any significant changes related to any of these characteristics resulting from the extraction.
- The effects of sand extraction revealed by the monitoring undertaken to date are not considered to be significant in relation to bathymetric change, and difficult to detect in terms of seabed features and sand texture.
- The use of bathymetric survey methods to provide realistic reflection of extracted quantities over the large areas intended for extraction, or to infer quantitative values for or identify the effects of sediment transport processes in the deeper areas has to date been unsuccessful.
- The effects of continued extraction are likely to be confined to minor and well-distributed lowering of the seabed, subject to planning and implementation of the extraction management set out in the proposed consent conditions and draft EMMP included with the consent application. Shorter term effects are likely to arise as localised areas of cut resulting from drag head tracks, which are gradually restored by natural wave induced effects to a uniform bed level. The area of the proposed extraction site is approximately 44.2 km^2 and the recovery of 2,000,000m^3 of sand is the equivalent of an overall distributed increase of 45mm of depthWith careful management of the extraction process as proposed, the effects of increase in depth are not expected to have any observable influence on coastal processes noting the 25-40m water depths across the extraction area.
- The seabed types/features (e.g. ripples) are considered to be formed and maintained as a result of the combination of wave action and water depth, and are expected to reform following temporary disturbance caused by extraction.
- Mean grain size changes in seabed sediment result from seasonal winnowing and redistribution of the finer fractions with changes in wave conditions. Such minor changes can be expected to continue, and are considered to be independent of the extraction processes.
- Components of the sediment transport processes and sediment budget for the embayment which may be active in the offshore areas include cross shelf transport and biogenic sand production. These inputs to the sediment budget are considered to be secondary and episodic, and unlikely to be affected by sand extraction from the offshore area.

On the basis that monitoring of offshore sand extraction of some 1,500,000 m^3 from a defined area between 2003 and 2019 has not identified significant effects on bathymetry, geomorphology or coastal processes, it is concluded that continuation of this activity will provide a useful resource without significant effects on these components. Mitigation of the effects of extraction in the deeper offshore areas can be achieved by management of the extraction process to limit localised effects. This is recognised by the Applicant in proposing much more closely controlled extraction management and monitoring procedures and methods under the renewed consent.

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Appendix A – Extraction Volumes

Appendix A – Extraction Volumes

Table A.1– Summary of Total Sand Extraction from Mangawhai-Pakiri Embayment

Period	Extraction Volume (m^3)	
Pre 1966	No Records	
1966 - 1987	approx. 1,500,000	
	All extractors	
1987 - 1988	70,000	
1988 - 1989	29,000	
1989 - 1990	86,000	
1990 - 1991	58,000	
1991 - 1992	85,000	
1992 - 1993	81,120	
1993 - 1994	77,775	
1994 - 1995	97,696	
1995 - 1996	124,800	
1996 - 1997	126,806	
	Nearshore	Kaipara Ltd Offshore
1997 - 1998	69,000	not available
1998 - 1999	69,000	not available
1999 - 2000	47,000	not available
2000 - 2001	51,000	not available
2001 - 2002	43,000	not available
2002 - 2003	53,000	not available
2003 - 2004	not available	not available
2004 - 2005	not available	97,354
2005 - 2006	65,450	72,980
2006 - 2007	62,900	60,834
2007 – 2008	43,510	103,335
2008 – 2009	19,240	86,808
2009 – 2010	22,540	85,721
2010 – 2011	23,460	76,970
2011 – 2012	22,758	76,375
2012 – 2013	16,560	91,139
2013 – 2014	not available	131,896
2014 – 2015	not available	131,980
2015 – 2016	not available	137,155
2016 – 2017	not available	152,430
2017 – 2018	not available	122,237

Period	Extraction Volume (m^3)	
2018 - 2019	not available	44,694 to Feb 19

Table A.2 - Annual Total Sand Taken from Offshore Coastal Permit RCAN 0621 (ARC20795)

Period	m^3
February 2004 to November 2005	97,354
December 2005 to November 2006	72,980
December 2006 to November 2007	60,834
December 2007 to November 2008	103,335
December 2008 to November 2009	86,808
December 2009 to November 2010	85,721
December 2010 to November 2011	76,970
December 2011 to November 2012	76,375
December 2012 to November 2013	91,139
08 November 2013 to 07 November 2014	131,896
08 December 2014 to 07 November 2015	132,000
08 December 2015 to 07 November 2016	137,155
08 December 2016 to 07 November 2017	152,430
08 December 2017 to 07 November 2018	122,237
08 December 2018 to 28 Feb 2019	44,694
TOTAL	**1,471,928 m^3**