Appendix D

Coastal Processes and Design Report

4SIGHT CONSULTING

LAND. PEOPLE. WATER.

THAMES COROMANDEL DISTRICT COUNCIL

Cooks Beach

For Thames Coromandel District Council

Coastal Processes and Design Report

April 2019

REPORT INFORMATION AND QUALITY CONTROL

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1 INTRODUCTION

Thames Coromandel District Council (TCDC) recently engaged 4Sight Consulting Ltd (4Sight) to develop options to manage coastal erosion of the southern reserve area at Cooks Beach on the eastern coast of the Coromandel Peninsula. It is understood that TCDC's preferred option is to build a backstop wall to ensure the integrity of infrastructure, as well understand the viability of a groyne control structure. This structure will then be subject to a nourishment program which will be supplemented by dune planting as a means of retaining natural character and amenity values on the beach.

This report presents the findings of a site-specific coastal processes investigation and assesses the nature of the erosion hazard at Cooks Beach. This information has also been used to identify the design parameters for the backstop wall and groyne structure, as well the extent of the beach nourishment programme. Two options for a vertical seawall have been developed and the various pros and cons discussed to assist TCDC when making a decision over the preferred option. This report will also inform and guide the compilation of the forth coming resource consent application.

Figure 1: Location of the subject site with the red box indicating the area of concern.

1.1 Site Description

Cooks Beach is situated on the east coast of the Coromandel Peninsula approximately 3km east of the Whitianga township. The subject area of sand loss is situated toward the eastern extent of the beach and has been exposed to notable erosion over the past few years. The erosion has, at least in part, been attributed to end effects from a recently constructed rock revetment seawall immediately to the west of the site. In order to address the end effects issue, re-nourishment works have been undertaken and an emergency rock revetment sea wall constructed.

2 GEOMORPHIC SETTING

Cooks Beach is approximately 3km in length and orientated roughly east to west, thus being open to wind and wave events from the northerly quarter. Significant protection is afforded to the site due to it's inset position within Mercury Bay and Shakespeare Cliffs to the west and Cooks Bluff to the east. Further details about the wave climate and other coastal processes are discussed **Section 3** below.

The wider system is considered to be an example of a wave dominated estuarine system, characterised by the spit, ebb tide delta and flood tide delta features (**Figure 2**). It is considered that the central basin estuarine feature is poorly formed due to the limited accommodation space afforded by the small drowned river valley being occupied by the Purangi Estuary system.

In accordance with the NIWA beach classification system[1] the beach itself is considered to be 'Reflective' due to its short beach length, beach cusps and wave climate. The bathymetry offshore gently grades into Mercury Bay to a depth of 10m before a sharp drop to 50m beyond the extent of the bay. Cooks Bluff to the east of the beach appears to provide significant shelter to the shoreline as the depth contours indicate a build up of sand material in it lee (**Figure 3**).

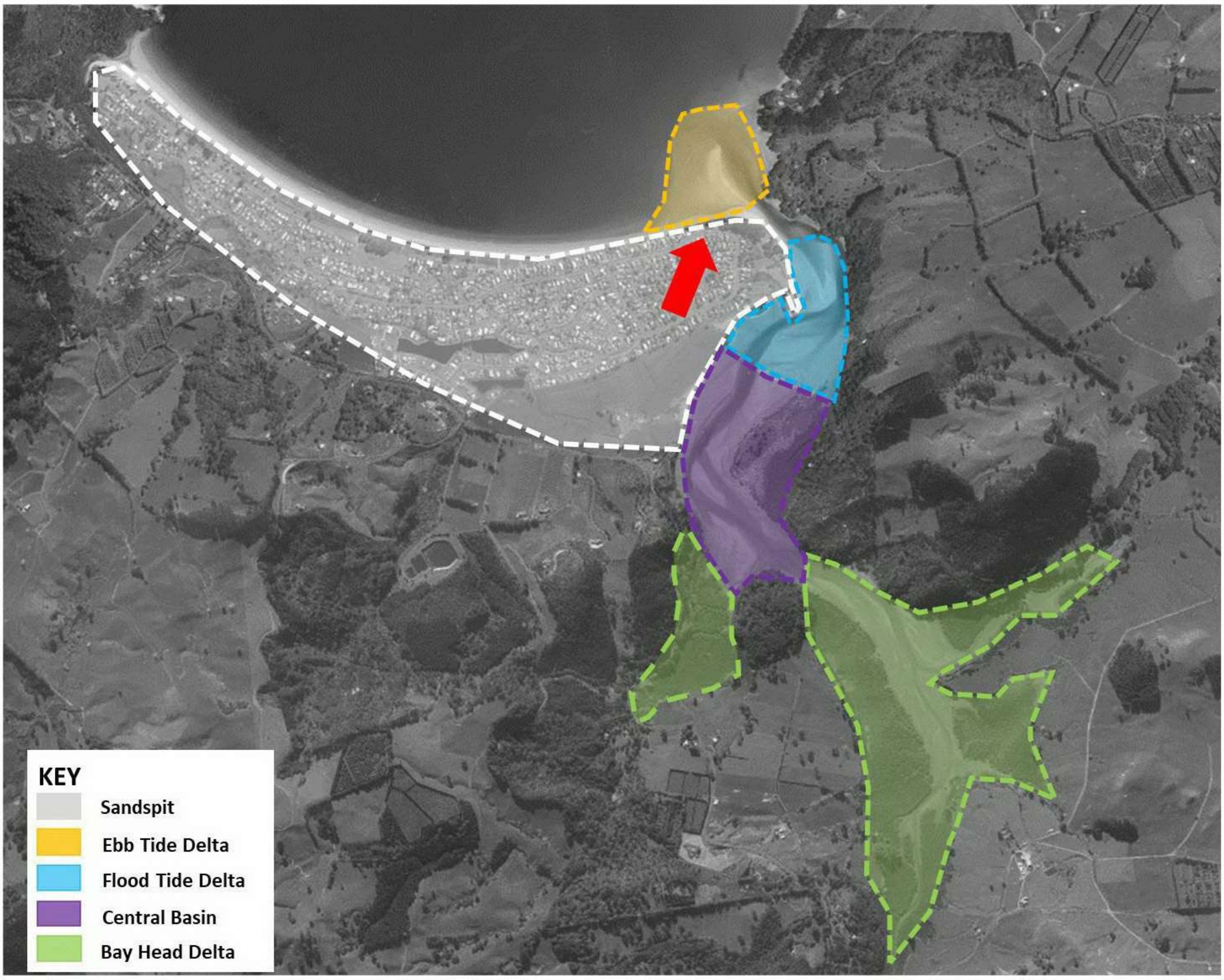

Figure 2: Geomorphic features of the Cooks Beach system.

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[1] https://www.niwa.co.nz/coasts-and-oceans/nz-coast/learn-about-coastal-environments/beach-types/13-beach-types

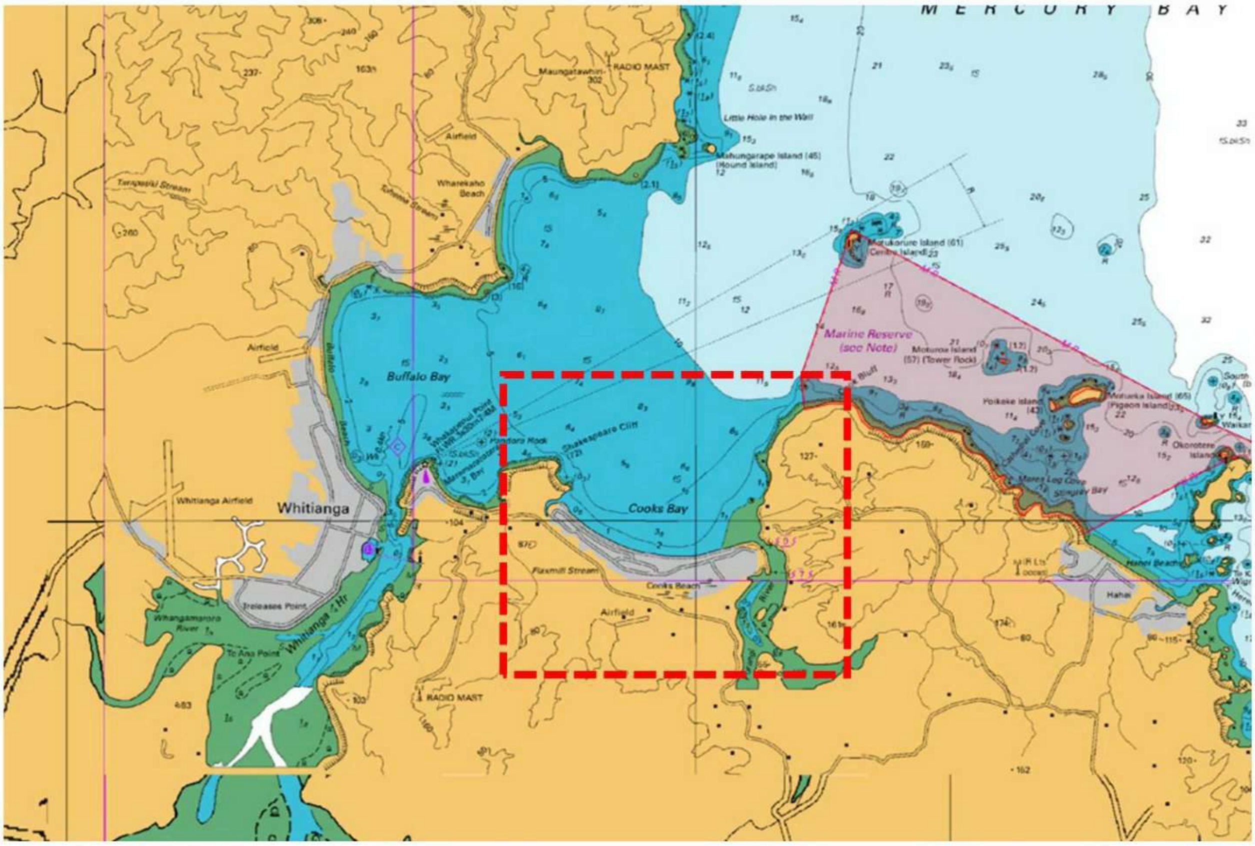


Figure 3: Offshore bathymetry and wider shore alignment. Cooks Beach indicated by red dashed square.

2.1 Recent Coastal Change

Analysis of the available historic aerial photos from the Retrolens website was undertaken as a part of this investigation. Of note is the orientation and eastward shift of the ebb tide delta and Purangi Estuary channel between 1971 and 1984. It is noted that the position of the channel has also moved post 1984 but the dominant trajectory has settled to a northerly flow as opposed to the more north-west flow in the aerial imagery prior to 1984. The 1984 image is also the first time a flood tide sub-channel is apparent in the air photo record. This is summarised in **Figure 4** below and the complete photo set analysed is provided within **Appendix A**. Detailed analysis of the flood tide delta form has not been undertaken, but changes in form and position are apparent. Anecdotal evidence suggests that the delta has been expanding and therefore decreasing the size of the channel adjacent to the main boat ramp over the past 10 years or so.

It was also noted that significant areas of mangrove colonisation have occurred post 1971 (**Figure 5** below). This is not uncommon across northern New Zealand and has been often attributed to land use changes and/or hydrodynamics changes to the system. At Cooks Beach it is mostly likely that land use change in the catchment and the limited accommodation space are the primary contributing factors. Whilst difficult to ascertain from aerial photography, sediment infilling is often associated with mangrove colonisation, which in turn can lead to a reduction in the tidal prism size. With a reduced tidal prism, the ebb tide flows and volumes are expected to have reduced which may in turn have contributed to the change in the form of the ebb tide delta noted above.

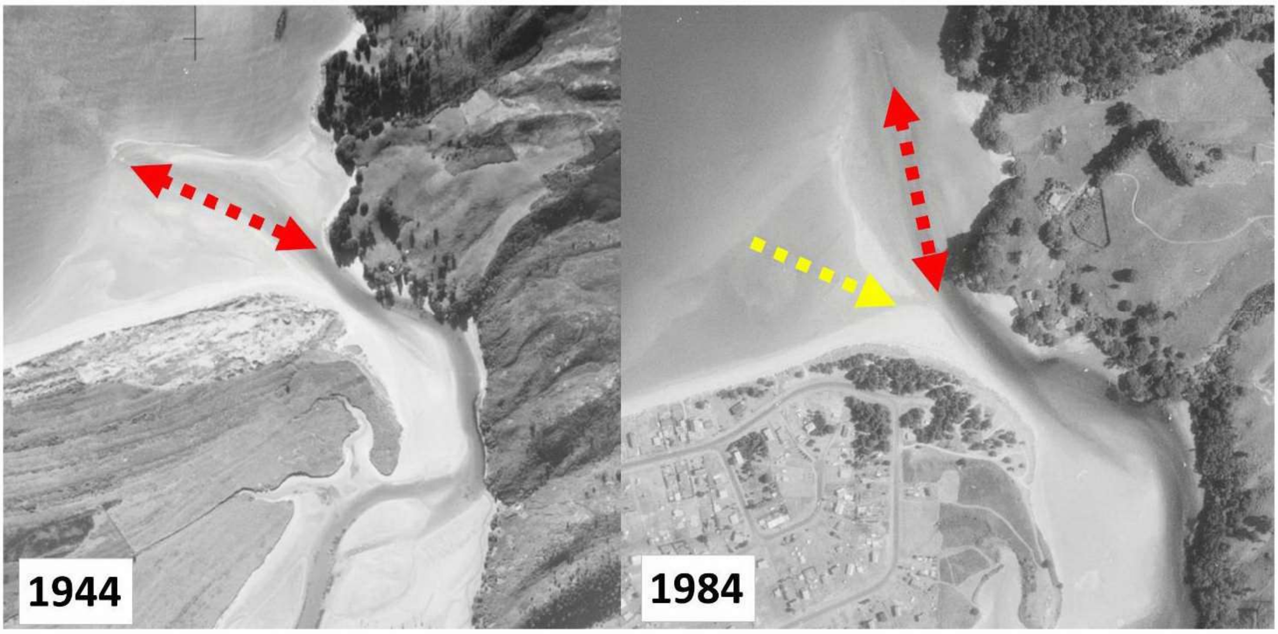


Figure 4: Channel position and orientation comparison between 1944 and 1984 indicated by the red arrows. The yellow arrow indicates the location and flow direction of the flood tide sub-channel.

Figure 5: Mangrove colonisation in the Purangi Estuary since 1971 indicated by red dashed lines.

2.2 Beach Monitoring Trends

A high-level analysis of the beach monitoring sites along Cooks Beach has been undertaken using the Beach Morphology Analysis Package (BMAP). More detailed analysis here focused on Profile CCS31-2 (**Figure 6**) as this is situated in the area of concern. The other remaining profiles were briefly analysed for context of wider beach behaviour. **Figures 7** & **8** demonstrate the western end of the beach monitoring to have a mild accretionary trend in volumes above Mean Sea Level (MSL). However, due to the sparsity of early data points the analysis may be slight skewed and it is assumed over this part of the beach is a dynamic equilibrium.

Data from profile CCS31 illustrates a reasonable strong erosion trend with an estimated 30% loss of material above MSL over the 40-year monitoring period (**Figure 9**). However, the position of the dune has not retreated to the same extent and this is thought to be related to the stability afforded by the dune planting cells. The erosion trend is not as strong in profile CCS31-1 (**Figure 10**), but this is thought to be related to the degree of modification that has occurred and eventual construction of a revetment seawall. Greater detail about the nature of the modifications may provide an insight to the nature of the beach behaviour at this monitoring point but for the purpose of this assessment it has been assumed that

Similarly, the data from CCS31-2 shows a weaker erosion trend (**Figure 11**) but this is thought to be the result of site modifications such as the nourishment and dune reconstruction works in 2016 artificially accreting the profile.

The position of the RL2.5m contour relative to the bench mark has been used as a proxy for the dune crest/bank position. Despite modifications and nourishment works at CCS31-2, this part of the beach system the dune crest has retreated approximately 20m over the past 27 years (**Figure 12**).

Figure 6: Location of beach monitoring profiles across Cooks Beach.

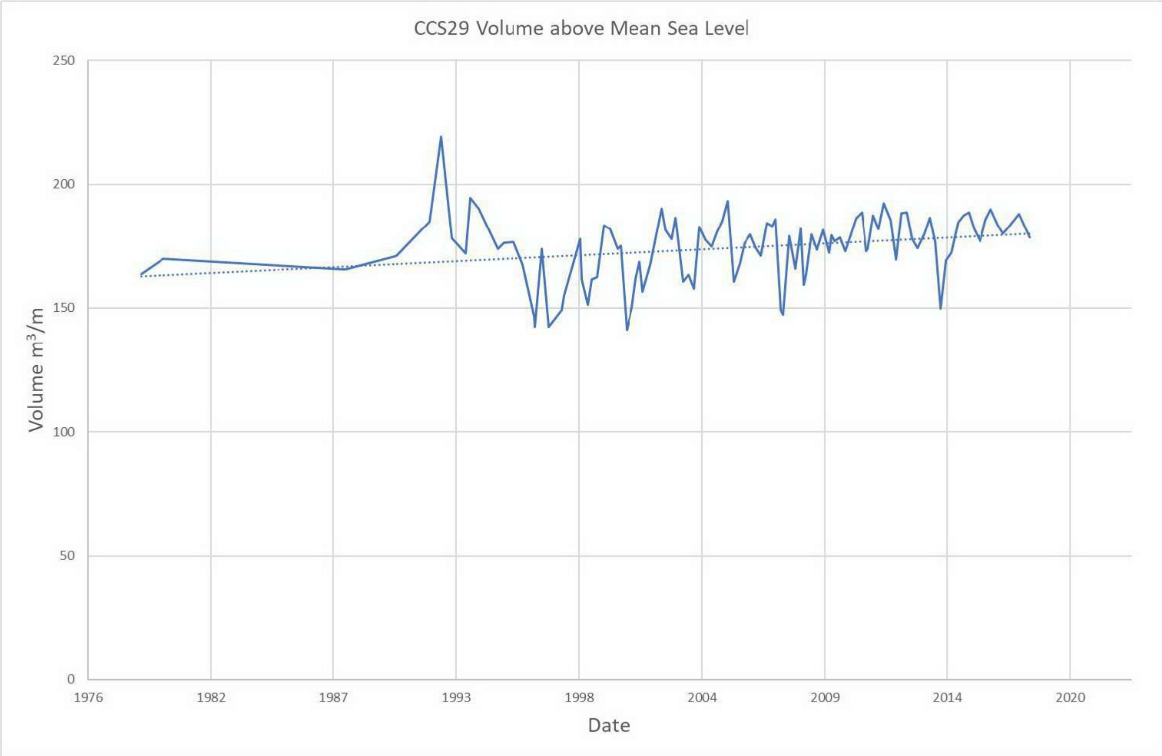


Figure 7: Beach monitoring data from the western end of Cooks Beach.

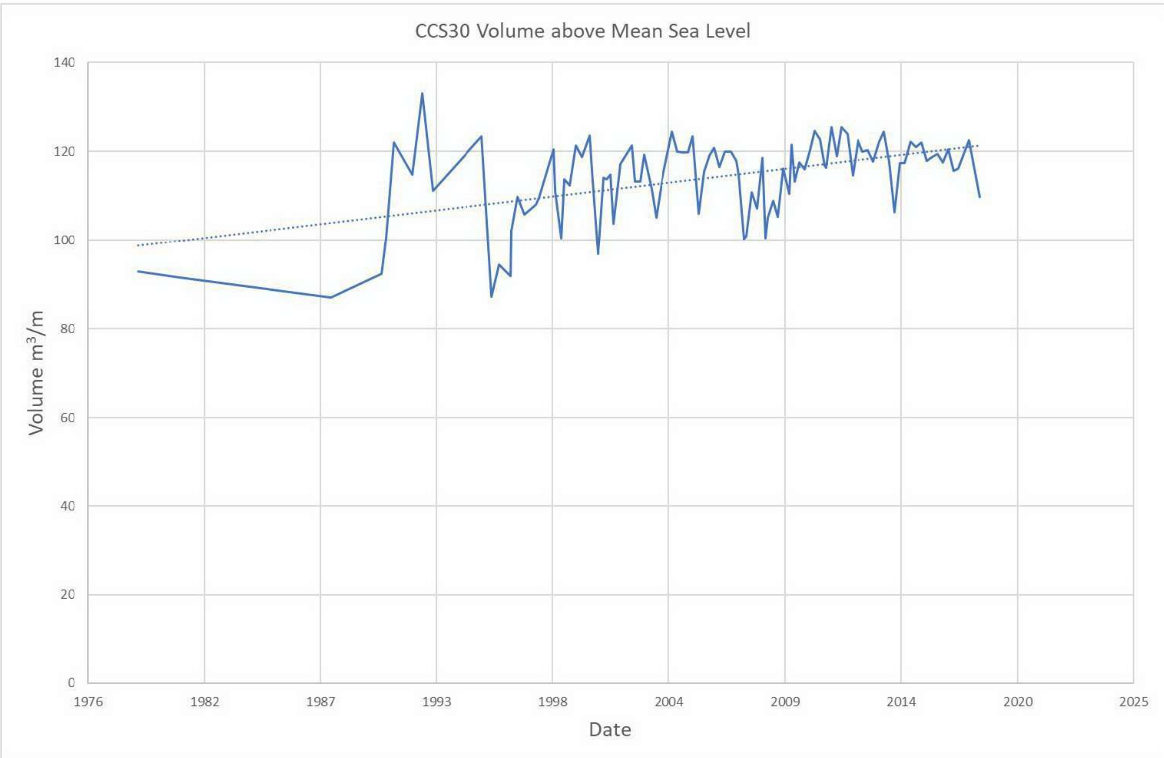


Figure 8: Beach monitoring data from the central portion of Cooks Beach.

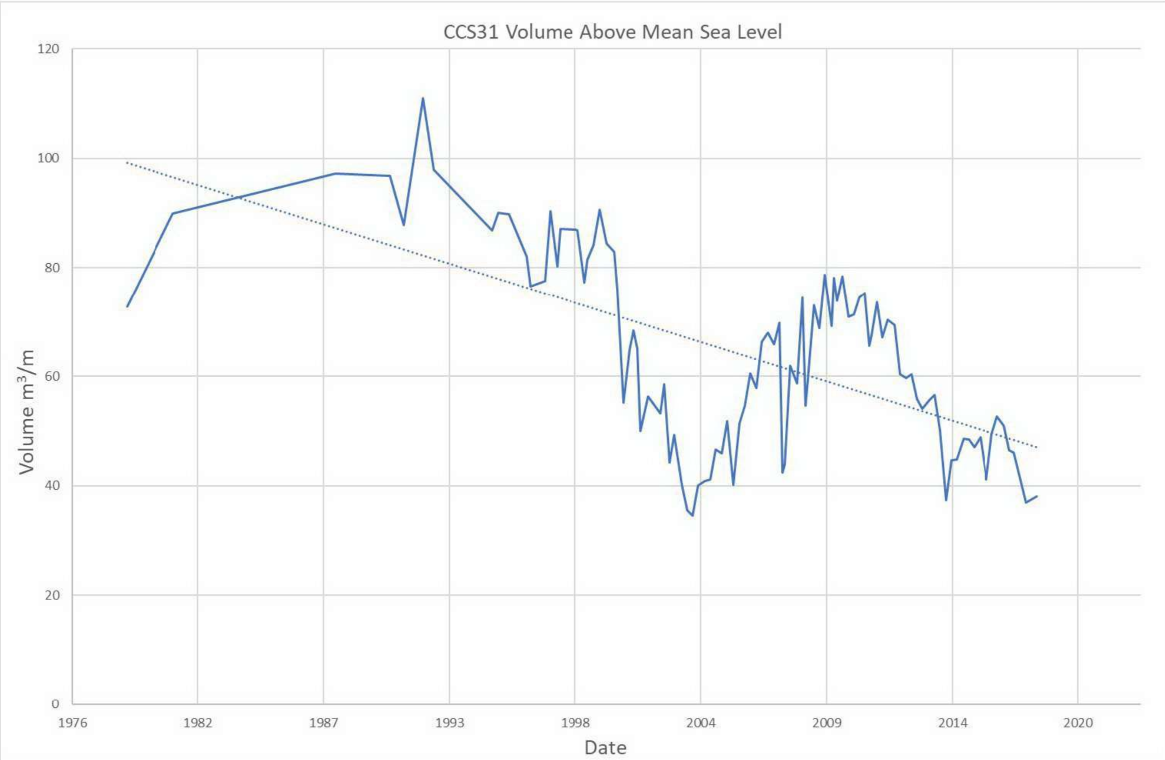


Figure 9: Beach monitoring data from the near-eastern end of Cooks Beach.

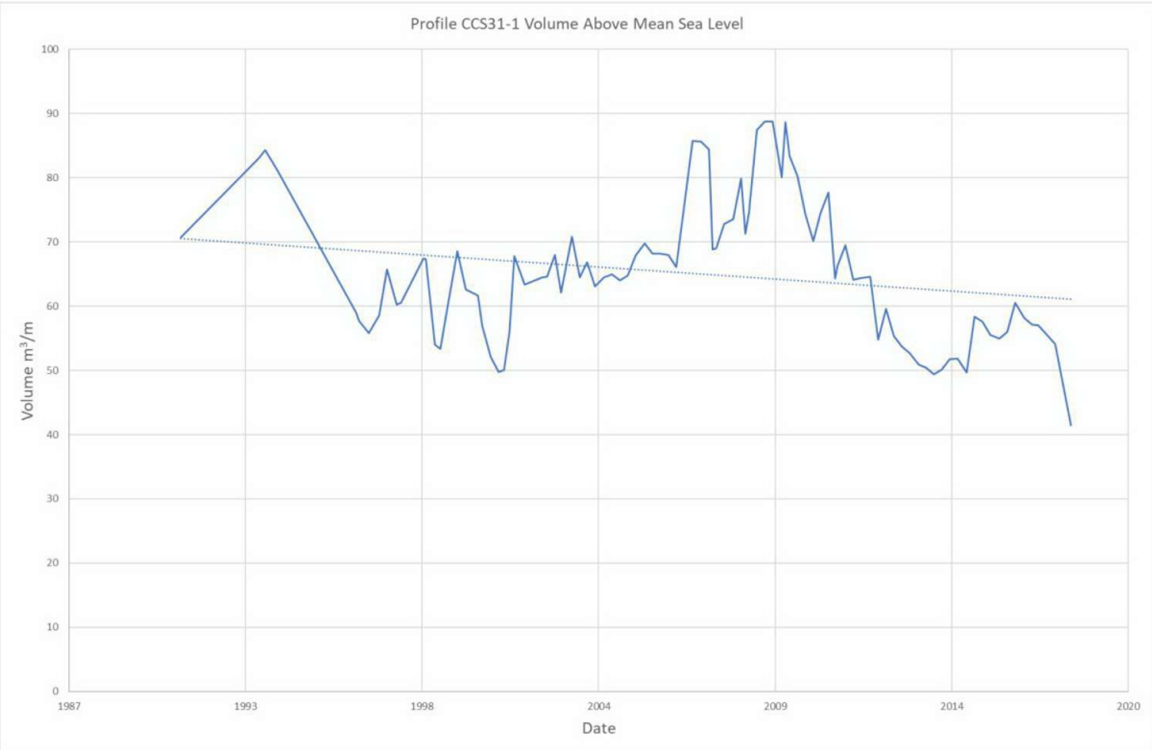


Figure 10: Beach monitoring data from the mid-eastern end of Cooks Beach.

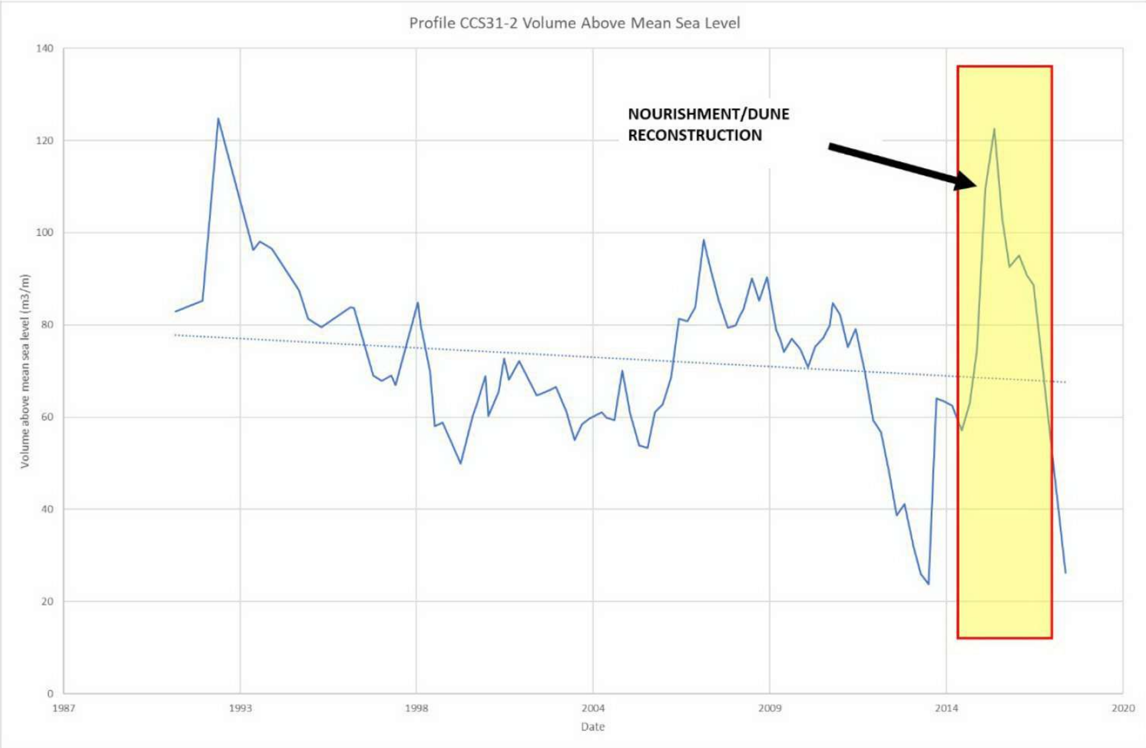


Figure 11: Beach monitoring data from the far-eastern end of Cooks Beach.

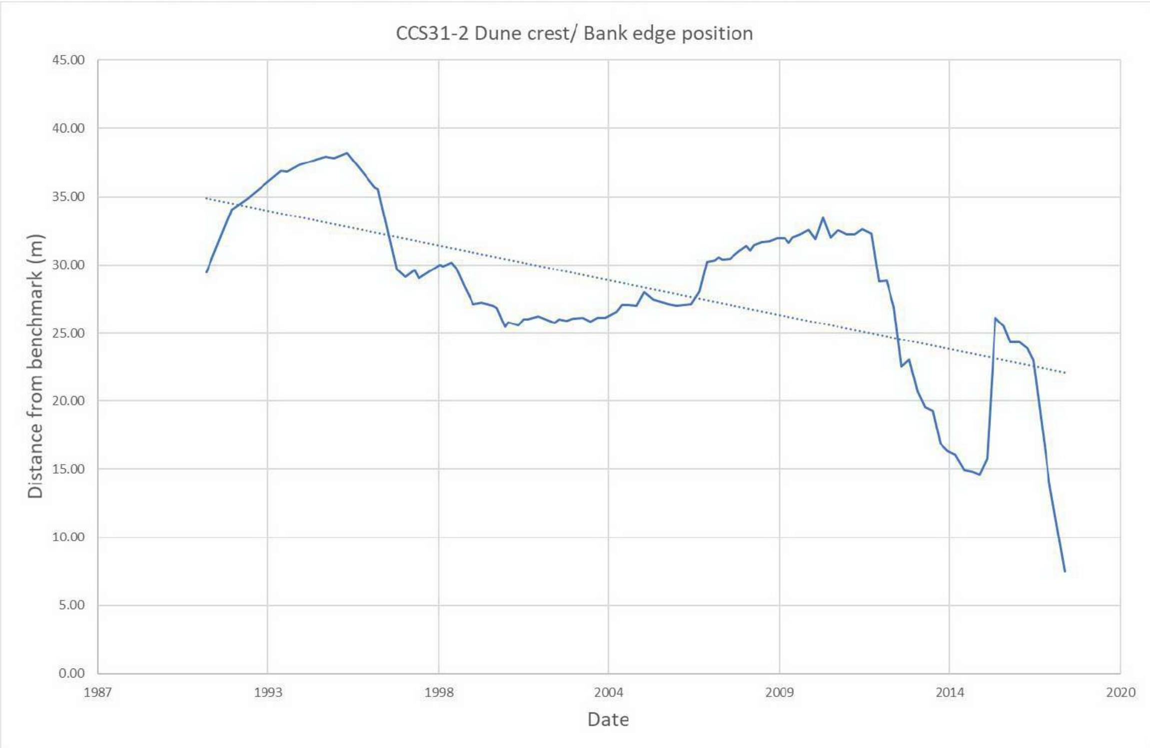


Figure 12:Migration of dune crest / bank edge from datum point at far-eastern end of Cooks Beach

3 LOCAL COASTAL PROCESSES

3.1 Wave Climate

The site is generally orientated east to west and therefore exposed to waves from the northwest to the northeast. Due to the limited fetch from the northwest and the north due to landmasses, it is considered that the largest waves approaching the beach are generally from the northeast either as wind generated storm events or open ocean swells refracting into the bay. Large east swell events are also thought to reach the site after similarly refracting around Cooks Bluff. **Figure 13** below shows the wave rose from the nearest offshore modelling location, and **Figure 14** provides the extreme offshore wave heights. In general, waves operating at the beach during storm and/or swell events will be in the range of 0.5-2m.

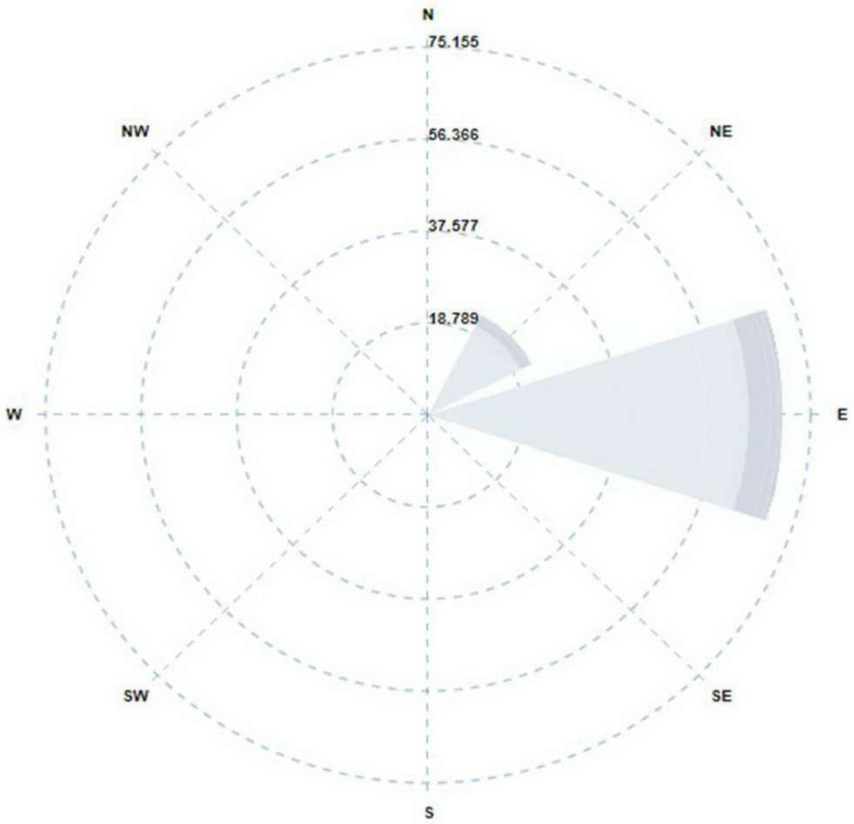


Figure 13: Offshore wave rose data for the subject site[2].

	Return period [years]		
	10	**100**	**10000**
Significant Wave Height [m]	6.1	7.7	10.8
Wind speed [knots]	46	52	65

Figure 14: Extreme offshore wave heights for subject site[3].

[2] https://app.metoceanview.com/hindcast/sites/nz/-36.8/175.8

[3] https://app.metoceanview.com/hindcast/sites/nz/-36.8/175.8

3.2 Coastal Water Levels

Table 1 below present a range of water levels associated with storm surge events obtained from Stephens et. al., 2015[4]. The value for MHWS was obtained from the Waikato Regional Council website and then converted to the local datum (MVD-94). A nominal value of 1m has been added to allow for future sea-level rise which is based upon guidance provided from the Waikato Regional Council[5].

Table 1: Predicted extreme water levels for the subject area converted to WVD-94 (Source: Table 7-1, Stephens et al., 2015)

Return Period	*MHWS*	*5yr ARI*	*20yr ARI*	*50yr ARI*	*100yr ARI*
WVD-94 RL(m)	*2.27*	*2.49*	*2.60*	*2.68*	*2.75*
+ SL Rise (100yrs)	*3.27*	*3.49*	*3.6*	*3.68*	*3.75*

4 DESIGN BASIS AND RATIONALE

4.1.1 Assessment of Erosion Issue

Based on the information presented above, it is considered the eastern end of Cooks Beach is subject to a progressive erosion issue. The cause of the erosion appears to be related to modification of sediment deposition patterns reducing the volume of sand material supplied to the eastern beach. This is thought to be the function of changes to the ebb tide delta tidal prism and infilling the Purangi Estuary, i.e. a shallower estuary has less tidal water capacity and subsequently has less potential energy in the ebb flow to transport sand to the beach.

This conclusion is consistent with estuarine evolutionary models which predict a loss of material from a barrier feature as a wave dominated estuary reaches its maturity. It is noted that upon reaching maturity the barrier feature is expected to then accrete as marine sediment sources are no longer able to be accepted within the estuarine system[6]. At the site specifically, this appears to be punctuated by end effects related to the construction of the adjoining revetment seawall to the west. The susceptibility of the site is heightened by the proximity of a flood-tide sub-channel that has erosive capacity and has apparently become a more permanent feature post 1970.

4.1.2 Design Concept Response

It is understood that TCDC have undertaken an internal initial options analysis for coastal protection measures at this location. A '*do nothing*' is not considered applicable in this location due to the proximity of infrastructure. A conventional hard protection structure was not considered appropriate due to the amenity and natural character values at the site. Therefore, TCDC requested a design for a backstop seawall along the length of the eroded beach east of the private rock revetment up towards the Purangi River mouth. Design for a supplementary beach nourishment and dune restoration regime has also been nominated as a measure to retain the high natural character values of the area whilst providing a buffer to coastal erosion at the site. Investigations have also been requested into assessing the concept of a groyne design to help retain sand in the upper portion of the beach in the subject area.

[4] Stephens, S., B. Robinson, R. Bell (2015) Analysis of Whitianga, Tararu and Kawhia sea-level records to 2014. NIWA report HAM2015-046 for Waikato Regional Council.

[5] https://waikatoregion.govt.nz/assets/PageFiles/41257/3700622-Coastal_Inundation_Tool_Guidance.pdf

[6] Dalrymple, R., Zaitlin, B. and Boyd R., 1992. Estuarine Facies Models: Conceptual Basis and Stratigraphic Implications. Journal of Sedimentary Petrology. v.62, n.6,

4.1.3 Beach Nourishment Design

The aim of beach nourishment at the site is to create a sufficient width of sand above MHWS to enable the establishment of dune plants and push the flood tide sub-channel seaward and away from the subject area. To enable this, it is proposed to shift the shoreline position approximately 40-45m seaward by depositing 15,000m^3 at the eastern end of Cooks Beach. This will adjust the position of MHWS beyond the extent of the existing emergency rock revetment and infill the flood tide sub-channel.

The nourishment will be achieved by extracting up to 15,000m^3 from the ebb tide delta immediately offshore from the Purangi River mouth. The intent is to recreate the flood tide sub-channel seaward of the deposition area to encourage the system to 'accept' the deposited sand.

Should not enough sand be available within the ebb tide delta, a secondary sand source has been identified within the channel straight. This area has been restricted in extent by the shellfish beds below the mid-tide mark and toward the channel. This habitat has been detailed in an ecological assessment which is contained within a separate report to be included with the resource consent application. In order to avoid impacting on this shellfish community, it is proposed that physical works in the area operate with a 5m exclusion buffer around the beds. The extent of beds and therefore the location of sand material to be extracted should be confirmed prior to physical works due to the fluctuating morphology of the sand bank feature. In order to offset any increased coastal processes activity created by deepening the sand flat, a small area of nourishment and planting is proposed by the exposed road edge.

It is expected that the nourished material will continue to erode over time as it is not practical to eliminate the causes of erosion. The residence time for the nourished material is difficult to determine as it is dependent upon fluctuations in weather conditions, frequency of storm events and delivery of sand to area. Hence, it is considered necessary that the nourishment programme is able to be repeated as required and planning permission for this maintenance activity be obtained.

4.1.4 Backstop Seawall Design

Two designs for a vertical 'backstop' wall have been considered within the concept design stage, being (1) a stabilised sand trenched wall; or (2) a traditional timber retaining wall. The wall alignment has been set back within the existing reserve area to avoid further structures being located in the active coastal zone. Final alignment will need to be determined on site once local services have been located, as the survey provided did not identify these. However, due to the simplistic and flexible nature of the proposed structures, avoiding any services is not seen as problematic. The wall height is to be set at existing ground levels, and it is recognised that in the future this area may become inundated with predicted sea level rise. However, the impact of potential overtopping is expected to be mitigated through the nourishment regime and additional drainage capacity within the wall design allowing the water moving over the structure to move back out efficiently. Founding depths are determinant on the retained height above average sand levels with and allowance for scouring during storm events. This depth will require further investigation at the detailed design stage.

Timber Wall

The favoured option proposed is a conventional timber seawall design with additional allowance for boards below the sand to prevent undermining. Drainage behind the wall will prevent the build up of ground water and lessen the potential impact of hydraulic loading through the wall should it be exposed during a storm event. Because the wall is to be built in-ground the construction is more complicated than more conventional timber walls. This is in part due to the additional trenching required to allow for the rails to be fixed to the rear of the posts and the geotextile cloth placed correctly.

5 COASTAL PROCESSES IMPACT ASSESSMENT

Backstop Seawall

If existing assets and use of the subject area are to be maintained, then an appropriate management response is required. The back-stop wall is expected to be outside of the influence of coastal processes for the majority of time due to the buffering influence of the supplementary beach nourishment, which will also retain natural character and amenity values. As explained below, this approach significantly reduces the risk of adverse effects on local coastal processes as a result of introducing the proposed structure.

Beach Nourishment

The quantity and depth of sand being extracted from the ebb tide delta is in the order of what is naturally moved during storm/wave events, and hence the system is expected to adjust following physical works. Sand from initial deposition is expected to erode during storm events over time and some adjustment at the margins as the system adjusts to the sand. Therefore, it is anticipated that maintenance nourishments will be required on a periodic basis.

The soft packed nature of sand and relatively deep anoxic layer from the secondary extraction area indicates that this deposit is mobile and is perhaps a transitional feature between the flood and ebb tide deltas. Due to the dynamic nature of this area, the quantity and depth of the extraction is not expected to adversely impact the feature.

There is a recognised risk of coastal processes and tidal energy acting upon the upper shoreline bank and margins as a result of slightly deeper water in the area. This is proposed to be mitigated by depositing a small amount of sand in front of the bank and stabilising with planting.

6 CONCLUSIONS

A description of the site's geomorphology, coastal processes and coastal hazards are provided above. This information has been used in the understanding of coastal erosion at the site. In general, there appears to be a progressive erosion issue at the east end of Cooks Beach. The degree and rate of erosion appears to have been exacerbated by the installation of the adjoining private revetment seawall to the west of the subject area.

The report and associated drawing set presents two options for a backstop seawall to preserve the integrity of roading and other infrastructure in the area. The effects of this structure are proposed to be offset and mitigated by its buried nature and proposed nourishment regime. It is proposed to plant dune species as a means of stabilising and retaining the dune sands.

In general, this approach and design has been undertaken to minimise the potential for impacts on local coastal processes. Further, investigation work is required to establish what effects a potential groyne structure will have on the local coastal processes.

Appendix A:

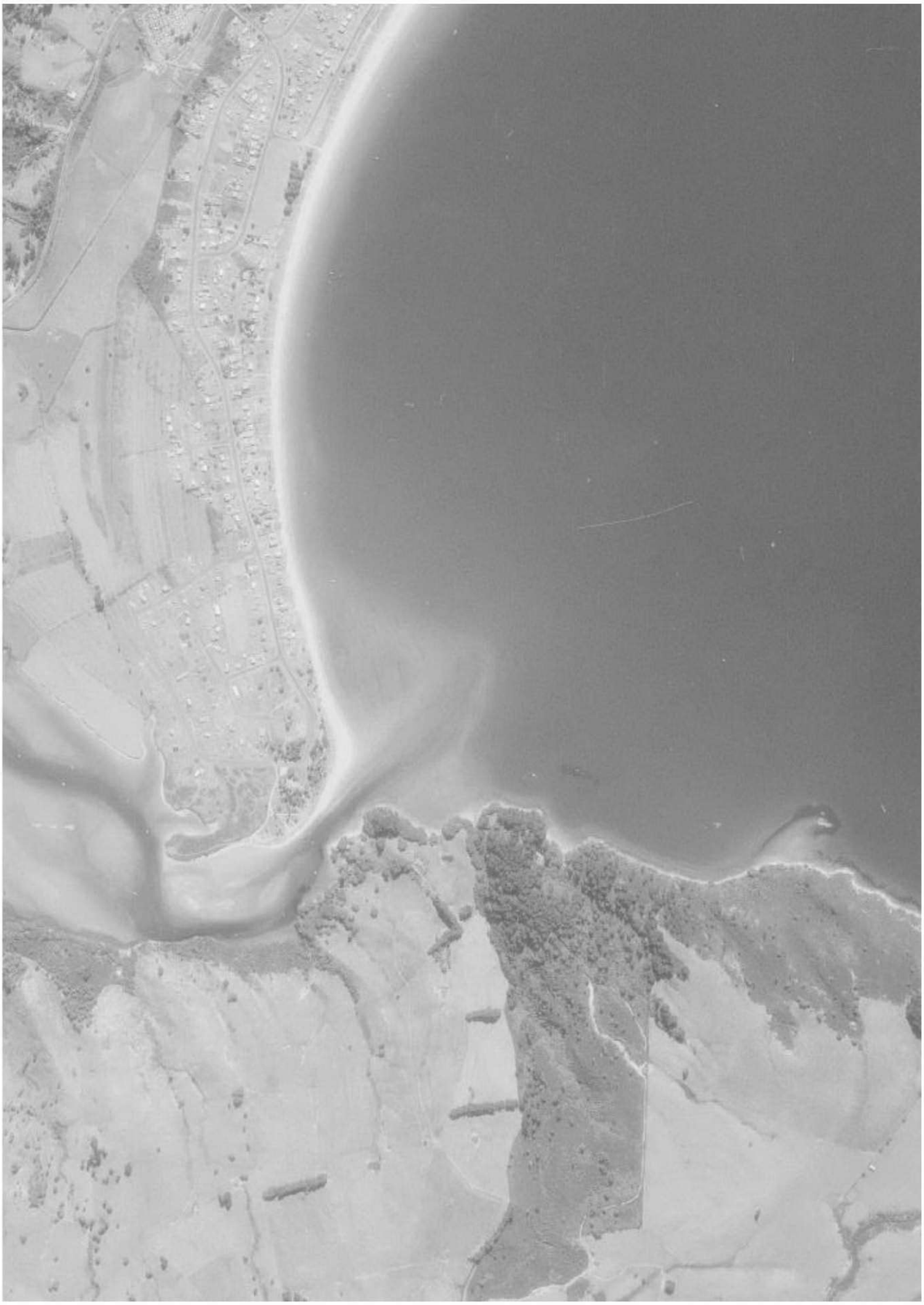
Historical Aerial Photographs

1944

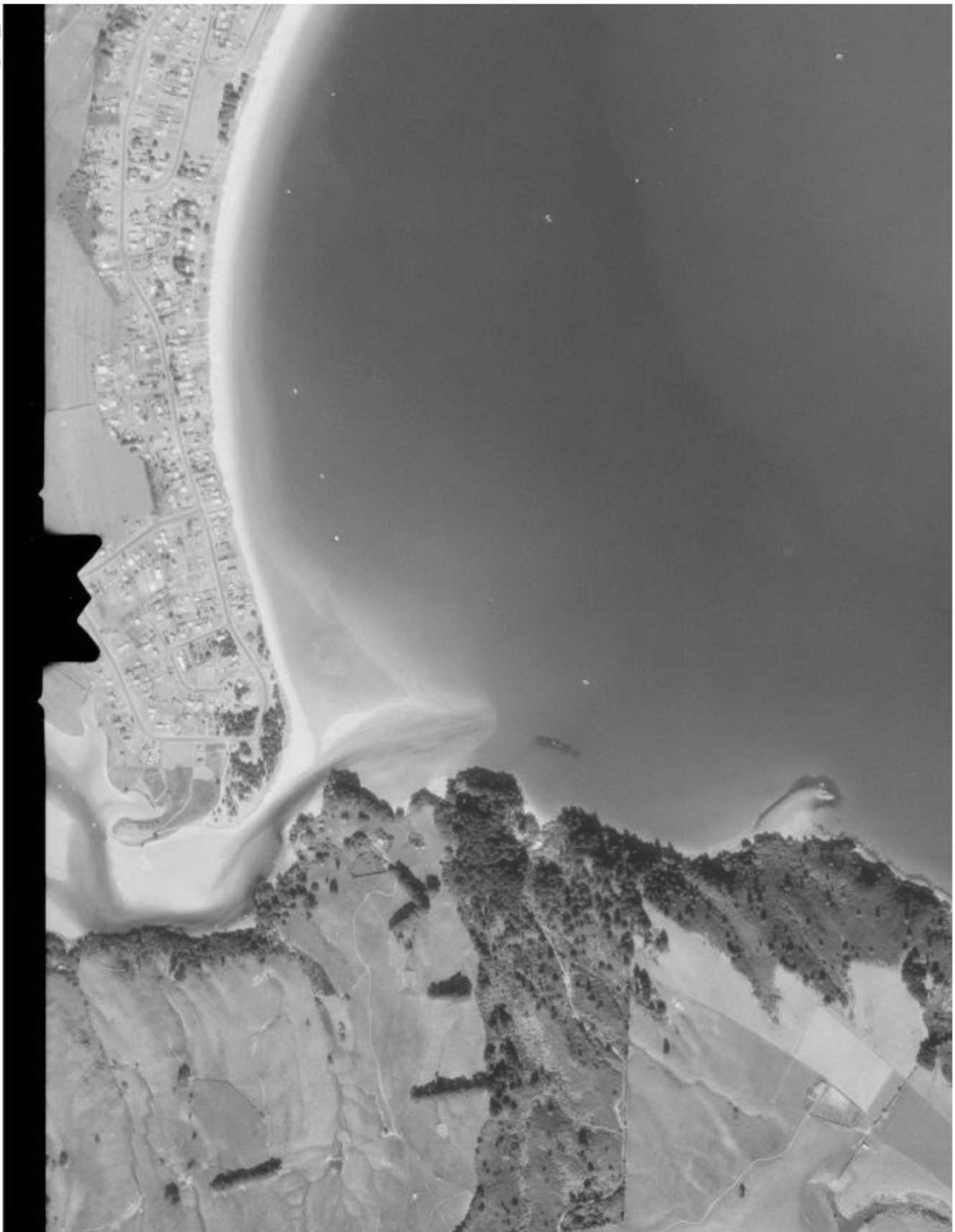
1966

1967

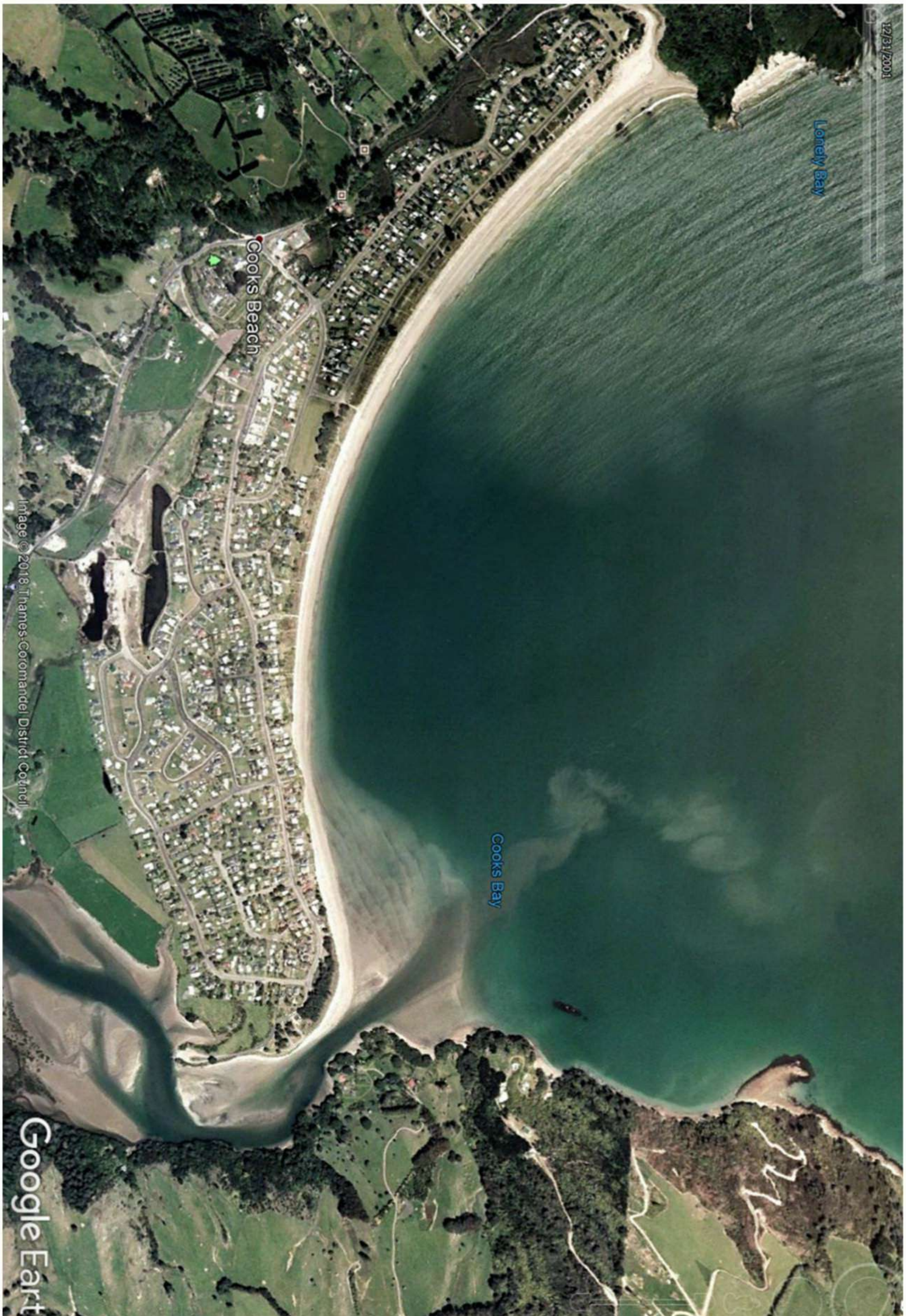
1971



1978

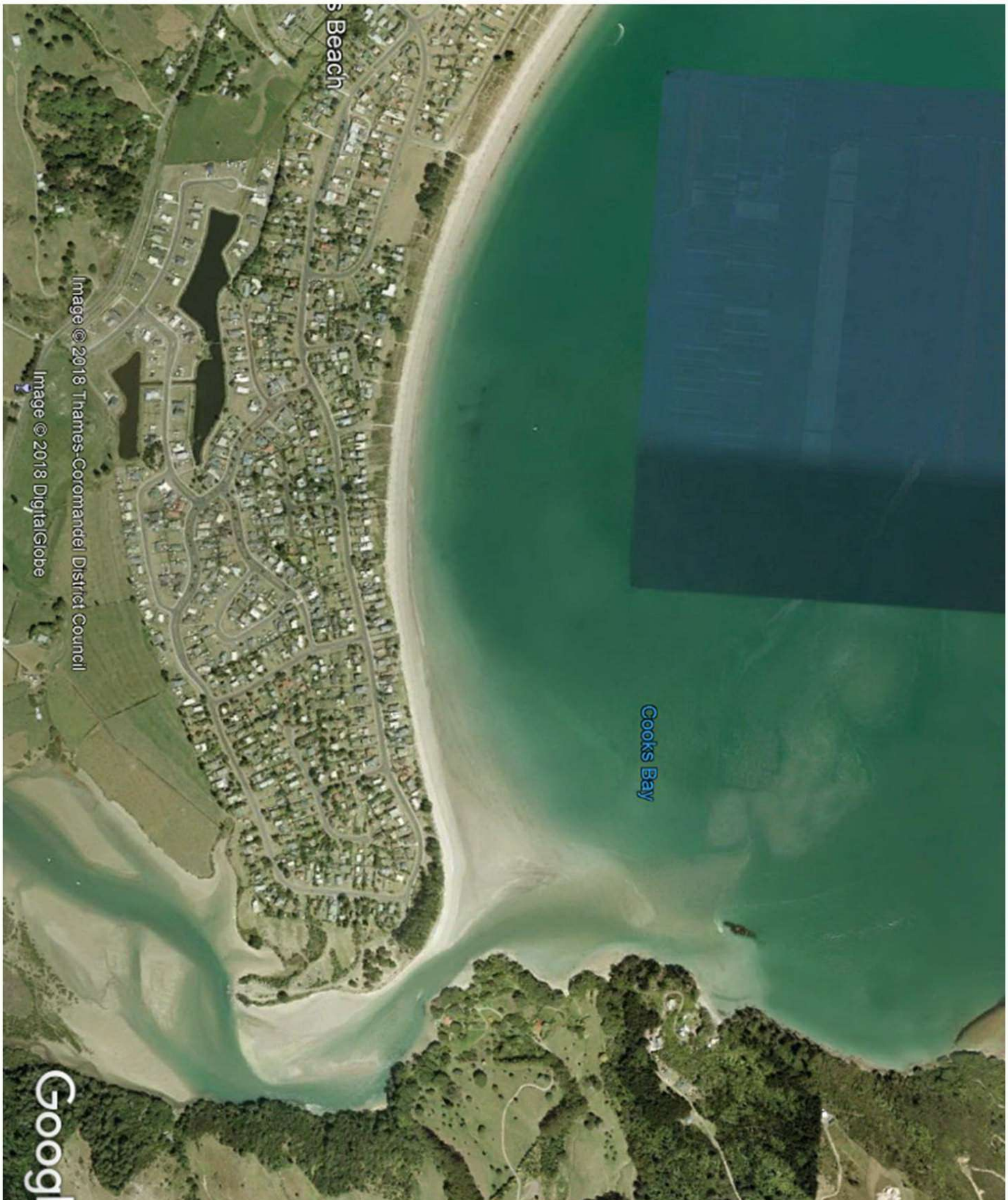


1984



12/31/2001
Lonely Bay
Cooks Beach
Image © 2018 Thames-Coromandel District Council
Cooks Bay
Google Earth

2001

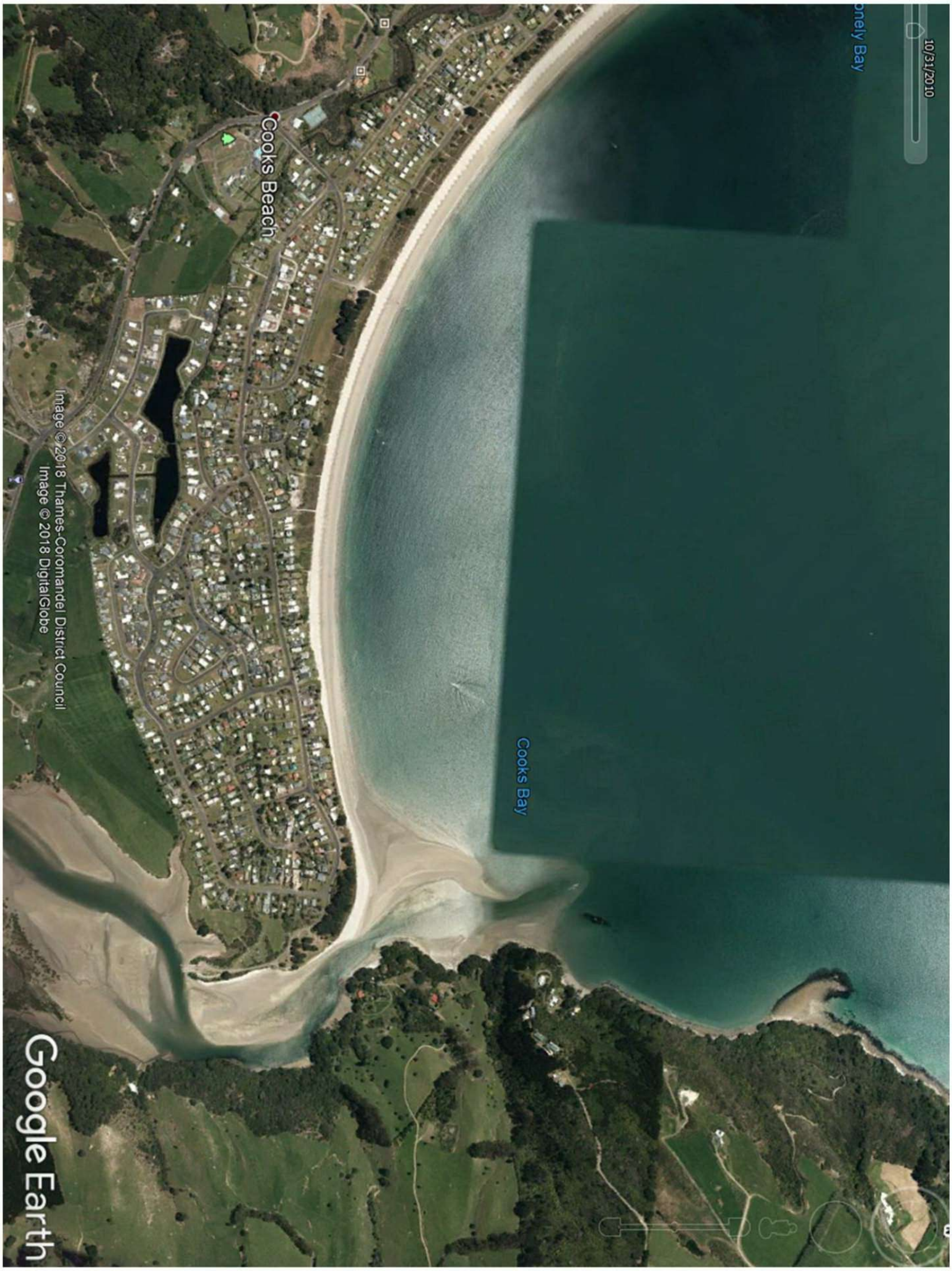


s Beach
Image © 2018 Thames-Coromandel District Council
Image © 2018 DigitalGlobe
Cooks Bay
Google Earth

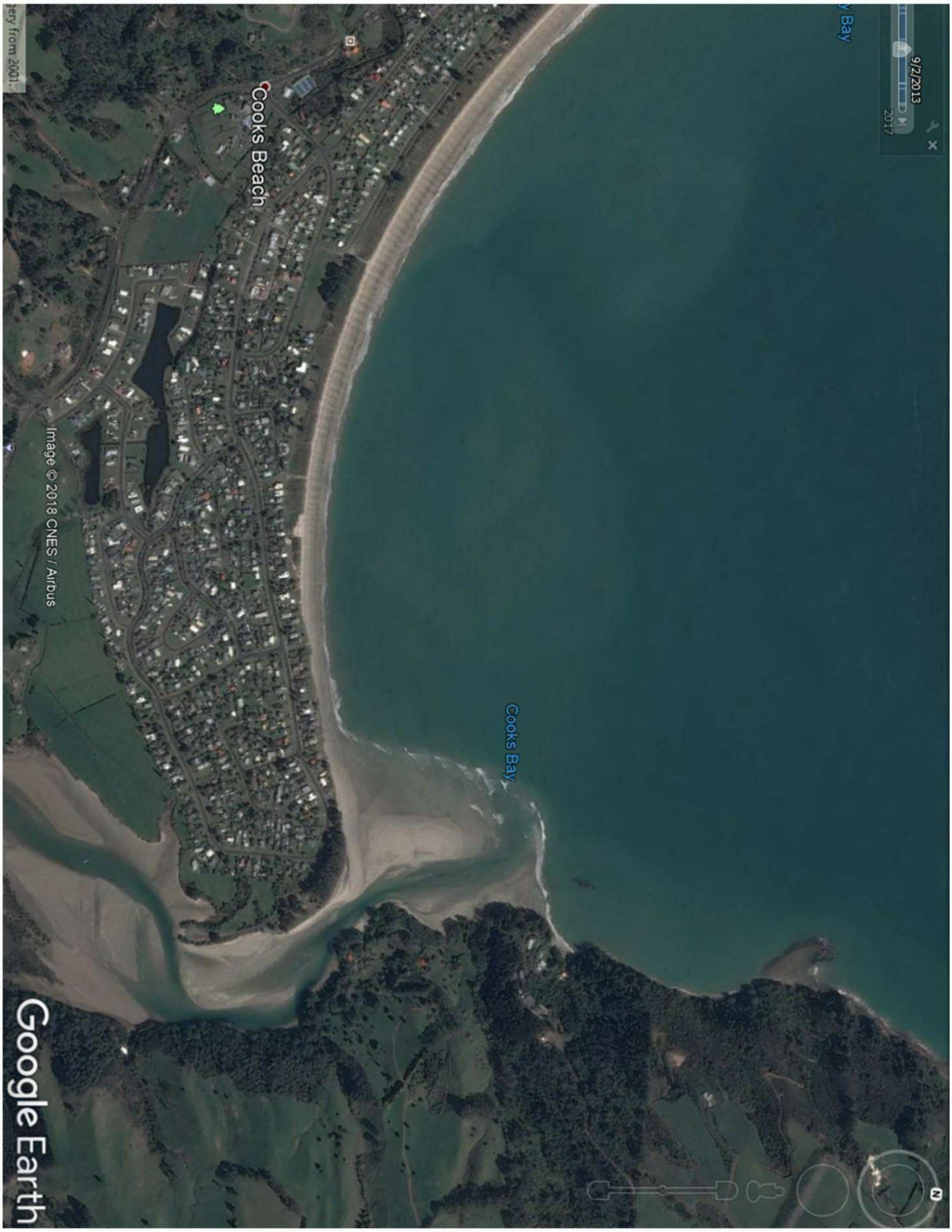
2007


Cooks Beach
Image © 2018 DigitalGlobe
Cooks Bay
Google Earth

April 2010

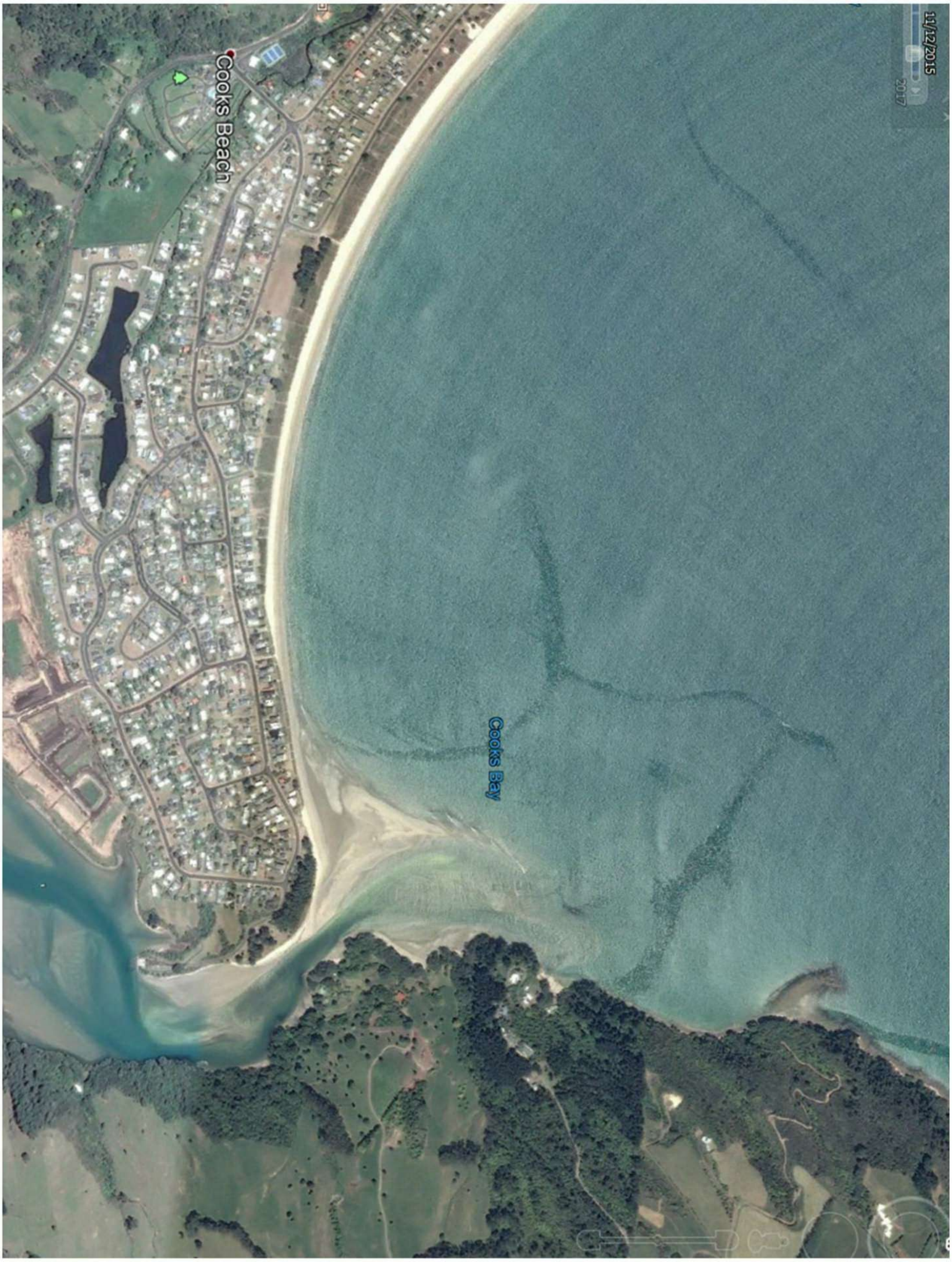

10/31/2010
Cooks Beach
Image © 2018 Thames-Coromandel District Council
Image © 2018 DigitalGlobe
Cooks Bay
Google Earth

Oct 2010

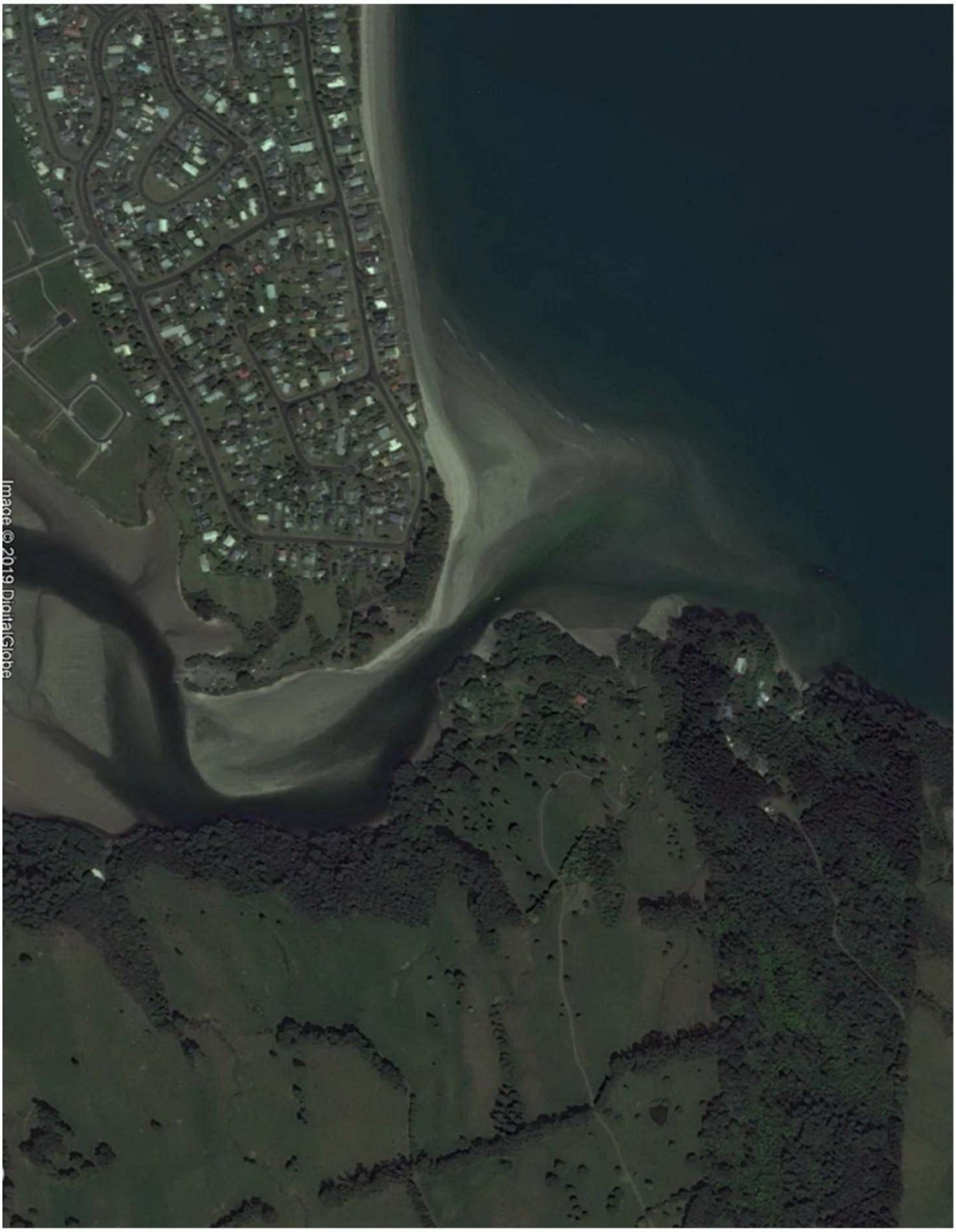


Cooks Beach
Cooks Bay
Image © 2018 CNES / Airbus
Google Earth
9/2/2013
2017

2013



2015



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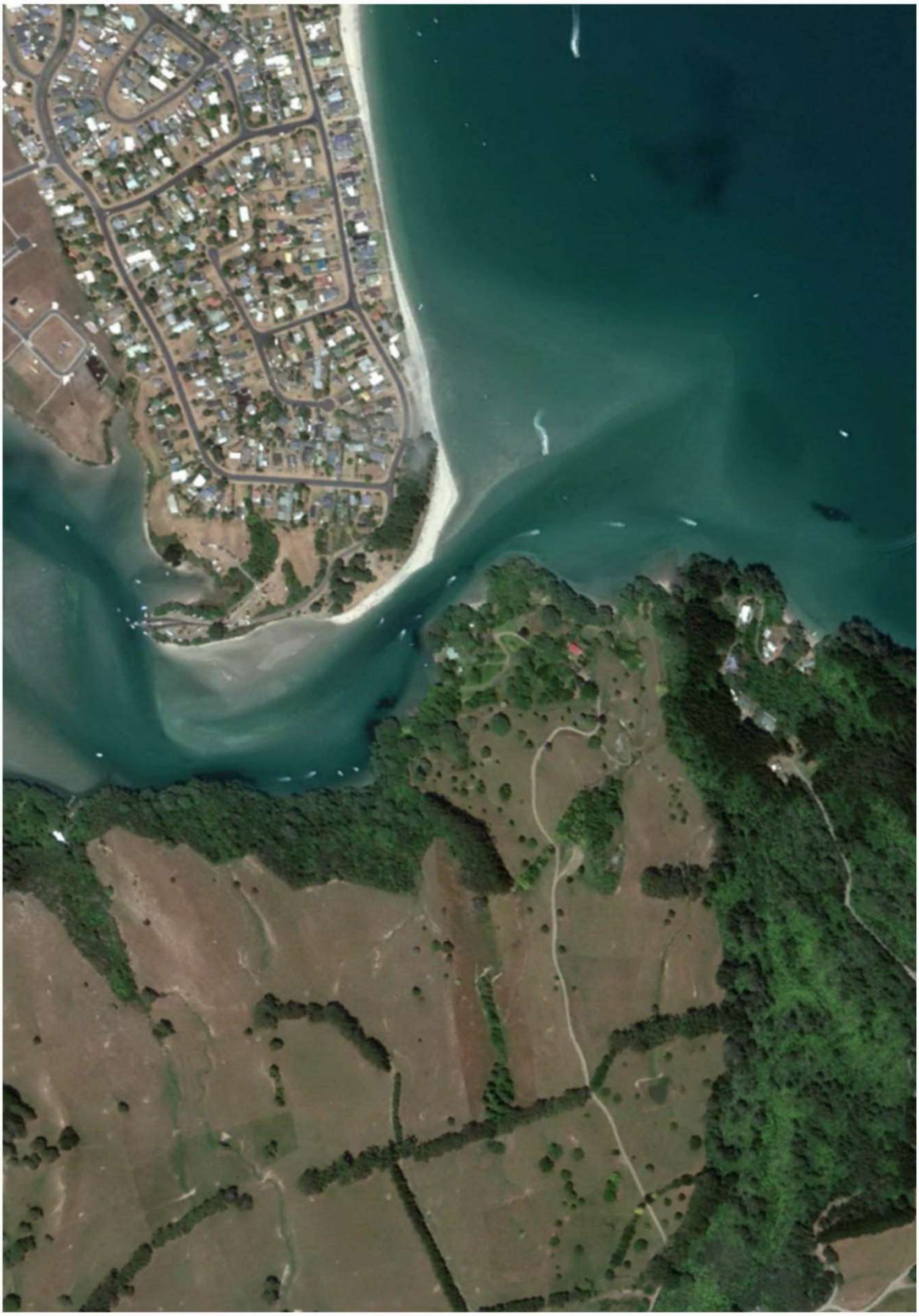

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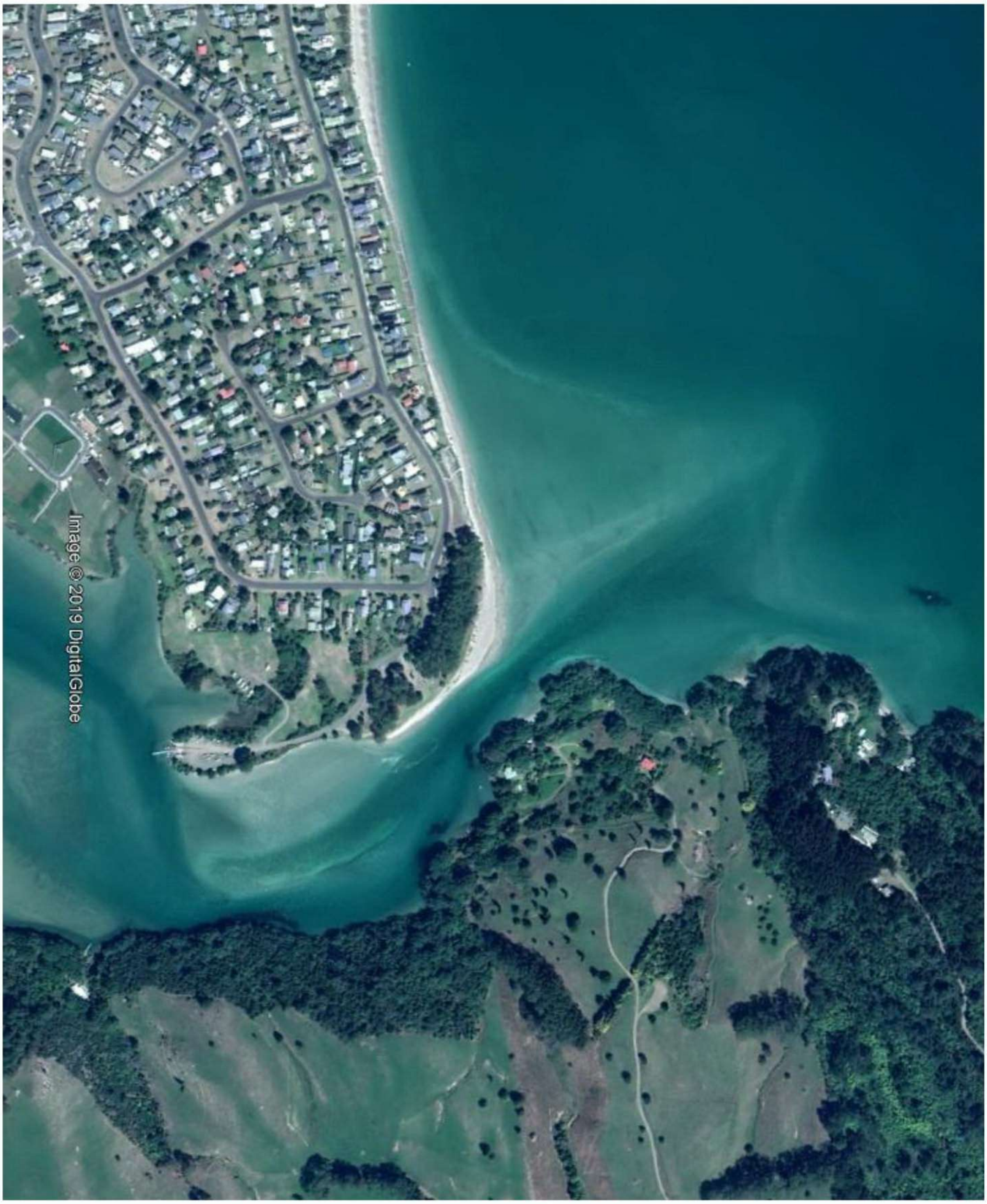

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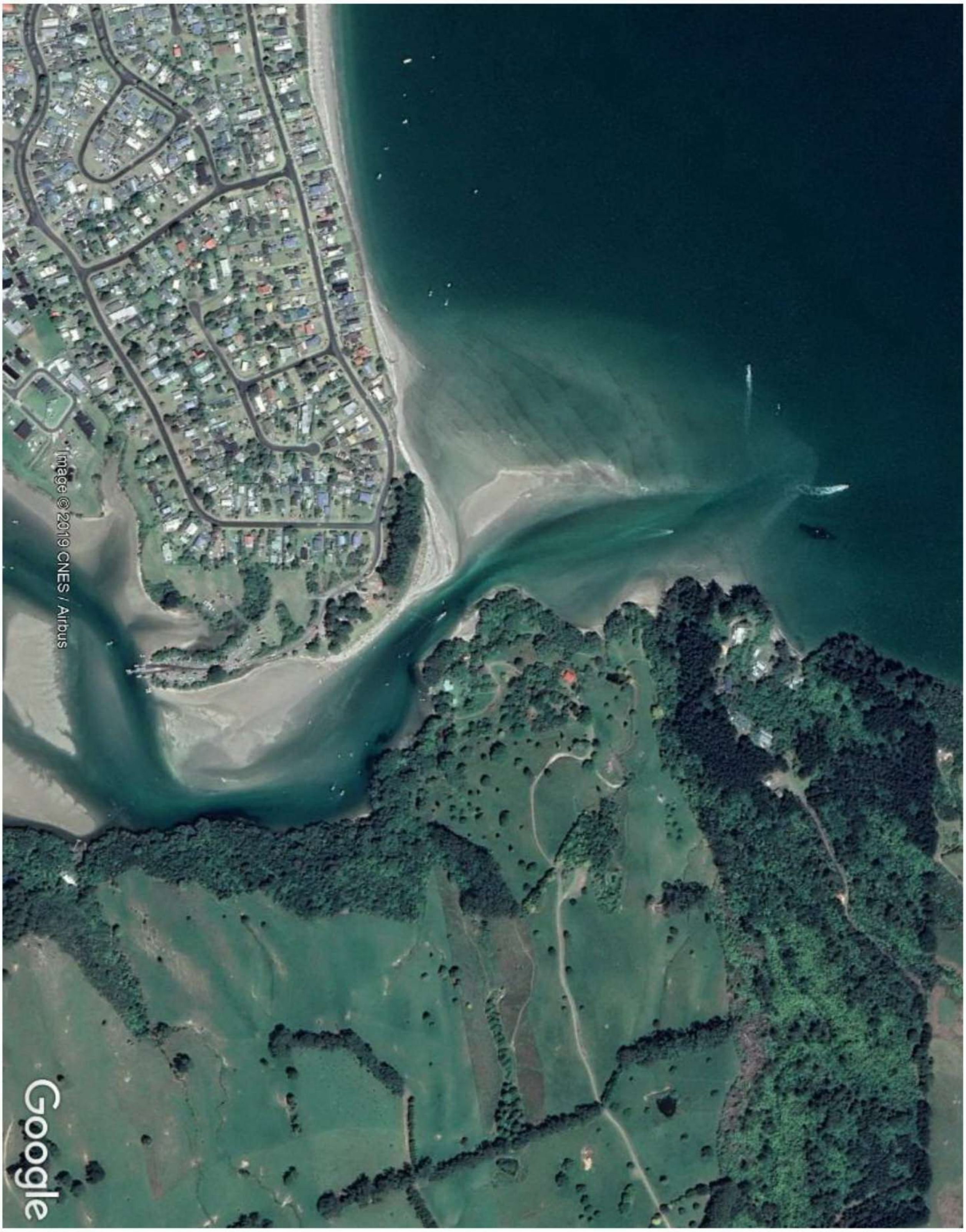

Dec 2018

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