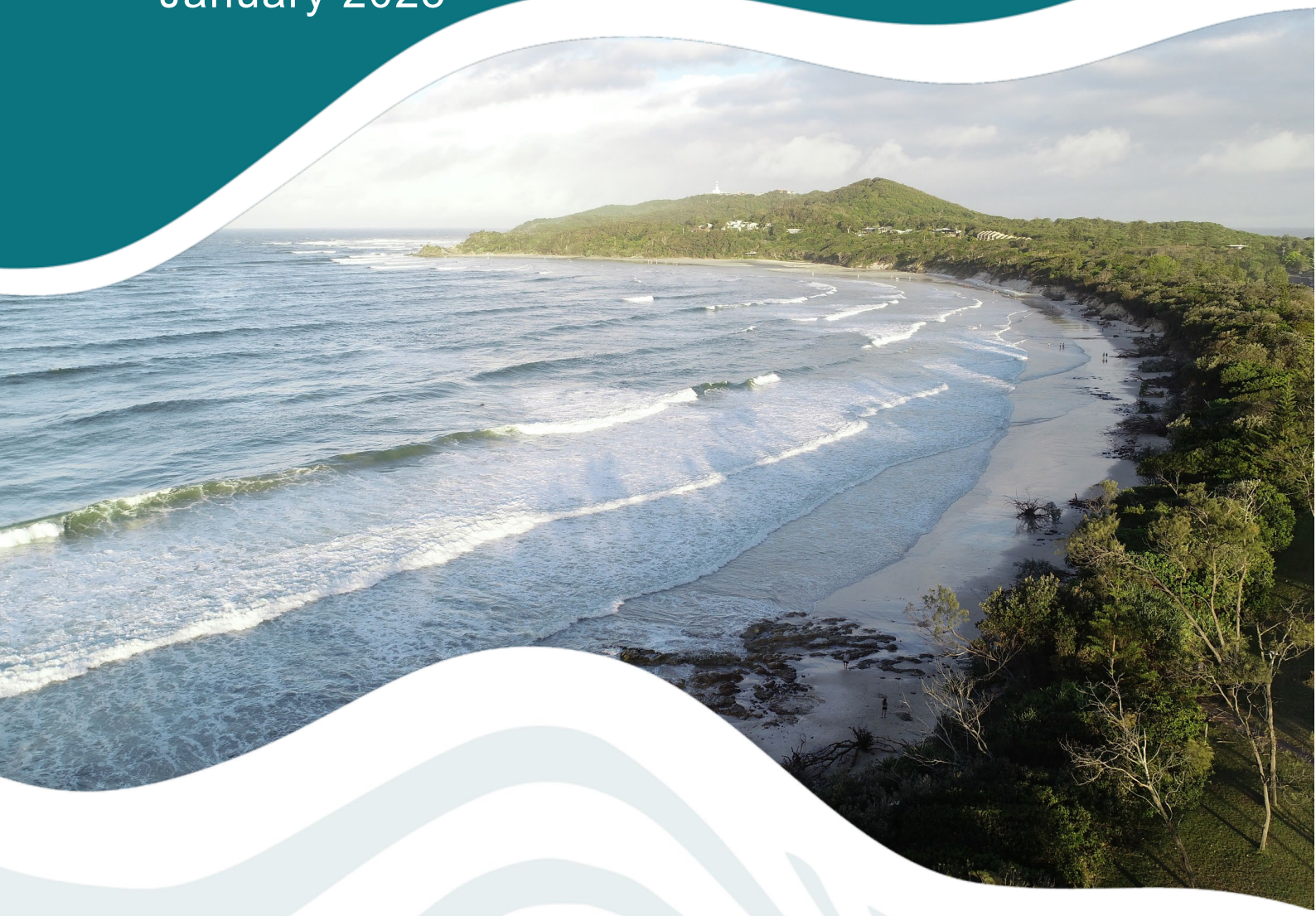
Main and Clarkes Beach Dune Recovery Project

Summary Report

January 2023



BYRON SHIRE COUNCIL

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Front Page: Aerial drone imagery of an eroded Main and Clarkes Beach – taken after the coastal erosion event (23 December 2020).

Introduction

During November 2022, Council commenced a dune recovery project at Main and Clarkes Beach, Byron Bay (Figure 1). The project is half funded through the Department of Planning and Environment's Coastal and Estuary Grants Program which provides technical and financial support to local government to help manage the coastal zone.

The aim of the project is to:

- Aid in the restoration of the dune system to assist in the recovery of its form and function;
- Aid in the rehabilitation of the dune ecosystem and habitat; and
- Improve the public's beach safety, access and amenity.

The project involved 'beach scraping and dune reprofiling' whereby small volumes of sand (i.e. small in the context of annual littoral transport volumes) are moved from the intertidal zone by mechanical means, to the back of the beach to aid in dune recovery.

Project components include:

- Planning documentation and approvals;
- Community and stakeholder engagement;
- Surveys and monitoring;
- Beach scraping and dune reprofiling works;
- Restoration and decommission of public beach access ways;
- Vegetation revegetation works; and
- Fencing of beach access ways and dune area.

Figure 1: Aerial drone imagery of an eroded Main and Clarkes Beach, taken after the coastal erosion event (23 December 2020).

Background

Coastal erosion has been a challenging issue for the Byron Shire Council and the Byron Bay community for many decades. Since the 1950s, 60s and 70s, cyclones and east coast lows have caused extensive damage to the Byron coastline, with these events most likely to occur during summer and autumn months. Erosion caused by storm events may also be significantly exacerbated by inconsistent sand supply to the Byron Bay embayment due to natural headland bypassing processes.

After a period of relative calm, since 2016, and rapidly increasing mid-2019 onwards, Clarkes and Main Beach in Byron Bay became subject to significant coastal erosion which resulted in significant losses of sand from the beach and foredune; damage and subsequent closure of beach access ways; and significant loss and damage of dune vegetation (Figure 2). Several erosion events caused by sand supply deficit, storm wave attack, combined with elevated water levels during large spring tides resulted in significant dune scarping along the majority of the dune system within the reserve.

In the short timeframe between April 2020 and July 2021, the dune eroded up to 45 metres landward, resulting in the significant loss of dune vegetation, formation of an unstable dune scarp and damage to beach accessways and other infrastructure.

In 2021, a large volume of sand slowly started to return to the Byron Bay embayment, assisting in the partial recovery of the eroded beaches. However, due to the significant volumes of sand lost from the dune system, it would likely take many years (if not decades) for the Clarkes and Main Beach dunes to recover to pre-storm form and function. The dune recovery project aims to assist sand migration onshore during the accretion phase to speed up the beach rebuilding process by using soft dune stabilisation practices including beach scraping (also known as sand harvesting) and dune reprofiling.

The expected outcomes of the project are:

- aid in restoration/rehabilitation of dune ecosystems and habitat;
- protection of cultural heritage;
- restoration of public beach access ways;
- improved beach amenity; and
- improved benefit for the Byron Bay community.

Figure 2: Photo of an eroded Clarkes Beach looking west, showing cobbles and coffee rock deposits (31 July 2020).

Project components

PLANNING DOCUMENTATION AND APPROVALS

With beach scraping works to be undertaken within the Cape Byron Marine Park Habitat Protection Zone declared under the *Marine Parks Act 1997,* a Marine Park permit was required. A comprehensive and detailed Review of Environmental Factors (REF) was completed for the project. The REF was undertaken under Part 5 of the *EPA Act 1979* to ensure that all aspects of the project were covered by an environmental assessment. The REF provides a description of relevant environmental planning instruments that apply to the project and is provided on Council's webpage along with other project related information (Figure 3).

Beach scraping works are considered *dredging work* under the *Fisheries Management Act 1994* which require approval from the Department of Primary Industries – Fisheries. With the works also proposed to be undertaken within the Cape Byron Marine Park a combined Fisheries and Marine Park permit was obtained.

The project involved beach scraping and the movement of small quantities of sand for restoration of beach access, improving public safety and beach/environmental amenity. The project was considered a foreshore management activity permitted without consent under the State Environmental Planning Policy (SEPP) Transport and Infrastructure 2021. The project did not include beach nourishment, or the placement of sandbags for more than 90 days, or maintenance or repair of coastal protection works and hence was not considered to be *coastal protection works* under the *Coastal Management Act 2016*.

The project extent was wholly located within the Crown Lands Reserve of Main and Clarkes Beach. With Council as the Land Manager of the Reserve, a Licence for the works from Crown Lands (as the landowner) was not required as long as the works were above the low water mark and the project was consistent with the reserve purpose for Public Recreation.

Main and Clarkes Beach Dune Recovery Project

Listen

The dunes of Clarkes Beach and Main Beach, Byron Bay have experienced significant erosion stemming from a weather event in December 2020.

The erosion and recession has resulted in

- lowering the beach and berm,
- eroding frontal dunes,
- exposing sand layers (clay, coffee rock), and
- damage to beach accessways, paths and other infrastructure.

In September 2021 a build-up of sand in Byron Bay along with information from aerial photos showed the worst of the erosion could be over for now with sand starting to push back onto beaches.

We have received State Government funding through the Coastal and Estuary Grants Program to target the rebuilding and revegetating of the dunes, fencing and restoration of beach access in 2022.

The Main and Clarkes Beach Dune Recovery Project has been assessed as having minor and predictable impacts. A Part 5 assessment under the EPA Act 1979 has been completed and endorsed by Council. You can download the Review of Environmental Factors (REF) (PDF, 9MB) to learn more.

Beach scraping works are scheduled to take place during November 2022, with revegetation and accessway works to follow.

For more information, see the frequently asked questions below and project factsheet in Related Information of this page.

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Related Information

- Coast and waterways
- Coastal Hazards
- Coastal Processes and Storms
- NSW Government Coastal and Estuary Grants
- Main and Clarkes Beach Dune Recovery Project (PDF, 261KB)
- Review of Environmental Factors (REF): Main and Clarkes Dune Recovery Project.pdf (PDF, 9MB)
- Angus Gordon Full Paper on Nature Assisted Beach Enhancement (NABE).pdf (PDF, 95KB)

Figure 3: Council's project webpage and link to the REF.

COMMUNITY AND STAKEHOLDER ENGAGEMENT

Engagement

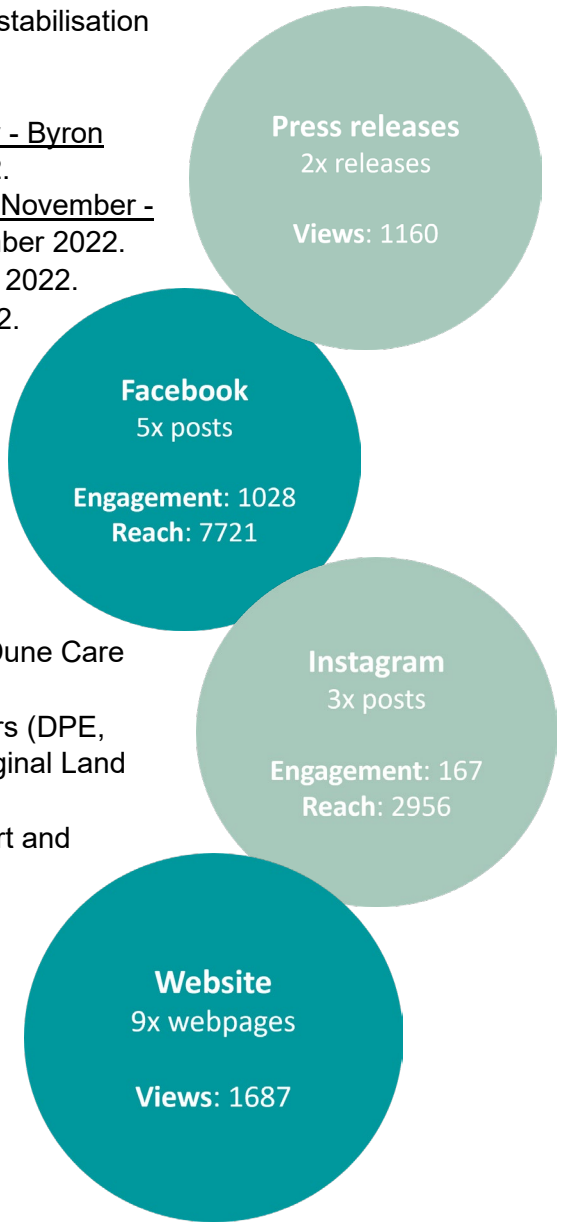
A Community and Stakeholder Engagement Plan was prepared for the project in consultation with Council's Communications Team. The plan outlines the key groups and stakeholders to be consulted and methods for consultation. Consultation was designed to be detailed and commence early, with continuous consultation occurring with key stakeholders to gain feedback, advice and input for incorporation in project planning, REF and project implementation.

A Project Working Group was formed, meeting every 3-4 weeks, to discuss the key components of project delivery. Agenda and Minutes were recorded for each meeting.

Key communications and engagement activities completed for project include:

Council webpage created with Fact Sheet

- 1x Advert in The Echo.
- Front page article in The Echo on 6 July 2022 – 'Soft stabilisation works' for Byron's beaches (Figure 4).
- 2 x Media Releases:
    - Helping nature rebuild the dunes at Byron Bay - Byron Shire Council (nsw.gov.au) – 20 October 2022.
    - Work on Byron Bay sand dunes to start on 21 November - Byron Shire Council (nsw.gov.au) – 15 November 2022.
- 5 x Facebook Posts: 25 October 2022 to 9 December 2022.
- 3 x Instagram posts: 25 October to 21 November 2022.
- Website: 9 webpages related to project (refer Main and Clarkes Beach Dune Recovery Project)
- Presentation to:
    - Council's Coast and ICOLL Advisory Committee.
    - Community Roundtable.
    - Byron Bay Masterplan Group.
    - Clarkes Beach Agency Working Group.
- Discussion with Green and Clean Awareness Team Dune Care group.
- On-site walk-overs with agencies and key stakeholders (DPE, Marine Parks, Arakwal and Tweed Byron Local Aboriginal Land Council (TBLALC).
- Engagement of TBLALC for a Cultural Heritage Report and Cultural Heritage Induction pre-works.
- Engagement of Arakwal for Cultural Heritage Monitoring during works.
- Project notification emails to key stakeholder list.
- Phone calls to directly affected key stakeholders.
- Letterbox drop to adjacent residents.
- Radio Interviews:
    - ABC with Mick O'Reegan on Monday 24 October at 9.15am.



  - ZZZ2LM Jenny Burgess on 16 November 2022.
- Online Media:
  - ABC North Coast – Facebook. 'Byron Shire Council starts sand scraping to save Main Beach' - ABC News.
  - 7 News (Ballina).
  - You Tube video – Soil Conservation Service.
- Live TV:
  - Nine NBN 6pm News – 21 November 2022.

Media coverage
6x stories

Networks: NBN, ABC North Coast, ZZZ2LM radio, The Echo, 7 News

'Soft stabilisation' works for Byron beaches

Paul Bibby

Byron Council will undertake a major dune recovery operation at Main and Clarke's Beach, after securing much-needed government funding for the project.

This part of the Shire's famous coastline has experienced significant erosion and recession over the past two years.

Particularly devastating were the storms and historically high tides that occurred in December 2020, which removed the entire front face of the dune system, along with large volumes of sand, and the majority of dune vegetation.

Nine of the 14 access paths had to be closed owing to safety issues.

Last month, Council was advised that its application to the State Government's Coastal and Estuary Grants Program was successful, subject to Council meeting the balance of funds for the project, and agreeing to the funding terms.

Sand dune ecosystems

The project aims to restore the sand dune ecosystems of Main and Clarkes Beach, using various methods, including 'soft stabilisation' techniques.

It is hoped this will rehabilitate and restore the dune system to its pre-storm form and function, increase sand volumes stored within the dune to re-establish the coast's natural defence mechanism, and improve the public's beach safety, access and amenity.

'The project will involve beach scraping and dune reprofiling, which involves moving small to medium quantities of sand harvested from the swash zone and lower part of

► Continued on page 4

Figure 4: Excerpt from the front-page article in The Echo, 6 July 2022

Feedback

Formal positive feedback was received via email from two local community members and the Arakwal Corporation. This was in addition to numerous positive comments received by the team on-site during the 5-day beach scraping works campaign by beach users.

"I have been a local for over 20 years and want to recognise the great job you have done with the sand restoration at Clarkes beach Byron Bay. It looks amazing and probably the best I have seen it since we've been here. Keep up the great work" – Community Member

"The beach scraping project went very well. The crew that you had assembled to carry out the work did a fantastic job. I visited the site daily to view their progress and they exceeded expectations. Well done to you and the team" - Arakwal GM

Positive feedback (especially formally) by email to Council is rare in the coastal space. Coastal projects tend to draw some banter or chatter on social media feeds but this rarely resolves into formal correspondence.

"I'd like to congratulate Byron Shire for the work recently completed along Clarkes and Main Beaches to repair coastal erosion. It is great to see our tax and council rate contributions deployed to this important project. Please pass my thanks to the entire team involved" - Community Member

SURVEYS AND MONITORING

Environmental and Cultural

A detailed review of the potential project impacts to flora, fauna and cultural heritage within the project area was completed through preparation of the REF which included review of existing information and assessments, studies and reports, and GIS and threatened species database search.

The REF noted potential impacts of the beach scraping works to threatened species was through the presence and activity of machinery, through production of noise and through direct mortality of benthic macrofauna (infauna), e.g. worms, pipis and other invertebrates.

The REF noted the positive impacts to cultural heritage through restoration of the dunes, and hence protection of objects that may be contained within.

Benthic Inter-tidal Macrofauna

There is a wealth of literature on the impact of beach scraping on inter-tidal benthic infauna completed for beach scraping and nourishment projects, studies and monitoring programs in NSW, nationally and internationally. Locally within Byron Shire a detailed study was completed as part of the 2010 New Brighton Beach Scraping Trial by Professor Stephen Smith, a marine scientist from the National Marine Science Centre (NMSC) part of Southern Cross University. The study found that there was no immediate effect of beach scraping on the biodiversity and assemblage patterns (species richness and abundance) of beach infauna from beach scraping, and that the deposition of scraped sand did not cause major changes to beach granulometry (or gross modification to habitat). The study suggested that the high energy and dynamic nature of the beach environment means that infauna have the capacity to recover rapidly from physical disturbance.

To minimise impacts of beach scraping on benthic infauna a scrape depth of 0.2m was recommended and has generally been adopted as best practice in NSW. [*Of note is that a single storm event can remove 1m+ of sand from a beach in a matter of hours]*. This beach scraping project comprised mere scraping of a 20-30cm depth at a much slower timescale. As such the likelihood of impact to benthic infauna was considered negligible.

However, as the activity had not been undertaken at this location (or within the Cape Byron Marine Park) to date, it was acknowledged that preliminary surveys are advantageous to understand species composition and distribution at this location and to highlight any concerns related to biological assemblages at this location. As such, the Department of Planning and Environment reached out to the previous author and scientist at the NMSC to undertake preliminary surveys in the project area to identify infauna assemblages across transects. The primary objective of this study was to determine if there were any rare or unusual species or assemblages amongst the beach infauna, or unusual densities of specific taxa (e.g. ghost crabs) in the study area (Figure 5 and Figure 6).

Figure 5: Scientists collect sand samples from intertidal zone for sieving and assessment (left) and scientists assessing sieved sample (right).

Figure 6: Scientist and author of the study assesses the macrofauna after sieving the core sample of sand (left) and worm specimen kept for identification (right).

Outcomes of the study concluded that the beach infauna assemblages sampled during the preliminary investigation did not contain any rare species or unusual assemblages and based on the observations from previous beach scraping work in the region, were unlikely to be severely impacted by the planned beach scraping. While ghost crabs will be affected over the short-term through burial of their primary habitat they were predicted to make a rapid recovery as densities in the adjacent areas support good populations of these highly mobile crustaceans. This was evident by the newly established crab holes in the dune the day after scraping (Figure 7).

Figure 7: Newly built dune with machine tracks and machines in the background (left) and crab holes visible in machine tracks post-scraping works (right).

The full report is provided in Appendix 1: Preliminary survey of beach macro-infauna at Clarkes Beach, Main Beach and Cavanbah Beach, Byron Bay.

Threatened Fauna Species

Threatened fauna with the potential to occur in the project area primarily includes shorebirds and turtles. The project area is a moderately disturbed environment with eroded and scarped dunes and therefore highly unlikely to represent good quality habitat for threatened species, however shorebird species are known to inhabit and nest further west at the entrance of Belongil Creek. Due to the small footprint of the works in terms of overall beach habitat and short duration (i.e. temporary nature) of the works, the likely impact to threatened species and biodiversity was considered low.

That being said, the location is a valued conservation area adjacent National Park estate and on occasion there have been turtles and shorebirds nesting at the location. Logger head and green turtles' nest between December and March so the timing of the physical scraping works was undertaken prior to mid-December to significantly reduce the potential for impact on nesting sea turtles.

The timing of works also aimed to reduce potential conflict with nesting shorebirds, such as Pied Oystercatchers, Little Terns and Beach Stone Curlews, as well as other bird species that may utilise the dune environment for nesting, for example Rainbow Bee Eaters and Pardalotes.

Prior to works commencement an ecological inspection was undertaken by project staff and Byron Bird Buddies to monitor for nesting birds, turtles, large reptiles and other native fauna that may be residing in the dune and upper beach areas. Where nesting fauna was identified, flagging tape was used to identify the potential location of the nest. During the works, daily inspection of beach and dune preceded works start up. The checks were

completed as part of the pre-start checks and work site evaluation. Any nest sites were clearly marked and works in the vicinity avoided until the site/s was no longer actively used. The main fauna observed during inspections were a large Carpet Python, Masked Lapwing Plovers, Rainbow Bee Eaters and Seagulls (Figure 8). No nesting shorebirds or turtles were reported during the works.

Figure 8: Carpet python located in back beach area of dunes amongst grass (left) and Rainbow Bee Eater resting on dune scarp (right).

The outline of Ecological Inspections completed is provided in Appendix 2: Ecological inspections.

Flora

During preparation of the REF a complete desk-top search of BioNet Atlas of NSW was completed. 32 listed threatened flora species were identified as potentially being recorded within a radius of 10km of the project site. An internal search of Council's and BioNet records indicated no presence of threatened flora species within the project area.

The REF concluded that project works will not disturb vegetation communities, rather the vegetation restoration associated with the project aims to enhance and maintain the communities into the future.

Any impacts to dune flora / vegetation was expected to be positive as the project aims to restore the dune habitat and associated vegetation through seedings, cuttings and plantings, enhancing and maintaining the vegetation communities into the future.

Minor smothering of existing vegetation was expected due to the placement of scraped sand. Some ground covers such as Spinifex are adapted to being buried by sand and are known to grow through the sand after beach scraping programs. However, any plants that were deemed to potentially not survive burial were considered for temporary re-location or placement above the sand placement zone. (Figure 9).

Figure 9: Vegetation specialist relocating Goats Foot ground cover to further up the dune face out of the impact area.

Aboriginal Cultural Heritage

There are a variety of culturally significant areas within the coastal zone that includes pathways, middens, stone arrangements, stone resource sites, ceremonial sites and burials. Some of the sites are listed on the State database and are in close proximity to the project area. These culturally significant objects, resources and areas are at risk of loss due to natural coastal processes. As part of the preparation of the REF a site walkover with Traditional Owners was undertaken and a report was produced by the Tweed Byron Aboriginal Land Council which provides an outline of the recommendations to Council as to how to minimise any project risks to Aboriginal cultural heritage.

The report outlines the zero likelihood that the recently deposited beach sand will contain any cultural heritage objects. It also reconfirms that restoration of the dune erosion is the best way to protect and preserve the midden deposits and any other cultural heritage that may be present in the dune system. The REF concludes the impact to cultural heritage is expected to be positive as the project will help to rehabilitate and restore the dunes, thereby protecting any objects within the dune system.

Due diligence was applied to the project with staff/contractors undertaking an on-site Cultural Heritage Awareness Induction on the first day of works (Figure 10). Works proceeded with caution, and implementation of a ‘Stop Work Procedure’ if any Aboriginal objects are found. An Arakwal Cultural Site Monitor was present to oversee the 5 day scraping works.

No cultural objects were found during the 5-day works campaign.

Figure 10: Objects discussed during the on-site Cultural Heritage Awareness Induction provided to the project crew - 21 November 2022.

Beach profile inspections and drone surveys

Beach Inspections

In the lead up to project commencement, beach inspections were undertaken to assess the beach condition to inform the most suitable project start date. Inspections comprised a walkover on-site to visually assess the width and approximate height of the beach berm, intertidal zone and sand coverage, locations or exposure of any geomorphic features (bed rock or coffee rock) and limit of wave run-up. Based on the beach inspection completed on 31 October, the project team made the decision to delay the commencement of works by 2 weeks from 7 November to 21 November due to concerns of a less accreted beach profile at Main Beach.

Coastal conditions were closely monitored in the lead up to project commencement. Forecast coastal conditions were for favourable/calm conditions with no significant swell events during a spring tide range of high tides above 1.7m ISLW. The experienced coastal conditions were extremely favourable with bay like conditions – nil to little wind, small waves and blue skies (Figure 11).

Figure 11: Blue sky days and calm conditions for the works.

The outline of beach inspections and coastal conditions is provided in Appendix 3: Beach inspections, forecast coastal conditions and approach to methodology.

Drone Surveys

Pre and post works drone surveys were completed to capture information about the state of the beach before and after works, ensure that an adequate depth of sand was overlying geomorphic features and to measure the amount of sand gained during the program of works and the form/profile of the newly built dune.

A summary of the results in provided later in the report.

BEACH SCRAPING AND DUNE REPROFILING WORK

Methodology

The proposed methodology for the works as outlined in the REF comprises moving small amounts of sand from the intertidal zone and placing it above the wave run-up limit. This creates a flatter beach profile (Figure 12) and accretion of the lower beach is accelerated where a flatter profile exists. Sand quickly moves in from the outer surf zone to fill the scraped area and re-establish the profile.

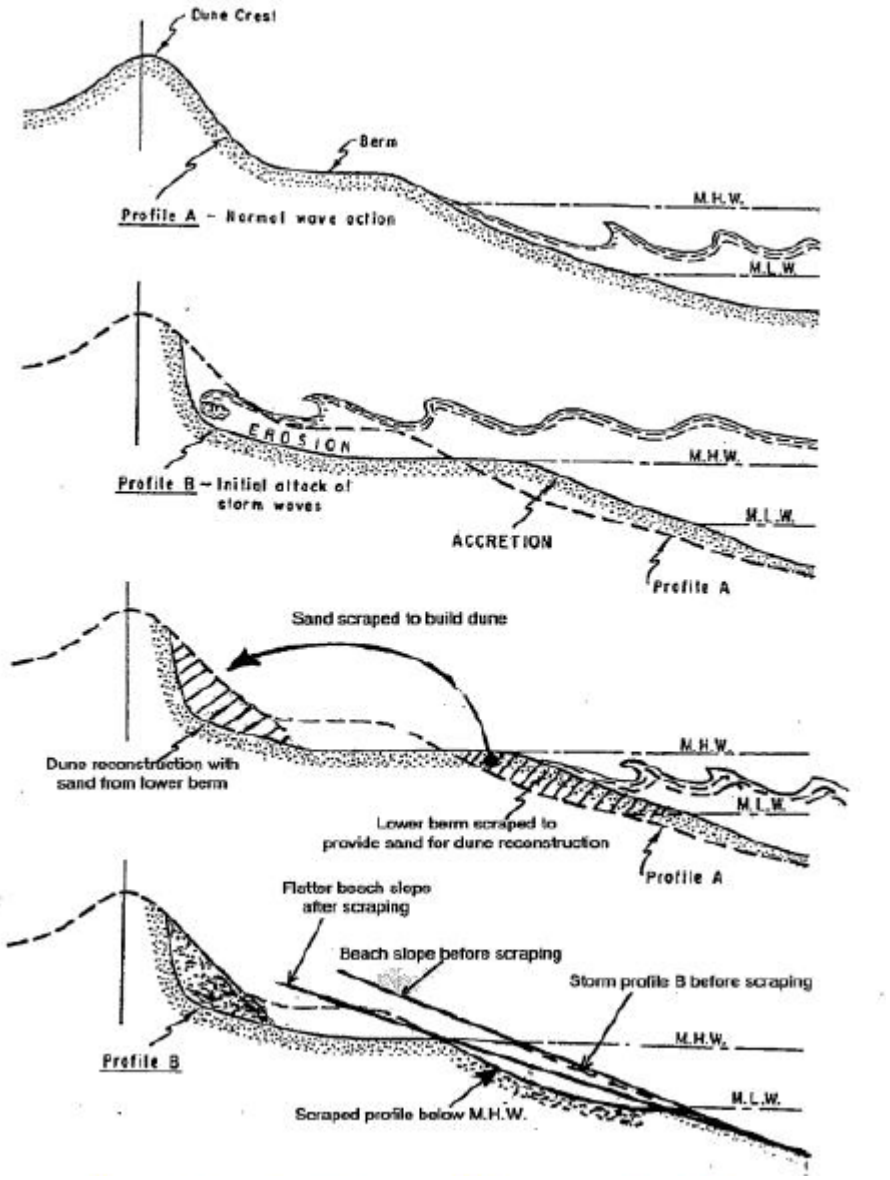


Figure 12: Concept of beach scraping

The project team discussed and refined the methodology closer to the commencement date, based on beach inspections and forecast conditions, discussion with the contractor, best practice, local knowledge, staff technical expertise and past project experience. A Project Inception meeting on the morning of the first day of the works was conducted to refine the works methodology, discuss safety management, environmental controls, and undertake a Cultural Heritage Awareness Induction (Figure 13).

Figure 13: Project Inception Meeting for staff and contractors, day one of beach scraping works – 21 November 2022.

Key points on the methodology approach to the scraping works are outlined below. Full details of the methodology can be found in the REF.

- Implementation of a beach scraping exclusion zone (i.e. no take sand area) of approximately 100m directly in front of the Surf Club to mitigate any risk to the less accreted area of Main Beach.
- The borrow area will be around a 40-50m wide scrape zone within the intertidal area up to a length of 750 longshore, with the aim to win 10-15m3 per lineal meters over several passes.
- Beach scraping works to start at the western end of the site (Surf Club) to win sand from the intertidal, before the larger predicted tides interact with the beach from Day 3 (Wednesday 23 November) onwards.
- Beach sand to be scraped/harvested by two machines (excavators) in a borrow area from the lower part of the beach. Excavators have better access and reach to intertidal sand and can work in the lowest part of the beach wining the most sand from the zone which is re-worked constantly through the entire tidal cycle. Sand is excavated to a shallow depth of 20-30cm per pass and placed on the beach berm in windrows.
- Two bulldozers are used to push the harvested sand up the beach face towards the dune scarp. Excavators are then used to place sand with precision at the base of the dune scarp to form an incipient dune, help to stabilise significant dune scarping and high risk mature dune vegetation, and to reinstate beach accessways.
- A Posi-track to be on stand-by to groom the beach berm following scraping completion of works as deemed necessary to reduce public safety risks and/or improve beach amenity.

Works program

Beach scraping works were completed over five days from Monday 21 November to Friday 25 November 2022. The contractor started early at 7.00am each day and finished late around 5pm maximising the long summer daylight hours. The day-to-day summary works program is outlined in

Table *1* below. The western portion of Main Beach received a second scrape as this area was prioritised due to the lack of frontal dune and thin stand of trees at risk of collapse.

Table 1: Summary of 5 day works program.

Date	Time	Tidal Condition	~ Metres of work area	Comments
21 Nov	7:00 AM	HT: 7:18 @ 1.45m LT: 13:12 @ 0.42m	140m	Opposite 22 Bay Street to Opposite 43 Lawson Street
22 Nov	7:00 AM	HT: 8:00 @ 1.58m LT: 14:02 @ 0.35m	190m	Opposite 43 Lawson Street to Opposite 44 Lawson Street
23 Nov	7:00 AM	HT: 8:43 @ 1.7m LT: 14:52 @ 0.29m	260m	Opposite 44 Lawson Street to Opposite 62-64 Lawson Street
24 Nov	7:00 AM	HT: 9:27 @ 1.79m LT: 15:45 @ 0.25m	520m	West of BBSC to Opposite 50 Lawson Street. Second scrape of areas outside of exclusion zone.
25 Nov	7:00 AM	HT: 10:13 @ 1.85m LT: 16:38 @ 0.24m	200m	Opposite 62-64 Lawson Street to the Beach Byron Café

Figures 14 to 18 provide visual representation of the works area each day. The **green lines** indicate the extent of scraping completed each day (i.e. metres of work area).

Figure 14: Day 1 (21/11/22) beach scraping works, located opposite 22 Bay St to opposite 43 Lawson St.

Figure 15: Day 2 (22/11/22) beach scraping works, located opposite 43 Lawson St to opposite 44 Lawson St.

Figure 16: Day 3 (23/11/22) beach scraping works, located opposite 44 Lawson St to 62-64 Lawson St.

Figure 17: Day 4 (24/11/22) beach scraping works, opposite Byron Bay Surf Life Saving Club to opposite 50 Lawson St.

Figure 18: Day 5 (25/11/22) beach scraping works, located opposite 62-64 Lawson St to the Byron Beach Café.

Restoration and decommission of public beach access ways

Prior to the erosion event of December 2020, along the approximate 750m length of Main and Clarkes Beach between the western access of the Byron Beach Café to the eastern access of the Byron Bay Surf Life Saving Club there were 12 public beach accessways. This equates to approximately an accessway every 60m. The erosion event impacted many of the accessways and some were temporarily closed to pedestrians due to safety (steep drop-offs etc). It was an intention of this project that permanent closure of some of the accessways would be completed to reduce the number of access entry points along the length of beach.

During the 5 day works program 3 out of the 12 accessways were decommissioned and 7 out of the 12 accessways were restored (refer Figure 14 and Figure 15). 2 accessways at the Surf Club are concrete ramps and not included in the works scope. Restoration of accessways involved removal of debris/waste material and reprofiling sand around the access track to allow a safe gradient. Decommission involved removal of waste and fencing and reprofiling / pushing sand into eroded areas.

Figure 14: Map of Main and Clarkes Beach access pathways permanently decommissioned (red symbol)

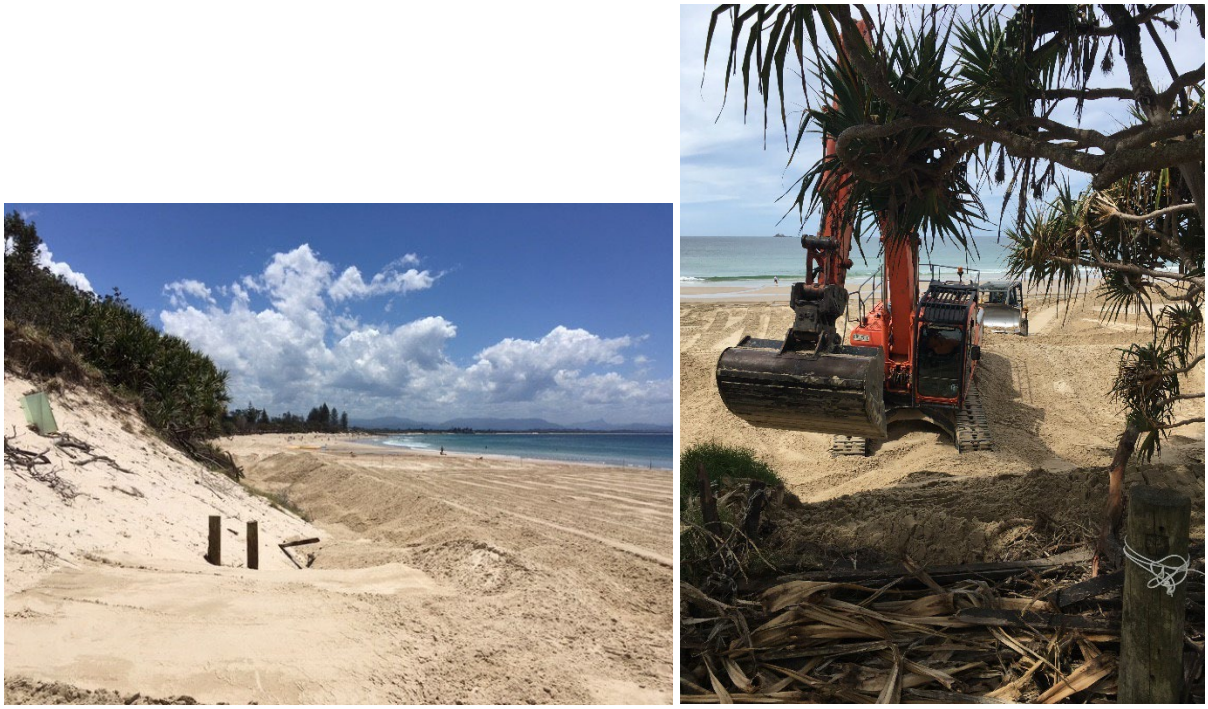


Figure 15: Restoration of Clarkes Beach Ex-Disabled Access (Access #11 from Figure 14) (left) and decommission of Dening Park West Access (Access #5 from Figure 14) (right)

Dune formation and vegetation management

The general plant zonation of natural dunes found on the north coast beaches is illustrated in Figure 16 and described below:

- Hind dune: the most landward zone with tertiary vegetation/large trees (Littoral Rainforest)
- Foredune: the first and often prominent ridge of sand behind and parallel to the beach, usually well vegetated with mid-level trees and shrubs (Wallum Heath)
- Swale: inter-dunal depression (low area) between the foredune and incipient dune provides a protected area for vegetation and accumulates organic matter.
- Incipient dune: a low, undulating accumulation of windblown sand between the beach face and foredune. Incipient dunes are the beginning stages of the dune colonised by fast growing ground cover vegetation and often eroded by storm waves.

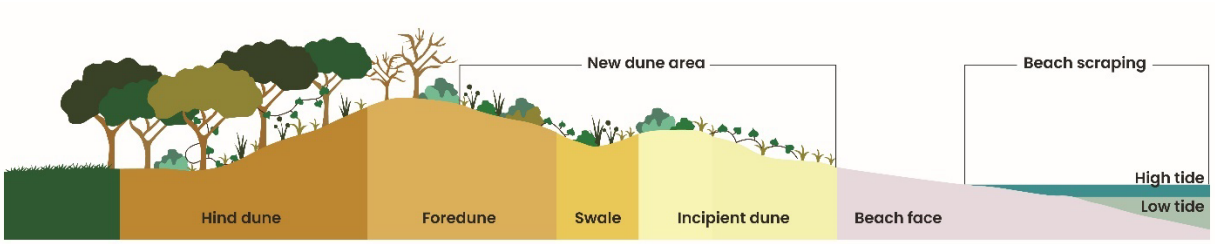


Figure 16: General plant zonation found across north coast foredune environments and showing scraping works location and newly built incipient dune.

The project focussed on creating a more natural style of beach profile and dune formation for Clarkes and Main Beach in alignment with general plant zonation. The hind dune area abuts directly to the grassy reserve and has been significantly impacted by erosion, resulting in the

loss of a significant amount of large trees and other dune vegetation. The most impacted area is the western extent, where the dune retreated up to 45 m landwards and where there is now limited hind dune vegetation remaining (only 1 row of larger trees). A lot of these large trees have exposed roots and are deemed to be at high risk of eventual lost due to direct wind and salt spray. Where success was deemed possible, a small amount of sand was pushed against the dune escarpment at certain locations covering the exposed tree roots in an attempt to stabilise the trees and allow for the roots to better retain moisture (Figure 17).

A large longshore incipient dune was built seaward of the dune escarpment up to a 4m AHD (Figure 17). Sand was also pushed over the incipient dune into the swale where there were large gaps and/or the bed level was low. As the dune starts to settle over the summer months with more northerly winds expected, sand will blow over the crest of the incipient dune into the swale, changing the formation of the dune shape from triangular to more rounded form and partially infilling the bed level of the swale.

The formation of the dune created is quite different to that created at New Brighton during the last beach scraping campaign in 2017. New Brighton beach does not have as wider beach face/berm with the dune squeezed between the road and wave run-up area. At New Brighton, the dune focus was on re-creating the foredune only. From time to time a small incipient dune does form when there is ample sand supply during calm conditions.

The purpose of the Clarkes / Main Beach approach was to create a more natural incipient dune form as well as; to minimise impact on existing foredune vegetation; create a more complex and lower wind velocity environment to encourage vegetation species diversity; create a wind trap for sand to fall into during northerly winds and thereby encouraging natural dune accretion whilst minimising loss of sand from the dune to the park reserve; minimise risk of impacts to cultural heritage, minimise pedestrian access across dune vegetation area; and minimise impact on nesting fauna.

Figure 17: Sand pushed against the escarpment under exposed trees (left) and new incipient dune formation (right).

The incipient dune at Clarkes Beach is above the wave run-up area during average ocean conditions and should remain in place for some time (depending on storm events), slowly growing with sand being fed from littoral drift, aeolian transport and captured by vegetation growth (ground covers). Due to the limited extent/width of the western area of Main Beach, the incipient dune is closer to the upper limit of wave run-up and may be impacted during high tide / moderate wave conditions. However, should the present accretionary / beach building phase continue with calm conditions over the summer, the beach will continue to widen and grow with time until the next period of erosion caused largely by storm events and a reduction of sand moving into the embayment as a result of reduced headland bypassing.

A Dune Vegetation Management Plan (VMP) was prepared for the project area by a local vegetation specialist in alignment with the with general plant zonation for natural dunes as outlined above and illustrated in Figure 16. The VMP comprises dedicated plantings, seeding and cuttings within the newly scaped dune area using diverse locally Indigenous species.

An area up to 5m within the grassy reserve has been expanded through fencing and revegetation, planted out with larger plants concentrating on species appropriate for the hind dune vegetation zone. This allows space for the dune to retreat landward instead of being squeezed between the ocean and the reserve (Figure 18).

Figure 18: Landward vegetated buffer within the grassy reserve to expand the hind dune area (yet to be planted out).

Monitoring of vegetation growth one month after planting shows rapid expansion of Goats Foot from the dune escarpment seaward into the swale area and germination of newly planted Spinifex (Figure 19).

Figure 19: Goats Foot ground cover slowly moving towards the ocean (left) and newly planted Spinifex starting to germinate (right), photos taken 11 December 2022.

Fencing of beach access ways and dune area

After the scraping works program was completed the dune fencing alongside the beach access ways was reinstated. Where existing fence posts could be retained or reused, this was done. Fencing consists of timber posts and 3-line Bayco® wire, similar to other beach fencing in the Shire. The alignment and location of fencing of the beach access ways focusses on streamlining pedestrian access straight to the beach, rather than allowing people to cut left or right onto the newly established incipient dune. New fencing was also installed along the beachside face of the newly formed incipient dune area for the entire project area between the Surf Club & the Beach Café. The beachside dune fencing ties-in to the beach access ways and the eastern and western extents in a smooth alignment. The fencing was positioned slightly up the front face of the incipient dune, above the potential wave run-up zone (Figure 20).

Figure 20: Fencing contractor - Clarkes Beach Café accessways (Access #11 from Figure 14) (left) and beachside fencing of Main Beach area (timber and 3-line wire) (right)

Signage

Temporary dune signage has been erected along the fenced dune and beach accessways (refer Figure 21). An informative project sign has been developed that will be installed within the reserve close to a main beach access way (Figure 22).

Figure 21: Dune and public access way signage.

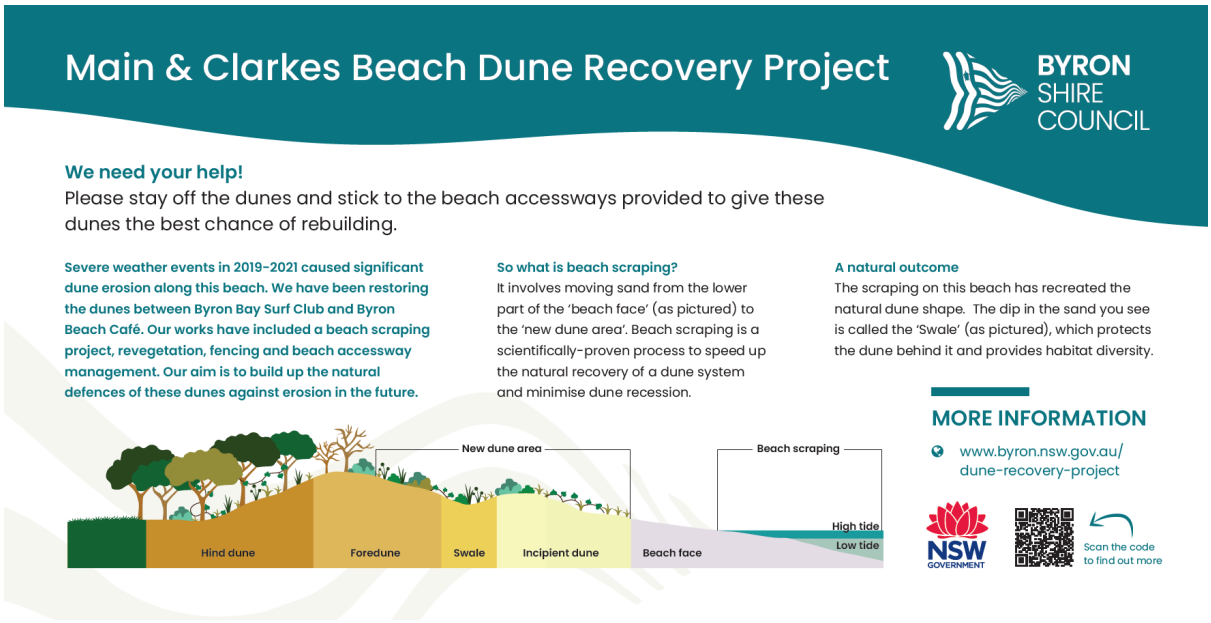


Figure 22: Project signage for the reserve.

Drone surveys, sand volumes and outcomes

Pre-works drone survey

Prior to beach scraping works a drone survey was undertaken on 15 November 2022 to estimate the height of sand along the beach profile along the longshore extent of the project works. The survey was compared to a previous survey from 15 December 2020 which illustrates the most recent eroded beach profile (captured by survey), to understand the level of sand above known coffee rock and peat layers on the beach.

The pre-works drone survey is provided in Appendix 4: Drone Surveys – Pre Works.

Note: Clearer detail is provided in the Appendix survey images than the figures in the body of this report.

Key features of the pre-works drone survey are summarised as follows:

- The central and eastern area has a smaller intertidal zone (width) in comparison to the western area which is quite wide as shown by the orange and yellow colouring (Figure 23).
- The central and eastern area has a larger beach face/berm up to 50m in width within in comparison to the western area which has a smaller beach face/beach berm around 10m width as shown by the green colouring (Figure 23).
- Outflow of the Cowper St stormwater outlet is clearly marked by a lower triangular depression in the beach berm flowing directly seaward.

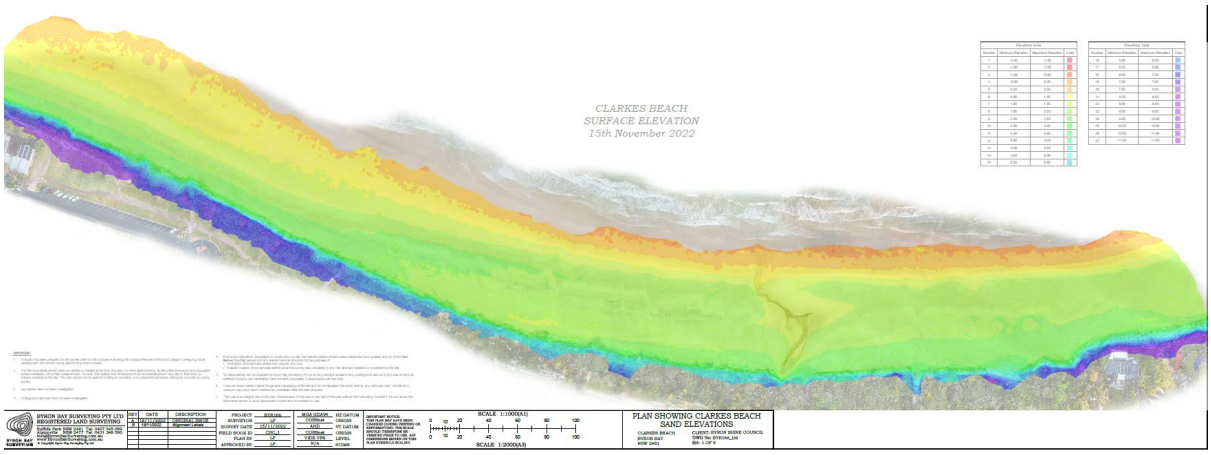


Figure 23: Surface elevation from 15 November 2022 pre-works drone survey.

- The beach face/berm of the western area has a low flat gradient which directly abuts the toe of the erosion escarpment at around 2.5m AHD (Figure 24). The central and eastern beach face/berm has a more natural shape and more pronounced and higher seaward hump formation (Figure 25).
- There was general clear gain of sand (i.e. accretion) along the entire project extent (with up to 2m of sand fill in the eastern area) deposited across the subaerial beach since the December 2020 survey (within 0m to 3m AHD surface elevation). Figure 24 provides an example of this gain of sand at Main Beach in front of the Surf Club between the surveys as shown by the difference in height elevation between the blue line (December 2020) and red line (November 2022).

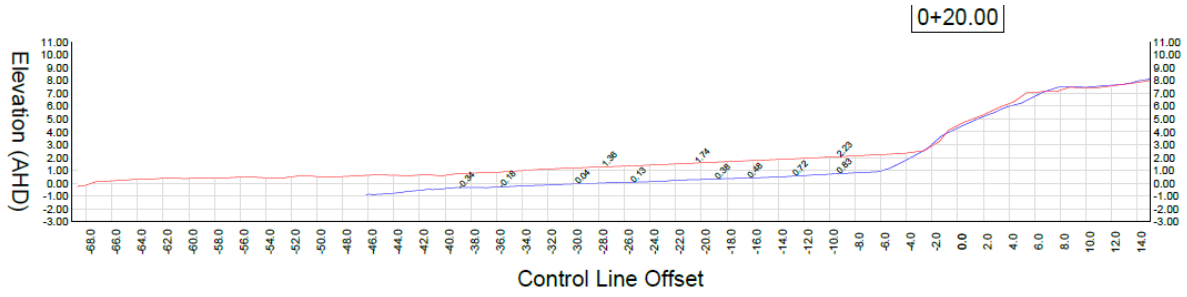


Figure 24: Beach profile elevation at Cross-Section 0+20 showing the height difference (up to 1.5m gain of sand fill) between 15 December 2020 (blue line) and 15 November 2022 (red line).

- Further recession of the back-beach erosion escarpment is evident along the majority of the project extent, apart from the western area of Main Beach (between Cross Sections 0+00 to 1+00), where the escarpment is already positioned significantly landward. Figure 25 provides an example of this landward recession of the dune

escarpment as shown by the distance between the toe of the dune escarpment of the blue line (December 2020) and red line (November 2022), which is up to 10 m wide in the central area.

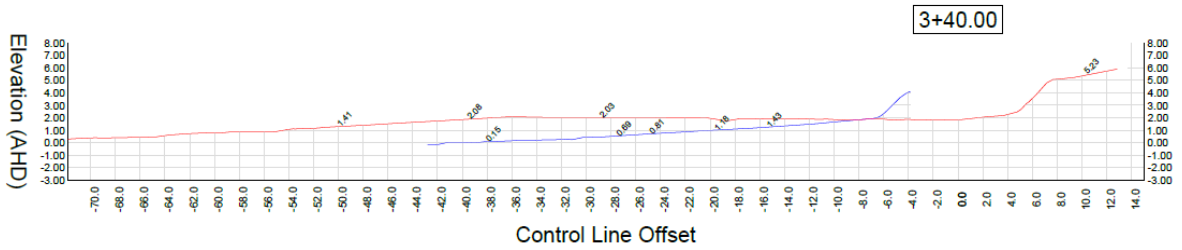


Figure 25: Recession landward of the back-beach erosion escarpment by up to 10m at Cross-Section 3+40 as shown by the distance between toe of the blue line and red line.

- The approximate volume of sand gained between surveys as defined by the red boundary between the 15 December 2020 and 15 November 2022 survey is 50,930 m3. The red boundary is defined as the area where a like-for-like spatial extent for both surveys could be compared. This equates to approx. 60m3/m of natural sand accretion over 2 years over an approximate extent of 850m.

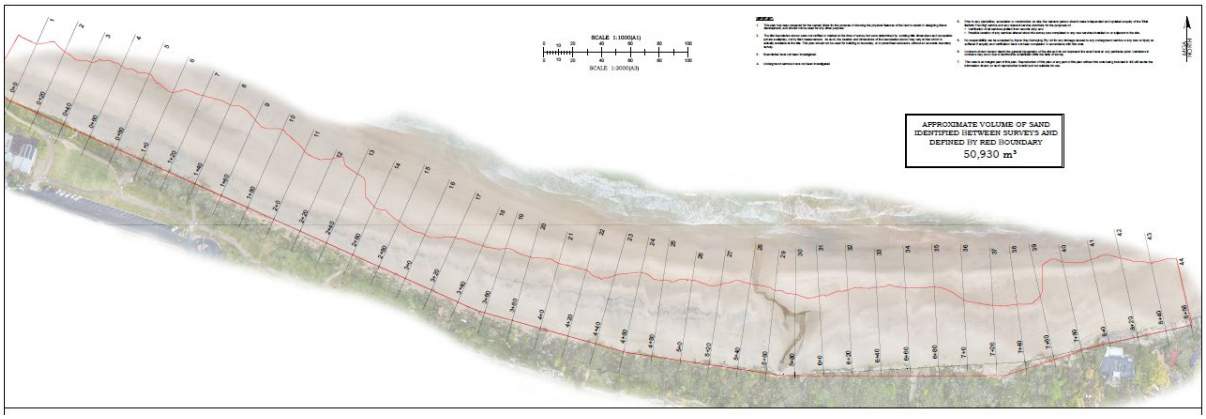


Figure 26: Approximate volume of sand gained between 15 December 2020 and 15 November 2022 survey is 50,930 cubic metres.

Post-works drone survey

A post-works drone survey was undertaken on 27 November 2022 to capture the height of sand along the beach profile and longshore extent of the works after the 5-day beach scraping campaign. This survey was compared to the pre-works survey completed on 15 November to understand the volume of sand gained by the beach scraping works.

The post-works drone survey is provided in Appendix 5: Drone Survey – Post Works.

Note: Clearer detail is provided in the Appendix survey images than the figures in the body of this report.

Key features of the post-works drone survey are summarised as follows:

- The western area intertidal area narrowed since the previous survey as shown by the small width of the orange and yellow colouring (Figure 23).
- The western area beach face/berm widened and increase in height since the previous survey as shown by the green colouring (Figure 23).

- Outflow of the Cowper St stormwater outlet is less pronounced with a shallower depression and narrower channel through the beach berm. There is minimal flow of stormwater directly seaward.

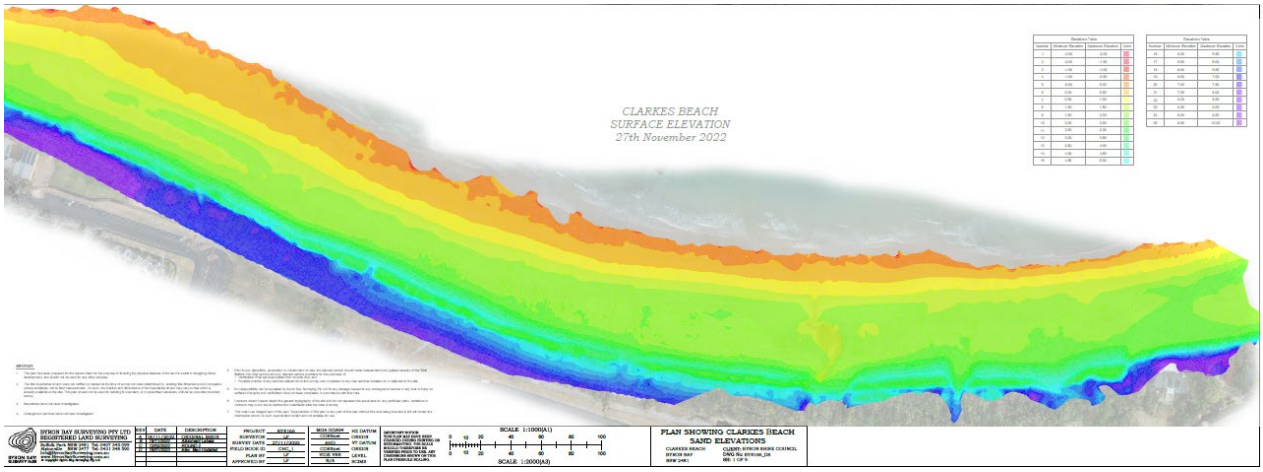


Figure 27: Surface elevation from 27 November 2022 post-works drone survey. The incipient dune and swale formation is shown as the light blue colouring that runs as a thin strip alongshore and seaward of the dark blue foredune.

- The new incipient dune and swale formation created by the beach scraping works is visible as shown by the light blue colouring in Figure 27 that runs as a thin strip alongshore and seaward of the dark blue foredune.
- The new incipient dune and swale formation has a dune crest height around 4m AHD and a width up to around 15m seaward of the foredune as shown in Figure 28.

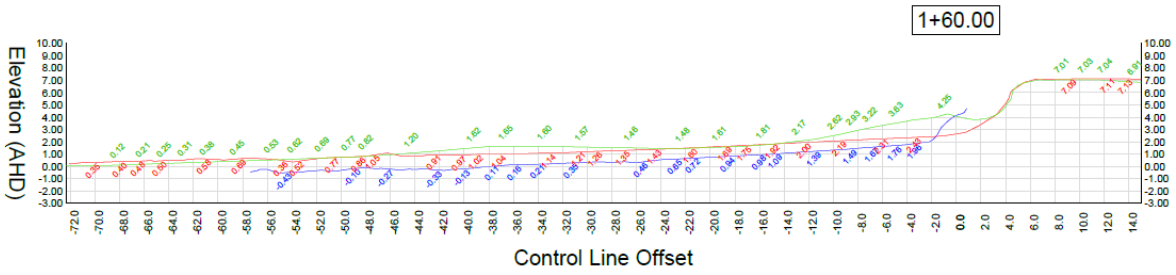


Figure 28: New incipient dune with dune crest around 4m AHD as shown by the green line at Cross-Section 1+60.

- Sand fill concentrated on forming the new incipient dune and swale formation and filling in areas below exposed trees where roots were visible (and the tree was assessed for possible successful re-establishment and stabilisation).
- In some areas sand was pushed directly up against the existing back-beach escarpment or within eroded areas of the dune as shown by the small fill area illustrated by the green line at a 45deg angle against the foredune as shown in Figure 29. This location is directly in front of the Surf Club where there was a large scallop eroded that was filled in (Figure 30).

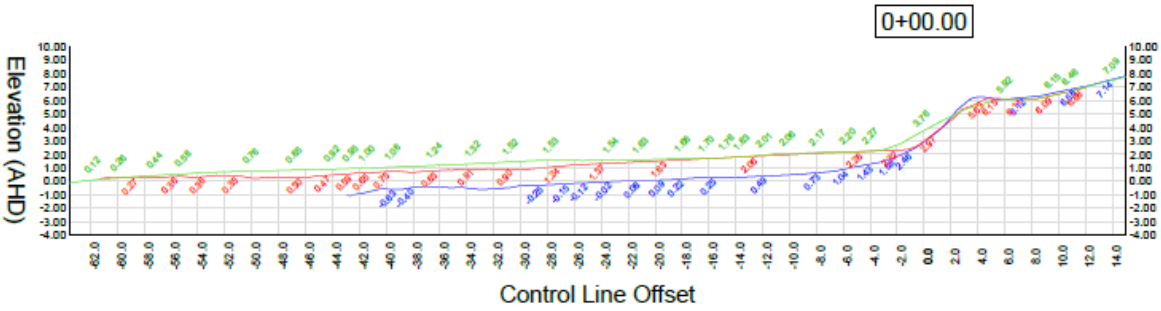


Figure 29: Sand pushed against the escarpment to fill in an eroded area in front of the BBSLSC as shown by the green line at Cross-Section 0+00 and Control Line Offset 0.0.

Figure 30: Photo of filled in eroded area in front of the Surf Club.

- There was natural accretion of the lower part/seaward face of the beach berm (within approx. 1m and 2m AHD) between the 15 and 27 November 2022 surveys. The largest gain in sand within the lower area is shown below at Cross Section 1+40 located just east of the Surf Club (Figure 31) illustrated by the height difference between the green and red lines in the central part of the cross-section (around Control Line Offset -36.0).

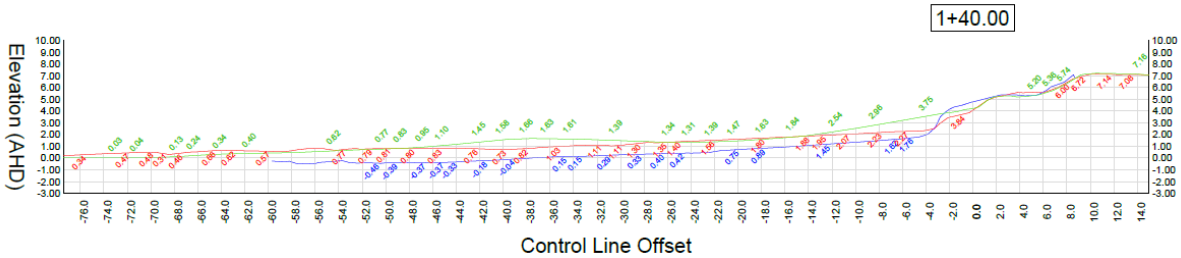


Figure 31: Natural accretion of the beach face/berm at Main Beach as shown by the height difference between the red line and green line at Cross-Section 1+40 and Control Line Offset -36.0.

- There was a small lowering of the lower part/seaward face of the beach berm within the central and eastern area of the project extent as illustrated by the height difference between the green and red lines on the LHS of the cross-section (around Control Line Offset -62.0) in Figure 32. This lowering was likely due to the tracking of heavy machines up and down the seaward face of the berm. There was quite a steep seaward face of the berm at Clarkes Beach due to the large ingress of the sand slug into the compartment and this steep face was reduced in gradient.

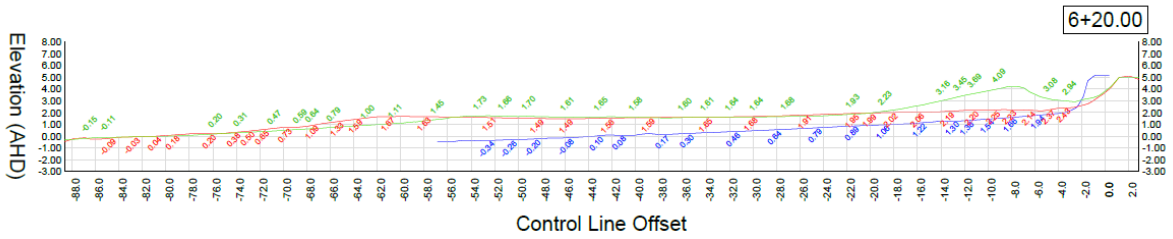


Figure 32: Lowering and decrease of the gradient of the lower part / seaward face of the beach berm at Clarkes Beach as shown by the height difference between the red line and green line at Cross-Section 6+20 and Control Line Offset -62.0.

- There was a small amount of natural sand accretion above the high tide area and swash zone between the pre and post drone surveys which aligns with the campaign being undertaken during beach building conditions.
- The approximate volume of sand gained between surveys as defined by the red boundary between the 15 November 2022 and 27 November 2022 survey is 12,000 m3 (Figure 33). The red boundary is defined as the area where a like-for-like spatial extent for both surveys could be compared. This equates to approx.14m3/m of sand fill gained over an approximate extent of 850m. Noting that beach scraping was only conducted within 650m of this 850m extent (i.e. the survey captured the area in front of the Beach Café where scraping was not undertaken), and hence the sand fill gained is more likely around 18m3/m. A small amount of this sand fill may be attributed to natural accretion.

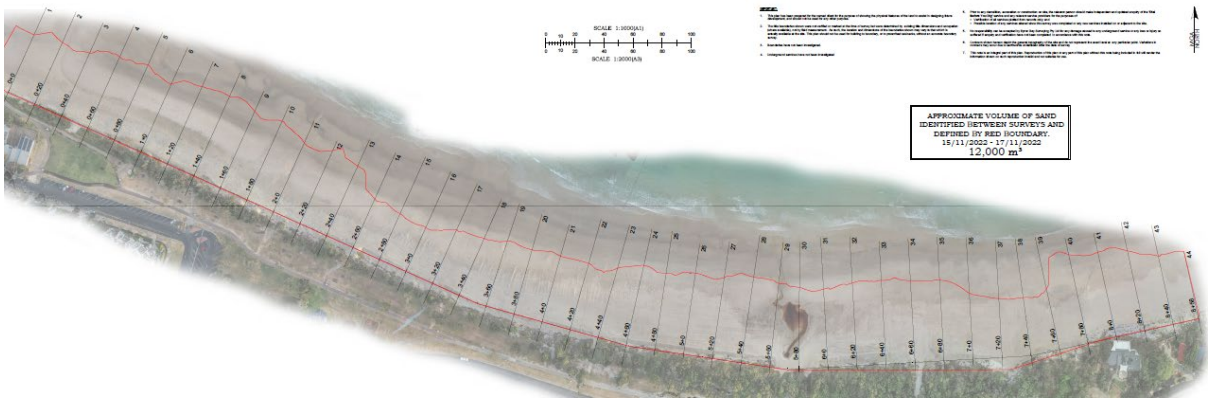


Figure 33: Approximate volume of sand gained between 15 November and 27 November 2022 survey is 12,000 cubic metres.

- The approximate volume change comparison as show by elevation differences between the 15 November 2022 and 27 November 2022 survey is provided in Figure 34. Red illustrates sand gain/fill (i.e., accretion, sand higher in elevation). Blue illustrates sand loss (i.e., erosion, sand lower in elevation). Green illustrates no change in elevation.

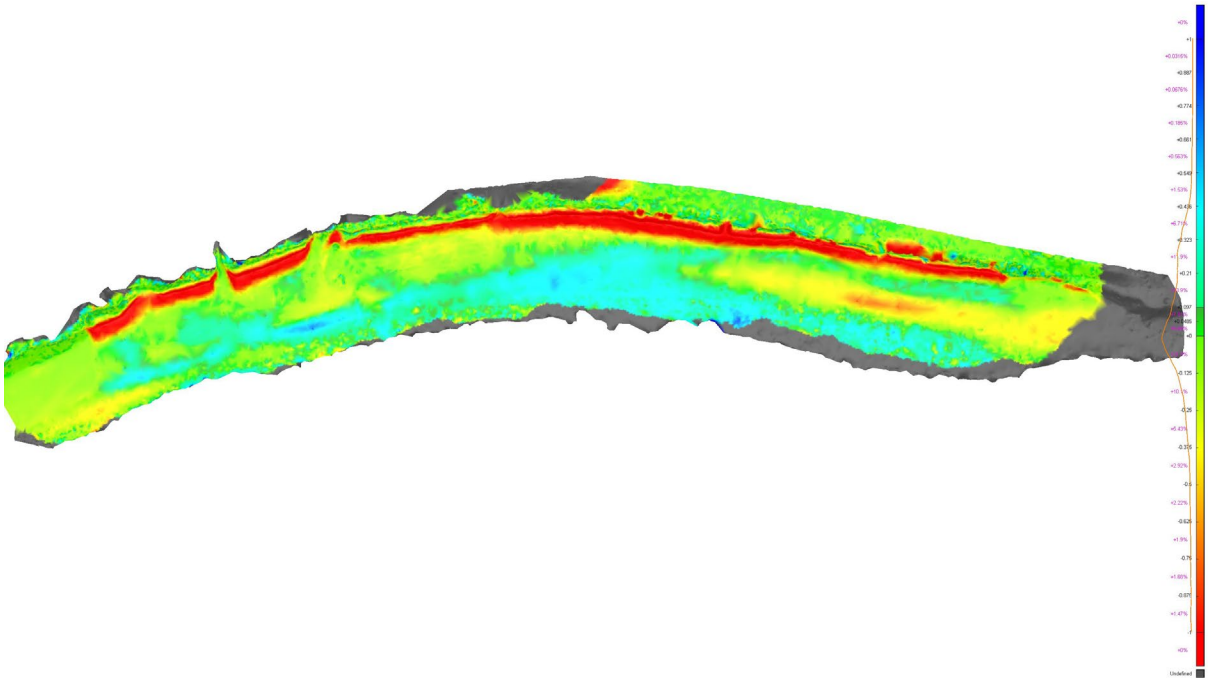


Figure 34: Approximate volume change comparison between the 15 November and 27 November 2022 survey shown in an Isopach image.

Project costs

The complete cost of the project was $164,520 shared equally by Council and the Department of Planning and Environment through the Coast and Estuary Grants Program. This equates to $82,260 equal contribution (Table 2).

If we consider the complete project costs in comparison to the overall sand volume gained between the pre and post drone surveys, this equates to approximately $14 per cubic metre of sand, or $250 per metre of beach with up to 18 cubic metres of sand won.

Table 2: Project components and costs.

Item	Cost (excl GST)
Approval Documentation (REF)	$3,100
Cultural Heritage Site Monitoring	$5,925
Engagement material & Advertising	$1,000
Beach/Dune Signage	$2,716
Educational Signage	$640
Community Dune Care Event	$1,100
Pre-Scrape Drone survey & Reporting	$2,700
Post-Scrape Drone survey & Reporting	$2,700

Item	Cost (excl GST)
Post-Scrape (12 mths) Drone survey & Reporting	$2,700
Beach Scraping Works	$91,159
Revegetation Works & Maintenance	$32,300
Fencing of Beach Accessways	$6,300
Fencing of Beach-side Dune	$11,250
Signage Installation	$930
Total project costs	$164,520
Council contribution	*$82,260*
Sate Government contribution	*$82,260*

Figure 35 illustrates the general distribution of project costs per component. Just over half of the project costs are the beach scraping works, with the next largest amount for revegetation works.

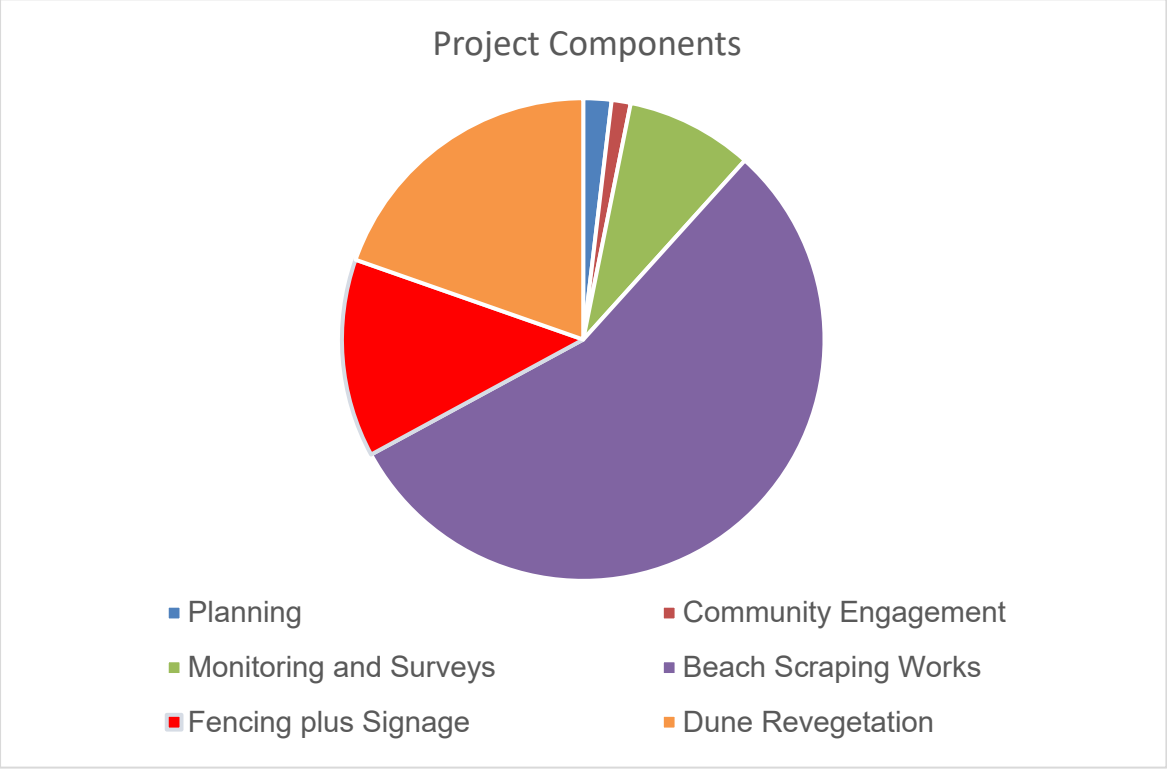


Figure 35: Distribution of project components and costs.

Lessons learnt

A project de-brief was held post completion of the beach scraping works on the 6 December 2022 with the project team and contractor to discuss:

- project delivery and outcomes;

- issues or incidents
- opportunities for improvement.

Key points discussed by the team for consideration in future scraping campaigns include:

Operators: Experienced, local operators who have completed beach scraping works are important. The skill of the operators on this project was excellent as they had completed coastal and beach work before on similar campaigns and knew the local landscape. An unskilled operator could potentially drop the height of the beach berm dramatically with results not known until further surveys are completed or the next high tide.

Machines and Equipment: To maintain the height of the beach shoulder/berm it would be advantageous to have the pre-works beach survey data input into GPS equipment and set ups fitted to the dozers. This would allow the operators to maintain the height of the beach berm with greater accuracy and minimise impact. Swampy dozers are sufficient but less preferrable by comparison to higher horsepower, ideally with GPS.

Pedestrian access: Pedestrian accessways need to be clarified at the start of works to establish good access points and have fully excluded areas within the work zone. Redirecting or excluding pedestrians from the work front allowed the dozers to push the full length of the works and allowed greater efficiencies for dozers and end of the day dune shaping.

Safety: No safety incidents occurred with works. There were several pedestrians that insisted on walking through flagged off areas, but no issues were encountered.

Methodology: Agreed work methods and desired outcomes should be established at commencement to avoid rework. In future, all project staff should be requested for the first 2 days as well as providing a printed method and design outline of dune for operators.

Operators: Skilful, experienced, local operators reduced the risk of rework requirements.

Machine access: Access between the compound and work zone could be improved in future, especially for emergency access. The size of machines is limited by the width of the vehicle beach access. Returfing of the compound area should be considered post works.

Noise: No noise complaints were received. This should be a consideration for all future projects due to volume of machinery, especially for projects outside of daylight savings which aided in this project's successful reception from neighbours.

Tides: Works preference is an afternoon low tide.

Events: No planned events supported greater ease of works. There was just one wedding that works fortuitously completed just in time.

Engagement: The level of community and stakeholder engagement completed prior to and during the works program was detailed and resulted in a well-informed community members and adjacent businesses with minimal queries and questions to the project team during the campaign. Overall, on-ground beach users were highly interested in the project and works each day, especially children. In future, Tonka trucks could be brought to the beach for kids and families who were enthusiastically watching works each day.

Outcomes

Overall the project team were all in agreeance that the project was planned and delivered well within expected costs and timeframes, with resulting sand volumes gained surpassing the goal of 10m3/m (up to 18m3/m sand won over 650m and reprofiled over 850m extent).

The expected outcomes of the project have been met, which include:

- aid in restoration/rehabilitation of dune ecosystems and habitat.
- protection of cultural heritage.
- restoration of public beach access ways.
- improved beach amenity; and
- improved benefit for the Byron Bay community.

A more natural dune formation was created which will evolve over time and encourage native plants to colonise and assist in dune growth and provide a more diverse beach landscape. The number of formal beach accessways have been reduced to provide the dunes more space alongshore to form naturally without being impacted by pedestrian trampling and potential sand blow outs. The full length of the Main and Clarkes Beach dune is now fenced landward and seaward alongshore tying in to the designated formal accessways. Extension of the hind dune into the grassy reserve provides resilience and space for the dune to migrate landwards over time (as needed).

A full dune revegetation plan has been implemented which includes follow-up maintenance for 12 months. Already there are signs of plant growth and germination.

Short-term project outcomes illustrate beach scraping during accretionary and beach building conditions to be a productive and viable ‘soft stabilisation’ strategy for the future management of this location at Main and Clarkes Beach. Beach scraping is cost-effective and provides a ‘no regrets’ management option for assisting in the recovery of beach sand volumes, rehabilitating and restoring the dune ecosystem and habitat, and improving the public’s beach safety, access and amenity. Further, during accretionary periods, repeated beach scraping and dune restoration campaigns may be utilised to build up a reserve of sand within the dune to create a natural coastal buffer to mitigate future impacts of storm events and/or during periods of erosion (i.e. when littoral supply around Cape Byron is reduced).

Beach scraping also appears to be an amenable strategy for the community, agencies and land managers for the management of Main and Clarkes Beach and should be considered in future coastal planning and management.

Appendix 1: Preliminary survey of beach macro-infauna at Clarkes Beach, Main Beach and Cavanbah Beach, Byron Bay.

Report by Stephen D. A. Smith of Aquamarine Australia to the NSW Department of Environment & Planning, October 2022

Preliminary survey of beach macro-infauna at Clarkes Beach, Main Beach, and Cavanbah Beach, Byron Bay

Stephen D. A. Smith

Report to the NSW Department of Environment & Planning.

October 2022.

AQUAMARINE AUSTRALIA

Contents

Cover image: the sand-bubbler crab *Scopimera inflata*

Executive Summary

To replenish the dunal system following recent and progressive erosion, beach scraping is proposed for the western half of Clarkes Beach and Main Beach, Byron Bay. This preliminary survey assessed beach infauna to document species composition and highlight any concerns related to unusual or significant biological assemblages. Eight transects, normal to the beach, were established from just eastward of the Reflections Byron Bay Holiday Park beach entrance, to ~100m westward of the Jonson Street Protection Structure on Cavanbah Beach.

Beach macro-infauna (≤ 1mm) were sampled at five beach levels on each transect using a standardised core (33 x 33 x 25cm), and later identified to the highest level of taxonomic resolution possible (species targeted), and counted. Three 4 x 5m transects were established in the upper beach at each transect position to evaluate the density of ghost crabs (Family Ocypodidae). Additional core samples (5.8cm internal diameter) were taken from the mid-to-high tide lagoon adjacent to the eastern transects to provide a preliminary assessment of the benthic (bottom-dwelling) infauna. The data from each component were compared to relevant, regional data sets to contextualise the results.

Fourteen species/taxa were present in the beach infaunal samples across the eight transects. The isopod *Pseudolana concinna* (96), pipis *Plebidonax deltoides* (25) and the amphipod *Urohaustorius halei* (22) together contributed 83% of the total fauna. No rare or unusual species were found. While the assemblages in the western transects were similar to those recorded in previous regional studies, diversity and abundance were comparatively low. The eastern transects had very low species richness and abundance: this is hypothesised to be due to the influence of the lagoon.

Ghost crab holes were present on all transects and, while there was some variation across the beach, densities were within the range observed in previous regional studies. Samples from the lagoon revealed very high densities of non-biting midge larvae (Family Chironomidae) (“blood worms”) with a mean density of 57,523 m^{-2}.

Based on previous studies, beach scraping in unlikely to have a measurable effect on beach infaunal assemblages. While ghost crabs will be affected over the short-term, they are predicted to make a rapid recovery as adjacent areas support good populations of these highly mobile crustaceans. The mid-to-high tide lagoon in the eastern section of the study area is an unusual feature that clearly influences the ecology of the beach. Further studies of its origin, flux, physico-chemical status and ecology would provide better context for its broader ecological role.

Introduction and scope

To replenish the dunal system following recent and progressive erosion, beach scraping is proposed for the western half of Clarkes Beach and Main Beach, Byron Bay. While previous studies of the impacts of beach scraping, where sand is borrowed from the lower sections of the same beach, have indicated that impacts on animals living within the sand matrix are minimal (Smith et al., 2011a,b; 2019), there is recognition that preliminary surveys are warranted to document species composition and distribution and highlight any concerns related to unusual or significant biological assemblages. This is particularly pertinent as the works will occur within the Cape Byron Marine Park. The northward-facing aspect of the beach suggests that mean wave energy is likely to be lower than east-facing beaches which have been the focus of assessments of biological impacts of beach-scraping in the region (New Brighton, Wooli). Previous research on Australian beaches has found that sheltered beaches tend to support more diverse or different suites of fauna (Hacking, 2007), hence, a preliminary survey of infauna in the proposed area of works will help inform planning for the works.

This study assessed infaunal assemblages across transects identified by the NSW Department of Planning and Environment (DP&E) and Byron Shire Council (BSC), both in the area of the proposed works, and in other areas of interest, between the Reflections Byron Bay Holiday Park to the east and Cavanbah Beach to the west (Figure 1). The specific objectives were to assess whether the beaches supported rare or unusual species or assemblages, determined based on a comparison with similar studies conducted in the region (mid-north and north coasts).

Figure 1. Map showing the position of transects (blue lines) sampled for this preliminary study of beach infauna. Transect numbers run sequentially from east (right) to west (left). Note - the green (deposition) and red (borrow) areas is indicative of position of beach scraping/dune rebuilding works (Figure supplied by NSW DP&E).

Methods

Macro-infauna

Previous studies of beach infauna have indicated that the most appropriate sampling method is to extract sand cores using a box corer (0.33 x 0.33m) to a depth of ≥0.25m, from different levels of the beach, and to sieve the matrix through a 1mm mesh to retain the macrofauna (Hacking, 1996, 1998, 2007; Smith et al., 2011a, b). Samples are taken at different positions along the beach gradient, with the number of sampling levels varying between different programs (from 4-10; Smith et al., 1997; Hacking, 1996, 1998, 2007). However, five levels are generally considered sufficient to sample across the recognised gradients of marine infauna occurring from the upper to lower intertidal beach face (e.g. Schoeman et al., 2003). Sampling areas are set up as transects perpendicular to the ocean with sampling occurring immediately below the most recent strandline (Level 1), and the lowest tidal level possible (Level 5), with the other levels allocated at approximately even intervals between Levels 1 and 5. In order to gain access to the diverse, lower reaches of the beach, sampling is generally conducted around low tides ≤ 0.4m, with Level 5 sampled at the tidal minimum.

For this preliminary survey, in consultation with staff from the NSW Department of Planning & Environment (DP&E), we evaluated a total of eight transects, six on Clarkes/Main Beach with a further two placed immediately west of the Jonson Street Protection Structure on Cavanbah Beach (Figure 1). The process for transect establishment was as follows: i) determine the position of the most recent high-tide strandline and mark-out the Level 1 core position 1-2m below this line; ii) measure the distance from Level 1 to the swash zone (the latter designated as Level 5); iii) mark-out cores for Levels 2-4 at approximately equal intervals between Level 1 and Level 5. While the removal of sand cores (using a shovel) is straightforward in the upper beach, the box corer was used as a sleeve to prevent sand slumping in Levels 4 and 5. An additional sample of sand was taken from Level 3 on each transect for assessment of granulometry (by the Environmental Assessment Laboratory and Southern Cross University).

Sand from each core was placed directly into the 1mm sieve which was housed on a trolley. Once the sample was fully extracted, the trolley was wheeled into the swash zone and gently agitated to flush the sand through the sieve, taking care to ensure that the sample was not inundated by wave action or that water and sand were not lost over the edge of the sieve. All animals retained on the sieve were collected using fine forceps and placed into labelled specimen jars containing 70% ethanol. In a few cases, live animals were released back onto the beach immediately after

sampling if their identity could be readily determined. For example, this was done for larger pipis (*Plebidonax deltoides*) and sand-bubbler crabs (*Scopimera inflata*).

All samples were subsequently examined under a dissecting microscope in the laboratory to determine species composition. While most could be identified to species level, some of the polychaete worms were missing body sections that are diagnostic (likely caught in, or passing through, the sieve mesh) necessitating identification to a higher taxonomic level than species. A reference collection was established for all discrete taxa, both as preserved specimens, and, where possible, as a photographic collection (Appendix 1). The abundance of each species (or taxon) was counted and recorded for each sample.

Ocypodid (ghost) crabs

Ghost crabs (Family Ocypodidae) live within sand burrows in the upper beach and scavenge across the beach face, mostly during the early morning and late afternoon. For this reason, they are likely to be affected by any substantial change to the beach-face environment and have been recommended as suitable indicators of a range of impacts in the upper beach (Barros, 2001; Moss and McPhee, 2004; Hobbs et al., 2008; Lucrezi et al., 2009; Noriega et al., 2012; Smith et al., 2019). Following the methods used for similar assessments at Wooli, NSW, active crab holes were assessed in the upper beach for each of the eight transects. Three transects measuring 5m along the beach and 4m up the beach were established within a 25m strip at the top of each transect. The upper limit of the transects was placed at, or just into, the vegetation line where this was present (Figure 2). On transects with highly eroded upper sections, the upper limit of the transect was delineated by the base of the steeply eroded area. Crab holes can readily be obscured by trampling by beach goers. For this reason, all assessments were conducted in the early morning (from 07:00) when active burrows are most obvious (Barros, 2001). Active burrows with a diameter ≥10mm were recorded in each transect.

Figure 2. Assessing the density of active ghost crab burrows in the upper beach, Transect 7.

Benthic infauna of the mid-to-high tide lagoon

Although not part of the proposed investigation, the importance of the mid-to-high tide lagoon adjacent to Reflections Holiday Park became apparent during the field program. Preliminary observations suggested that it may be eutrophic (i.e. have high nutrient levels) with extensive blooms of algae both on the surface and benthos (Figure 3). Further observations suggested very high densities of small, red invertebrates. For this reason, five cores were removed from the middle of the southern edge of the lagoon at intervals of approximately 2m. Cores measured 5.8cm (internal diameter) and were taken to a depth of approximately 8cm. As initial observations indicated many individuals are small enough to pass through a 1mm mesh, the cores were sieved through both 1mm and 0.5m sieves to maximise faunal retention. Densities of the dominant taxon (Chironomidae) were assessed to allow estimates of standing stock in the lagoon. Taxa found in lower abundance were simply noted as being present.

Figure 3. Algal blooms in the lagoon adjacent to Reflections Byron Bay Holiday Park.

Data analysis

The primary objective of this study was to determine if there were any rare or unusual species or assemblages amongst the beach infauna, or unusual densities of specific taxa (e.g. ghost crabs) in the study area. Two approaches were taken to inform this assessment for the beach infauna. First, the list of species was compared to lists available from similar work within the north coast region – from Cudgen and Cabarita beaches (Hacking, 1998) and New Brighton Beach (Smith et al., 2011a). A caveat with this comparison is that the scope of the previous studies was much greater (more beach levels by Hacking, more samples by Smith et al.) so they are likely to have recorded more species (generally, the number of species found in a habitat is strongly related to the area of the habitat evaluated i.e. the species-area relationship (Connor & McCoy, 1979)). Nevertheless, these studies provide a reference against which to help define a "normal" state.

The second approach was more quantitative and consisted of a meta-analysis of three relevant, historical data sets. Previous work using the same or similar field methods, has been conducted on the Coffs Coast as part of an investigation into the possible impacts of nutrient enrichment from effluent discharge into a small Intermittently Closed and Open Lake and Lagoon (ICOLL) (Smith et al., 1997). Sampling for that work involved the establishment of 10 transects on the beach adjacent to each of three different ICOLLs. Transects were adjacent to, but not in the direct flow of, estuarine discharge (a total of 30 transects). Sampling used the same core size but was only carried out at four beach levels. The second data set resulted from an investigation into the effects of beach scraping on the infauna of New Brighton Beach (Smith et al., 2011a). That study involved a total of five sample periods, each comprising five transects with five beach levels at four separate sites using the same sized box corer. For this meta-analysis, only the samples from the first (pre-impact) sample period were used (a total of 20 transects). The third data set came from a previous assessment of zonation of beach fauna at 10 sites on the NSW north coast, summarised in Hacking (1998). Data for eight of the 10 sites were used – however, data for Cabarita Beach were missing and those for Hearnes Lake omitted as more recent data were available for that site. Summary data, comprising the sum of three core samples from each of 10 beach levels at each site were provided by Dr. Nicole Hacking (pers. com. 19 October 2022). To make these data comparable with the Byron Bay data set, data corresponding to the five beach levels (Hacking's levels 2, 4, 6, 8 and 10) were summed for each transect (one transect per site) and divided by 3 to provide mean abundances per 33x33cm core.

Inevitably, when comparing across multiple studies, there are likely to be some inconsistencies in the taxonomic certainty of identifications, exacerbated in Australia by the relative lack of taxonomic work on beach fauna. For this reason, it is often the case that studies designate identifications at levels higher than species (e.g. Spionid sp. 1). Therefore, for this analysis, where there was any uncertainty, species were aggregated to the highest level of taxonomic resolution possible to retain all of the records from each study. In some cases, this led to aggregation at the Family level (e.g. for many of the polychaete worms), while well-known species (e.g. pipis, ghost crabs, sand-bubbler crabs) were retained as discrete species.

Data from the current study were compared to these previous studies in two ways. First, the mean number of species and abundance of taxa were evaluated at the scale of the transect (i.e. data from all levels were aggregated for each transect); and, second, a comprehensive assessment of differences in assemblage structure was performed using multivariate statistical analysis. This type of analysis determines the similarity of assemblages based on the species present and their abundance and allows exploration of differences in overall assemblage structure. To do this, data were aggregated at the transect level and abundances were square-root transformed (which downplays the influence of abundant species on assemblage patterns) and the similarity between each pair of transects in the data set was determined using the Bray-Curtis similarity measure (with the addition of a dummy variable due to low species counts in some samples). The relationship amongst samples was then visualised using non-metric multidimensional scaling (nMDS) which visually translates the faunal similarity among samples into a two-dimensional figure, in which samples that are similar in composition are placed close together. As the intention of this analysis was to provide a broad comparison of assemblage structure and determine how the samples from Byron Bay compared to those from other sites, rather than a formal test of hypotheses related to differences, no further statistical comparisons were made.

Results

Beach condition at the time of sampling

Beach slope and condition varied considerably across the eight transects. The presence of a strong berm in the eastern transects limited tidal influence in the mid-to-upper beach. As sampling occurred only within the beach matrix below the most recent strandline, these transects therefore extended only over the lower part of the beach. A gradual reduction in the size and presence of

the berm was evident in a westerly direction and it was absent on Transects 6-8. A brief description of each transect is provided below together with images taken from the top of the beach. Refer to Figure 1 for the positions of the transects.

Transect 1 (Figure 4) – (length ~23m). This transect was placed between sections of the high-tide lagoon at the eastern end of the survey area. A strong berm was present with a vertical face measuring approximately 0.5m. The most recent strandline was above the berm and so the transect commenced just above the berm and ran down the moderately steep beach face. A low-tide moat was present at low tide with an emerged sand-bank to seaward. The Level 5 sample was taken on the sand-bank. The mid-section of the sample area was dominated by sand balls resulting from activity of sand-bubbler crabs, *Scopimera inflata*. A reduced layer (the Redox Potential Discontinuity Layer – RPDL), characterised by a transition from pale, oxygenated sand to grey/back, reduced sand was evident at Level 3 at a depth of 8cm. A moderate amount of coarse shell grit was retained in the sieve at Levels 3 and 4.

Figure 4. Transect 1 (left), Transect 2 (right).

Transect 2 (Figure 4) - (length ~23m). Transect 2 commenced at the bottom of the berm. As for Transect 1, the Level 5 sample was taken on a sand bank beyond the low-tide moat. The near-vertical berm measured approx. 0.7m with a moderately steep beach-face below. The mid-section

of transect (Level 3 and Level 4) was dominated by sand balls resulting from activity of sand-bubbler crabs, *Scopimera inflata.*

Transect 3 (Figure 5) – (length ~19m). Transect 3 had a similar profile to Transect 2 with a prominent berm on the lower beach and a moderately steep profile. Sampling occurred just above the berm (Level 1) and ran down to the low tide level.

Figure 5. Transect 3 (left), Transect 4 (right).

Transect 4 (Figure 5) – (length ~34m). Transect 4 was located immediately to the west of a semi-permanent water flow from a stormwater drain at the top of the beach. A strong berm with a near-vertical face measuring approx. 0.5m was present. Level 1 was established on top of the berm with the other levels equally spaced to the low tide level.

Transect 5 (Figure 6)– (length ~60m). The strong beach berm evident in Transects 1-4 was lacking on Transect 5 although there was evidence of a slight elevation in profile (<30cm) corresponding to the start of the stronger berm to the east. With the lack of a berm barrier, seawater flooded further up the beach at high tide with the consequence that the transect was longer than those to the east.

Transect 6 (Figure 6) – (length approx. 86m). The beach profile at Transect 6 comprised a shallow, monotonic slope with the recent strandline occurring approximately 80% of the distance from the

low water level to the base of the dune. Thus, this was the longest of any of the transects evaluated.

Figure 6. Transect 5 (left), Transect 6 (right).

Figure 7. Transect 7 (left), Transect 8 (right)

Transect 7 (Figure 7) – (length ~41m). This transect was placed approximately 20m east west of the rock-wall structure at the end of the Jonson Street breakwall. The upper beach was highly eroded with a steep dune face (see Figure 2). The beach had a monotonic slope that was steeper than Transect 6 to the east.

Transect 8 (Figure 7) – (length ~38m). As for Transect 7, the upper beach was highly eroded with a steep dune face and a monotonic slope that was steeper than Transect 6.

Composition of infauna

A total of 14 discrete taxa were present in the beach samples across the eight transects with the following breakdown: three species of polychaete worm; one bivalve mollusc; three amphipod crustaceans; three isopod crustaceans; three crabs; and one insect larva. The most abundant species was the scavenging isopod *Pseudolana concinna* (96) which accounted for 55% of the total animals counted. Pipis *Plebidonax deltoides* (25) and the low-tide amphipod *Urohaustorius halei* (22) contributed 14% and 13% of individuals, respectively. Together, these three species comprised 83% of the total fauna.

There was an obvious gradient in abundance from east to west across the eight transects (Figure 8). Generally, transects adjacent to the strong berm (Transects 1-4) had much lower abundance compared to the others (Transects 5-8). Zero counts were common in the upper and mid-tidal levels between Transects 1-5 (10 out of 25 cores) and most fauna were found either in the upper or lower survey levels. Species richness was quite low across all transects and clear trends were less evident, with the exception that Transect 6 (11) had more than twice the richness of any other transect (the next highest was Transect 8 with 5 species).

The species complement present within the samples across all transects was similar to that found by Hacking (1998) for Cudgen and Cabarita beaches (Appendix 2). The main difference was the greater species richness of crabs at Byron Bay (three species compared to one at the other sites). However, the differences in sampling intensity should be noted – a total of 40 cores at Byron Bay and 30 each at Cabarita and Cudgen.

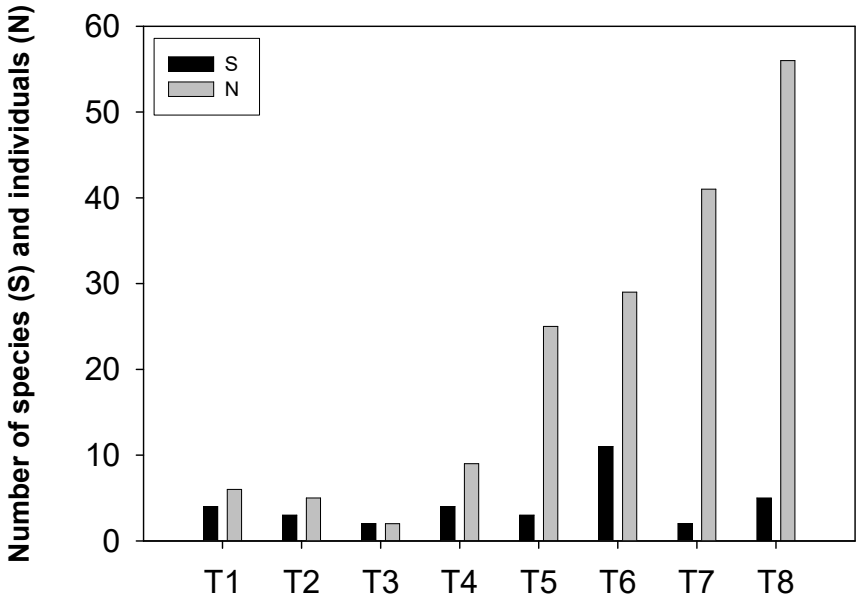


Figure 8. Trends in the number of species (S) and number of individuals (N) across the different transects (data pooled across beach levels).

Meta-analysis

To put these findings into a broader context, a comparison of basic assemblage descriptors (species richness – S; abundance – N) was made between the current data and those from previous studies in the region (see details in *Methods*, above). In this case, transect data were averaged over the total number of transects performed in each study and displayed together with an indication of variation around the mean (Standard Error - SE). For the study by Hacking (1998), the data for Cudgen are presented separately due to their relative proximity to the Byron Bay study area; averages are provided across all other locations (mostly from the Coffs Coast).

The results clearly indicate that mean faunal diversity in the Byron Bay transects were lower than all other sites for which historical data were available (Figure 9). However, mean abundance was similar to that found by Hacking (1998) at Cudgen, and higher than the 1997 samples adjacent to ICOLLs on the Coffs Coast (noting that these comprised only four rather than five beach levels).

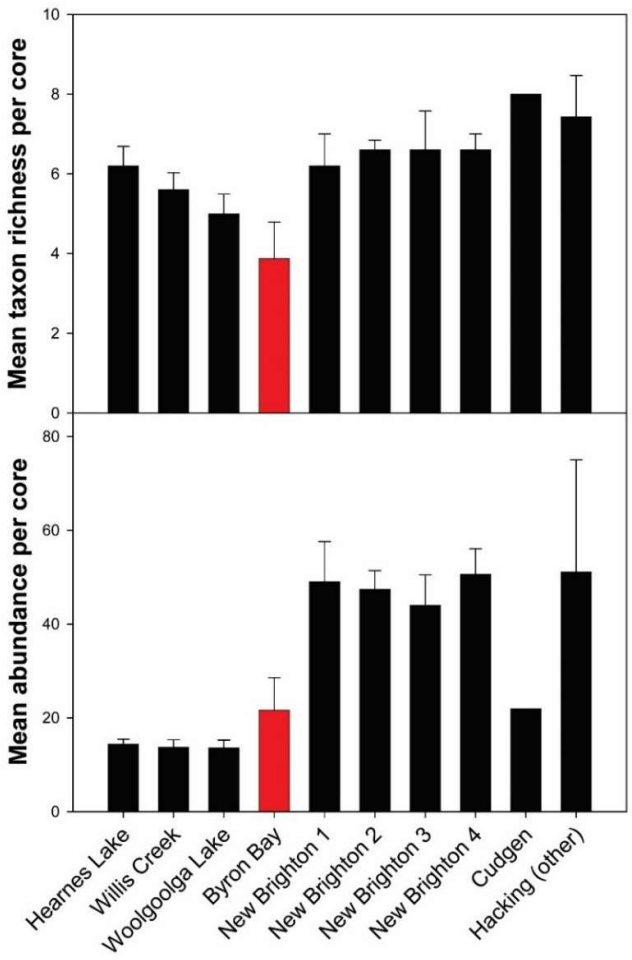


Figure 9. Comparison of mean (± SE) species richness (S) and number of individuals (N) across different beach studies within the region (mid-north coast to north coast NSW). Mean data for Byron Bay are shown in red.

The multivariate analysis of beach data sets, while complex (Figure 10), provides further insight into the composition of beach infauna in a regional context. Each data point in the plot represents a transect, with transect number added for the Byron Bay samples. The main feature is the discrete clustering of samples from the beach at New Brighton (red symbols) to the left, and those from beaches adjacent to ICOLLs on the Coffs Coast (blue symbols) to the right. The transects from Byron Bay are spread across the plot with Transects 6 and 8 showing a much greater similarity to those from other locations. The transects hypothesised to be most affected by proximity to the lagoon (Transects 2 and 3) are clear outliers at the top of the plot, Transect 7 has a similar structure to samples from New Brighton, and Transects 4 and 5 are spread between Transects 2

and 3 and the New Brighton transects. Transect 1 is an outlier to the bottom of the plot and most similar to transects adjacent to Woolgoolga Lake on the Coffs Coast.

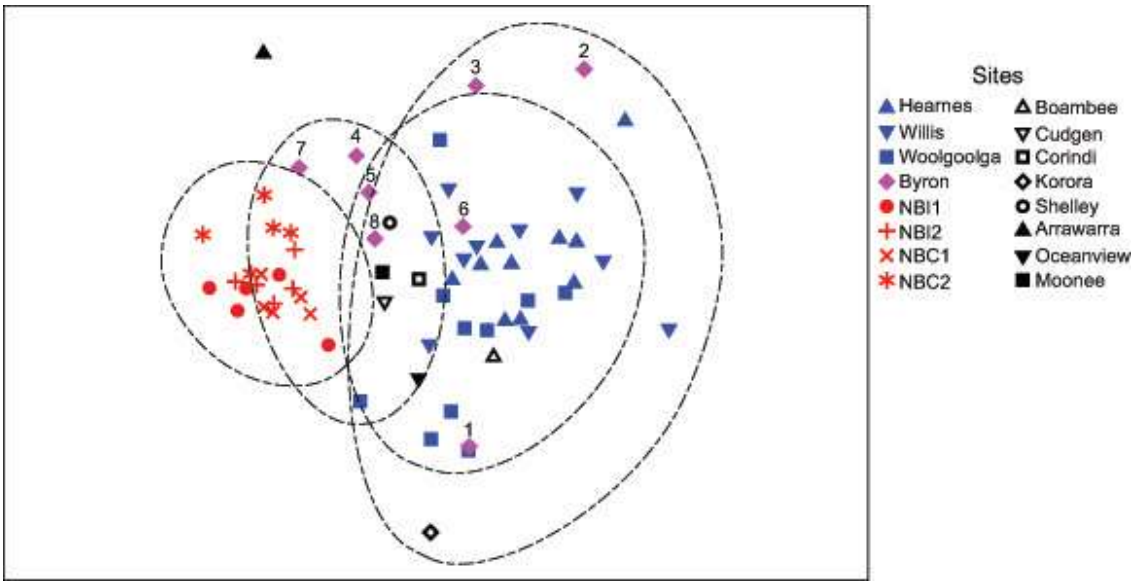


Figure 10. Non-metric multidimensional scaling plot portraying the similarity among beach transect samples from different regional studies. Samples that are close together within the plot have similar assemblage structure (i.e. species complement and abundance).
Kruskal's stress = 0.20.

Densities of ghost crabs

With the exception of Transect 5 which had much higher densities, and Transect 3 which had lower densities, the abundance of crab holes was relatively consistent across the sample sites (Figure 11), and within the range of values averaged over time from a 10-month survey at multiple sites at Wooli, NSW (means of all observations at control sites over the full program at Wooli ranged from 23-51 holes per $20m^2$ – Smith et al., 2019). Mean densities on Transect 3 were just below this mean range (15.7), while those on Transect 5 well above (122.7), but still within the range of observations at some sites in individual time periods (range = 2.0 to 129.9 per $20m^2$). Although no crabs were observed, the diameter of the burrows suggests the presence of both common species of ghost crab, *Ocypode ceratophthalma* and *Ocypode cordimana*.

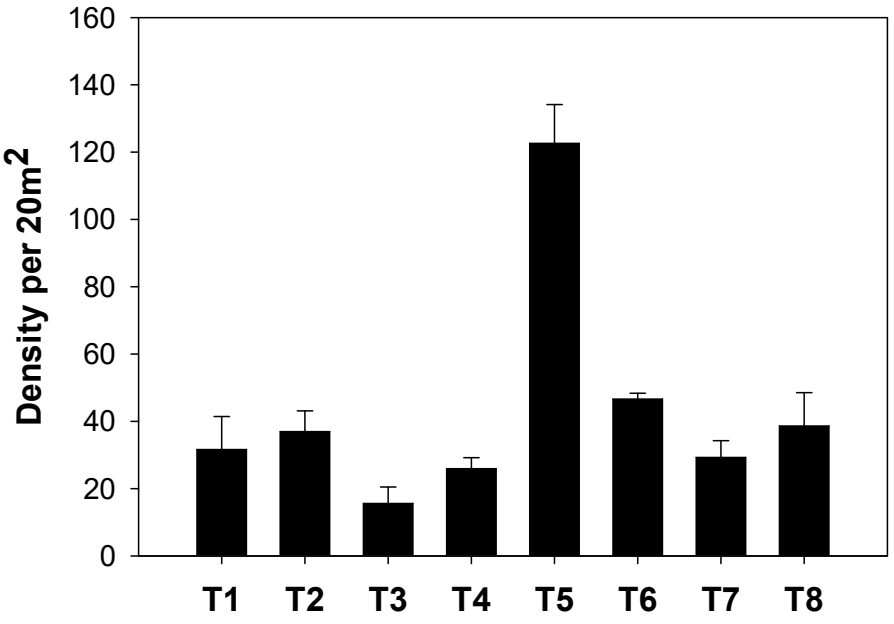


Figure 11. Mean densities (± SE) of ghost crab holes in the upper beach of each transect at Byron Bay.

Lagoon cores

The edges of the lagoon contained obvious signs of the presence of tubicolous animals. These biogenic structures were slightly elevated above the substratum and occurred in high densities (Figure 12). Field examination indicated a large abundance of small, red “worms” along the edges of the lagoon, but biogenic structures could also be seen towards the central sections of the lagoon. By far the majority of animals examined were the same, larvae of non-biting midges in the Family Chironomidae (sometimes referred to as “blood worms”). Chironomid larval abundance in the five core samples ranged from 88-289 with a mean of 152 (SE = 36.09). Sixty percent of the chironomids passed through the 1mm sieve and were retained on the 0.5mm sieve. Further examination indicated that individuals also passed through the 0.5mm sieve though this fraction was not evaluated. The different sizes of individuals suggest the presence of the full range of instar stages (chironomids have four larval instar stages – Zerguine, 2021). This very high density equates to 57,523 chironomid larvae per square metre. If densities are the same in other sections of the lagoon, and using the dimension of the lagoon from the most recent Google Earth images, standing stock is likely to exceed 500 million. Images of the larvae found in the core samples are shown in Appendix 1.

Figure 12. Tubes of chironomid larvae occurred in high densities along the edges of the lagoon and were sampled with a small core (5.8cm internal diameter).

Granulometry of sand samples

While all sediment samples primarily comprised fine (125-250µm) and medium (250-500µm) sand (see Appendix 3), Transect 1 was dominated by fine sand (60.5%) and Transect 8 by medium sand (67%). However, the gradient of increasing coarseness was not a simple progression from east to west, with Transects 4 and 6 also showing a dominance of medium-grained sand (Figure 13).

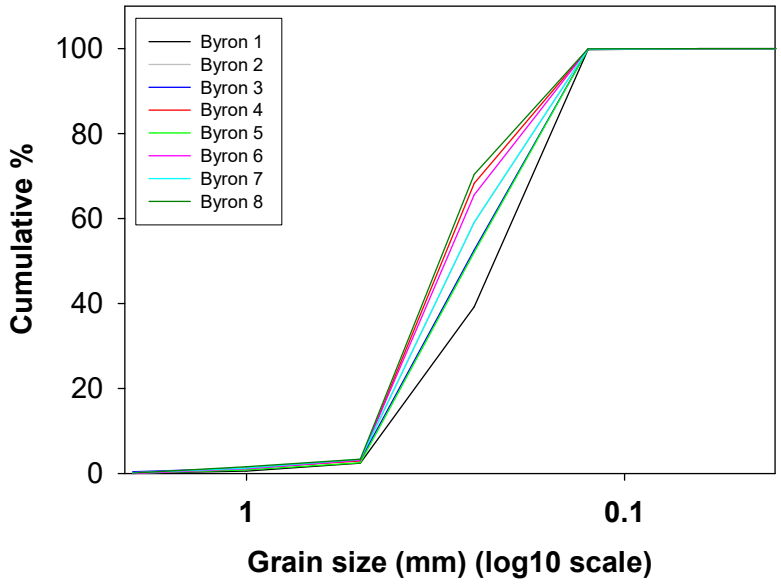


Figure 13. Plot of cumulative percentage of grain sizes in sediment samples from each transect at Byron Bay (note logarithmic scale and reversed x-axis – largest to smallest).

Discussion and conclusions

The core samples evaluated from the eight transects between Clarkes and Cavanbah beaches indicate a heterogeneous beach environment over a scale of approximately 1.5km. While samples taken from the three western transects (Transects 6-8) had a similar faunal composition (types of species) to that found in previous regional studies, both species richness and abundance were substantially lower than recorded from nearby New Brighton Beach (Smith et al., 2011a). Highly motile crustaceans dominated core samples from these western transects: these taxa migrate with the tide and are therefore highly dynamic over very small temporal and spatial scales (Hacking, 1996). Indeed, this dynamism is hypothesised to be the primary reason why no impact of extensive beach scraping works at New Brighton Beach was detectable even one day after the works were completed (Smith et al., 2011a, b). That study hypothesised that migration from unaffected sites was rapid and so disturbed beach habitat was recolonised quickly, possibly within a single tidal cycle. The eastern samples were quite different in composition from the western transects, primarily due to the very low species richness and faunal abundance, and the almost complete lack of amphipod crustaceans. Although species richness averaged over the eight transects was similar to that recorded from Cudgen Beach (Hacking, 1998) (Fig. 9), sampling effort (number of cores) was 25% higher in the current study at Byron Bay. The beach faunal complement did not contain any rare of unusual species or assemblages, and all of the species/taxa found have previously been recorded in the immediate region (New Brighton Beach – Smith et al., 2011a; Cudgen and Cabarita beaches – Hacking, 1998). These results, when contextualised with previous studies, strongly suggest that beach scraping is unlikely to have a measurable effect on beach infauna in the area proposed for beach scraping works.

Given the relative protection from wave action provided by Cape Byron, there was an expectation that there may be a gradient of declining species richness and abundance from the more sheltered eastern transects to the more exposed western transects. While the granulometry provided some support for the most easterly (Transect 1) and westerly (Transect 8) transects being, respectively, at the sheltered and exposed extremes, there was no simple gradient in infaunal assemblages. A number of studies have indicated an inverse relationship between wave exposure and species richness (MacLachlan & Brown, 2006; Hacking, 2007), but Transect 6 had the highest richness in this case and was one of the three most exposed sites. It is highly likely that the main reason for this lack of predicted pattern relates to the influence of the lagoon on the eastern transects and the consequent heterogeneity of beach conditions.

The lagoon in the upper beach in the eastern section of the sample area is one feature that is unusual in the context of regional beaches. At the time of sampling (tidal range was 0.30 – 1.71m), the lagoon appeared to have limited marine influence from tidal inundation and wave action, although some wave-swash overtopping was observed in the western section during the second day of field work. However, the expansion and contraction of the margins with high and low tides suggests some tidal pumping through the beach matrix. The lagoon appeared to be fed predominantly from freshwater run-off from the top of the beach, with a drain adjacent to the entrance to Reflections Holiday Park being an obvious, over-beach source. As the lagoon was not an *a priori* focus of this preliminary investigation, no data were collected to further investigate its physico-chemical characteristics. However, the algal blooms (both benthic and in the water column – Figure 3) and very shallow Redox Potential Discontinuity Layer (a few millimetres below the surface) are suggestive of nutrient, and possibly organic, enrichment.

The areas both immediately landward and seaward of the lagoon provided conditions that clearly favoured sand-bubbler crabs (*Scopimera inflata*) and there was a "halo" of dense activities of these small crabs for approximately 2-3m around the lagoon. It is highly likely that seepage of fresh/brackish water through the beach matrix both reduced the diversity and abundance of fully marine beach infauna and also provided conditions that favoured sand-bubbler crabs lower down the beach. Thus, the mid-levels of the transects seaward of the lagoon were characterised by depauperate infaunal assemblages, with zero counts predominating, as well as dense aggregations of sand balls generated by the feeding activities of sand-bubbler crabs.

The samples of shallow lagoon sediments were completely dominated by chironomid larvae which likely proliferated in this habitat due to their wide tolerance of environmental conditions and their use of haemoglobin to enhance oxygen acquisition under conditions of low oxygen tension (Nath, 2018; Zerguine, 2021). This feature gives them a characteristic red appearance, and the common epithet of "blood worms", and facilitates their ability to occupy a huge diversity of aquatic habitats (e.g. Nath, 2018; Zerguine, 2021). The extremely high densities of individuals in sediment samples suggests they might form an important food source for foraging animals such as birds. Indeed, we noted a substantial number of bird species visiting the lagoon over the two days of field sampling; in particular, silver gulls, white-faced herons, Pacific reef herons, little black cormorants, pied oystercatchers, and welcome swallows. Some birds appeared to be feeding in the margins of the lagoon, while others (e.g. pied oystercatchers) appeared to be feeding on sand-bubbler crabs adjacent to the lagoon, or possibly on emerging insects (welcome swallows - although we made no

direct observations of prey). While these chironomids are therefore likely to provide substantial ecosystem services, the very high densities may also have an impact on public amenity through the mass emergence of non-biting midges.

An obvious question to ask is whether or not the lagoon represents an unusual natural feature, or is an artefact of localised anthropogenic activity. Examination of historical images from Google Earth (back to 2006) suggest that, while over-beach flow from the larger drain adjacent to Transects 4 (Figure 1) is a consistent feature, the lagoon adjacent Transects 1-3 is more ephemeral. However, the tendency for water to pool in the upper beach at different positions west of The Pass is indicative that drainage from the landward area to the south, rather than from a point source, is the principal feeder for the lagoon.

In conclusion, the beach infaunal assemblages sampled from this preliminary investigation did not contain any rare species or unusual assemblages and, based on the observations from previous beach scraping work in the region, are unlikely to be severely impacted by the planned beach scraping (Smith et al., 2011a, b). While ghost crabs will be affected over the short-term through burial of their primary habitat (Smith et al., 2019), they are predicted to make a rapid recovery as densities in the adjacent areas support good populations of these highly mobile crustaceans. Based on previous investigations at Wooli, NSW, where 13,600 m^3 of sand was deposited in an 800m section of the upper beach, recruitment of crabs to the impacted area will commence within days of the completion of works, and densities may return to pre-impact levels within three months (Smith et al., 2019). The mid-to-high tide lagoon in the eastern section of the study area is an unusual feature that clearly influences the ecology of the beach. While this is outside the area of the proposed beach scraping, further studies of its origin, flux, physico-chemical status and ecology would provide better insight into its broader ecological role.

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References

Barros, F. (2001). Ghost crabs as a tool for rapid assessment of human impacts on exposed sandy beaches. *Biological Conservation*, **97**, 399-404.

Connor E.F. & McCoy, E.D. (1979). The statistics and biology of the species-area relationship. *American Naturalist*, **113**, 791-833.

Hacking, N. (1996). Tidal movement of sandy beach macrofauna. *Wetlands (Australia)*, **15**, 55-71.

Hacking, N. (1998). Macrofaunal community structure of beaches in northern New South Wales, Australia. *Marine and Freshwater Research*, **49**, 47-53.

Hacking, N. (2007). Effects of physical state and latitude on sandy beach macrofauna of eastern and southern Australia. *Journal of Coastal Research,* **23**, 899-910.

Hobbs, C.H., Landry, C.B. & Perry, J.E. (2008). Assessing anthropogenic and natural impacts on ghost crabs (*Ocypode quadrata*) at Cape Hatteras National Seashore, North Carolina. *Journal of Coastal Research*, **246**, 1450-1458.

Lucrezi, S., Schlacher, T.A. & Walker, S. (2009). Monitoring human impacts on sandy shore ecosystems: a test of ghost crabs (*Ocypode* spp.) as biological indicators on an urban beach. *Environmental Monitoring and Assessment*, **152**, 413-424.

McLachlan, A. & Brown, A. (2006). *The ecology of sandy shores*, 2nd ed. Burlington: Academic Press.

Moss, D. & McPhee, D.P. (2006). The impacts of recreational four-wheel driving on the abundance of the ghost crab (*Ocypode cordimanus*) on a subtropical sandy beach in SE Queensland. *Coastal Management*, **34**, 133-140.

Nath, B.B. (2018). Extracellular hemoglobin and environmental stress tolerance in *Chironomus* larvae: *Chironomus* hemoglobin and stress tolerance. *Journal of Limnology,* **77**(s1).

Noriega, R., Schlacher, T.A. & Smeuninx, B. (2012) Reductions in ghost crab populations reflect urbanization of beaches and dunes. *Journal of Coastal Research*, **28**, 123

Smith, S.D.A., Hacking, N.J. & Simpson, R.D. (1997). *A comparative study of the intertidal marine benthic communities associated with Flat Top Rock and the adjacent beach habitat, mid-north coast, New South Wales*. Report to the NSW Department of Public Works. University of New England, Coffs Harbour.

Smith, S.D.A., Harrison, M.A. & Rowland, J. (2011a). *The effects of beach scraping on the infauna of New Brighton Beach northern NSW*. Report to Byron Shire Council. Southern Cross University, Coffs Harbour, 33 pp.

Smith, S.D.A., Harrison, M.A., Rowland, J. & Fitzgibbon, B.E. (2011b). Assessing the impacts of beach scraping on the macroinvertebrates of New Brighton Beach, northern NSW. *Proceedings of the 20th Coastal Conference*, Tweed Heads, 2011.

Smith, S.D.A., Tucker, J. & Nimbs, M.J. (2019). *An assessment of biological impacts of beach scraping at Wooli Beach, northern NSW*. Report to Clarence Valley Council. Southern Cross University, Coffs Harbour, 12 pp.

Zerguine, K. (2021). Chironomidae: Biology, Ecology and Systematics, in: Farzana Khan, P. (Ed.), *The Wonders of Diptera*. IntechOpen, Rijeka, Chapter 6.

Appendix 1

Images of the main species found in beach transects and from the high-tide lagoon (last 3 images), Clarkes Beach, Main Beach and Cavanbah Beach, Byron Bay. October 2022.

Glycera americana

Nephtys longipes

Nemertean

Exoediceroides ? maculosus

Tittakunara katoa

Urohaustorius halei

Mictyris platycheles

Ocypode cordimana

Scopimera inflata

Plebidonax deltoides

4th instar chironomid larvae

Insect pupa

Insect larvae

Appendix 2

Checklist of species found in this study and by Hacking (1998) at Cudgen Beach and Cabarita Beach (note, some species in the isopod family Cirolanidae pooled).

Taxon		Byron Bay	Cabarita	Cudgen
Mollusca				
Plebidonax deltoides	Bivalve	*	*	*
Donax veruinus	Bivalve		*	*
Neverita incei	Gatropod		*	*
Polychaeta				
Arabella iricolor iricolor	Oenonidae		*	
Glycera americana	Glyceridae	*		
Hemipodus australiensis	Glyceridae		*	*
Hirsutonuphis mariahursta	Onuphidae		*	
Lobochesis longiseta	Opheliidae		*	
Nephtys australiensis	Nephtyidae	*	*	
Nephtys longipes	Nephtyidae	*		*
Nemertea	Nemerteans	*		*
Crustacea				
Pseudolana concinna	Isopod	*	*	*
Cirolanid spp. (other)	Isopod	*	*	*
Exoediceroides ? *maculosa*	Amphipod	*	*	
Tittkunara katoa	Amphipod	*	*	*
Urohaustorius gunni	Amphipod			*
Urohaustorius halei	Amphipod	*	*	*
Ocypode cordimana	Crab	*	*	*
Mictyris platycheles	Crab	*		
Scopimera inflata	Crab	*		
Austrosquilla vercoi	Mantis Shrimp			*
Haplostylis indicus	Mysid		*	
Insect larvae	Insect	*	*	*

Appendix 3. Results of granulometric evaluation of sediment samples from each transect. Values are the percentage of the total sample by weight. Data supplied by EAL, Southern Cross University.

	> 4 mm Gravel	3.35–4 mm Gravel	2.36–3.35 mm Gravel	2–2.36 mm Gravel	> 2 mm Gravel	1–2 mm Very Coarse Sand	500 µm–1 mm Coarse Sand	250–500 µm Medium Sand	125–250 µm Fine Sand	63–125 µm Very Fine Sand	< 63 µm Mud (Silt/Clay)
Transect 1	0.0	0.0	0.0	0.0	0.08	0.48	1.87	36.80	60.51	0.24	0.01
Transect 2	0.0	0.0	0.0	0.0	0.19	0.92	2.05	55.89	40.80	0.15	0.01
Transect 3	0.0	0.0	0.0	0.0	0.42	0.79	1.89	49.50	47.25	0.15	0.00
Transect 4	0.0	0.0	0.0	0.0	0.21	1.03	1.73	65.31	31.57	0.14	0.00
Transect 5	0.0	0.0	0.0	0.0	0.04	0.80	1.70	49.51	47.82	0.13	0.00
Transect 6	0.0	0.0	0.0	0.0	0.00	1.14	2.01	62.44	34.27	0.13	0.00
Transect 7	0.0	0.0	0.0	0.0	0.15	1.17	2.01	55.82	40.75	0.10	0.00
Transect 8	0.0	0.0	0.0	0.0	0.12	1.47	1.78	67.01	29.55	0.06	0.00

Appendix 2: Ecological inspections prior to and during works

Report compiled by Byron Shire Council, Coastal and Biodiversity Coordinator, December 2022.

Main and Clarkes Beach Dune Recovery Project

Ecological Inspections

A key objective of the beach scraping works was to minimise potential adverse impact on wildlife, particularly nesting shorebirds and/or sea turtles. Works were planned for November 2022, prior to the December to March summer months to avoid turtle and shorebird breeding seasons.

Birds that were likely to be present are outlined below. These birds may be directly impacted as they could be nesting at the location. Other birds that may be present at the location included shorebirds (Oyster Catchers, Little Terns, Beach Stone Curlews) but aren't known to use the area for nesting (only foraging). The primary nesting area is further west at Belongil Creek.

Rainbow Bee Eaters

- These birds have been sighted in the area, though can be flighty and hard to locate/see
- Nest in the crest or top of dunes and only have one nest and tunnel that is used at any one time. Though some of the Aunties may use the parents' nest. Their nests / nest status come and go so regular inspections are beneficial.
- Nest holes are up really high and can be obscured by vegetation.
- Dozer operation unlikely to impact birds as they are so focused on their activity and have become habituated to a high use visitation area. Dozers won't be pushing sand up to the crest of the dune in most places.

Striped Pardalote

- Nest in the top of the dune

Masked Lapwing Plover

- Nest in sand and quite aggressive/confrontational if impacted.

BYRON SHIRE COUNCIL

Inspections

Pre-project inspections were completed which comprised beach walk surveys to identify any existing nest sites for exclusion during project works. Daily monitoring of the work zone for nesting birds including Rainbow Bee Eaters and/or sea turtles was also completed prior to daily work commencing.

Any nesting sites were clearly marked and an exclusion zone established.

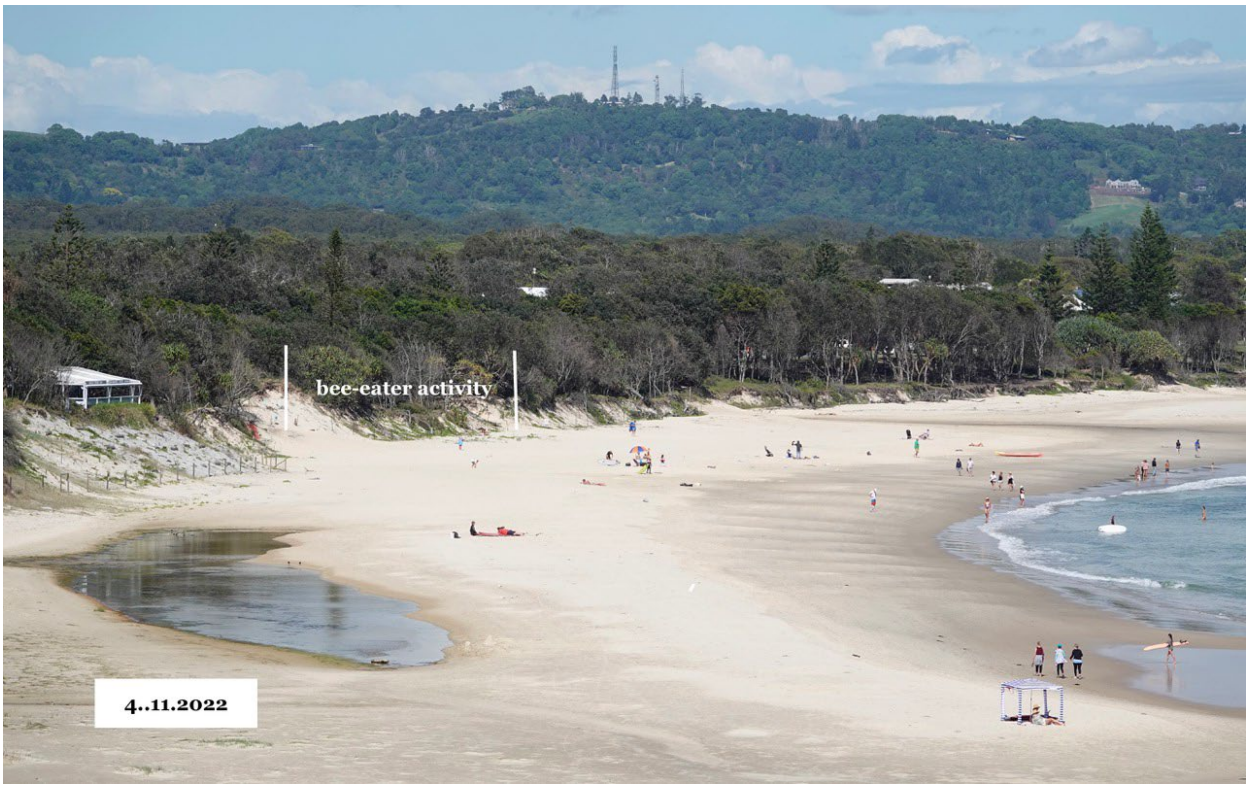
Date	Person	Notes of Inspection
31 October 2022 (pre-works)	Chloe Dowsett (Council)	Beach walk over project footprint. Identification of potential/possible Rainbow Bee Eater nest sites in the crest of the scarped dune. To be confirmed by Byron Bird Buddies inspection. Yellow flagging located at possible/potential nest sites. Nesting Plovers (chick and egg) located near Cowper St stormwater outlet. Rainbow Bee Eater activity present in the high dunes towards SSLC (two birds/pair).
4 November 2022 (pre-works)	Reid Waters (Byron Bird Buddies)	Beach walk along the project footprint. Rainbow Bee Eater activity present in the high dunes close to the Beach Café and also the SSLC. 3 high dune Bee-Eater nest entrances noted toward SLSC current occupancy status unknown. Masked Lapwing Plovers present on the beach with 2 chicks. Six masked lapwing adults present. Other birds present include the Figbrid and Wattlebird.
16 November 2022 (pre-works)	Chloe Dowsett (Council)	Beach walk over project footprint.
21 November 2022 Day 1 of works)	Chloe Dowsett (Council) Zoe Immisch (DPE) Simon King (Arakwal)	(Mid-Morning Walk) Beach walk along the entire project footprint, however primarily focusing on the daily works area (between BBSLSC and the first accessway for decommission). Tracks from 3 Bush Rats (or potentially small mammal) seen. Snake skin found in dune.

		2 Masked Lapwing Plovers, both with chicks (one smaller than the other). Rainbow Bee Eaters seen on the wing (3). Seagulls present on beach. (Afternoon Walk) Large carpet python, adjacent mound of grass/plants (Beach Beach). Pink flagging tape erected at the location to mark the (potential) next site of the snake for exclusion.
22 November (Day 2 of works)	Chloe Dowsett (Council)	Checked snake nest site – no visual sign of snake present. No markings on sand around the mound present. Vibrations likely made snake move on. Seagulls present on beach.
23 November 2022 (Day 3 of works)	Chloe Dowsett (Council)	Checked snake nest site – no visual sign of snake present. No markings on sand around the mound present. Snake likely no longer at location. Seagulls present on beach.
24 November 2022 (Day 4 of works)	Chloe Dowsett (Council)	2 Masked Lapwing Plovers, with one chick (one smaller than the other). Water dragons sighted on crest of dune in vegetation. Seagulls present on beach.
25 November 2022 (Day 5 of works)	Chloe Dowsett (Council)	Seagulls present on beach.

Photos from the pre-project inspection conducted by Byron Bird Buddies on the 4 November are provided below.

Main and Clarkes Beach Dune Recovery Project - Ecological Inspections

Main and Clarkes Beach Dune Recovery Project - Ecological Inspections



Main and Clarkes Beach Dune Recovery Project - Ecological Inspections

4.11.2022 high dune bee-eater nest entrance active/inactive?

4.11.2022 Masked Lapwings Clarkes Beach

Main and Clarkes Beach Dune Recovery Project - Ecological Inspections

Appendix 3: Beach inspections, forecast coastal conditions and approach to methodology

Report compiled by Byron Shire Council, Coastal and Biodiversity Coordinator, November 2022.

Main and Clarkes Beach Dune Recovery Project

Beach Inspections, Forecast Coastal Conditions and Approach to Methodology, 17 November 2022

Beach Inspections

In the lead up to project commencement, beach inspections were undertaken to informally assess the beach for project commencement. Inspections comprised a walkover on-site to visually assess the width and approximate height of the beach berm, intertidal zone and sand coverage, locations or exposure of any geomorphic features (bed rock or coffee rock) and limit of wave run-up. These inspections are outlined in the table below.

As noted in the inspection comments for 31 October, the project team made the decision to delay the commencement of works by 2 weeks from 7 November to 21 November due to concerns of a less accreted beach profile at Main Beach.

Date	Whom	Notes of Inspection
31 October 2022 Morning inspection during LT incoming. Spring tides: LT 0658 of 0.64m ISLW	Chloe Dowsett (BSC); Ben Fitzgibbon (DPE); Zoe Immisch (DPE); James Trevillion (SCS); Andrew Page (SCS).	**Clarkes:** A slug of sand appears to be moving through The Pass into Clarkes Beach with a wide sub aerial berm and moderate beach face. High tide run-up was penetrating landward of the seaward berm crest. While there appears to be sufficient sand in the eastern area of Clarkes the profile at Main is lower. **Main:** Appears to have been impacted by the East Coast Low swell experienced the week prior. Concern raised in relation to less accreted profile and decision made to delay the commencement of the project by 2 weeks (i.e., from 7 Nov to 21 Nov).

Date	Whom	Notes of Inspection
14 November 2022 Morning inspection during LT incoming. Neap tides: LT 0604 of 0.72m ISLW	Ben Fitzgibbon (DPE)	**Clarkes:** Intertidal zone reasonably accreted, having a steeper profile and wide sub-aerial berm. High tide run-up was not evidenced to be penetrating landward of the seaward berm crest, noting the tides were in neap phase. **Main:** Intertidal zone more accreted than observed during previous beach inspection on 31 October 2022. However, the profile at Main is less accreted, flatter and lower than Clarke's profile. Wave run-up was penetrating towards the back beach dune (within approx. 15-20m of dune toe) as evidenced by wet sand and a strand line. Tides were neap and as such, it is predicted that during spring tides, wave run-up would penetrate further towards the back beach dune.
16 November 2022 Morning inspection at LT. Neap tides: LT 0800 of 0.80m ISLW	Ben Fitzgibbon (DPE)	**Clarkes:** A slug of sand appears to be moving through The Pass into Clarkes Beach. There is an area of deeper water off eastern Main Beach on the leading edge of this slug. **Main:** Profile appears to be continuing its slow recovery but remains (anecdotally) lower than Clarkes Beach and the 'typical' accreted profile.
16 November 2022 Afternoon inspection during HT.	Chloe Dowsett (BSC); James Trevillion (SCS); Andrew (SCS)	**Clarkes:** Sub aerial beach a lot wider than at Main. **Main:** Wave run-up during high tide conditions closer to the back beach. Beach is a lot slimmer than the eastern section.

Forecast Coastal Conditions

Tides for the week commencing 21 November are spring coming into a New Moon on 24 November with high tides >1.7m ISLW commencing Tuesday 22 November. The swell forecast into the week of 21 November does not show any significant swell events. This may change closer to 21 November and coastal conditions will be monitored each day. Current conditions during the preceding week of project works (14-20 Nov) and into the week of project works would appear to favour beach building (i.e., sand accretion).

Tides and swell forecast are shown in the table below. **Bold** numbers **indicate high tide of 1.7m or more** or **low tide of 0.3m or less.**

Date	Low Tide*	High Tide*	Swell Forecast**
Monday 21 November	0035; 0.42m ISLW 1312; 0.51m ISLW	0659; 1.58m ISLW 1908; 1.49m ISLW	Wave heights <2.0m from N, switching to ESE.
Tuesday 22 November	0112; 0.39m ISLW 1400; 0.41m ISLW	0737; **1.71m** ISLW 1955; 1.49m ISLW	Wave heights <2.0m from S.
Wednesday 23 November	0150; 0.38m ISLW 1448; 0.31m ISLW	0818; **1.82m** ISLW 2044; 1.48m ISLW	Wave heights <2.0m from S.
Thursday 24 November	0230 0.38m ISLW 1538; **0.25m** ISLW	0901 **1.91m** ISLW 2135 1.45	Wave heights around 1.5m from SSE.
Friday 25 November	0315; 0.41m ISLW 1630; **0.21m** ISLW	0947; **1.97m** ISLW 2229; 1.41m ISLW	Wave heights <1.5m from SSE.

*Tidal Prediction for Sydney Harbour (July 2022-June 2023)
** Swell forecast estimated from Windguru - Byron Bay (17/11/22)

Approach to Methodology

After the on-site beach inspections on Wednesday 16 November, the project team confirmed the preferred approach to the methodology to make the most of the spring tides (i.e., higher highs and lower lows) and the current beach conditions.

Key points on the recommended approach are:

- Beach scraping works start at the western end of the site (SSLC) to win sand from the intertidal, before the larger predicted tides interact with the beach from Wednesday 23 November onwards.
- It is noted that there is a risk that the larger predicted tides from mid-next week (23 Nov) into the weekend will enable waves to interact with the back beach dune at Main Beach. If swell is low this is not expected to result in any significant erosion. If swell is powerful, some erosion of the scraped dune may occur. This risk always remains regardless of beach profile, however, may be elevated when the beach has a lower profile as Main Beach does currently (anecdotally).
- The predicted tide on Friday 27 November is 1.97m (ISLW) at 0947am. Only limited intertidal scraping works might be achieved within 1-2 hours leading up to and following the peak of this high tide.
- A second excavator to be on stand-by to assist in the works (if determined necessary) for improving efficiency and the range of access on both low and high tides. Excavators enable

better access to the lower intertidal area and enable access to the swash zone which is beneficial during high tide when only limited intertidal area is available to scrape.

- A Posi-track to be on stand-by to groom the beach berm following scraping completion of works as deemed necessary to reduce public safety risks and/or improve beach amenity.

Reference Material

- http://www.bom.gov.au/australia/charts/viewer/index.shtml?domain=combinedW&type=sigWaveHgt
- https://www.windguru.cz/62174

Appendix 4: Drone Surveys – Pre Works, 15 November 2022

CLARKES BEACH
AERIAL IMAGE
15th November 2022

MGA
NORTH

CLARKES BEACH
SURFACE ELEVATION
15th November 2022

Elevations Table			
Number	Minimum Elevation	Maximum Elevation	Color
1	-1.00	-0.90	
2	-0.90	-0.80	
3	-0.80	-0.70	
4	-0.70	-0.60	
5	-0.60	-0.50	
6	-0.50	-0.40	
7	-0.40	-0.30	
8	-0.30	-0.20	
9	-0.20	-0.10	
10	-0.10	0.00	
11	0.00	0.10	
12	0.10	0.20	
13	0.20	0.30	
14	0.30	0.40	
15	0.40	0.50	
16	0.50	0.60	
17	0.60	0.70	
18	0.70	0.80	
19	0.80	0.90	
20	0.90	1.00	

Elevations Table			
Number	Minimum Elevation	Maximum Elevation	Color
21	1.00	1.10	
22	1.10	1.20	
23	1.20	1.30	
24	1.30	1.40	
25	1.40	1.50	
26	1.50	1.60	
27	1.60	1.70	
28	1.70	1.80	
29	1.80	1.90	
30	1.90	2.00	
31	2.00	2.10	
32	2.10	2.20	
33	2.20	2.30	
34	2.30	2.40	
35	2.40	2.50	
36	2.50	2.60	
37	2.60	2.70	
38	2.70	2.80	
39	2.80	2.90	
40	2.90	3.00	

Elevations Table			
Number	Minimum Elevation	Maximum Elevation	Color
41	3.00	3.10	
42	3.10	3.20	
43	3.20	3.30	
44	3.30	3.40	
45	3.40	3.50	
46	3.50	3.60	
47	3.60	3.70	
48	3.70	3.80	
49	3.80	3.90	
50	3.90	4.00	
51	4.00	4.10	
52	4.10	4.20	
53	4.20	4.30	
54	4.30	4.40	
55	4.40	4.50	
56	4.50	4.60	
57	4.60	4.70	
58	4.70	4.80	
59	4.80	4.90	
60	4.90	5.00	

Elevations Table			
Number	Minimum Elevation	Maximum Elevation	Color
61	5.00	5.10	
62	5.10	5.20	
63	5.20	5.30	
64	5.30	5.40	
65	5.40	5.50	
66	5.50	5.60	
67	5.60	5.70	
68	5.70	5.80	
69	5.80	5.90	
70	5.90	6.00	
71	6.00	6.10	
72	6.10	6.20	
73	6.20	6.30	
74	6.30	6.40	
75	6.40	6.50	
76	6.50	6.60	
77	6.60	6.70	
78	6.70	6.80	
79	6.80	6.90	
80	6.90	7.00	

Elevations Table			
Number	Minimum Elevation	Maximum Elevation	Color
81	7.00	7.10	
82	7.10	7.20	
83	7.20	7.30	
84	7.30	7.40	
85	7.40	7.50	
86	7.50	7.60	
87	7.60	7.70	
88	7.70	7.80	
89	7.80	7.90	
90	7.90	8.00	
91	8.00	8.10	
92	8.10	8.20	
93	8.20	8.30	
94	8.30	8.40	
95	8.40	8.50	
96	8.50	8.60	
97	8.60	8.70	
98	8.70	8.80	
99	8.80	8.90	
100	8.90	9.00	

Elevations Table			
Number	Minimum Elevation	Maximum Elevation	Color
101	9.00	9.10	
102	9.10	9.20	
103	9.20	9.30	
104	9.30	9.40	
105	9.40	9.50	
106	9.50	9.60	
107	9.60	9.70	
108	9.70	9.80	
109	9.80	9.90	
110	9.90	10.00	
111	10.00	10.10	
112	10.10	10.20	
113	10.20	10.30	
114	10.30	10.40	
115	10.40	10.50	
116	10.50	10.60	
117	10.60	10.70	
118	10.70	10.80	
119	10.80	10.90	
120	10.90	11.00	

Elevations Table			
Number	Minimum Elevation	Maximum Elevation	Color
121	11.00	11.10	
122	11.10	11.20	
123	11.20	11.30	

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3. Boundaries have not been investigated.
4. Underground services have not been investigated
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REV	DATE	DESCRIPTION
A	18/11/2022	ORIGINAL ISSUE
B	18/11/2022	Alignment Labels

PROJECT	BYR166
SURVEYOR	LF
SURVEY DATE	15/11/2022
FIELD BOOK ID	CHC_1
PLAN BY	LF
APPROVED BY	LF

MGA GDA94	HZ DATUM
CORSnet	ORIGIN
AHD	VT DATUM
CORSnet	ORIGIN
VIDE VRS	LEVEL
N/A	SCIMS

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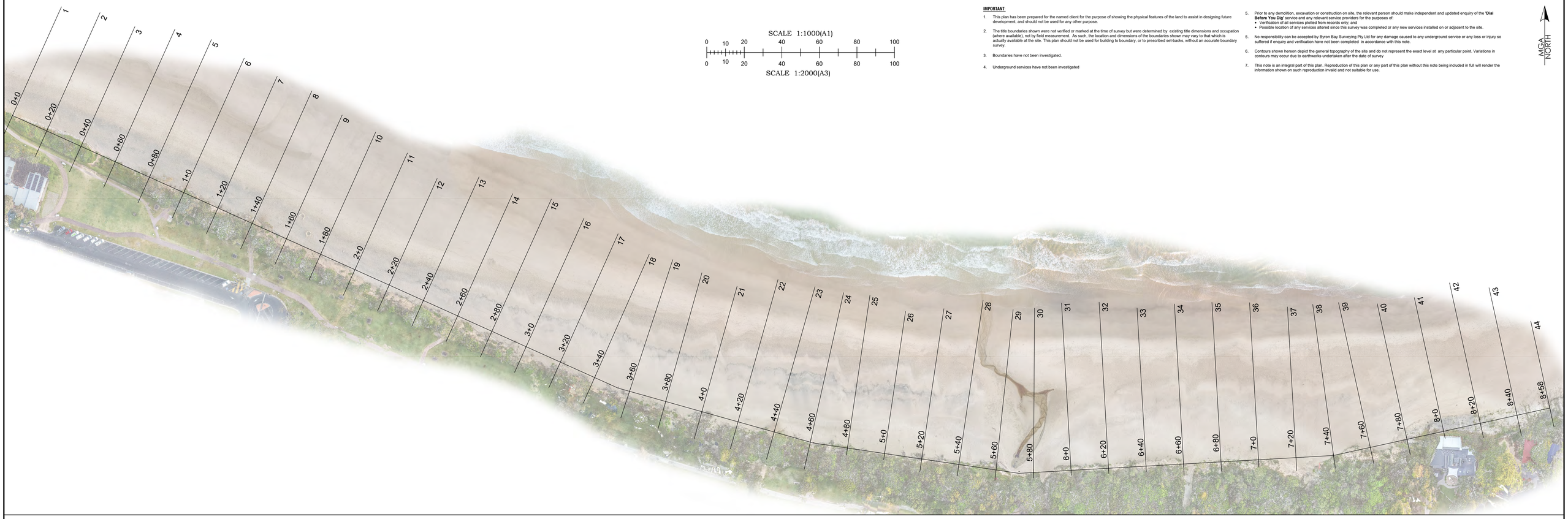
SCALE 1:1000(A1)
0 10 20 40 60 80 100
0 10 20 40 60 80 100
SCALE 1:2000(A3)

PLAN SHOWING CLARKES BEACH SAND ELEVATIONS

CLARKES BEACH
BYRON BAY
NSW 2481

CLIENT: BYRON SHIRE COUNCIL
DWG No: BYR166_DS
SH: 1 OF 9



SCALE 1:1000(A1)

0 10 20 40 60 80 100

0 10 20 40 60 80 100

SCALE 1:2000(A3)

MGA NORTH

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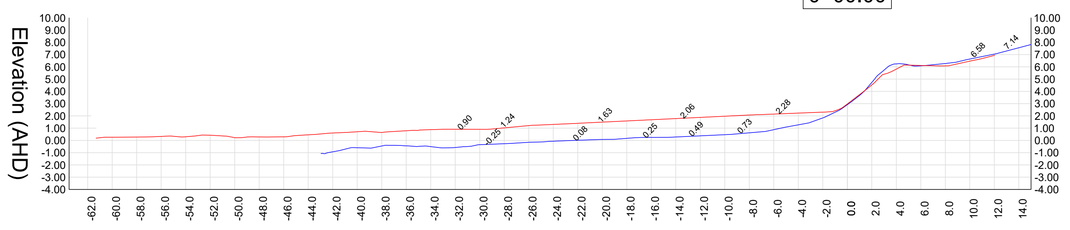

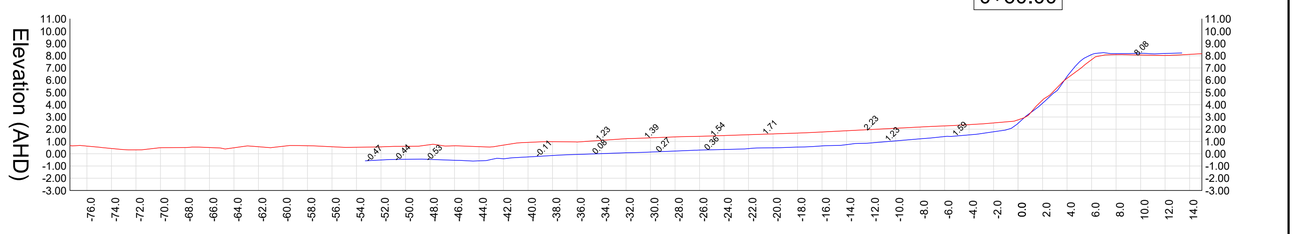

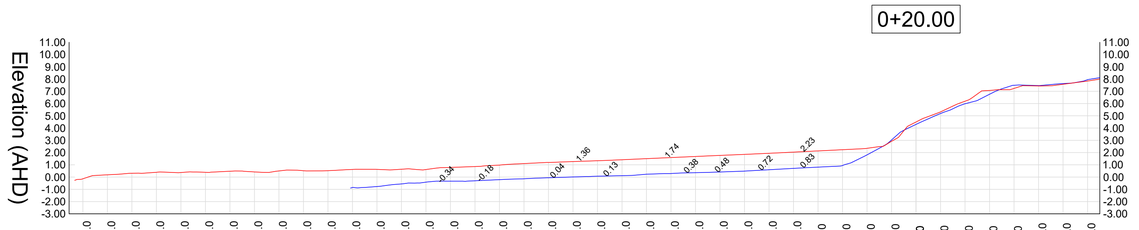

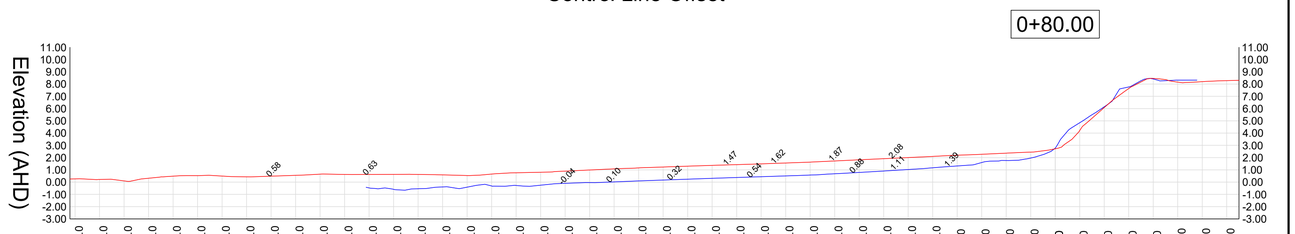

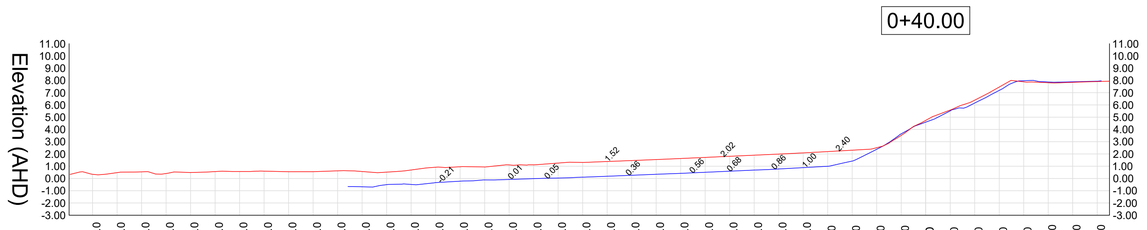

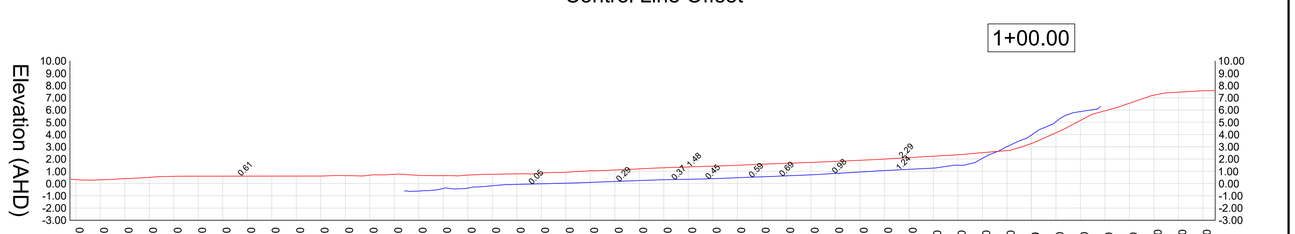

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REV	DATE	DESCRIPTION
A	18/11/2022	ORIGINAL ISSUE
B	18/11/2022	Alignment Labels

PROJECT	BYR166
SURVEYOR	LF
SURVEY DATE	15/11/2022
FIELD BOOK ID	CHC_1
PLAN BY	LF
APPROVED BY	LF

MGA GDA94	HZ DATUM
CORSnet	ORIGIN
AHD	VT DATUM
CORSnet	ORIGIN
VIDE VRS	LEVEL
N/A	SCIMS

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SCALE 1:250(A1)

0 5 10 15 20 25

0 5 10 15 20 25

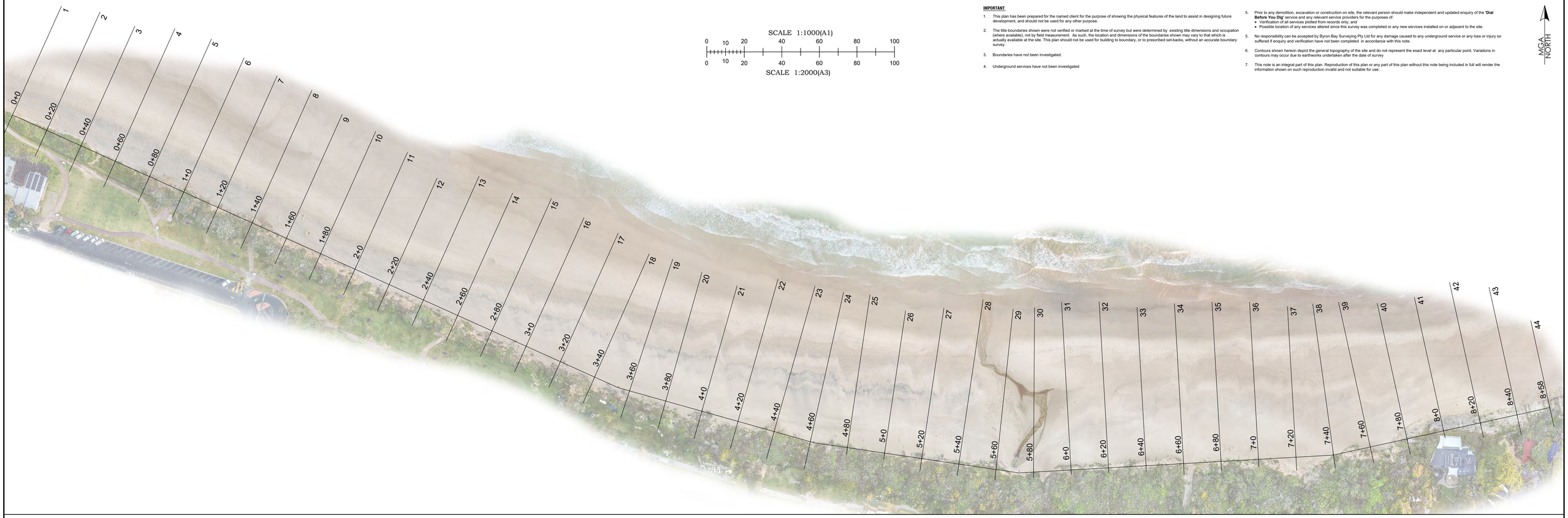
SCALE 1:500(A3)

PLAN SHOWING CLARKES BEACH CROSS SECTIONS

CLARKES BEACH
BYRON BAY
NSW 2481

CLIENT: BYRON SHIRE COUNCIL
DWG No: BYR166_DS
SH: 2 OF 9

- 15th November 2022 SURFACE PROFILE BY BYRON BAY SURVEYING
- December 2020 SURFACE PROFILE BY BLUECOAST CONSULTANTS



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0 10 20 40 60 80 100

0 10 20 40 60 80 100

SCALE 1:2000(A3)

MGA NORTH

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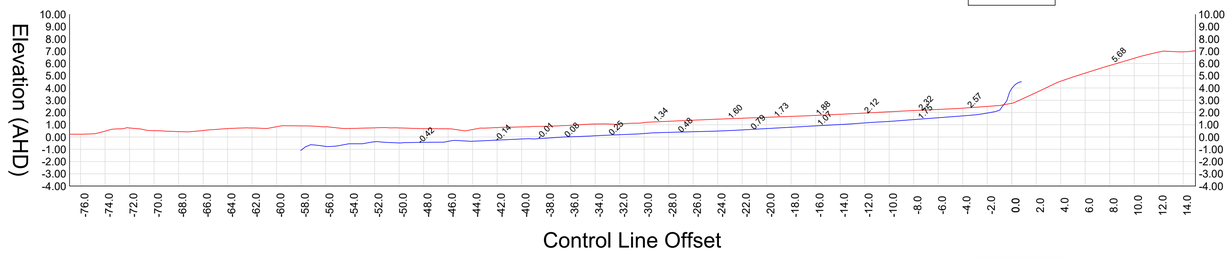
1+20.00



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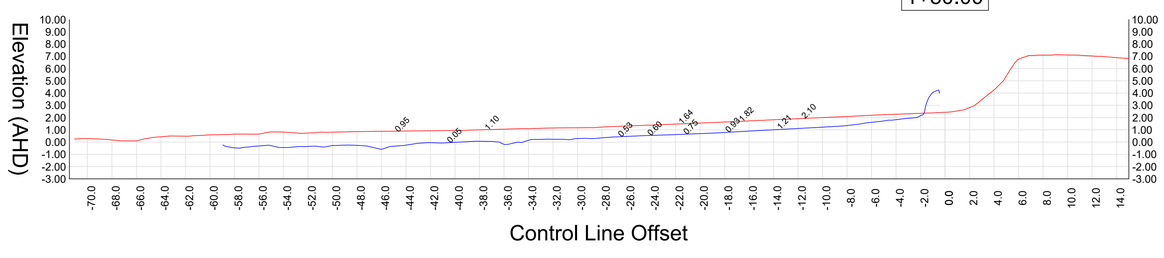

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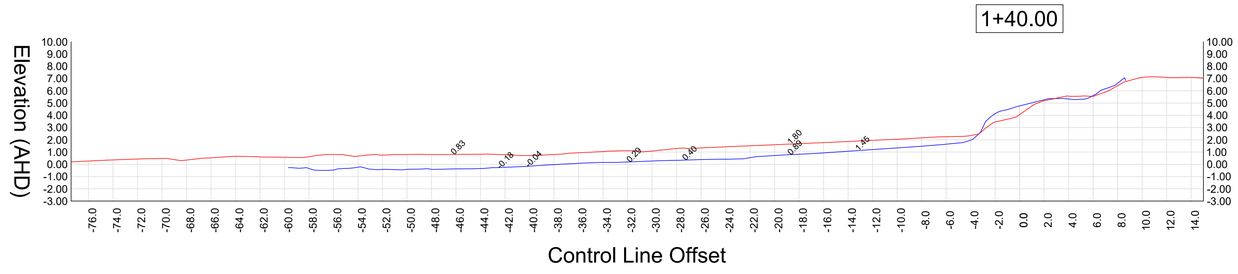

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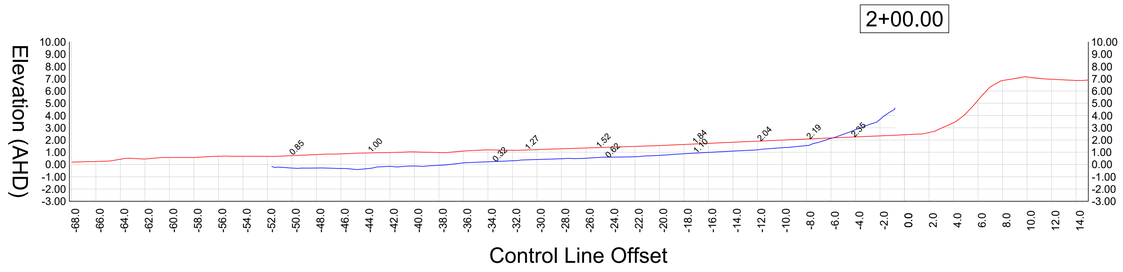

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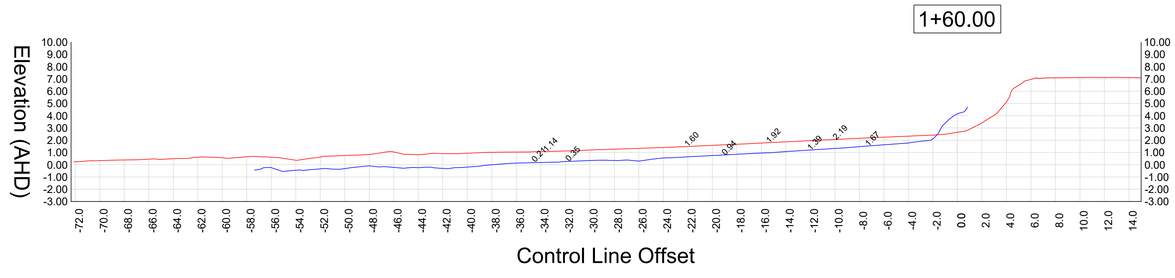

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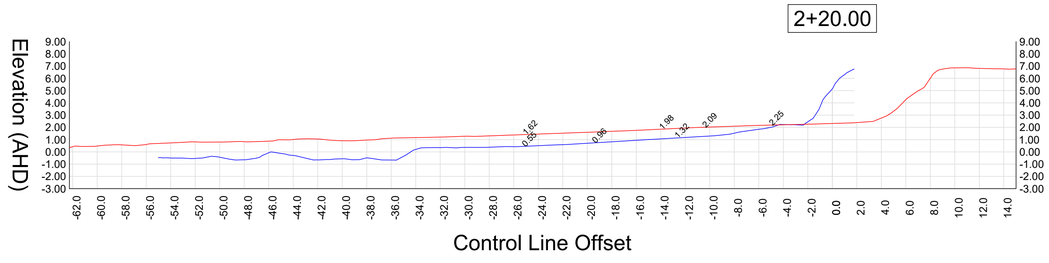

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SURVEYOR	LF
SURVEY DATE	15/11/2022
FIELD BOOK ID	CHC_1
PLAN BY	LF
APPROVED BY	LF

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SCALE 1:250(A1)

0 5 10 15 20 25

0 5 10 15 20 25

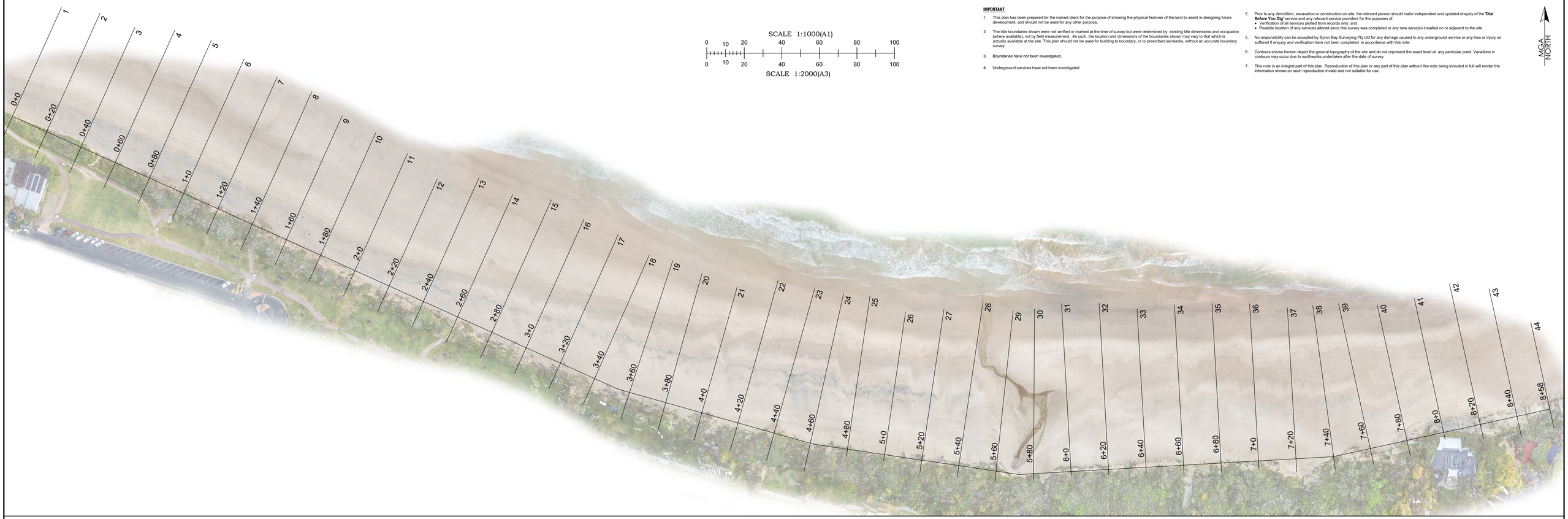
SCALE 1:500(A3)

PLAN SHOWING CLARKES BEACH CROSS SECTIONS

CLARKES BEACH
BYRON BAY
NSW 2481

CLIENT: BYRON SHIRE COUNCIL
DWG No: BYR166_DS
SH: 3 OF 9

- 15th November 2022 SURFACE PROFILE BY BYRON BAY SURVEYING
- December 2020 SURFACE PROFILE BY BLUECOAST CONSULTANTS



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0 10 20 40 60 80 100

SCALE 1:2000(A3)

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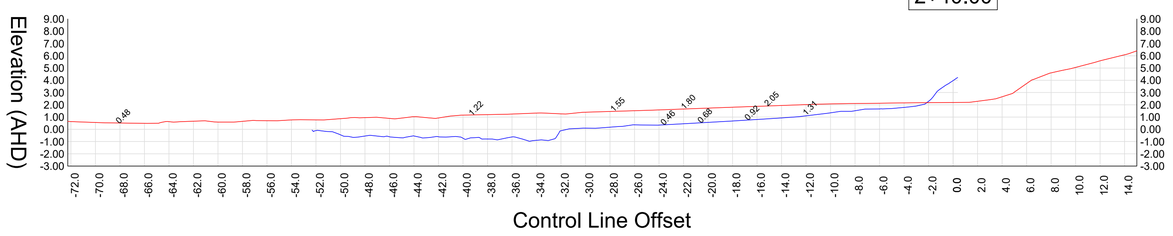
2+40.00



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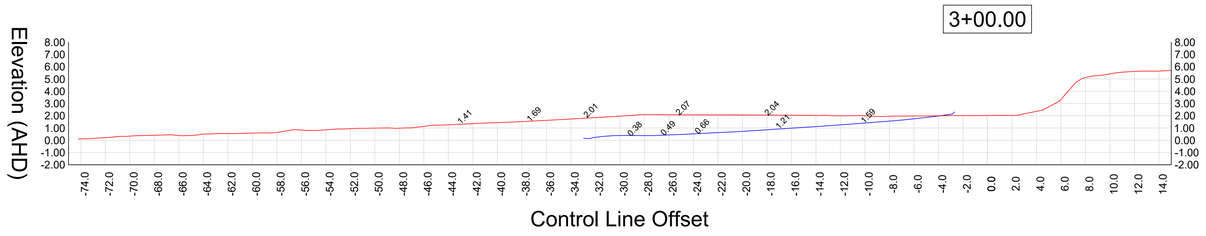

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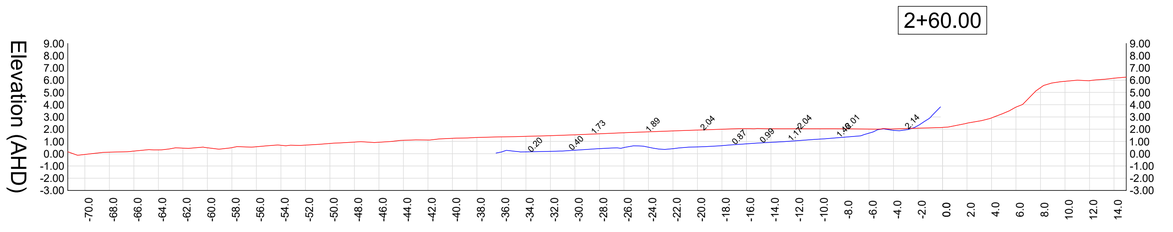

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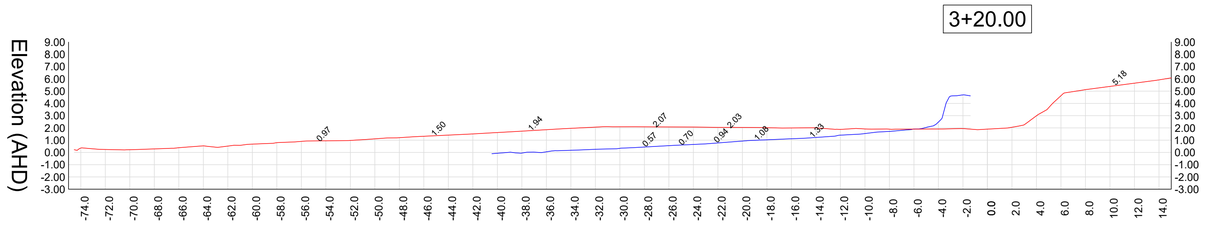

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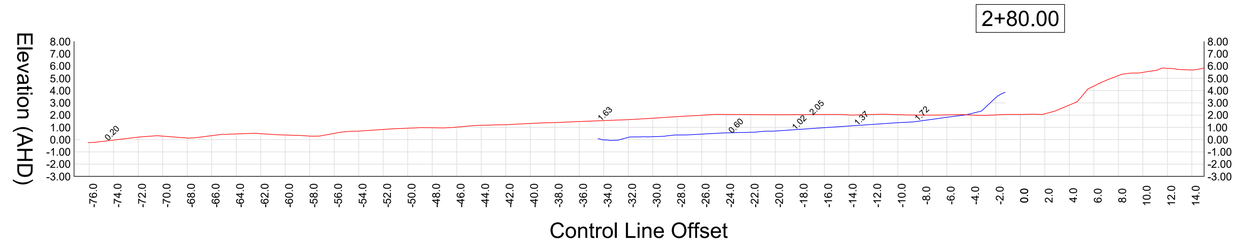

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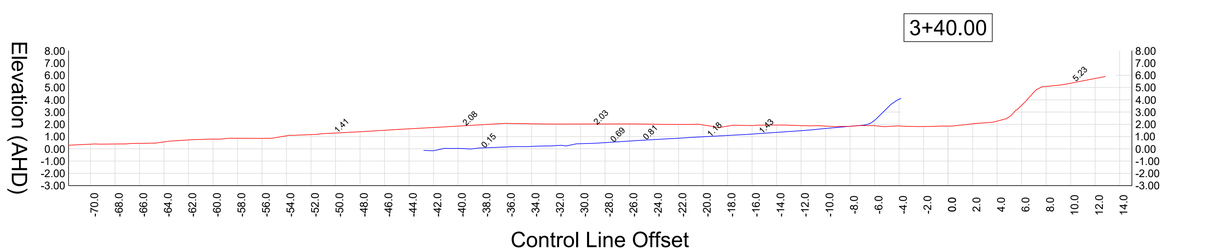

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A	18/11/2022	ORIGINAL ISSUE
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PROJECT	BYR166
SURVEYOR	LF
SURVEY DATE	15/11/2022
FIELD BOOK ID	CHC_1
PLAN BY	LF
APPROVED BY	LF

MGA GDA94	HZ DATUM
CORSnet	ORIGIN
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SCALE 1:250(A1)

0 5 10 15 20 25

0 5 10 15 20 25

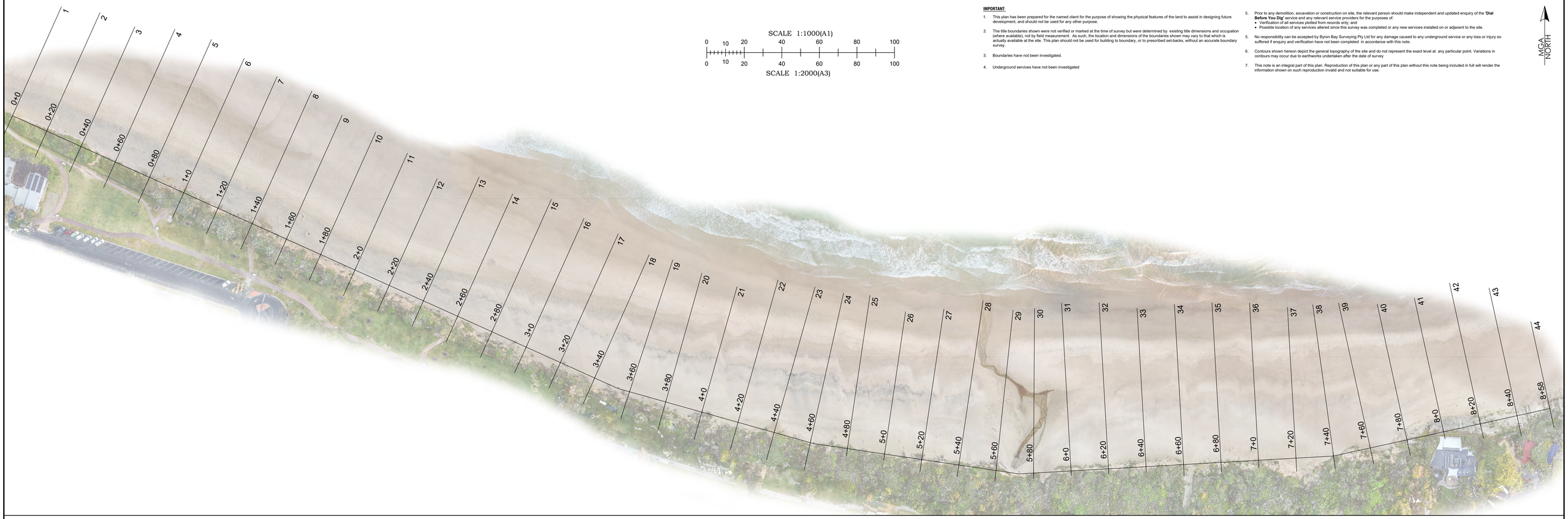
SCALE 1:500(A3)

PLAN SHOWING CLARKES BEACH CROSS SECTIONS

CLARKES BEACH
BYRON BAY
NSW 2481

CLIENT: BYRON SHIRE COUNCIL
DWG No: BYR166_DS
SH: 4 OF 9

- 15th November 2022 SURFACE PROFILE BY BYRON BAY SURVEYING
- December 2020 SURFACE PROFILE BY BLUECOAST CONSULTANTS



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0 10 20 40 60 80 100

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SCALE 1:2000(A3)

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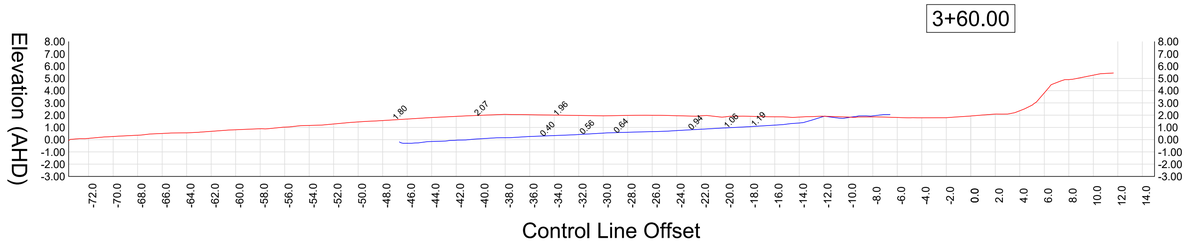

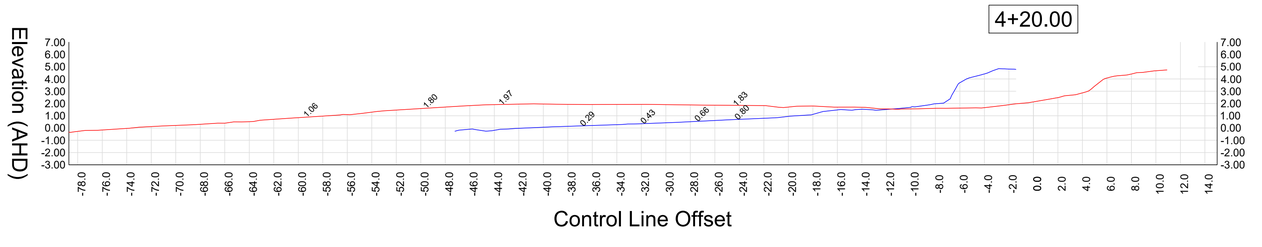

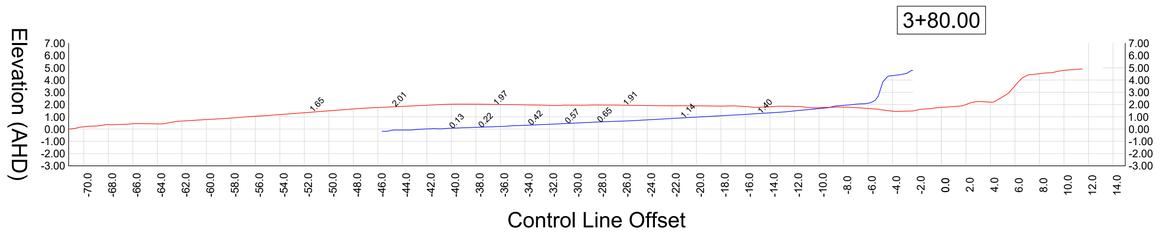

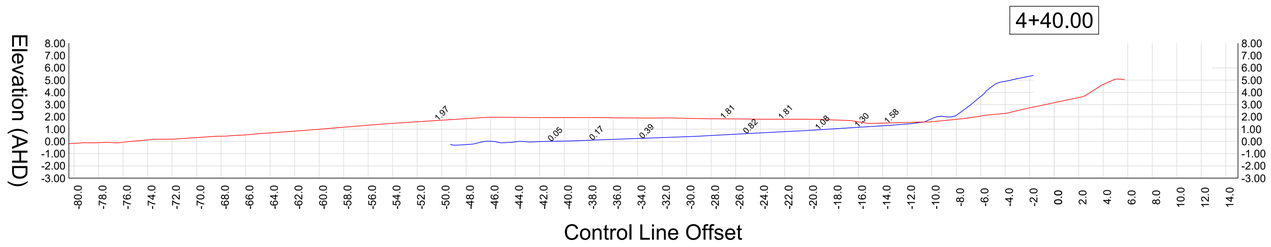

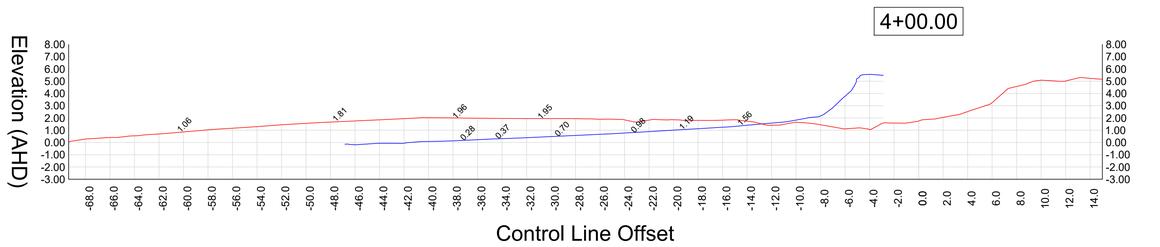

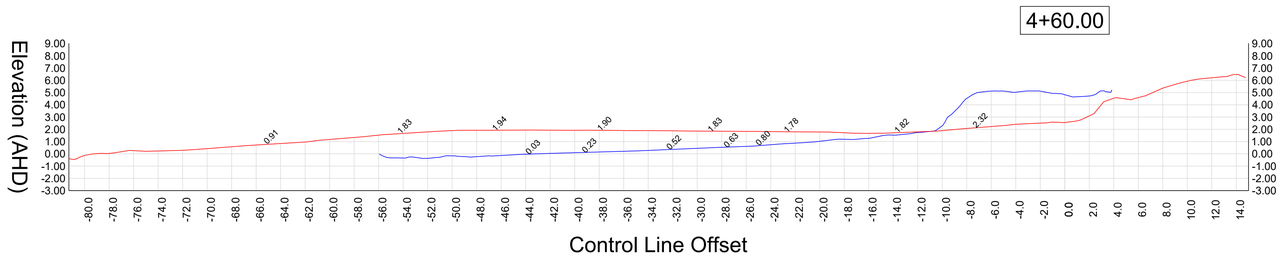

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SURVEYOR	LF
SURVEY DATE	15/11/2022
FIELD BOOK ID	CHC_1
PLAN BY	LF
APPROVED BY	LF

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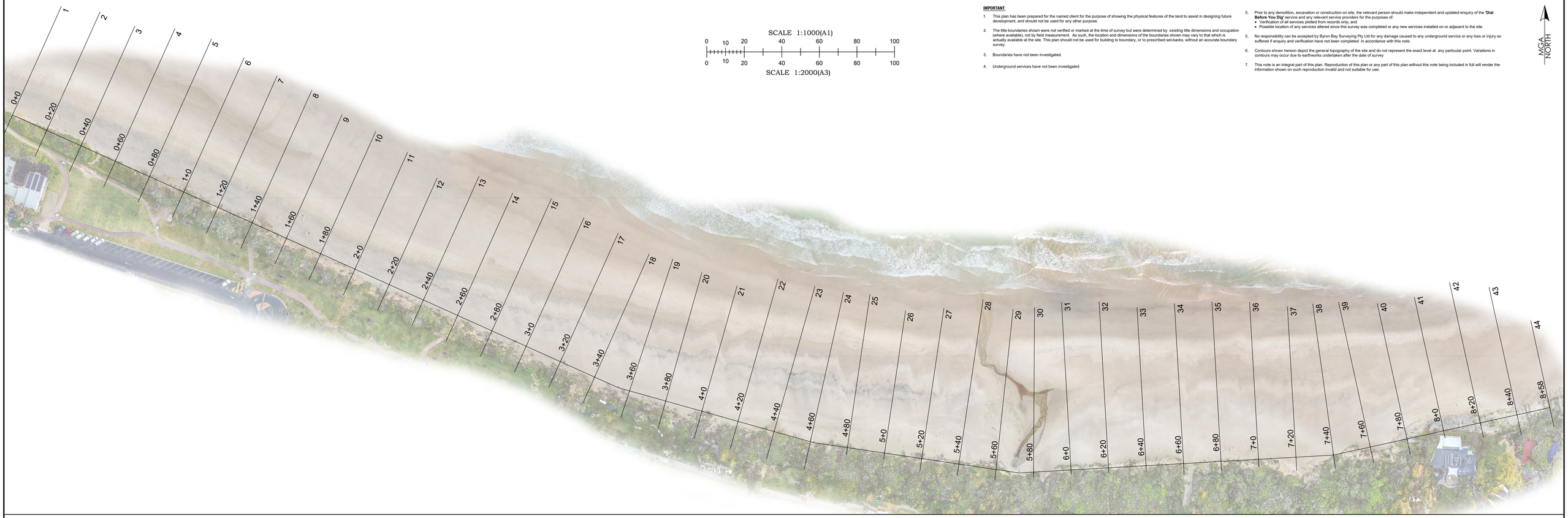
SCALE 1:500(A3)

PLAN SHOWING CLARKES BEACH CROSS SECTIONS

CLARKES BEACH
BYRON BAY
NSW 2481

CLIENT: BYRON SHIRE COUNCIL
DWG No: BYR166_DS
SH: 5 OF 9

- 15th November 2022 SURFACE PROFILE BY BYRON BAY SURVEYING
- December 2020 SURFACE PROFILE BY BLUECOAST CONSULTANTS



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SCALE 1:2000(A3)

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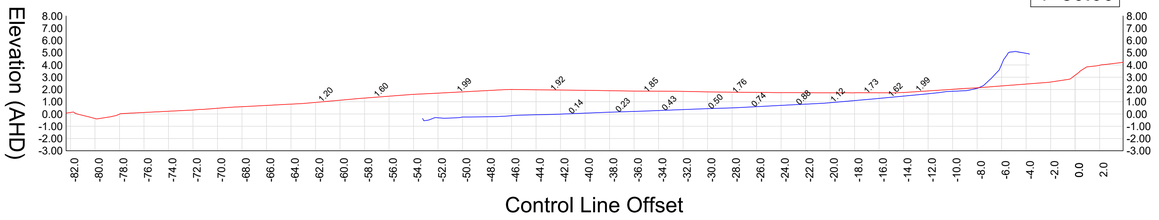
4+80.00



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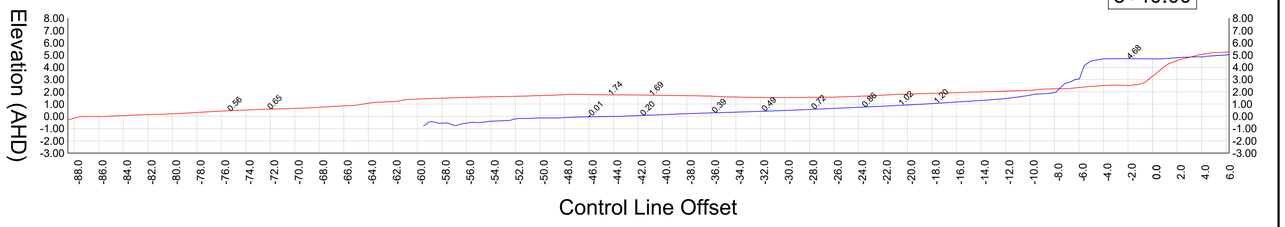
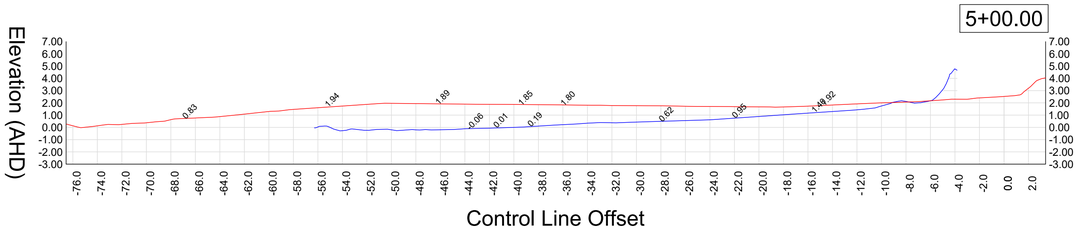


5+00.00



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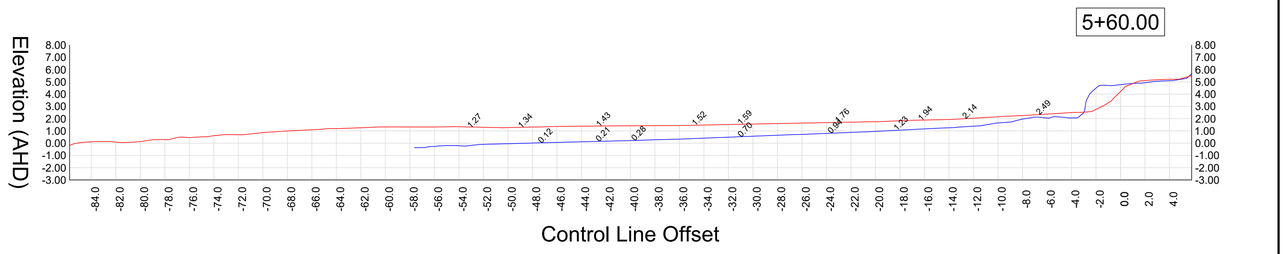

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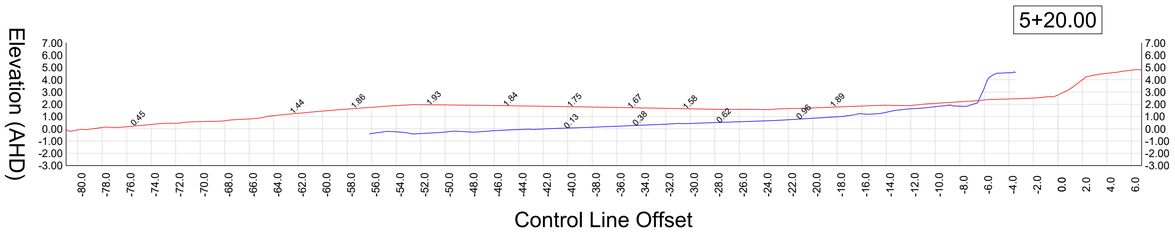

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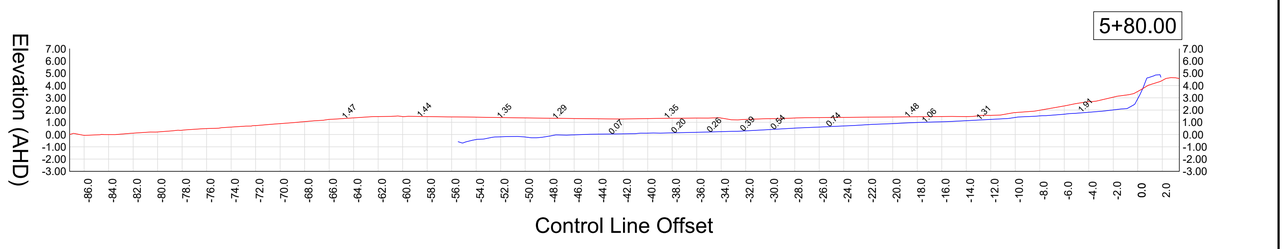

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SURVEY DATE	15/11/2022
FIELD BOOK ID	CHC_1
PLAN BY	LF
APPROVED BY	LF

MGA GDA94	HZ DATUM
CORSnet	ORIGIN
AHD	VT DATUM
CORSnet	ORIGIN
VIDE VRS	LEVEL
N/A	SCIMS

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SCALE 1:250(A1)

0 5 10 15 20 25

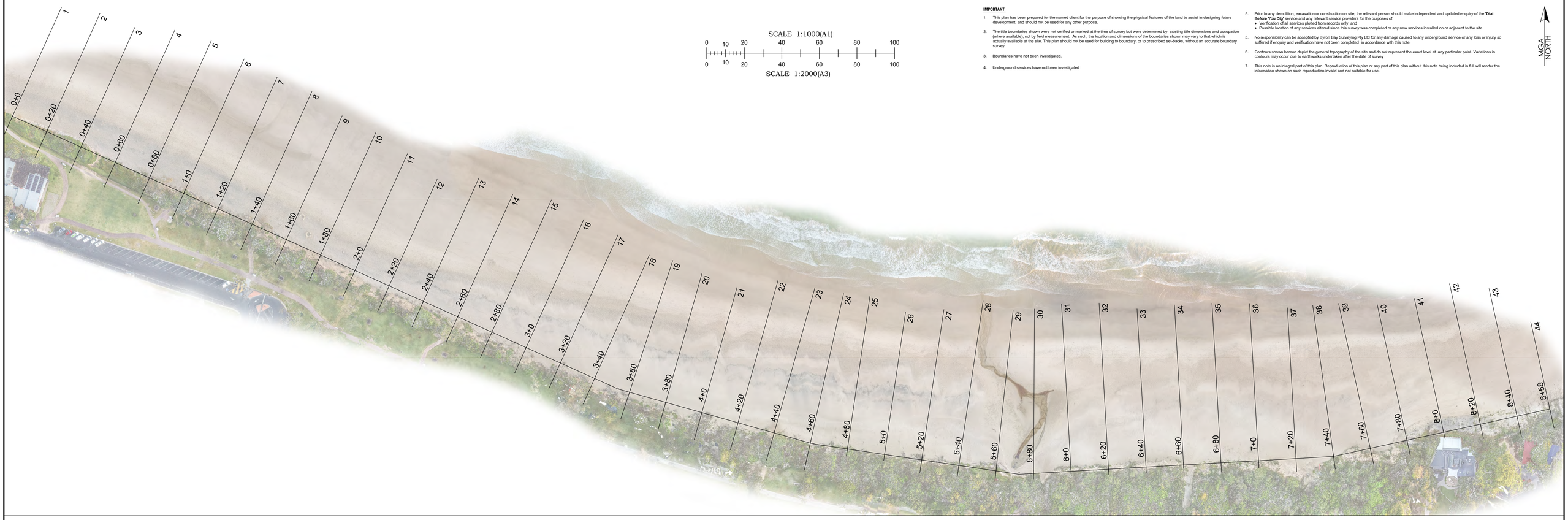
SCALE 1:500(A3)

PLAN SHOWING CLARKES BEACH CROSS SECTIONS

CLARKES BEACH
BYRON BAY
NSW 2481

CLIENT: BYRON SHIRE COUNCIL
DWG No: BYR166_DS
SH: 6 OF 9

- 15th November 2022 SURFACE PROFILE BY BYRON BAY SURVEYING
- December 2020 SURFACE PROFILE BY BLUECOAST CONSULTANTS



SCALE 1:1000(A1)

0 10 20 40 60 80 100

0 10 20 40 60 80 100

SCALE 1:2000(A3)

MGA NORTH

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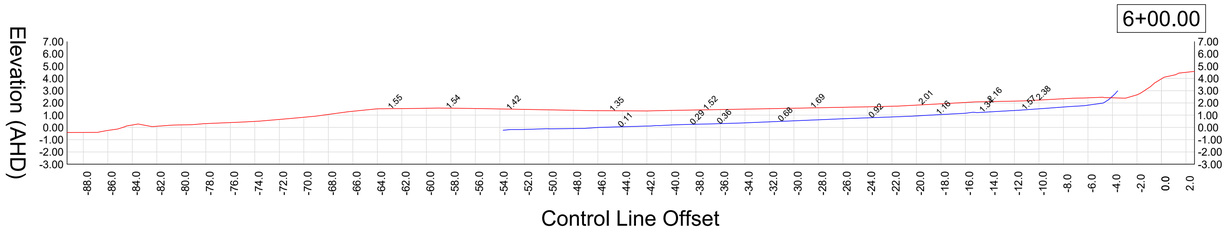

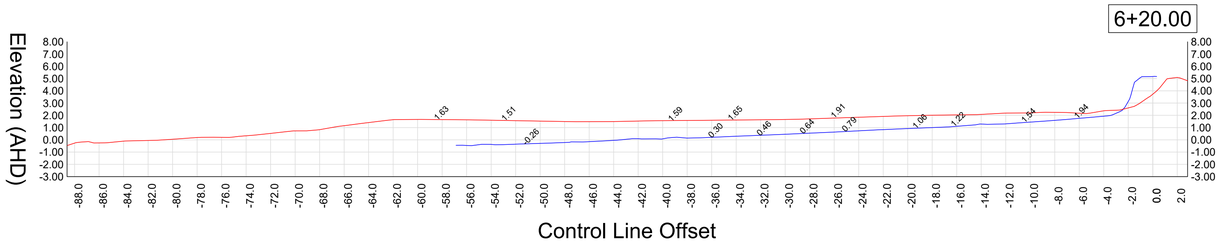

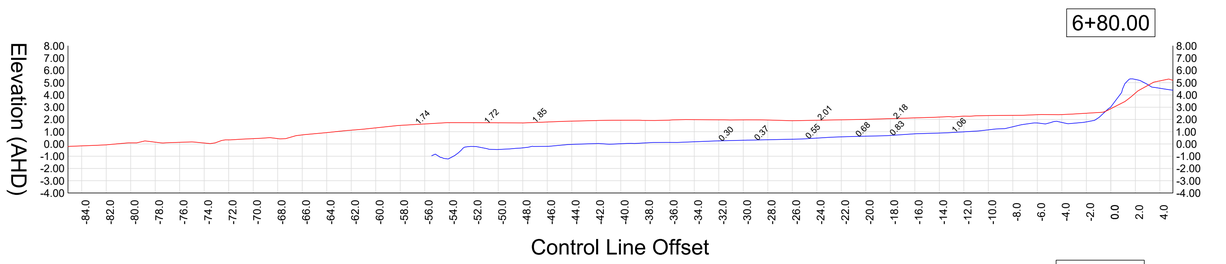

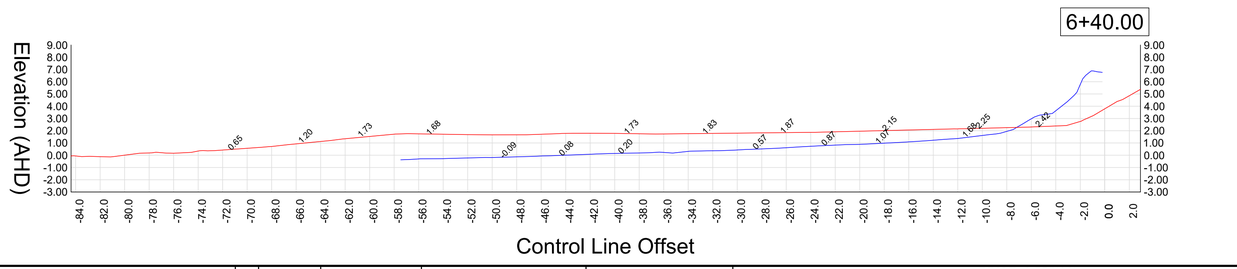

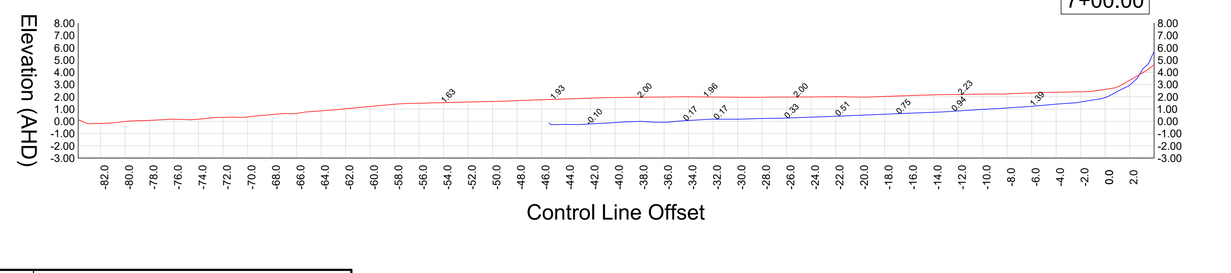

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Alstonville NSW 2477 Tel: 0431 348 590
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www.ByronBaySurveying.com.au

REV	DATE	DESCRIPTION
A	18/11/2022	ORIGINAL ISSUE
B	18/11/2022	Alignment Labels

PROJECT	BYR166
SURVEYOR	LF
SURVEY DATE	15/11/2022
FIELD BOOK ID	CHC_1
PLAN BY	LF
APPROVED BY	LF

MGA GDA94	HZ DATUM
CORSnet	ORIGIN
AHD	VT DATUM
CORSnet	ORIGIN
VIDE VRS	LEVEL
N/A	SCIMS

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SCALE 1:250(A1)

0 5 10 15 20 25

0 5 10 15 20 25

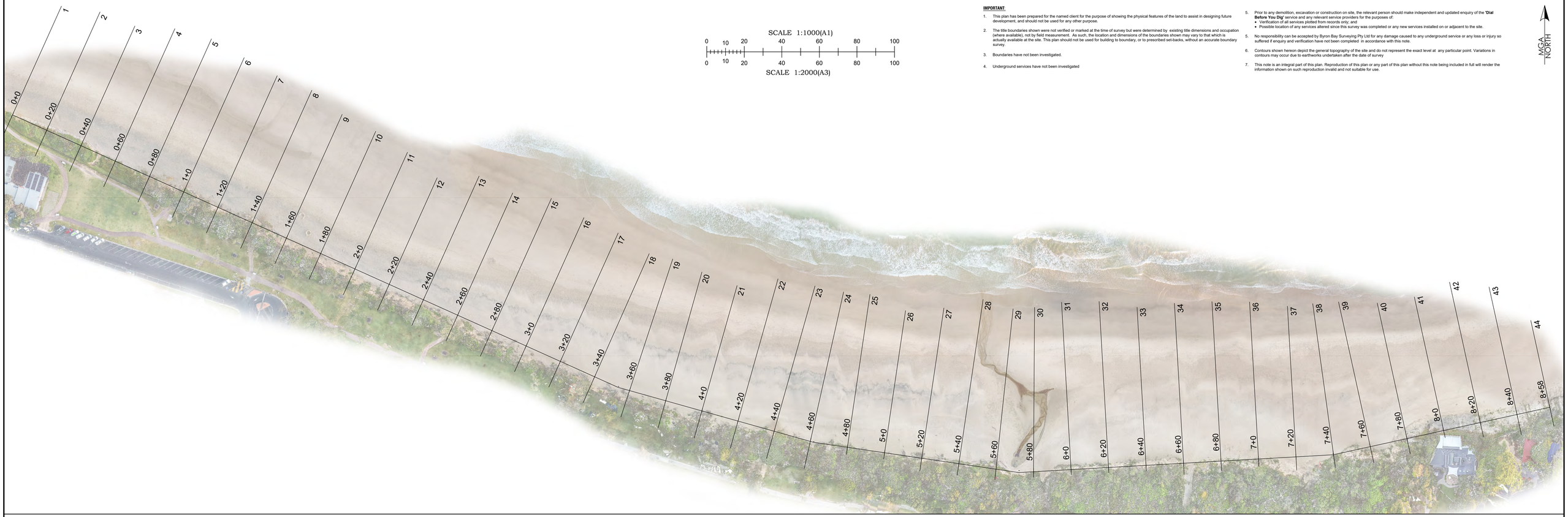
SCALE 1:500(A3)

PLAN SHOWING CLARKES BEACH CROSS SECTIONS

CLARKES BEACH
BYRON BAY
NSW 2481

CLIENT: BYRON SHIRE COUNCIL
DWG No: BYR166_DS
SH: 7 OF 9

- 15th November 2022 SURFACE PROFILE BY BYRON BAY SURVEYING
- December 2020 SURFACE PROFILE BY BLUECOAST CONSULTANTS



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0 10 20 40 60 80 100

0 10 20 40 60 80 100

SCALE 1:2000(A3)

MGA NORTH

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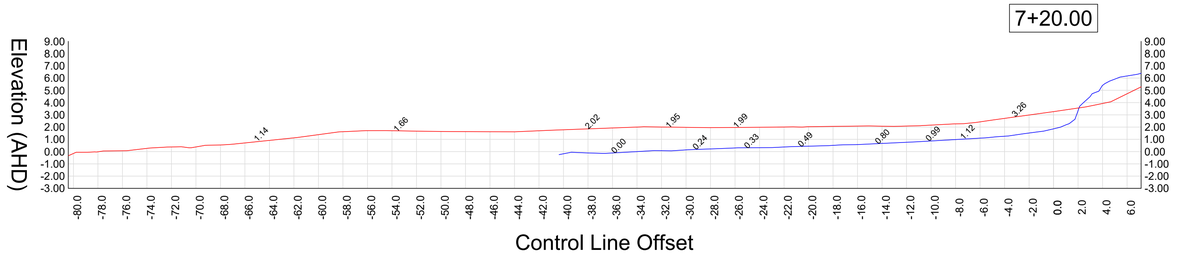

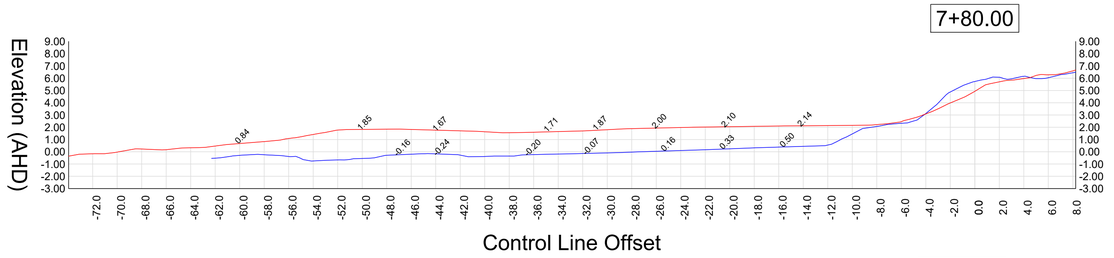

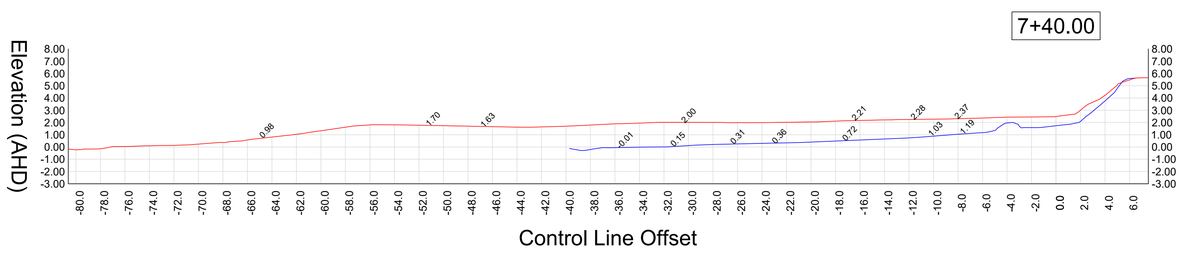

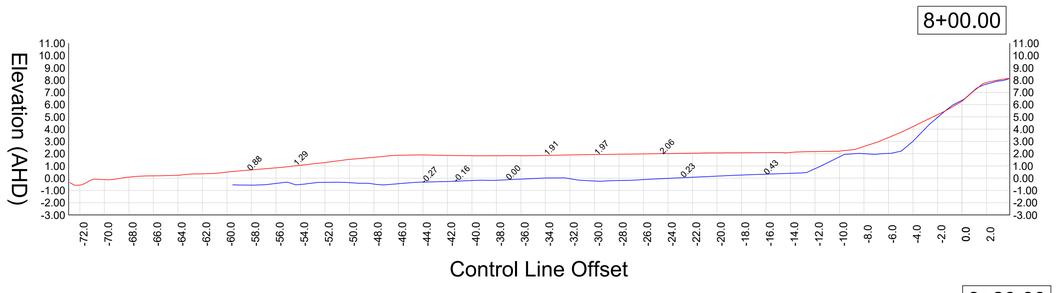

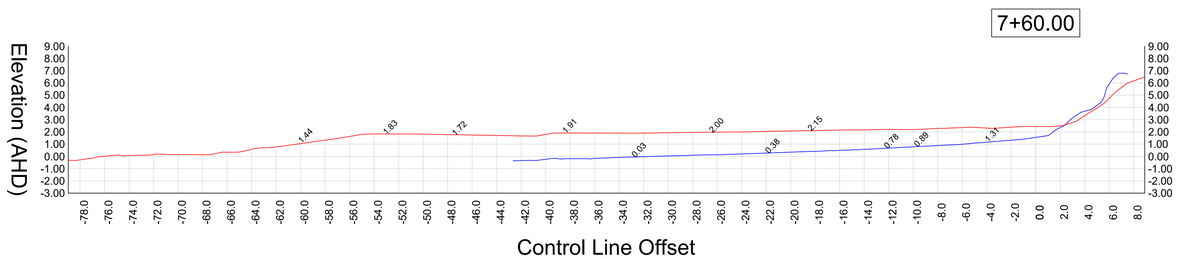

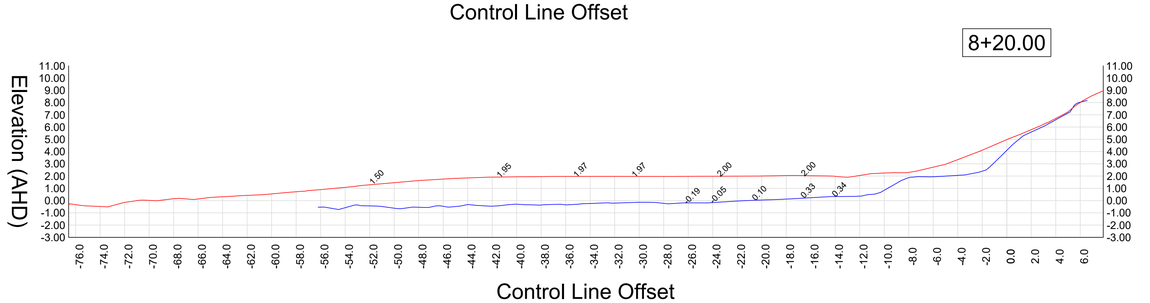

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REV	DATE	DESCRIPTION
A	18/11/2022	ORIGINAL ISSUE
B	18/11/2022	*Alignment Labels*

PROJECT	BYR166
SURVEYOR	LF
SURVEY DATE	15/11/2022
FIELD BOOK ID	CHC_1
PLAN BY	LF
APPROVED BY	LF

MGA GDA94	HZ DATUM
CORSnet	ORIGIN
AHD	VT DATUM
CORSnet	ORIGIN
VIDE VRS	LEVEL
N/A	SCIMS

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SCALE 1:250(A1)

0 5 10 15 20 25

0 5 10 15 20 25

SCALE 1:500(A3)

PLAN SHOWING CLARKES BEACH CROSS SECTIONS

CLARKES BEACH
BYRON BAY
NSW 2481

CLIENT: BYRON SHIRE COUNCIL
DWG No: BYR166_DS
SH: 8 OF 9

- 15th November 2022 SURFACE PROFILE BY BYRON BAY SURVEYING
- December 2020 SURFACE PROFILE BY BLUECOAST CONSULTANTS

SCALE 1:1000(A1)

0 10 20 40 60 80 100

0 10 20 40 60 80 100

SCALE 1:2000(A3)

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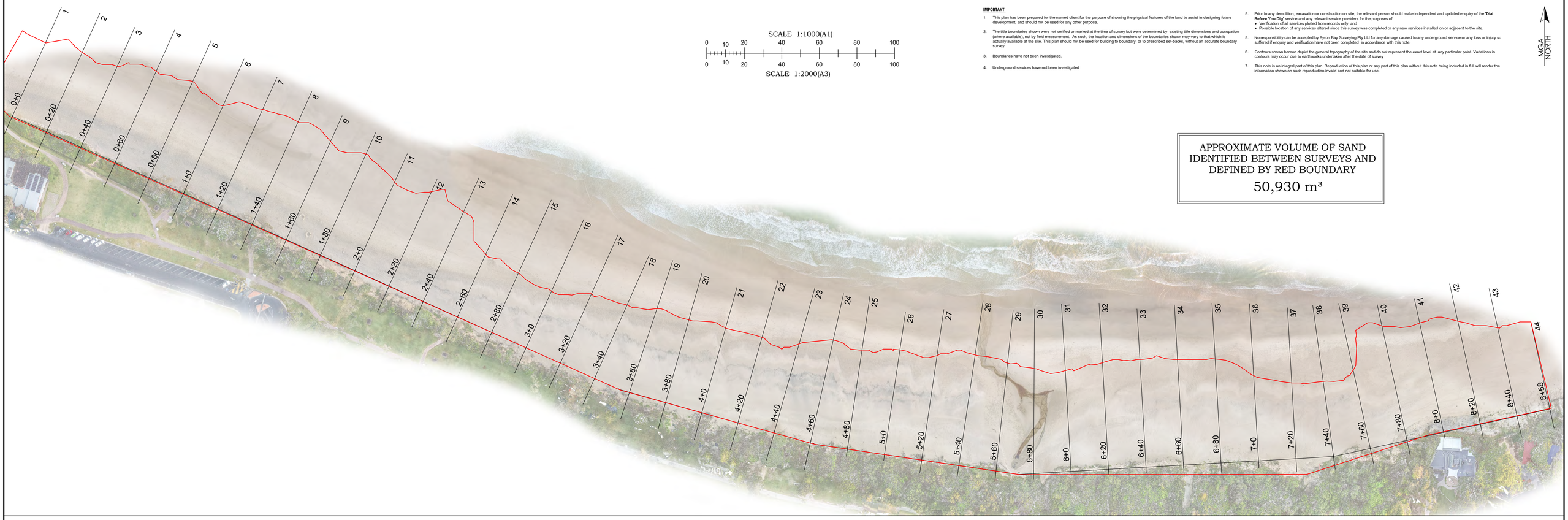
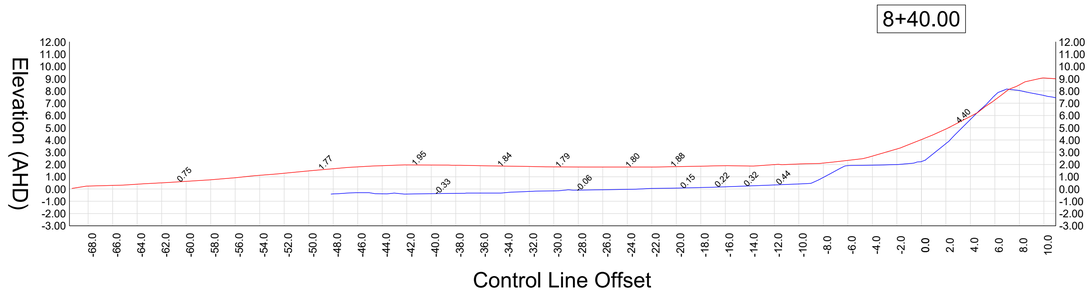
MGA NORTH



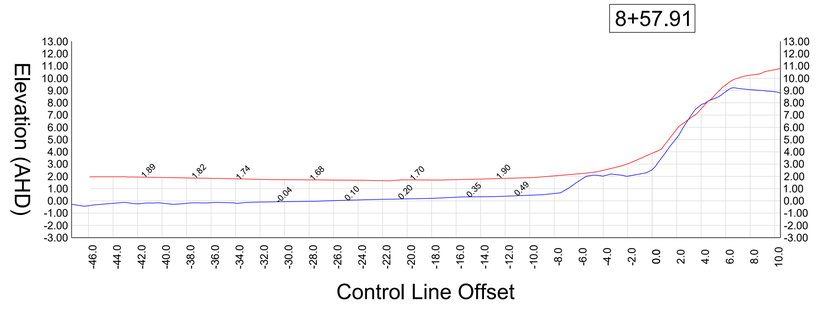
APPROXIMATE VOLUME OF SAND IDENTIFIED BETWEEN SURVEYS AND DEFINED BY RED BOUNDARY

50,930 m³

8+40.00



8+57.91



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SURVEYOR	LF
SURVEY DATE	15/11/2022
FIELD BOOK ID	CHC_1
PLAN BY	LF
APPROVED BY	LF

MGA GDA94	HZ DATUM
CORSnet	ORIGIN
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VIDE VRS	LEVEL
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SCALE 1:250(A1)

0 5 10 15 20 25

0 5 10 15 20 25

SCALE 1:500(A3)

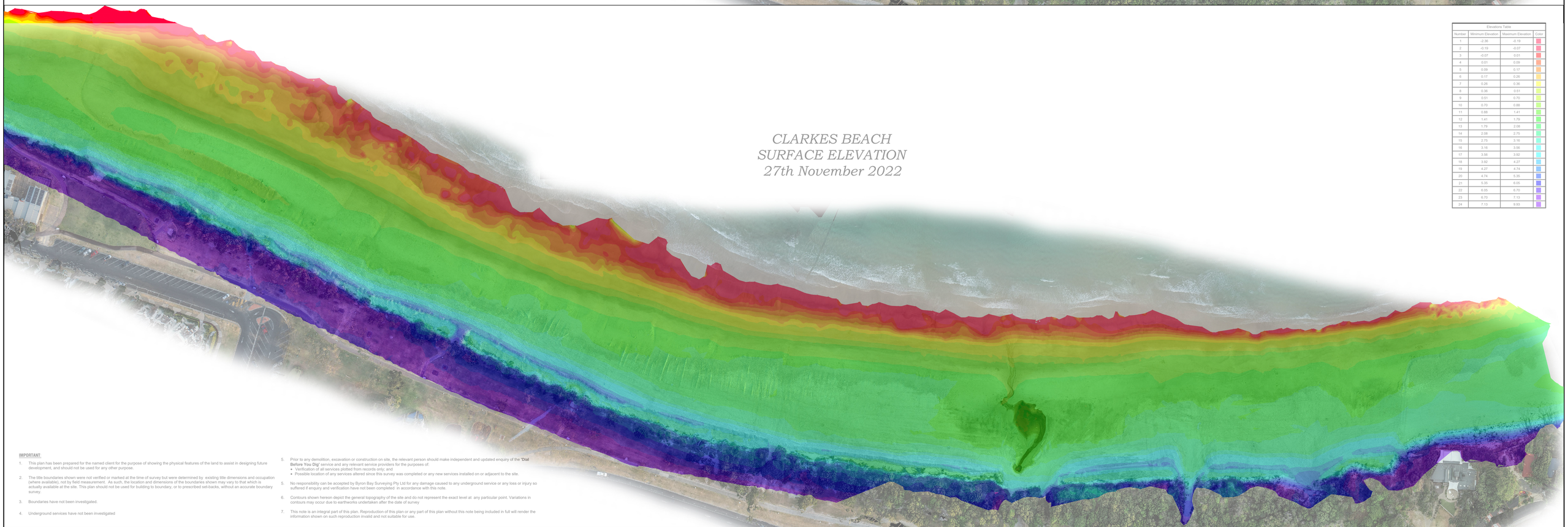
PLAN SHOWING CLARKES BEACH CROSS SECTIONS

CLARKES BEACH
BYRON BAY
NSW 2481

CLIENT: BYRON SHIRE COUNCIL
DWG No: BYR166_DS
SH: 9 OF 9

- 15th November 2022 SURFACE PROFILE BY BYRON BAY SURVEYING
- December 2020 SURFACE PROFILE BY BLUECOAST CONSULTANTS

Appendix 5: Drone Survey – Post Works, 27 November 2022



Elevations Table			
Number	Minimum Elevation	Maximum Elevation	Color
1	-2.36	-0.19	
2	-0.19	-0.07	
3	-0.07	0.01	
4	0.01	0.09	
5	0.09	0.17	
6	0.17	0.26	
7	0.26	0.36	
8	0.36	0.51	
9	0.51	0.70	
10	0.70	0.88	
11	0.88	1.41	
12	1.41	1.79	
13	1.79	2.08	
14	2.08	2.75	
15	2.75	3.16	
16	3.16	3.56	
17	3.56	3.92	
18	3.92	4.27	
19	4.27	4.74	
20	4.74	5.35	
21	5.35	6.05	
22	6.05	6.70	
23	6.70	7.13	
24	7.13	9.93	

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REV	DATE	DESCRIPTION
A	18/11/2022	ORIGINAL ISSUE
B	18/11/2022	Alignment Labels
C	12/02/2022	ROUND 2

PROJECT	BYR166
SURVEYOR	LF
SURVEY DATE	27/11/2022
FIELD BOOK ID	CHC_1
PLAN BY	LF
APPROVED BY	LF

MGA GDA94	HZ DATUM
CORSnet	ORIGIN
AHD	VT DATUM
CORSnet	ORIGIN
VIDE VRS	LEVEL
N/A	SCIMS

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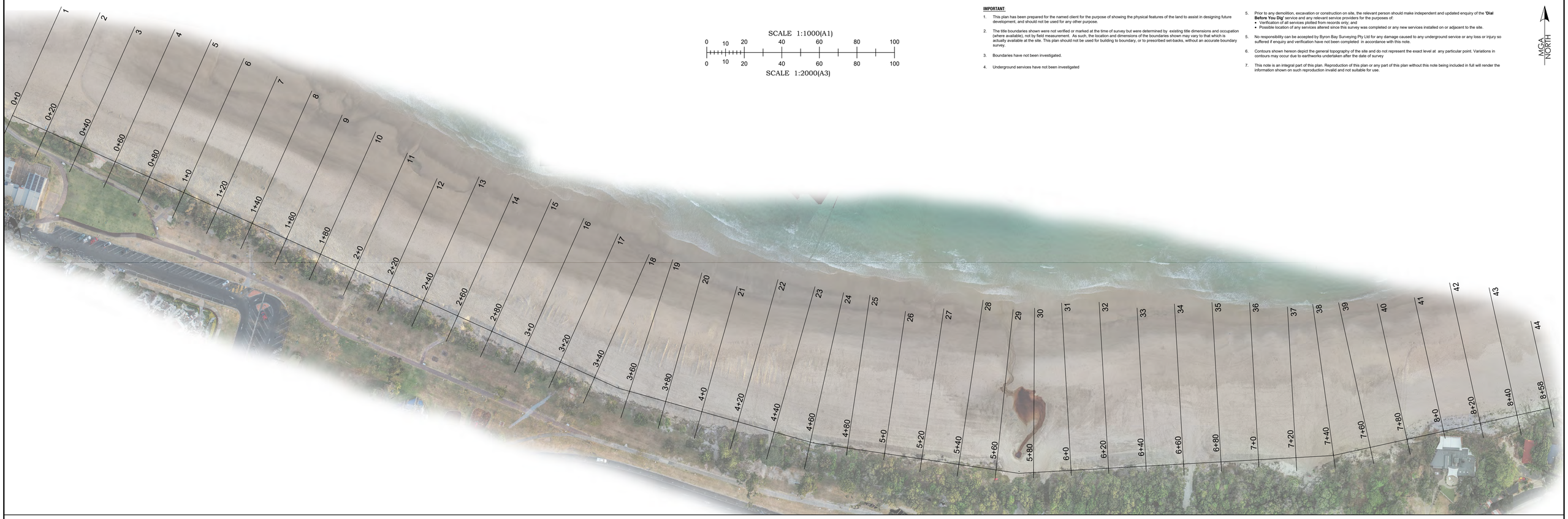
SCALE 1:1000(A1)
0 10 20 40 60 80 100
0 10 20 40 60 80 100
SCALE 1:2000(A3)

PLAN SHOWING CLARKES BEACH SAND ELEVATIONS

CLARKES BEACH
BYRON BAY
NSW 2481

CLIENT: BYRON SHIRE COUNCIL
DWG No: BYR166_DS
SH: 1 OF 9



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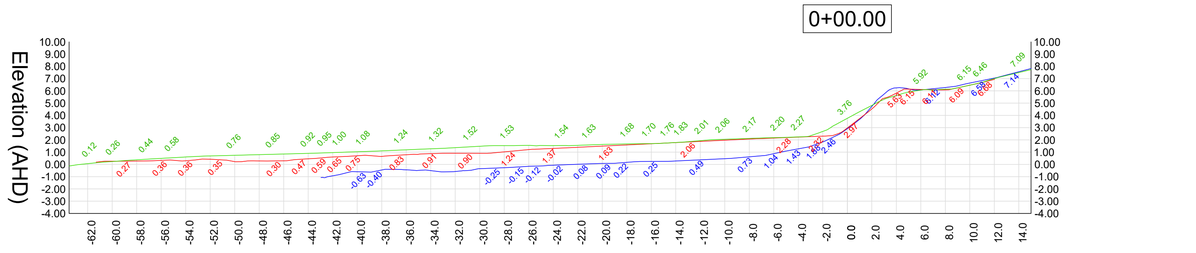

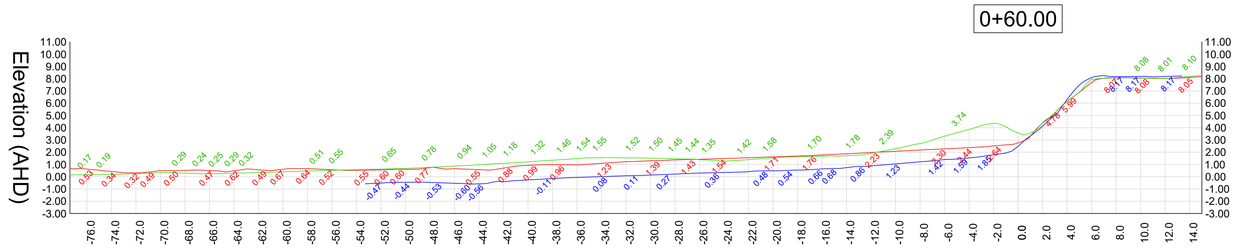

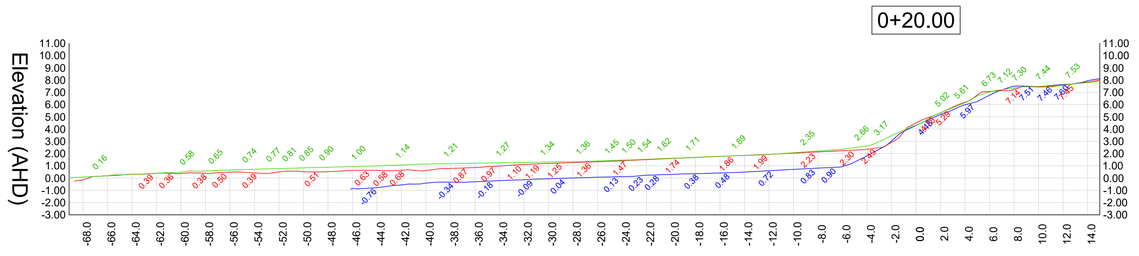

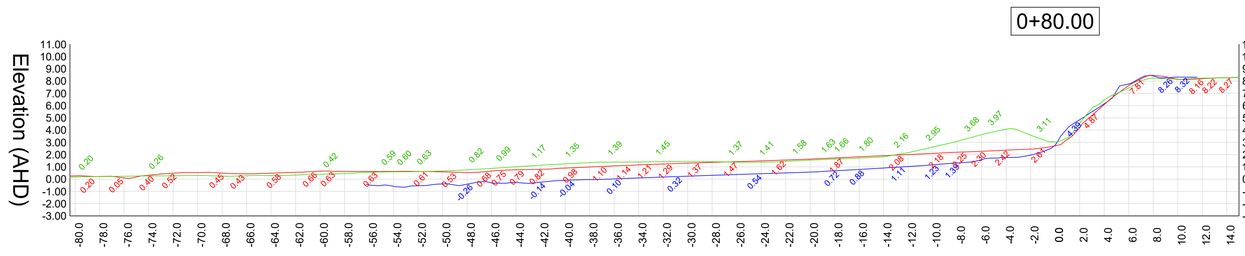

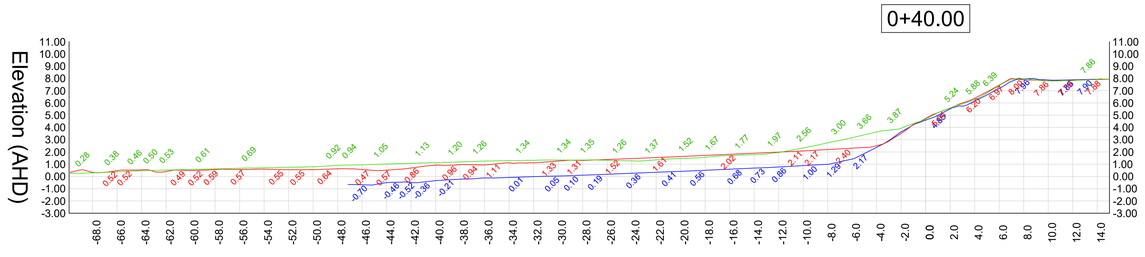

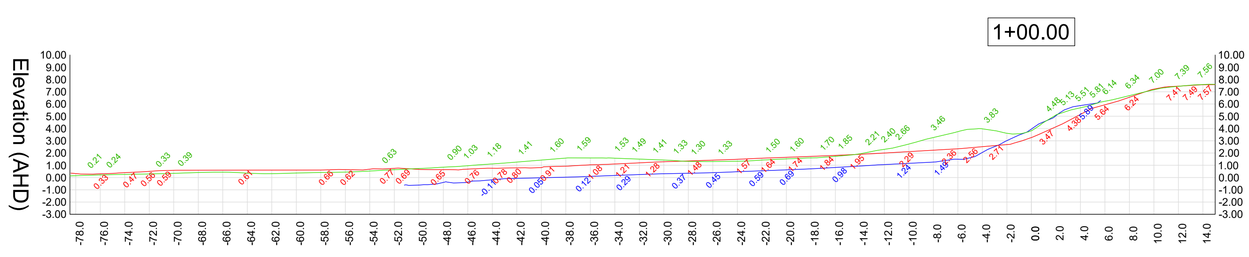

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SURVEY DATE	27/11/2022
FIELD BOOK ID	CHC_1
PLAN BY	LF
APPROVED BY	LF

MGA GDA94	HZ DATUM
CORSnet	ORIGIN
AHD	VT DATUM
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VIDE VRS	LEVEL
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SCALE 1:250(A1)

0 5 10 15 20 25

0 5 10 15 20 25

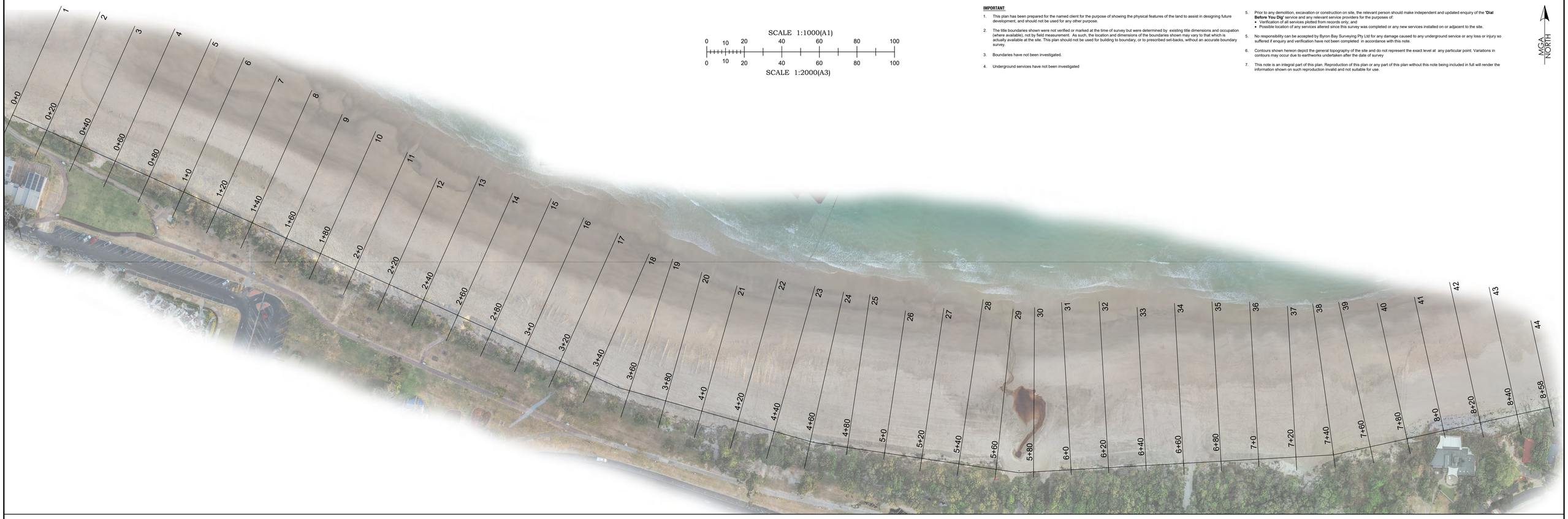
SCALE 1:500(A3)

PLAN SHOWING CLARKES BEACH CROSS SECTIONS

CLARKES BEACH
BYRON BAY
NSW 2481

CLIENT: BYRON SHIRE COUNCIL
DWG No: BYR166_DS
SH: 2 OF 9

- 27th November 2022 SURFACE PROFILE BY BYRON BAY SURVEYING
- 15th November 2022 SURFACE PROFILE BY BYRON BAY SURVEYING
- December 2020 SURFACE PROFILE BY BLUECOAST CONSULTANTS



SCALE 1:1000(A1)

0 10 20 40 60 80 100

0 10 20 40 60 80 100

SCALE 1:2000(A3)

MGA NORTH

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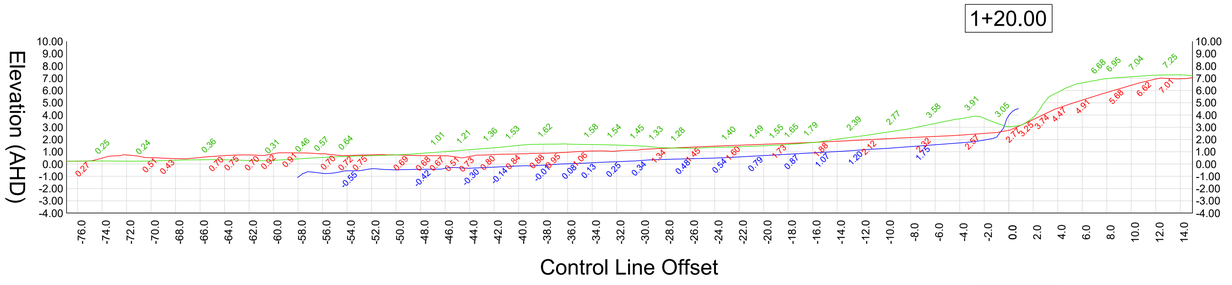

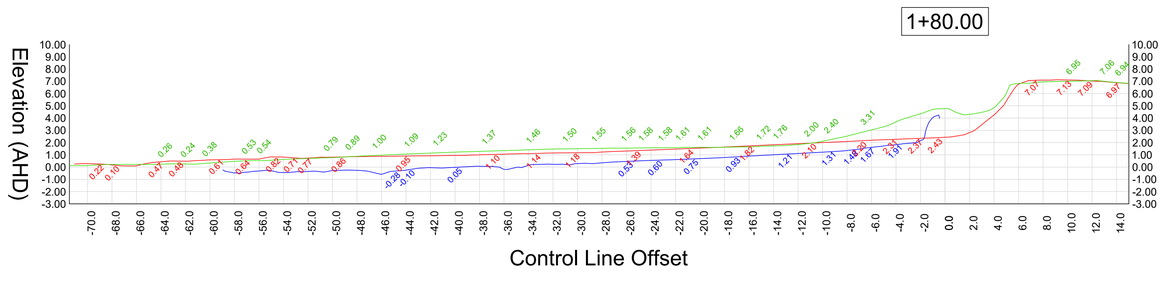

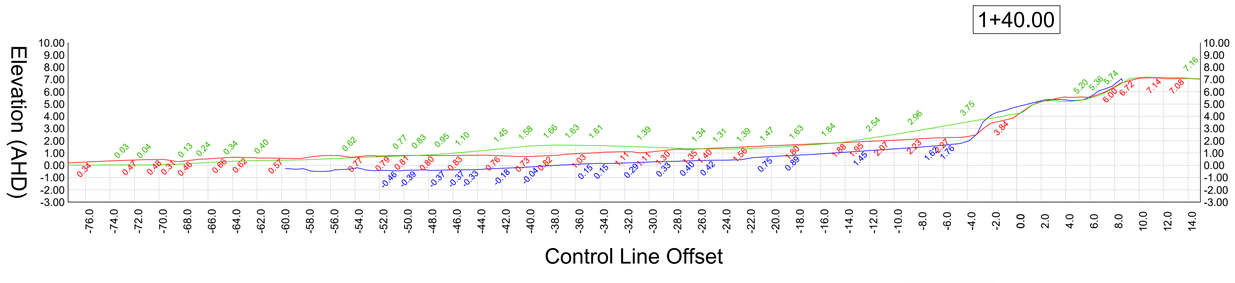

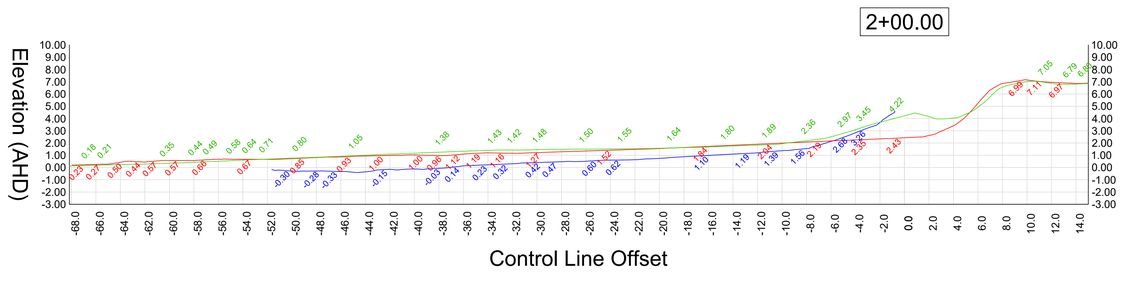

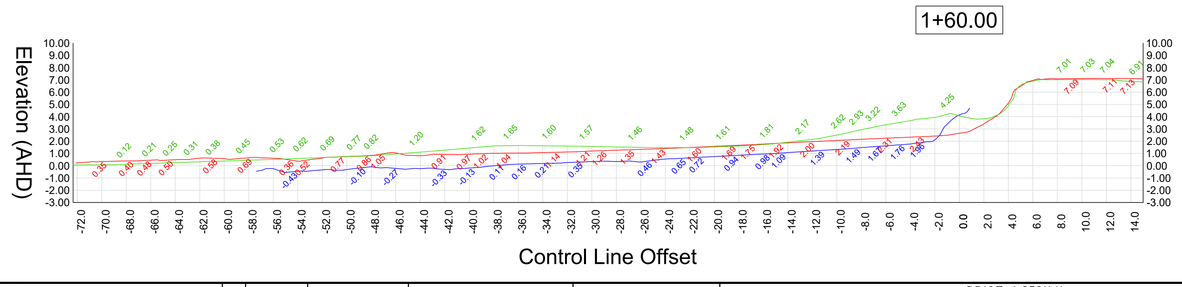

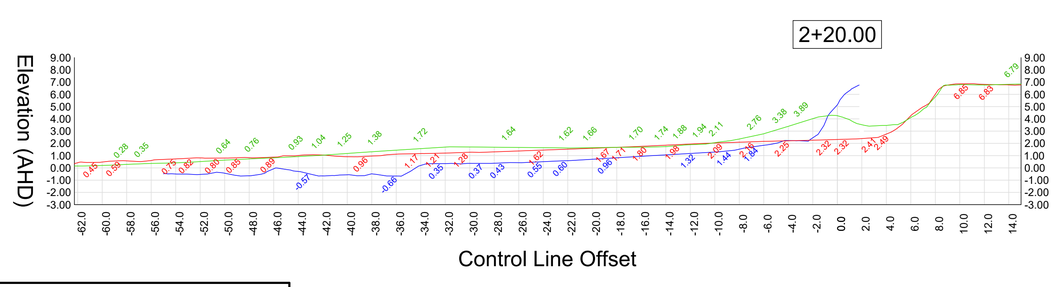

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Suffolk Park NSW 2481 Tel: 0407 345 099
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www.ByronBaySurveying.com.au

REV	DATE	DESCRIPTION
A	18/11/2022	ORIGINAL ISSUE
B	18/11/2022	Alignment Labels
C	12/02/2022	ROUND 2

PROJECT	BYR166
SURVEYOR	LF
SURVEY DATE	27/11/2022
FIELD BOOK ID	CHC_1
PLAN BY	LF
APPROVED BY	LF

MGA GDA94	HZ DATUM
CORSnet	ORIGIN
AHD	VT DATUM
CORSnet	ORIGIN
VIDE VRS	LEVEL
N/A	SCIMS

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SCALE 1:250(A1)

0 5 10 15 20 25

0 5 10 15 20 25

SCALE 1:500(A3)

PLAN SHOWING CLARKES BEACH CROSS SECTIONS

CLARKES BEACH
BYRON BAY
NSW 2481

CLIENT: BYRON SHIRE COUNCIL
DWG No: BYR166_DS
SH: 3 OF 9

- 27th November 2022 SURFACE PROFILE BY BYRON BAY SURVEYING
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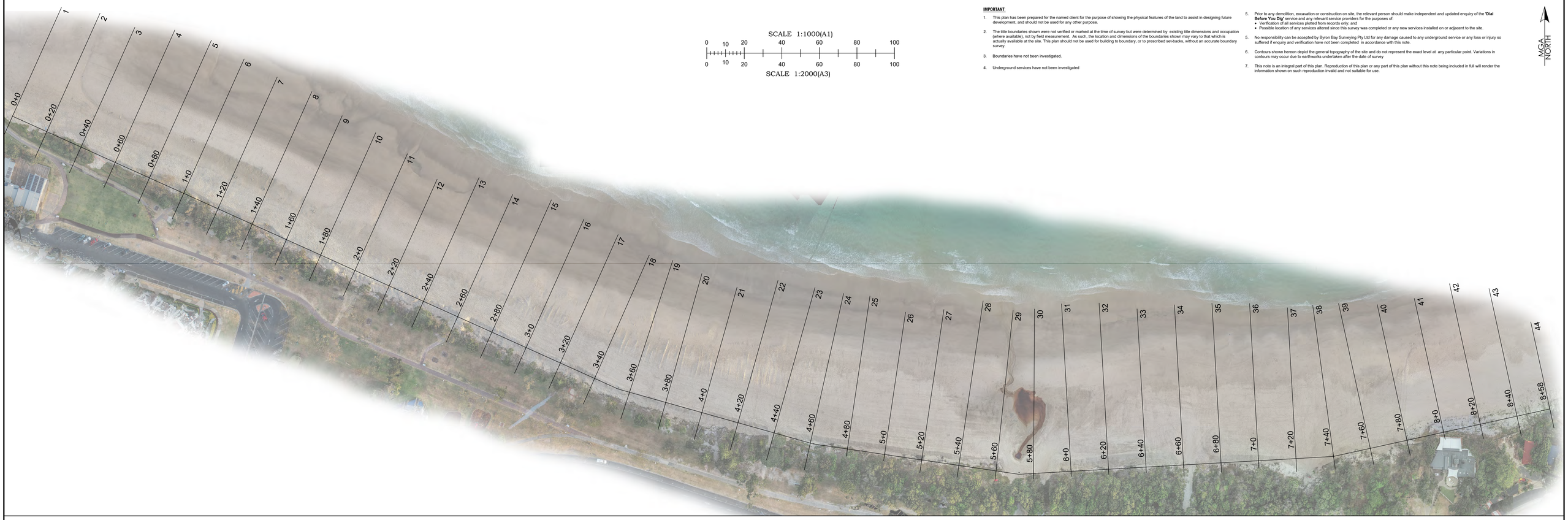

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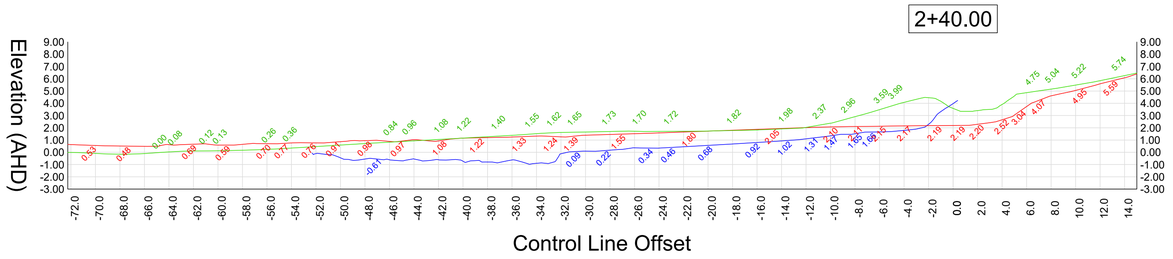

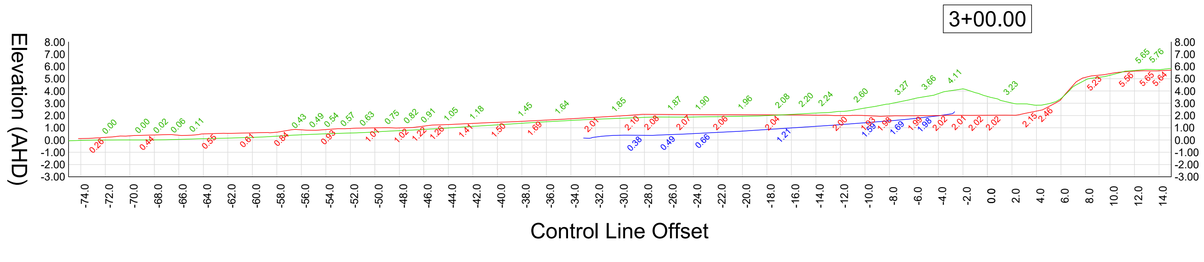

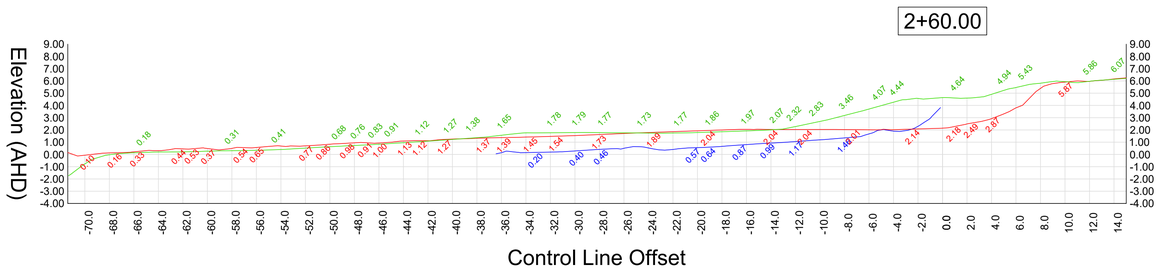

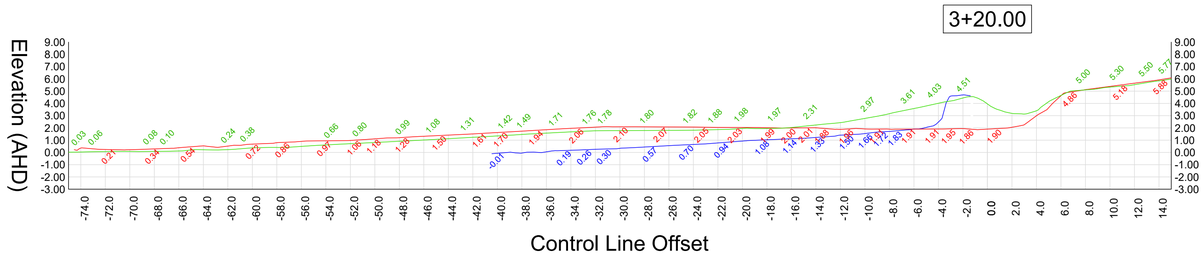

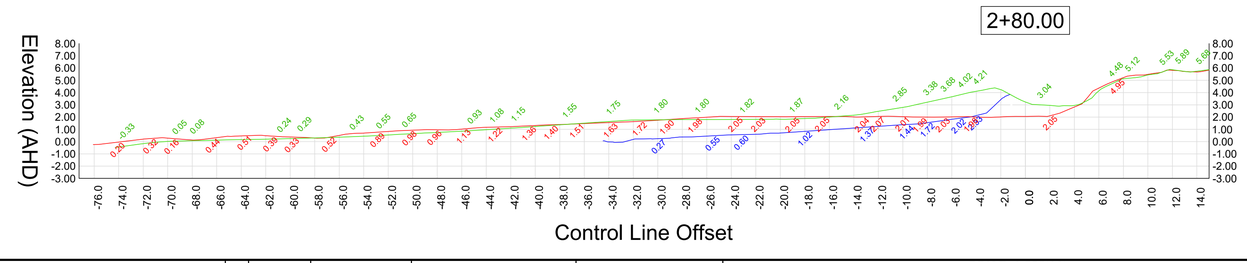

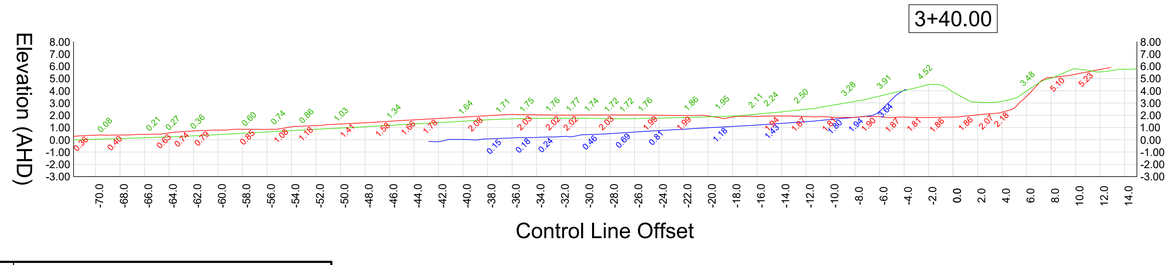

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PROJECT	BYR166
SURVEYOR	LF
SURVEY DATE	27/11/2022
FIELD BOOK ID	CHC_1
PLAN BY	LF
APPROVED BY	LF

MGA GDA94	HZ DATUM
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0 5 10 15 20 25

0 5 10 15 20 25

SCALE 1:500(A3)

PLAN SHOWING CLARKES BEACH CROSS SECTIONS

CLARKES BEACH
BYRON BAY
NSW 2481

CLIENT: BYRON SHIRE COUNCIL
DWG No: BYR166_DS
SH: 4 OF 9

- 27th November 2022 SURFACE PROFILE BY BYRON BAY SURVEYING
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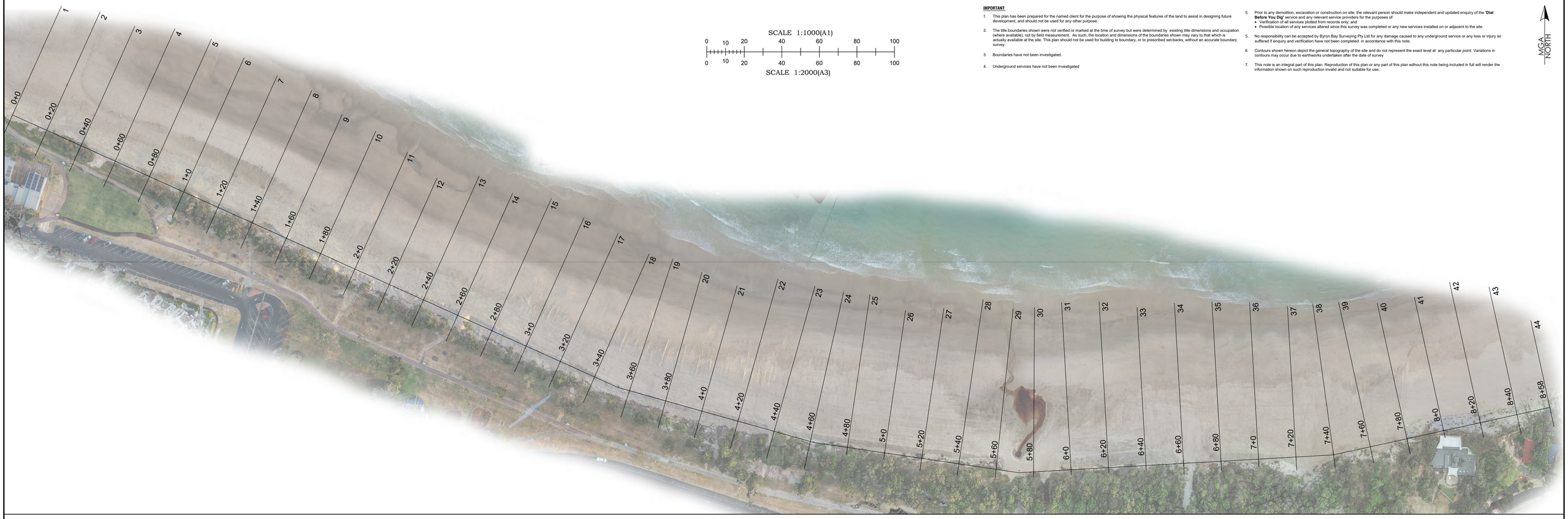

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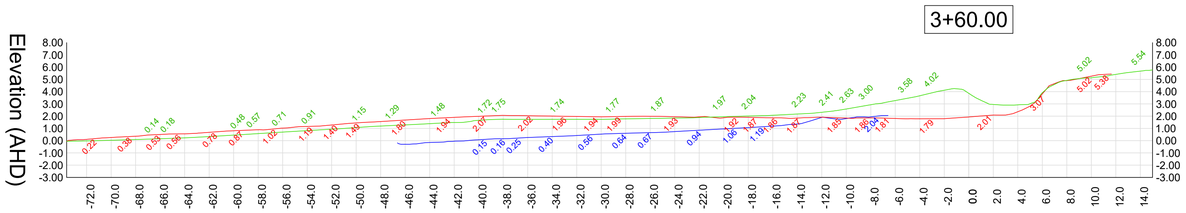

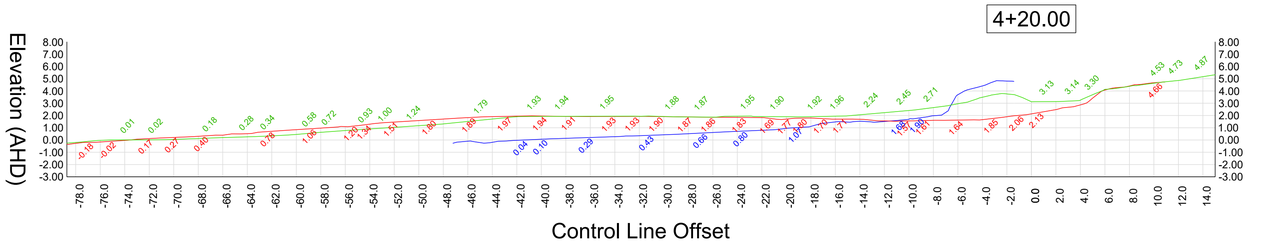

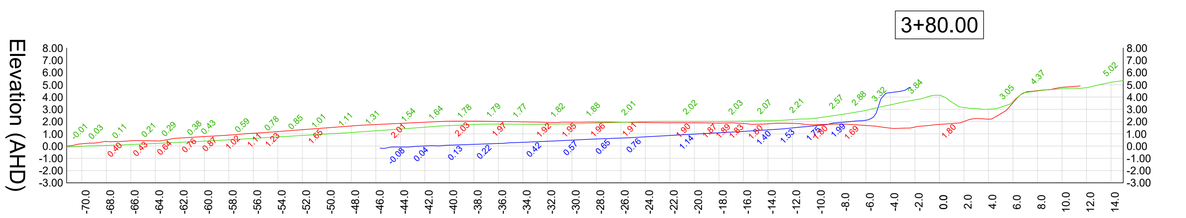

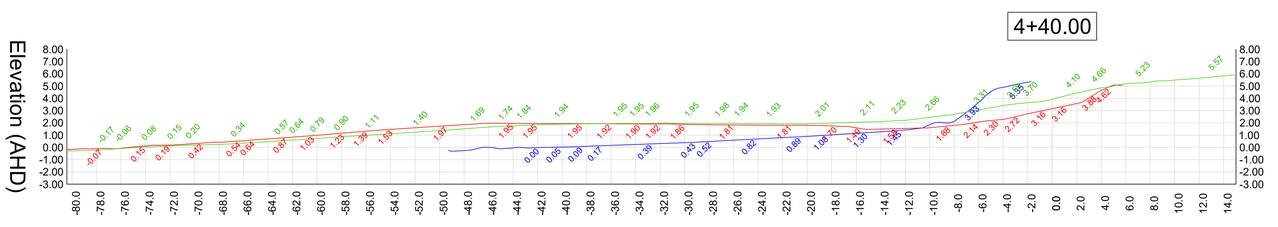

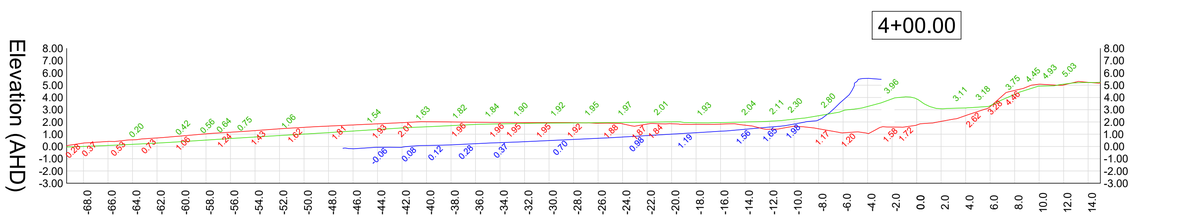

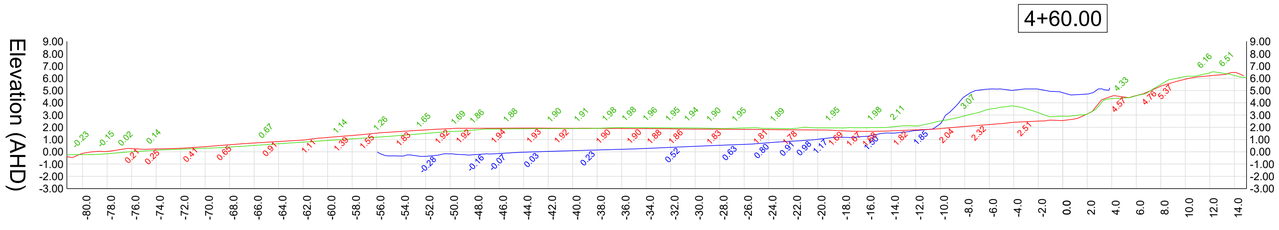

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PROJECT	BYR166
SURVEYOR	LF
SURVEY DATE	27/11/2022
FIELD BOOK ID	CHC_1
PLAN BY	LF
APPROVED BY	LF

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PLAN SHOWING CLARKES BEACH CROSS SECTIONS

CLARKES BEACH
BYRON BAY
NSW 2481

CLIENT: BYRON SHIRE COUNCIL
DWG No: BYR166_DS
SH: 5 OF 9

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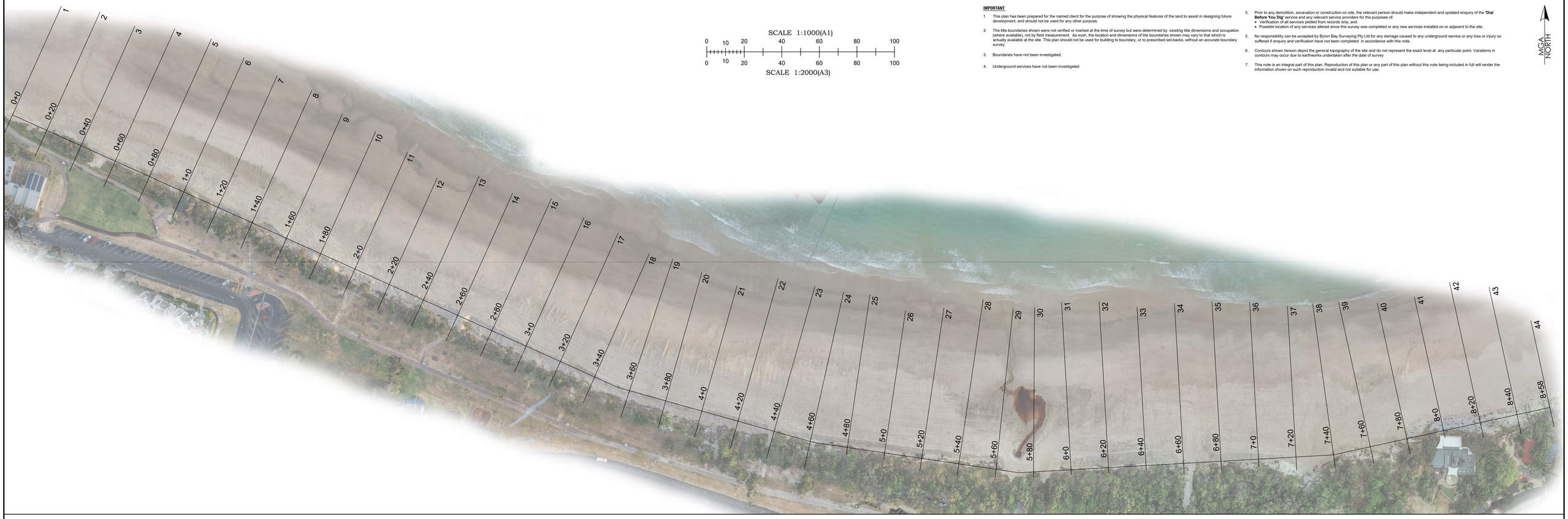

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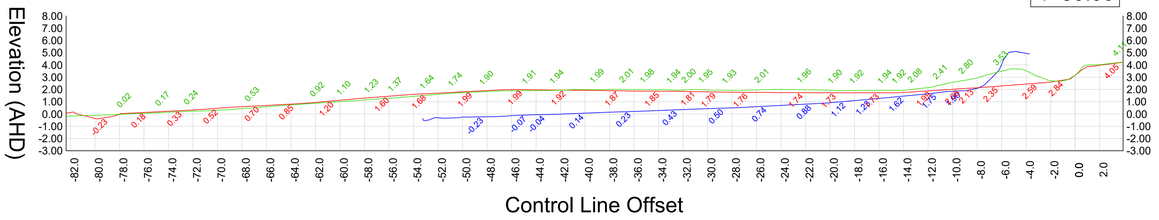
4+80.00



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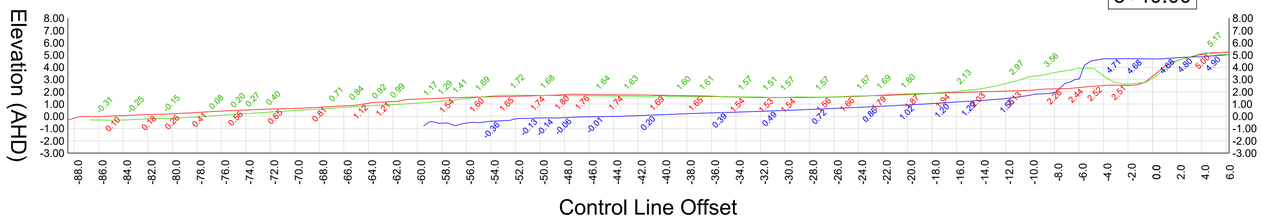

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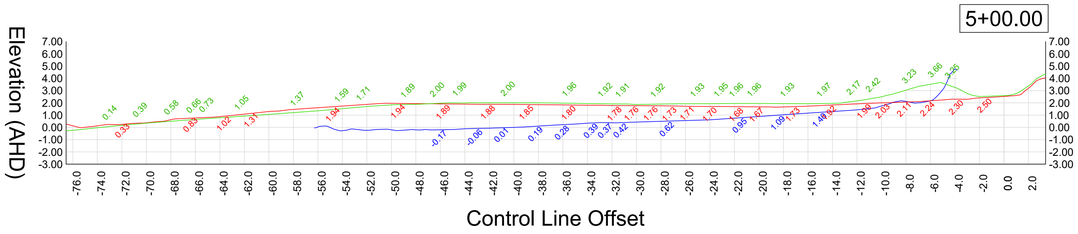

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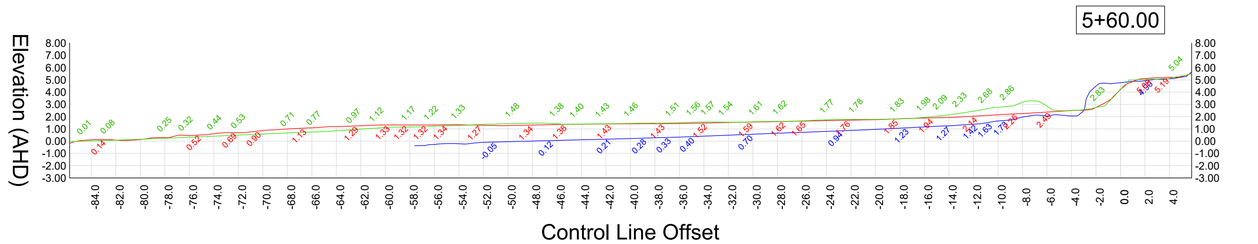

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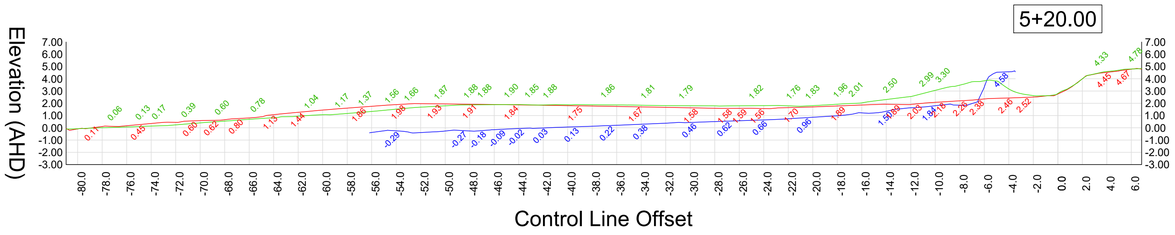

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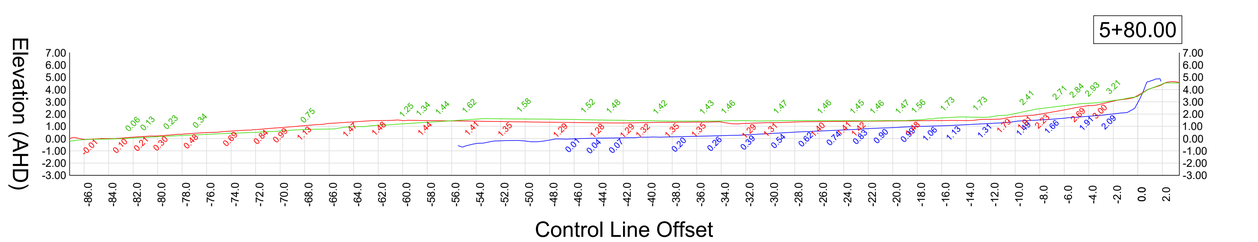

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SURVEY DATE	27/11/2022
FIELD BOOK ID	CHC_1
PLAN BY	LF
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PLAN SHOWING CLARKES BEACH CROSS SECTIONS

CLARKES BEACH
BYRON BAY
NSW 2481

CLIENT: BYRON SHIRE COUNCIL
DWG No: BYR166_DS
SH: 6 OF 9

- 27th November 2022 SURFACE PROFILE BY BYRON BAY SURVEYING
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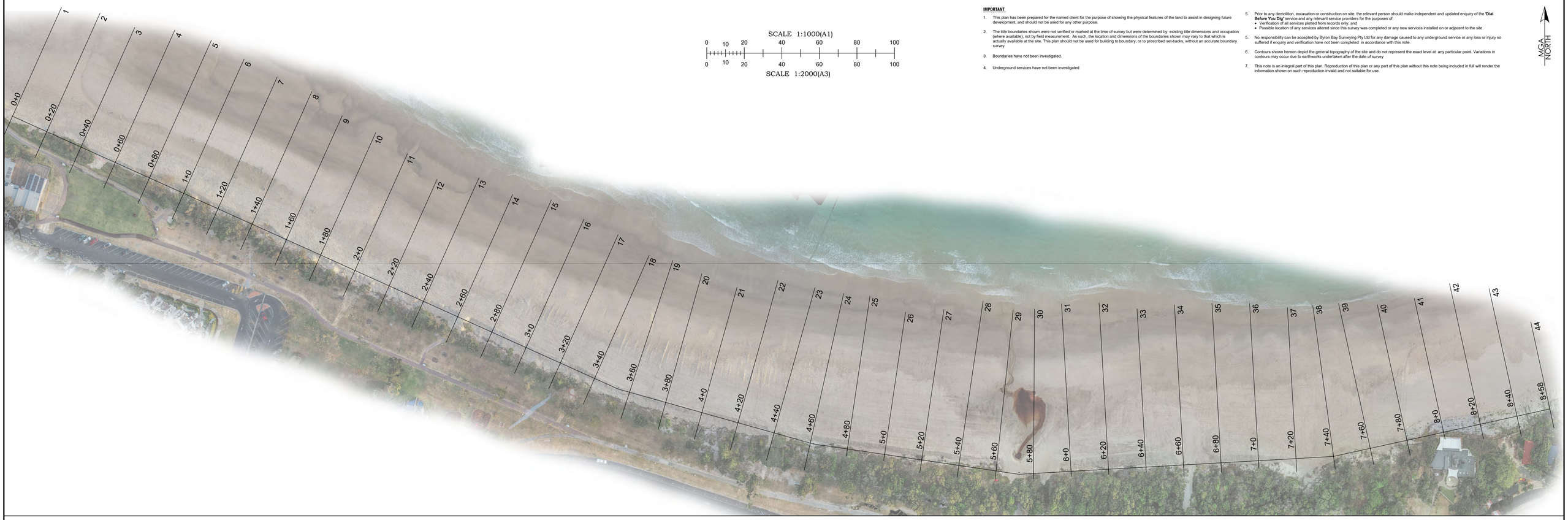

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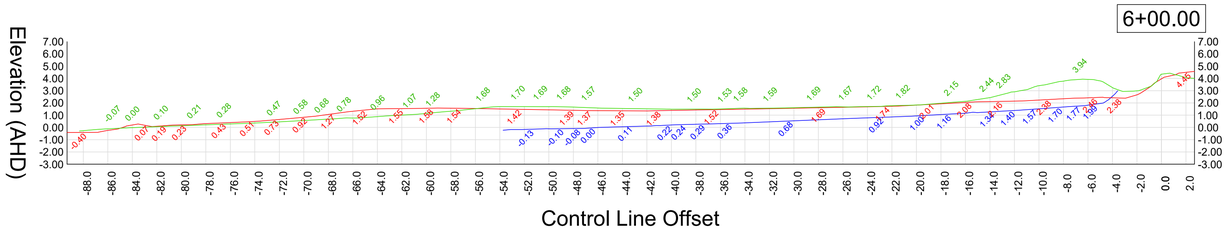

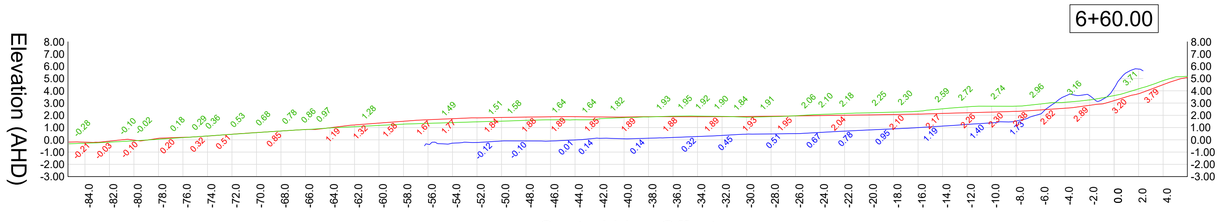

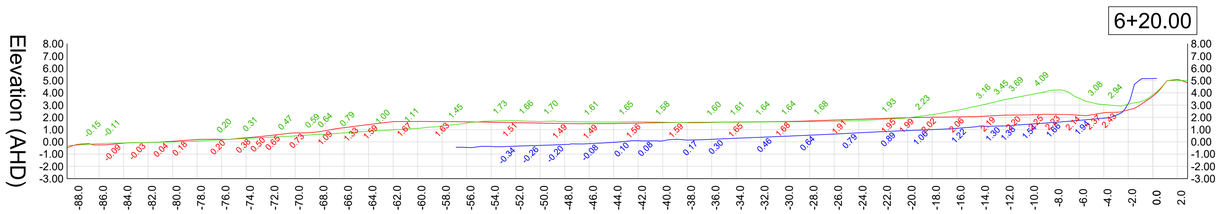

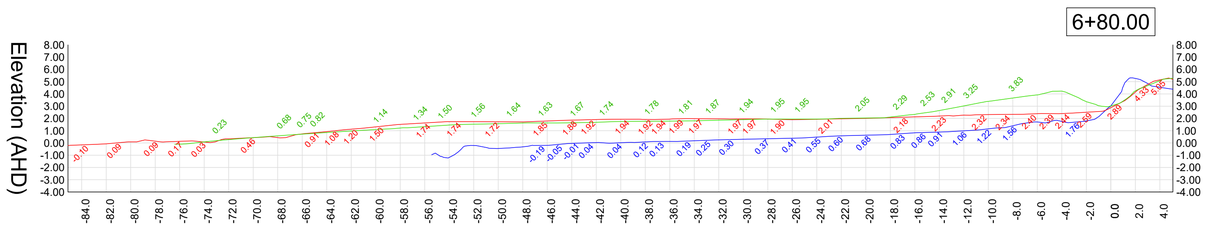

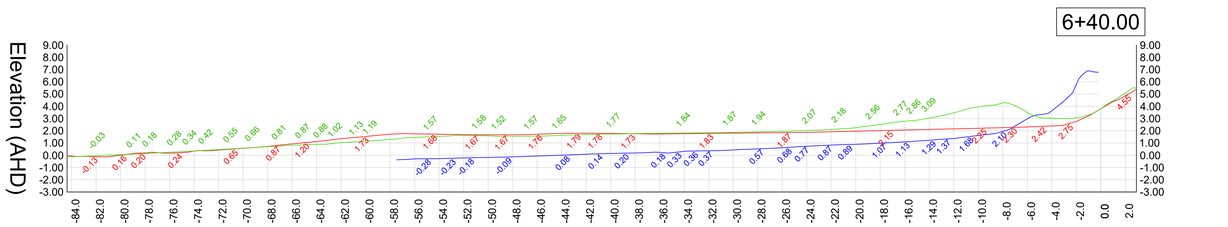

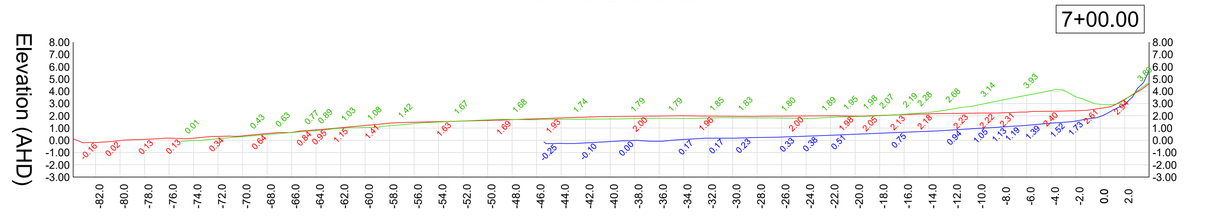

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Alstonville NSW 2477 Tel: 0431 348 590
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www.ByronBaySurveying.com.au

REV	DATE	DESCRIPTION
A	18/11/2022	ORIGINAL ISSUE
B	18/11/2022	Alignment Labels
C	12/02/2022	ROUND 2

PROJECT	BYR166
SURVEYOR	LF
SURVEY DATE	27/11/2022
FIELD BOOK ID	CHC_1
PLAN BY	LF
APPROVED BY	LF

MGA GDA94	HZ DATUM
CORSnet	ORIGIN
AHD	VT DATUM
CORSnet	ORIGIN
VIDE VRS	LEVEL
N/A	SCIMS

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SCALE 1:250(A1)

0 5 10 15 20 25

0 5 10 15 20 25

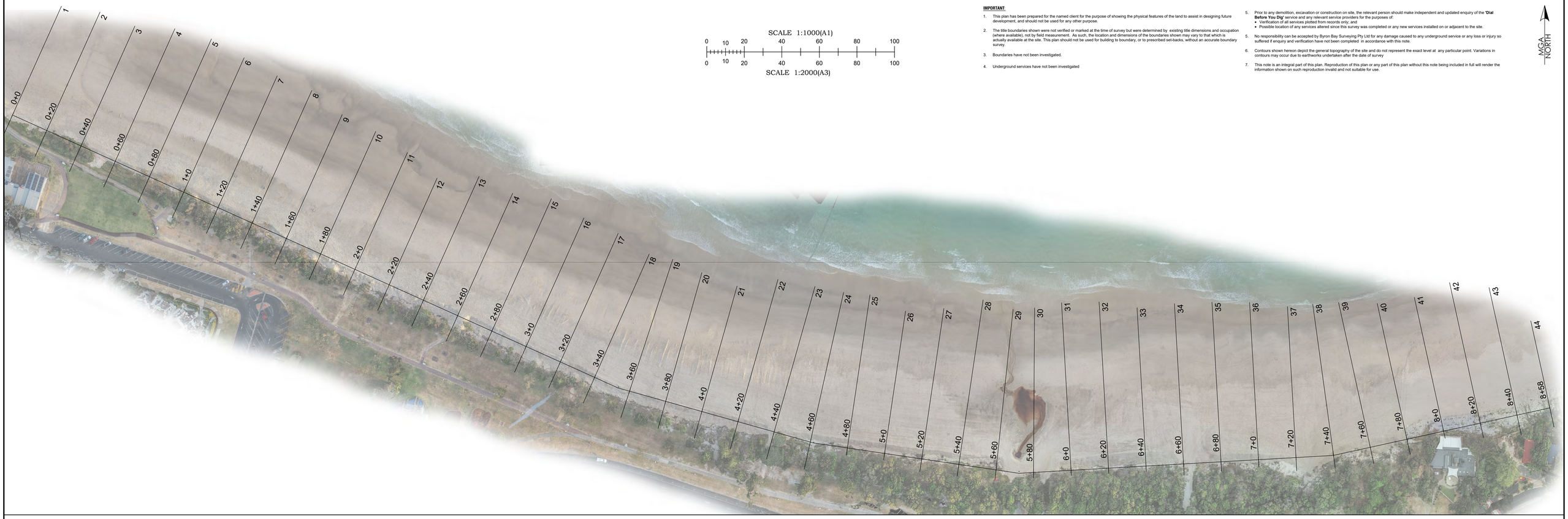
SCALE 1:500(A3)

PLAN SHOWING CLARKES BEACH CROSS SECTIONS

CLARKES BEACH
BYRON BAY
NSW 2481

CLIENT: BYRON SHIRE COUNCIL
DWG No: BYR166_DS
SH: 7 OF 9

- 27th November 2022 SURFACE PROFILE BY BYRON BAY SURVEYING
- 15th November 2022 SURFACE PROFILE BY BYRON BAY SURVEYING
- December 2020 SURFACE PROFILE BY BLUECOAST CONSULTANTS



SCALE 1:1000(A1)

0 10 20 40 60 80 100

0 10 20 40 60 80 100

SCALE 1:2000(A3)

MGA NORTH

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4. Underground services have not been investigated
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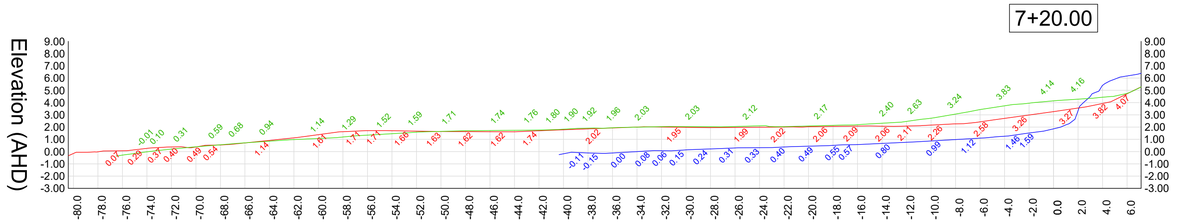

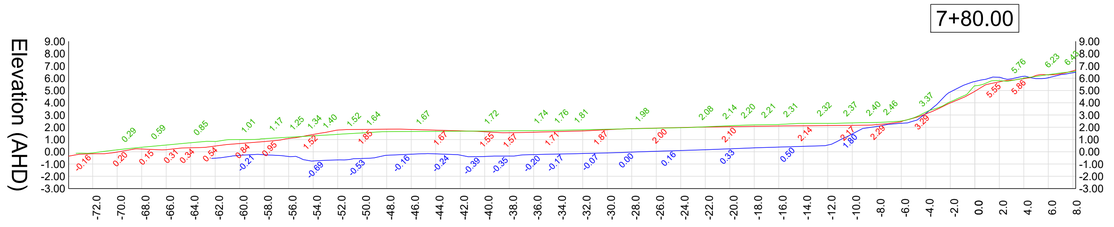

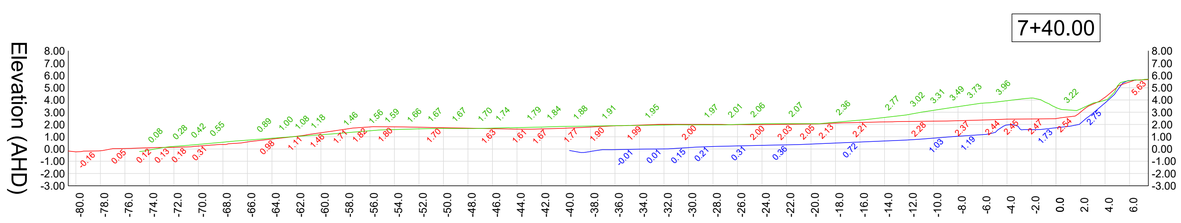

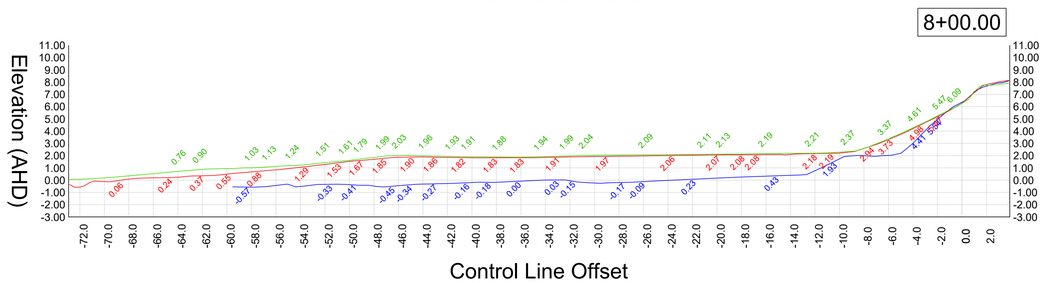

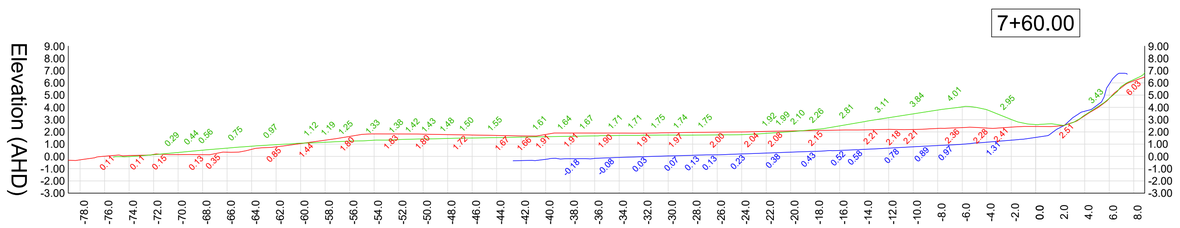

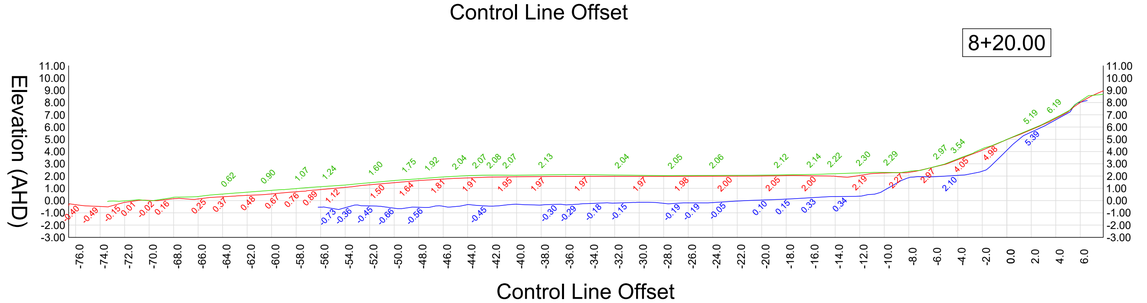

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REV	DATE	DESCRIPTION
A	18/11/2022	ORIGINAL ISSUE
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C	12/02/2022	ROUND 2

PROJECT	BYR166
SURVEYOR	LF
SURVEY DATE	27/11/2022
FIELD BOOK ID	CHC_1
PLAN BY	LF
APPROVED BY	LF

MGA GDA94	HZ DATUM
CORSnet	ORIGIN
AHD	VT DATUM
CORSnet	ORIGIN
VIDE VRS	LEVEL
N/A	SCIMS

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SCALE 1:250(A1)

0 5 10 15 20 25

0 5 10 15 20 25

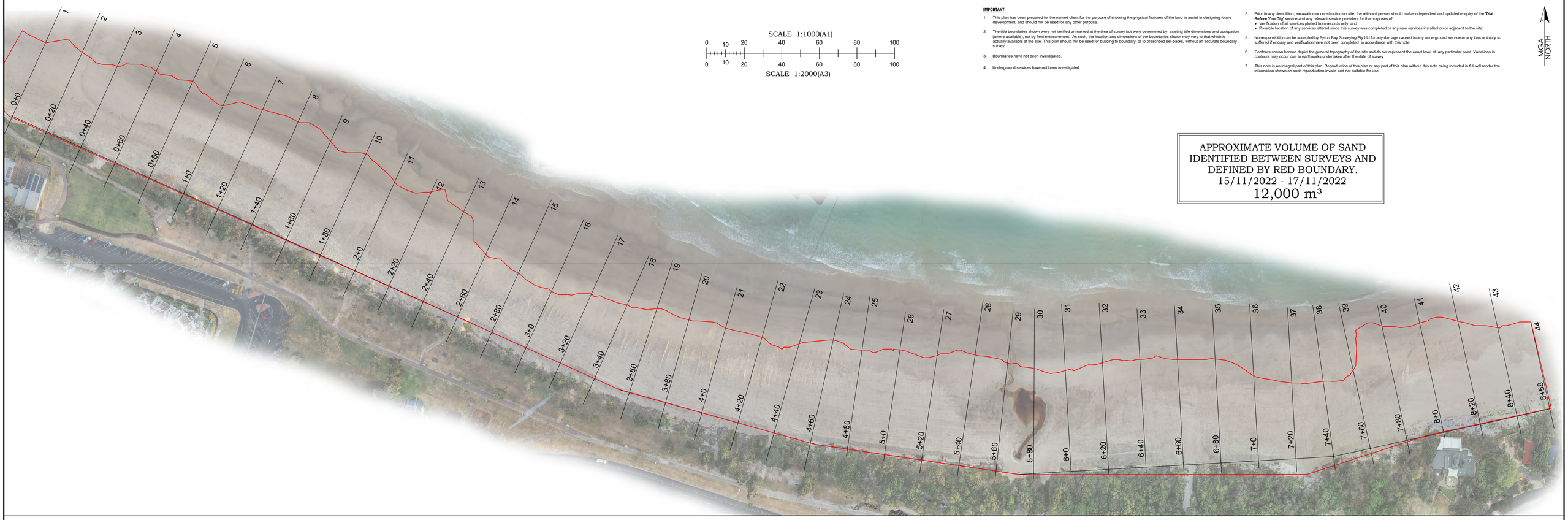
SCALE 1:500(A3)

PLAN SHOWING CLARKES BEACH CROSS SECTIONS

CLARKES BEACH
BYRON BAY
NSW 2481

CLIENT: BYRON SHIRE COUNCIL
DWG No: BYR166_DS
SH: 8 OF 9

- 27th November 2022 SURFACE PROFILE BY BYRON BAY SURVEYING
- 15th November 2022 SURFACE PROFILE BY BYRON BAY SURVEYING
- December 2020 SURFACE PROFILE BY BLUECOAST CONSULTANTS



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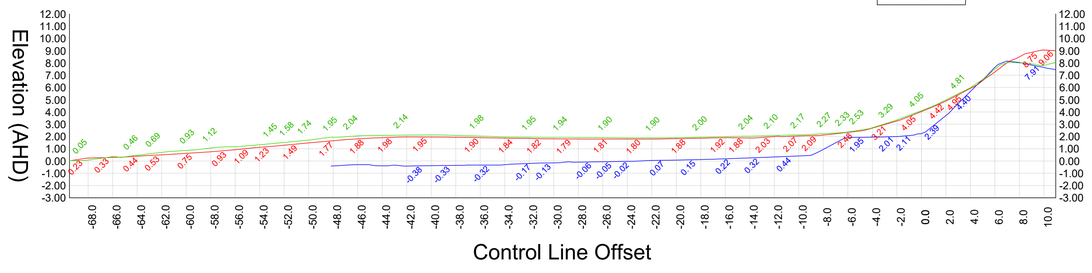
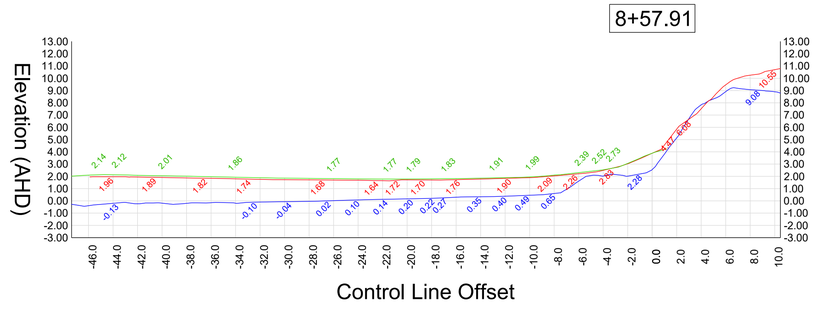
MGA NORTH

APPROXIMATE VOLUME OF SAND IDENTIFIED BETWEEN SURVEYS AND DEFINED BY RED BOUNDARY.
15/11/2022 - 17/11/2022
12,000 m³

8+40.00



8+57.91



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SURVEYOR	LF
SURVEY DATE	27/11/2022
FIELD BOOK ID	CHC_1
PLAN BY	LF
APPROVED BY	LF

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PLAN SHOWING CLARKES BEACH CROSS SECTIONS

CLARKES BEACH
BYRON BAY
NSW 2481

CLIENT: BYRON SHIRE COUNCIL
DWG No: BYR166_DS
SH: 9 OF 9

- 27th November 2022 SURFACE PROFILE BY BYRON BAY SURVEYING
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BYRON
SHIRE
COUNCIL

FOR MORE INFORMATION

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