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Attn: Alex Facchin

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Date:	8 December 2022	Contact name:	Greg Britton
Your reference:		Telephone:	+61 2 8854 5000
Our reference:	8A0132_L005.F01-response	Email:	greg.britton@rhdhv.com

Dear Alex

PPSSTH-176 – SHELLHARBOUR – DA0276/2021 – COVE BOULEVARD, SHELL COVE - PRECINCT H SUBDIVISION
Response to Comments from Southern Regional Planning Panel

Further to our recent discussions, please find below a response to each of the eight comments made by the Southern Regional Planning Panel in relation to PPSSTH-176-Shellharbour-DA0276/2021 – Cove Boulevard, Shell Cove – Precinct H Subdivision, set out in the Record of Briefing and Site Visit held on Wednesday 28 September 2022.

The comment is reproduced in full, followed by the response.

Comment 1 – The potential extent of coastal hazards over a minimum 100-year timeframe (ie. to 2123), consistent with guidance in the NSW Coastal Management Manual 2018, as referenced by the *Coastal Management Act 2016*.

Response:

General

The potential extent of coastal hazards to 2125, rather than 2123, have been assessed by Advisian in consultation with the writer[1]. Of the seven coastal hazards defined in the *Coastal Management Act 2016*, the three hazards relevant for the Precinct H assessment are:

- beach erosion;
- shoreline recession; and
- coastal inundation.

It is convenient to consider the beach erosion hazard and shoreline recession hazard jointly, followed by the coastal inundation hazard.

[1] *It is relevant to note that the coastal engineer within Advisian who carried out the current coastal hazards assessment is the same person who carried out the Shellharbour Coastal Hazard Study (SMEC, 2010) which is referenced in this response (Mr Chris Adamantidis Principal Coastal Engineer).*

Beach Erosion Hazard and Shoreline Recession Hazard

Assessment of the beach erosion hazard and shoreline recession hazard involves consideration of the following:

- pre-storm profile;
- storm erosion demand;
- shoreline recession due to net sediment loss (underlying recession);
- shoreline recession due to sea level rise; and
- the zone of slope adjustment (ZSA) and zone of reduced foundation capacity (ZRFC) based on the methodology outlined in Nielsen et al (1992). This methodology is depicted graphically in Figure 4 in response to Comment 5.

Selection of the pre-storm profile upon which to apply the total shoreline recession and storm demand is important as it influences the ultimate position of the future coastal hazard zones. In selecting the pre-storm profile, the aim should be to adopt a relatively accreted beach profile, typically referred to by the writer as an 'average beach full' profile, as the high storm erosion demands adopted for the assessment can only be realised in practice if accreted profiles exist[2]. The pre-storm profile adopted was based on the DPIE 2019 Topo-marine LiDAR data combined with the design dune profile adjacent to Precinct H with a crest level of 5.5m AHD. The pre-storm profile takes into account the observed changes to the planform of the beach which have taken place since construction of the breakwaters.

A storm erosion demand value of 190m^3/m has been adopted, the same value as that adopted in the Shellharbour Coastal Hazard Study (SMEC, 2010). This study formed the basis for the Shellharbour Coastal Zone Management Study prepared for Council by BMT WBM (2017) and the Shellharbour Coastal Zone Management Plan (CZMP) prepared for Council by BMT WBM (2018). Review by Advisian of additional beach profile data available since the analysis in SMEC (2010) did not lead to any justification for a change to the value of 190m^3/m. It is considered likely by the writer that the value of 190m^3/m is somewhat conservative on the basis of the assessment in Patterson Britton (2005) and Worley (2009) where a value of 160m^3/m was adopted. Nevertheless, a value of 190m^3/m has been adopted as noted above.

Shoreline recession due to net sediment loss was taken to be zero, again the same value as that adopted in SMEC (2010). This is considered reasonable.

The shoreline recession due to sea level rise is dependent on the adopted sea level rise scenario and the Bruun factor[3]. Three sea level rise scenarios have been considered, as described further below following consideration of the Bruun factor.

In SMEC (2010) a Bruun factor of 43 was adopted. It was acknowledged at the time that this value was conservative, ie. a lesser multiplying factor is likely to be appropriate for determining the shoreline recession due to sea level rise for a given amount of sea level rise. It was noted for example that Patterson Britton had adopted a Bruun factor of 30 for the Shellharbour sandy coastline, including Shellharbour South Beach, based on considerations outlined in Nielsen (1994) and Rijkwaterstaat (1987), and a study of bathymetric data and the equilibrium profile for the Shellharbour South Beach.

[2] *In the situation of eroded profiles there are large quantities of sand in offshore bars which dissipate wave energy giving lower storm demands.*

[3] *It is assumed that the Panel members are familiar with various sea level rise scenarios and the meaning and application of the Bruun factor.*

Advisian has re-assessed the Bruun factor along the section of Shellharbour South Beach adjacent to Precinct H as part of preparation of this response based on offshore profiles determined from the DPIE 2019 Topo-marine LiDAR data and consideration of the depth of closure[4]. On this basis a Bruun factor of 36 has been adopted in the current assessment.

The following three sea level rise scenarios have been considered as per the latest AR6 IPCC Report:

- SSP2-4.5: Intermediate emissions scenario
- SSP3-7.0: High emissions scenario
- SSP5-8.5: Very High emissions scenario

A description of each of the above scenarios from an emissions/concentrations and temperature perspective, taken from the latest AR6 IPCC Report is provided in Table 1.

The sea level rise projections for each scenario at 2125 have been determined by Advisian directly from the IPCC AR6 report projections for Port Kembla. The median values for sea level rise are set out in Table 2. Adoption of the median values is considered reasonable since calculation of the future coastal hazards by Advisian has been based on a deterministic rather than probabilistic approach[5].

Table 1 Description of sea level rise scenarios considered in the current assessment

Scenario	Description
SSP2-4.5 (Intermediate)	Scenario approximately in line with the upper end of aggregate Nationally Determined Contribution (NDC) emission levels by 2030. CO_2 emissions remaining around current levels until the middle of the century. Special Report (SR) 1.5 assessed temperature projections for NDCs to be between 2.7 and 3.4°C by 2100 corresponding to the upper half of projected warming under SSP2-4.5. New or updated NDCs by the end of 2020 did not significantly change the emissions projections up to 2030, although more countries adopted 2050 net zero targets in line with SSP1-1.9 or SSP1-2.6. The SSP2-4.5 scenario deviates mildly from a 'no-additional-climate-policy' reference scenario, resulting in a best estimate warming around 2.7°C by the end of the 21st century relative to 1850-1900.
SSP3-7.0 (High)	An intermediate to high reference scenario resulting from no additional climate policy under the SSP3 socio-economic development narrative. CO_2 emissions roughly double from current levels by 2100. SSP3-7.0 has particularly high non-CO_2 emissions, including high aerosols emissions.
SSP5-8.5 (Very High)	A high-reference scenario with no additional climate policy. CO_2 emissions roughly double from current levels by 2050. Emission levels as high as SSP5-8.5 are not obtained by integrated assessment models (IAMs) under any of the SSPs other than the fossil-fuelled SSP5 socio-economic development pathway.

[4] *The outer limit for the nearshore littoral drift and exchange zone of littoral material between the shore and the offshore bottom area (Bruun, 1962).*

[5] *In the deterministic approach, each parameter that is an input to the calculation of the coastal hazard is assigned a single value. The single value is typically a conservative estimate for the parameter. In addition, the approach constrains the design storm to occur at the end of the planning period at the time of maximum shoreline recession, which is conservative.*

Table 2 Sea level rise median projections at 2125 for Port Kembla from IPCC AR6 report

Scenario	Median Projection
SSP2-4.5 (Intermediate)	0.65m
SSP3-7.0 (High)	0.87m
SSP5-8.5 (Very High)	1.01m

The calculated 2125 hazard zones (ZSA and ZRFC) for scenarios SSP2-4.5 (Intermediate), SSP3-7.0 (High) and SSP5-8.5 (Very High) are shown in Figures 1, 2 and 3 respectively. The ZRFC is the landward of the two zones, as depicted in Figure 4 under the response to Comment 5.

The following points can be made in relation to the position of the coastal hazards in 2125 based on Figures 1, 2 and 3:

- in relation to Boollwarroo Parade:
  - the ZSA and ZRFC do not impact on this road for any of the sea level rise scenarios,
- in relation to the carparks on the eastern side of Boollwarroo Parade:
  - the ZSA does not impact on the carparks for any of the sea level rise scenarios,
  - the ZRFC does not impact on the carparks for sea level rise scenarios SSP2-4.5 (Intermediate) and SSP3-7.0 (High),
  - the ZRFC for sea level rise scenario SSP5-8.5 (Very High) encroaches partially within the northern carpark and is adjacent to the southern carpark (northern end).

The location of the ZRFC for sea level rise scenario SSP5-8.5 (Very High) relative to the carparks is not considered to be of concern since it is very unlikely this scenario would represent the world's climate future, having regard to the existing national policies and expected future policies regarding fossil fuels and renewable energy, ie. the assumptions underlying the scenario (refer Table 1) are very unlikely to prevail in practice.

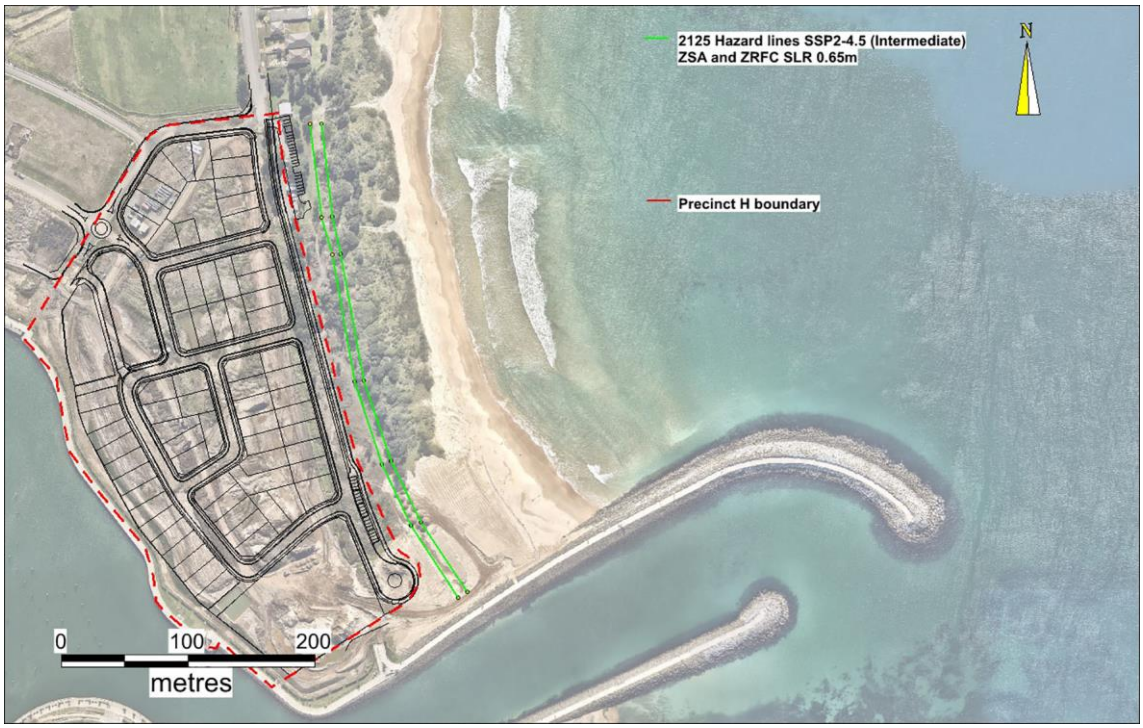

Figure 1 2125 coastal hazard zones (ZSA and ZRFC) for SSP2-4.5 (Intermediate)

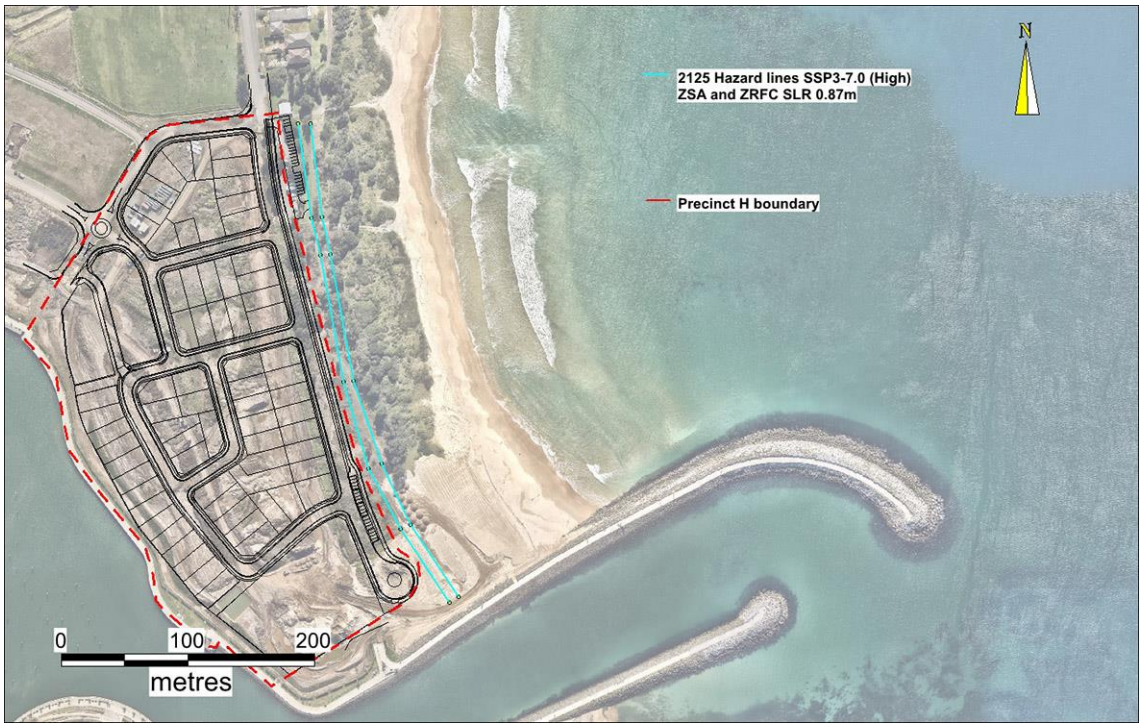

Figure 2 2125 coastal hazard zones (ZSA and ZRFC) for SSP3-7.0 (High)

Figure 3 2125 coastal hazard zones (ZSA and ZRFC) for SSP5-8.5 (Very High)

Coastal Inundation Hazard

A present day 100 year ARI maximum coastal inundation level of 4.6m AHD was adopted in SMEC (2010) and in Advisian (2020). Advisian has confirmed that this value it still appropriate although it may be slightly conservative (high) subject to wave transformation modelling which is currently underway.

The inundation level would increase with future sea level rise, with the increase being approximately equal to the amount of the sea level rise. As such, the following maximum inundation levels would apply at 2125 for each of the sea level rise scenarios:

- SSP2-4.5 (Intermediate): 4.6m AHD + 0.65m = 5.25m AHD
- SSP3-7.0 (High): 4.6m AHD + 0.87m = 5.47m AHD
- SSP5-8.5 (Very High): 4.6m AHD + 1.01m = 5.61m AHD

The proposed crest level of the dune system adjacent to Precinct H is 5.5m AHD, which should be maintained into the future as a minimum. As such, coastal inundation is not considered to be an issue for Precinct H noting that:

- estimated inundation levels are below the dune crest level for sea level rise scenarios SSP2-4.5 (Intermediate) and SSP3-7.0 (High);
- the estimated inundation level for sea level rise scenario SSP5-8.5 (Very High) is only marginally above the dune crest level, and since:
  - this sea level rise scenario is very unlikely to represent the world's climate future as noted above,
  - any overtopping flow would travel as a sheet flow at shallow depth, spreading out and infiltrating into the sandy profile,

- any overtopping flow which reaches Boollwarroo Parade or the carparks would be captured in the drainage systems and be distributed away from building development.

Comment 2 – Erosion and recession due to sea level rise including inundation, wave overtopping and sea level rise over the minimum 100-year timeframe.

Response:

It is considered that the erosion and recession hazards, and coastal inundation hazard (including wave overtopping), with reference to sea level rise, have been adequately addressed in the response to Comment 1.

Comment 3 – The effects of the recently constructed breakwaters on wave transformation and sediment transport processes particularly regarding the likely location of coastal risk zones at current and future timeframes.

Response:

Construction of the breakwater and groyne structures at the entrance to Shell Cove Boat Harbour commenced in 2014 and were completed to their full seaward extents by late 2017/early 2018.

In accordance with requirements of the Shell Cove Boat Harbour Operation Environmental Plan (OEMP), monitoring of beach behaviour at Shellharbour South Beach was carried out prior to and during the breakwater and groyne construction, and is ongoing.

A coastal engineering analysis of beach surveys at seven profile locations along the beach, together with analysis of additional survey information, has been completed by Advisian (2020)[6]. The main findings of these analyses relevant to Precinct H were as follows:

- the planform of the beach north of the breakwater now exhibits greater curvature, principally due to the progradation (seawards advancement) of the shoreline adjacent to the breakwater. This change in planform had been predicted in small scale physical model testing carried out by Australian Water and Coastal Studies (AWACS) in initial design studies for the Boat Harbour development (AWACS, 1994); and
- the planform changes to the beach north of the breakwater, in response to the breakwater construction, commenced relatively quickly, within weeks following commencement of construction, and were considered to have stabilised by 2020.

Figure 4 taken from Advisian (2020) shows ortho-rectified vertical aerial images of the beach over a series of dates from May 2012 (prior to breakwater and groyne construction) to June 2020 (after breakwater and groyne completion) together with the outline of the breakwater and groyne, foreshore vegetation, and beach shoreline, as at June 2020 (all in red). The sequence of images shows the evolution of the beach planform in response to the breakwater construction, together with the beach response to storms, eg. the East Coast Low in February 2020.

It is considered that the effects of the recently constructed breakwater on the likely location of the coastal risk zones has been taken into account since the pre-storm beach planform adopted in the current

[6] *The additional survey information comprised high resolution LiDAR data (December 2010 – March 2011), beach profile data from the NSW Beach Profile Database, and data derived from the NSW DPIE Marine LiDAR project (July – December 2018).*

coastal hazard assessment (2019, refer response to Comment 1) essentially accounts for the beach response to the breakwater construction.

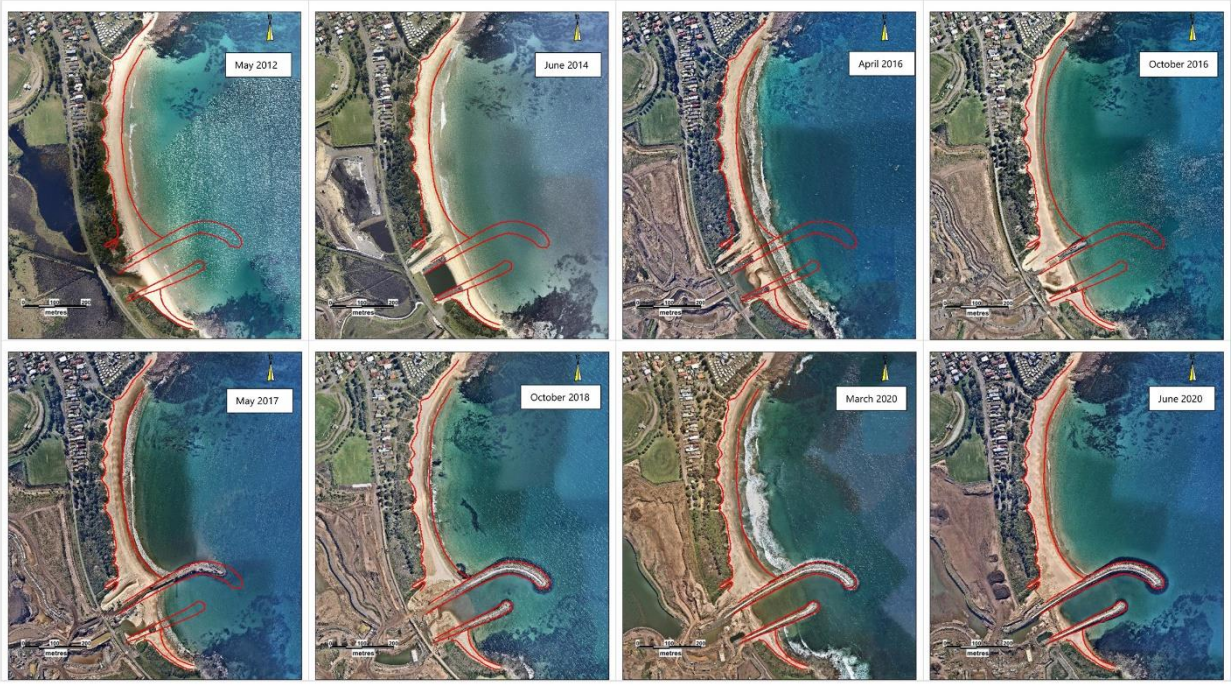

Figure 4 Ortho-rectified aerial photography 2012 to 2020 (source Nearmap). Red line shows shoreline, vegetation, breakwater and groyne as at June 2020

Wave transformation modelling to assess the effects of the breakwater and groyne construction is currently underway and results should be available soon. However, the expectation is that the breakwater would create some further sheltering of the beach immediately to the north due to the effects of refraction and diffraction of the incident waves. In turn this may lead to a reduction in storm erosion demand and a consequent shift in the hazard zones further seaward than shown in Figures 1, 2 and 3.

The breakwater and groyne structures have altered sediment transport processes at the southern end of Shellharbour South Beach, leading to changes in the beach planform for example. These changes are evident in the series of vertical aerial images in Figure 4. The beach to the north of the breakwater and the beach to the south of the groyne are essentially now separate coastal compartments.

The changes in sediment transport processes leading to beach planform change have been accounted for in the assessment of the likely location of the coastal risk zones, as outlined above.

Comment 4 – The effects of beach stormwater outlets on potential coastal erosion and inundation risk zones.

Response:

There are no stormwater outlet structures proposed across the beach associated with Precinct H, or with the Shell Cove Boat Harbour development generally. There is a proposed infiltration basin on the eastern side of Boollwarroo Parade opposite the northern end of Precinct H (south of the proposed

carpark) which will receive flows from the carpark, part of the dunal area, part of the road system, and seven lots within Precinct H[7].

The infiltration basin has a volume of approximately 130m^3. It has the capacity to capture and infiltrate all storm (rainfall) events up to and including the 100 year Average Recurrence Interval (ARI) event. Stormwater directed to the infiltration basin from the carpark, roads, and lots, would be treated prior to entry to the basin by a gross pollutant trap (GPT) and an 'Ocean Protect Jellyfish' filter system.

The capacity of the infiltration basin means that no overflow of the basin would occur towards the ocean up to the 100 year ARI rainfall event. Accordingly, no coastal erosion would occur due to stormwater flows up to the 100 year rainfall event. In addition, the basin would not be expected to have any significant impact on the inundation hazard due to its relatively small size (no significant reduction in coastal inundation storage capacity). There could be some minor benefit to the inundation hazard should the basin be dry at the time of the coastal inundation event.

The sand excavated to form the infiltration basin would be distributed on the seaward side of the basin to maintain the total sand storage volume available to combat the beach erosion and shoreline recession hazard.

Drawings showing the proposed infiltration basin, the area draining to it, and the ponded water levels in the 2 year, 5 year and 100 year ARI events, are included in Appendix A.

Comment 5 – The calculation of the expected zone of reduced foundation capacity (extending landward) taken from the proposed dune height of 5.5m.

Response:

The expected zone of reduced foundation capacity (ZRFC) has been calculated according to the methodology set out in Nielsen et al (1992), shown in Figure 5. This is standard practice in NSW coastal hazard assessment.

Nielsen et al (1992) proposed a natural angle of repose of the dune sand (phi) equal to 34^o and a Factor of Safety (FOS) of 1.5 for calculation of the ZRFC. A slightly lesser value for phi of 33^o has been adopted in the determination of the coastal hazards outlined in this response, which is slightly conservative. A FOS of 1.5 has been adopted consistent with Nielsen et al (1992).

[7] *This catchment area could not be drained to the Boat Harbour as it resulted in surcharge to downstream stormwater pits.*

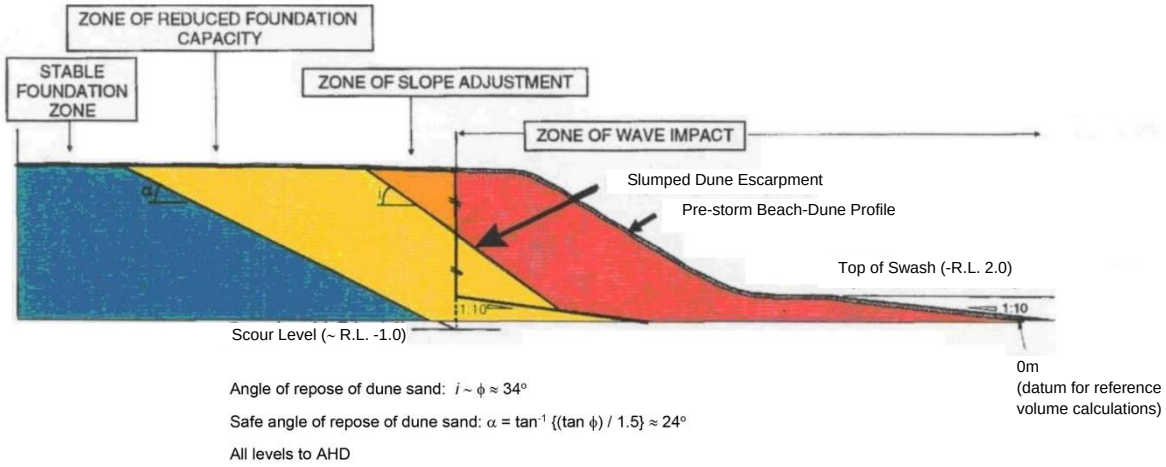

Figure 5 Methodology for calculation of coastal hazard zones in Nielsen et al (1992)

Comment 6 – Revised mapping of coastal hazard extents at appropriate time intervals.

Response:

It is considered this comment has been adequately addressed in the response to Comment 1.

Comment 7 – Long term mitigation options for managing coastal risks to the development (Boollwarroo Pde in its proposed location, and residences), noting that coastal hazard impacts will continue to occur beyond 100 years' time.

Response:

Long term mitigation options for managing coastal risks to the development (Boollwarroo Parade in its proposed location, and residences) beyond a planning period of 100 years, would comprise coastal protection works, as defined in Section 4(1) of the *Coastal Management Act 2016*, reproduced below:

> *(a) beach nourishment activities or works, and*
> *(b) activities or works to reduce the impact of coastal hazards on land adjacent to tidal waters, including (but not limited to) seawalls, revetments and groynes.*

In practice it is considered likely that the primary coastal protection works options would comprise beach nourishment or a combination of beach nourishment and a seawall/revetment. In the latter case, the nourishment volume would be calculated to maintain beach amenity over time and the seawall/revetment would comprise a terminal defence to beach erosion events.

Shellharbour South Beach exhibits a number of key attributes compared to many other beaches on the open coast which will assist in its long term management; namely, it exhibits no long term recession due to net sediment loss, ie. it is essentially a closed sediment system, and it is relatively sheltered by Bass Point from storm waves from the south-east sector hence exhibits a lesser storm erosion demand.

Comment 8 – A description of proposed dune management including the maintenance requirements for the dunes, and discussion of the limitations of dune management as a long term risk management solution.

Response:

Management of the dune system along Shellharbour South Beach including maintenance requirements was first outlined in the Shell Cove Boat Harbour Construction Environmental Management Plan (CEMP) (Patterson Britton, 2012) and the Shell Cove Boat Harbour Operation Environmental Management Plan (Patterson Britton, 2007). These documents were prepared in accordance with the Conditions of Consent, Conditions of Concurrence, the Environment Protection Licence (EPL), and a range of other relevant legislation.

The CEMP included a Beach Nourishment/Rehabilitation Management Plan – Construction Phase. The OEMP included a Beach Nourishment/Rehabilitation Management Plan.

Subsequently, Advisian (2020) prepared a Beach Nourishment/Rehabilitation Management Plan. This Plan provides the current framework for the rehabilitation and management of the coastal dunes on Shellharbour South Beach, in accordance with the Conditions of Consent for the Boat Harbour development.

The objectives of the Plan have been developed to cover both the construction and operational phases of the Shell Cove Boat Harbour development and to align with those of the broader Shellharbour Coastal Dunes Management Plan (Shellharbour City Council, 2016) and the Shellharbour Coastal Zone Management Plan (BMT WBM, 2018). The Plan was prepared in consultation with, and to the satisfaction of, the Department of Planning and Environment. The Department formally endorsed the Plan. Shellharbour City Council were closely involved in the review process and Council input was included in the final Plan.

A copy of the Advisian (2020) Beach Nourishment/Rehabilitation Management Plan is included in Appendix B. It is noted that the proposed dune crest level is now 5.5m AHD.

The Panel has inferred that dune management has limitations as a long term risk management solution. Presumably this is because dune management would not prevent beach erosion in a storm event or shoreline recession. This may be so, but dune management is fundamental to good coastal management practice for a range of reasons including beach amenity, ecology, and to prevent windblown sand losses which could exacerbate shoreline recession.

In the long term, options to manage coastal risks would be assessed and an appropriate management option(s) adopted.

Dune management should be ongoing and feature in the long term risk management strategy for the reasons noted above.

References

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Shellharbour City Council (2016), Shellharbour Coastal Dunes Management Plan, February

SMEC (2010), Shellharbour Coastal Hazard Study, prepared for Shellharbour City Council, Revision No. 3 (Final)

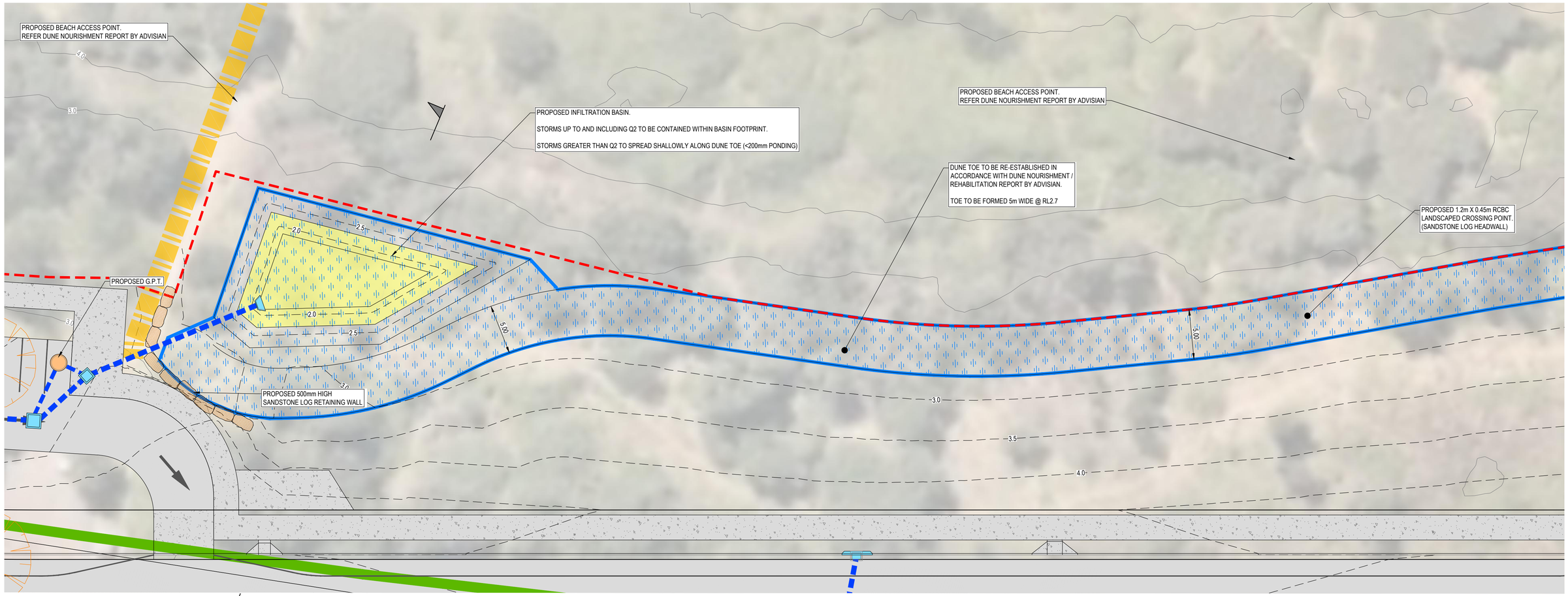
WorleyParsons (2009), Shell Cove Boat Harbour Precinct – Concept Application and Environmental Assessment – Support Information on Coastal Processes and Water Cycle Management, September 2009

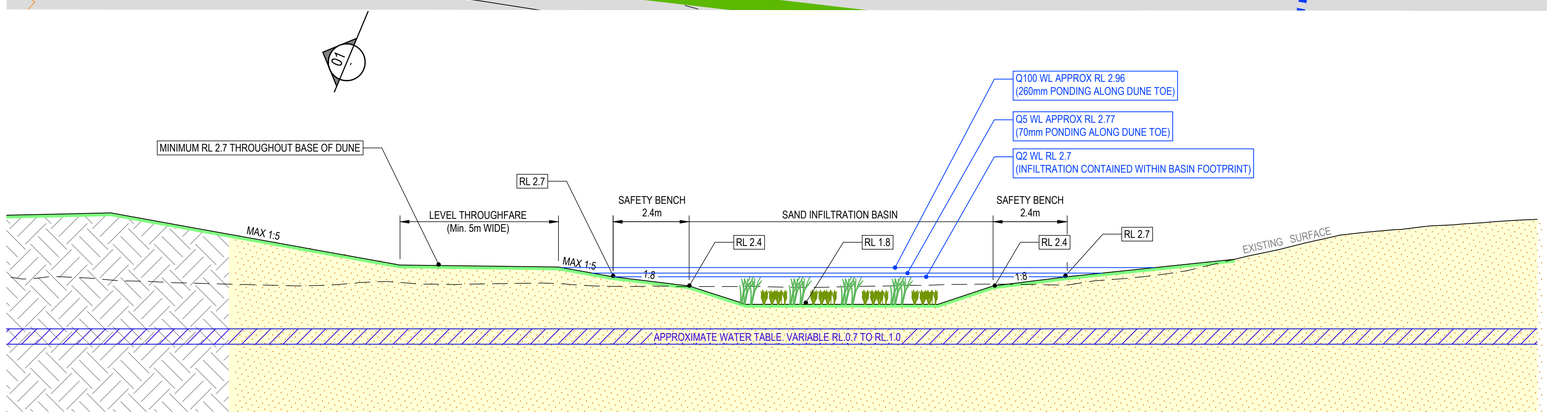
I trust the above is satisfactory. Please contact me should you require any clarification or additional information.

Yours faithfully

Greg Britton
Technical Director – Water, Australia

APPENDIX A – DRAWINGS OF PROPOSED INFILTRATION BASIN





INFILTRATION BASIN 01
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INFILTRATION NOTES

- DURING EXCAVATION OF INFILTRATION BASINS & BIORETENTON SWALE THE CONTRACTOR SHALL ARRANGE FOR THE SITE GEOTECHNICAL ENGINEER TO OBSERVE THE EXPOSED NATURAL SAND FOR ANY INCONSTANT MATERIAL AND CONDUCT PERMEABILITY TESTS TO ENSURE THAT THE MATERIAL CAN ACHIEVE A PERMEABILITY OF 180mm/hr OR GREATER.
- MAIN INFILTRATION BASIN TO BE EXCAVATED TO 300mm ABOVE F.S.L. FOR EROSION & SEDIMENT CONTROL.
- DURING CONSTRUCTION THE CONTRACTOR MUST TAKE ALL NECESSARY EROSION AND SEDIMENT CONTROL PRECAUTIONS TO ENSURE THAT SILT DOES NOT ENTER THE BASIN AFTER IT HAS BEEN EXCAVATED.
- PRIOR TO PRACTICAL COMPLETION, THE CONTRACTOR SHALL ARRANGE FOR THE SITE GEOTECHNICAL ENGINEER TO INSPECT THE INFILTRATION BASIN FOR CONTAMINATION BY SILT OR ANY FOREIGN MATERIAL THAT WILL REDUCE PERMEABILITY AND THEN CONDUCT PERMEABILITY TESTS TO ENSURE THAT THE MATERIAL CAN ACHIEVE A PERMEABILITY OF 180mm/hr OR GREATER. ANY FOREIGN MATERIAL OR REDUCTION OF THE INFILTRATION CAPACITY OF THE BASIN MUST BE RECTIFIED BY THE CONTRACTOR AT THEIR COST.
- THE GEOTECHNICAL ENGINEER MUST CONFIRM COMPLIANCE WITH THE ABOVE REQUIREMENTS AND PROVIDE THE GEOTECHNICAL ENGINEER'S CERTIFICATION TO THE SUPERINTENDENT.

A1 PLOT 100 — 0 1 2 3 4 — 200 A3 PLOT
2 1

No.	AMENDMENT	APPROVED	DATE	AMENDED BY
4	RE-ISSUE FOR APPROVAL (LINEMARK-CARPARK-XING)	KJM	07.07.22	SJW
2	REM'D NETTECH GPT. REPLACED FOR STANDARD GPT.	KJM	14.09.21	SJW
1	ISSUE FOR APPROVAL	KJM	20.04.21	SJW

FOR APPROVAL

CLIENT: FRASERS PROPERTY

MAKER ENG

APPROVED KJM DATE 20.04.21
CHECKED KJM DATE 20.04.21
DESIGNED BY SJW
DRAWN BY SJW
CAD FILE G:\ISC00223 Shell Cove - Precinct H\Acad\Civil\10 - DA\ISC00223-DA-C140.dwg
SCALE 1:100 ORIGINAL SIZE A1

PROJECT
CIVIL STRATEGY
PROPOSED SUBDIVISION OF PRECINCT H SHELL COVE

DRAWING TITLE
INFILTRATION BASIN PLAN AND DETAIL

PROJECT No. ISC00223-DA | DRAWING No. C140 | AMDT 4

APPENDIX B – COPY OF ADVISIAN (2020) BEACH NOURISHMENT/REHABILITATION PLAN

Shell Cove Boat Harbour Beach Nourishment/ Rehabilitation Management Plan

Final

July 2020

Level 17, 141 Walker St
North Sydney NSW 2060
Australia

301015-02681-001

www.**advisian**.com

Advisian
Worley Group

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Project No: 301015-02681-001 – Shell Cove Boat Harbour Beach Nourishment/ Rehabilitation Management Plan: Final

Rev	Description	Author	Review	Advisian Approval	Date
A	Draft for Internal Review	C. Adamantidis			6/11/17
B	Draft for Client/OEH Review	C. Adamantidis	B. Morgan	B. Morgan	5/02/18
C	Draft for Client/OEH Review	C. Adamantidis	B. Morgan	B. Morgan	17/11/17
D	Revised Draft following OEH Review	C. Adamantidis	B. Morgan	B. Morgan	10/7/18
E	Final following Council Review	C. Adamantidis	B. Morgan	B. Morgan	12/02/18
F	Issue for Use	G. Tooker	B. Morgan	B. Morgan	29/04/20
G	Re-issue for Use	G. Tooker	B. Morgan	B. Morgan	01/07/20

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1 Introduction

This document presents a Beach Nourishment/Rehabilitation Management Plan for the Shell Cove Boat Harbour development. The Plan covers nourishment and rehabilitation works along Shellharbour South Beach with a focus in the vicinity of the Boat Harbour works that include creation of the Access Channel to be trained by the Breakwater and Groyne.

1.1 Objectives of this Plan

This Beach Nourishment/Rehabilitation Plan provides a framework for the rehabilitation and management of the coastal dunes on Shellharbour South Beach, in accordance with the requirements of the Conditions of Consent for the Shell Cove Boat Harbour development. The objectives of this Plan have been developed to cover both the construction and operational phases of the Shell Cove Boat Harbour development, and to align with those of the broader Shellharbour Coastal Dunes Management Plan (Shellharbour City Council, 2016) and Shellharbour Coastal Zone Management Plan (Shellharbour City Council 2017).

The objectives of the Shellharbour Coastal Zone Management Plan relevant to this Plan are:

- protect and enhance coastline biodiversity through the conservation of high value coastal ecosystems and habitat areas (including for listed threatened/endangered species and ecological communities);
- rehabilitate priority degraded coastal ecosystems along the coastline; and
- protect and enhance the aesthetic qualities of the coastline.

The construction aspects of this Management Plan in relation to the Shell Cove Boat Harbour development would be managed by Frasers Property Australia, with the operational aspects to be managed by Frasers Property Australia for up to three years, following which responsibility for the management of the dunes at Shellharbour South Beach would revert to Shellharbour City Council. The ongoing future management of the dunes is to be undertaken in accordance with Council's Shellharbour Coastal Dunes Management Plan (Shellharbour City Council, 2016).

The broad objectives of this Plan are as follows:

- protect and enhance coastline biodiversity through the conservation of high value coastal ecosystems and habitat areas (including any listed threatened/endangered species and ecological communities);
- sympathetically rehabilitate and manage the coastal dune ecosystem along Shellharbour South Beach, specifically where these dunes have been modified due to construction works that have taken place for the Shell Cove Boat Harbour development project;
- maintain and improve dune stability to assist in providing a natural defence against coastal hazards and the potential impacts associated with projected climate change;
- through the implementation of a suitable program, monitor the condition of the coastal dunes of Shellharbour South Beach to maintain and secure coastline biodiversity;
- assist with the protection of all known and potential Aboriginal and European sites/items (both tangible and non-tangible) within the coastal dune system in accordance with the

Construction Environmental Management Plan (CEMP) and Consent and Permit #2534 pursuant to section 87 of the *National Parks and Wildlife Act 1974* to disturb and move Aboriginal objects for the purpose of salvage;

- ensure appropriate public access is provided and maintained including access for emergency and surf life-saving club vehicles and activities;
- contribute towards achieving the relevant goals, objectives and strategic actions under the Coastal Management State Environmental Planning Policy (SEPP);
- appropriately consider how visual surveillance of beach areas may be maintained for surf life-saving practices;
- establish relevant timeframes for the implementation and review of prioritised conservation initiatives; and,
- provide and prioritise dune rehabilitation and ongoing dune management recommendations and actions.

This Plan is based on the Dune Rehabilitation Plan as described in the already adopted Shell Cove Boat Harbour CEMP but provides additional detail to align with the requirements of the Shellharbour Coastal Dunes Management Plan (Shellharbour City Council, 2016).

1.2 Requirements

The Conditions of Consent for the Shell Cove Boat Harbour development (clause 15(d)(xi)) require a Beach Nourishment/Rehabilitation Management Plan to be prepared in consultation with and to the satisfaction of the Office of Environment and Heritage (OEH, formerly Department of Environment, Climate Change and Water).

This Beach Nourishment/Rehabilitation Management Plan has been prepared in accordance with the Conditions of Consent. As such, the construction aspects of the Beach Nourishment/Rehabilitation Management Plan are covered under the approvals for the Shell Cove Boat Harbour project.

The Shell Cove Boat Harbour CEMP and Operational Environmental Management Plan (OEMP) outline the general requirements for this Beach Nourishment/Rehabilitation Management Plan. The scope of the Beach Nourishment/Rehabilitation Management Plan is outlined in the Conditions of Consent for the Shell Cove Boat Harbour Development and is to provide detail on:

- beach and dune profiles and the proposed works to the dune system;
- beach access;
- landscaping/revegetation;
- mitigation measures;
- monitoring;
- triggers for beach nourishment to proceed;
- beach cleaning; and,
- beach and surf patrolling.

The Conditions of Consent also outline the requirement for monitoring of the beaches at the north and south of the entrance of the marina, especially during the period immediately after

construction of the entrance structures and undertaking the entrance channel dredging, as well as the requirement to undertake necessary sand nourishment to rectify erosion and recession. While some of this detail has been incorporated into the already adopted Dune Management/Rehabilitation Plan that was prepared under the CEMP for the Shell Cove Boat Harbour development, this Plan provides additional detail relating to the construction works required and ongoing management of the dunes as well as to align with the requirements of the Shellharbour Coastal Dunes Management Plan (Shellharbour City Council, 2016).

Aspects of this Beach Nourishment/Rehabilitation Management Plan fall into both the Construction and Operational phases of the project.

This document shall act as a living document that is to be updated on an as-needs basis during the construction and operational phases of the project.

1.3 Area Covered by this Plan

This Beach Nourishment/Rehabilitation Management Plan covers both construction and operational aspects of the project along Shellharbour South Beach with the extents shown on **Figure 1**. The construction aspect focuses on the areas near the Boat Harbour works north of the Breakwater and south of the Groyne.

This Plan outlines the proposed methodology for the nourishment and rehabilitation works, and has been prepared generally in accordance with the following:

- *NSW Coastal Management Act 2016*
- NSW Coastal Management Manual (Office of Environment and Heritage, 2018)
- Coastal Dune Management – A Manual of Coastal Dune Management and Rehabilitation Techniques (NSW Department of Land and Water Conservation, 2001)
- Shellharbour Coastal Dunes Management Plan (Shellharbour City Council, 2016)
- Shellharbour Coastal Zone Management Plan (Shellharbour City Council, 2017).

Figure 1 - Shellharbour South Beach extents covered by this Beach Nourishment/Rehabilitation Management Plan

1.4 Potential Environmental Impact

Impacts on the beach environment during construction may result from a number of aspects of the project:

- partial restriction of beach access;
- disturbance of the beach and dunes to provide temporary construction fencing so as to restrict public access and define the limits of construction activity;
- excavation and dredging of the beach and dunes and construction of the Breakwater and Groyne;
- beach and dune nourishment including creation of the beach fillet adjacent to the Breakwater; and
- placement of gross pollutants or other foreign material on the beach due to construction activities.

Impacts on the beach environment during operation may result from:

- indiscriminate access;
- beach erosion and shoreline recession;
- litter and other gross pollutants; and
- beach safety.

This Plan aims to outline the measures required to minimise these potential environmental impacts.

2 Management Strategy - Construction

The Contractor shall ensure that all activities carried out for the nourishment and rehabilitation works are in accordance with the Contract. It is the responsibility of the Contractor to ensure that construction activities minimise damage to the beach and dune system, minimise disruption to beach users and do not impact avoidably on beach amenity and safety. Additionally, the Contractor shall be responsible for meeting all the relevant management strategies and control measures and implementing the corrective actions (if and when necessary).

The nourishment and rehabilitation works to be undertaken by the Contract are presented in this Section. The Design Drawings and Technical Specification are provided in **Appendix A**.

2.1 Dune and Beach Profiles

2.1.1 Design Considerations

The purpose of the Shell Cove Nourishment and Dune Rehabilitation Plan is to guide rehabilitation of the dunes that were impacted by the construction of the breakwaters, extend the dune system over the old creek to the north of the Breakwater, raise dune heights where required so that the area is not affected by wave overtopping, and to undertake nourishment of the beach if required to rectify any erosion or recession.

The required dune crest level has been set for Shellharbour South Beach based on the results of wave runup calculations undertaken in the Shellharbour Coastal Hazard Analysis by SMEC (2010) and confirmed independently by field observations and wave runup calculations undertaken for this Dune Rehabilitation and Nourishment Plan. The results from the assessment indicate that if the dune crest at Precinct A is maintained at a minimum elevation of 4.5 m AHD, this would obviate the future risk of wave overtopping of the dune.

DPIE has provided a survey of the debris line from the June 2016 storm event, for Shellharbour South Beach north of the Breakwater (**Figure 2**). The debris line is a suitable proxy for the extent of wave runup. It can be seen that the wave runup levels reach approximately 4.6 m at the northern end of the surveyed area, but that there is a gradient in the wave runup with lower levels toward the southern end of the surveyed area. The June 2016 storm event is a particularly useful one for examining wave runup levels at Shellharbour South Beach, as the east-northeast approach direction of the June 2016 East Coast Low made that event particularly significant for east facing beaches. Due to the approach direction, that storm event is likely to have resulted in higher wave runup levels than for other notable storm events that caused significant erosion at other beaches along the NSW coast (such as the May-June 1974 storm events, which had a more southerly approach direction).

At the Botany Bay offshore Waverider buoy which provides wave data representative of the region, offshore significant wave heights reached a maximum of 7.2 m, from the east during the June 2016 event. The 6-hour duration offshore significant wave height was 6.15 m, with an offshore direction of 87°TN. From **Table 1**, the 100 year ARI significant wave height for waves from the East is 7.0 m –

this means that the June 2016 East Coast Low is in excess of a 1 in 100 year ARI event for storms from the easterly direction. The storm coincided with the maximum spring tide of the year, making this storm particularly damaging for beaches worst affected by swells from the east.

The combined probability of the storm approach direction, wave height and period makes the June 2016 East Coast Low a suitable design storm event for estimation of wave runup levels with an annual exceedance probability of less than 1%.

Table 1 - 100 Year ARI 1 hour Significant Wave Heights and Periods for Sydney

Direction	NE	ENE	E	ESE	SE	SSE	S	WSW
H_s (m)	4.4	6.0	7.0	7.3	8.5	9.3	8.8	5.5
T_p (s)	9.2	10.7	11.6	11.8	12.7	13.3	13.0	10.2

In addition to the wave runup debris survey data, wave runup has been calculated for the southern end of Shellharbour South Beach using survey data from September 2017 and the results of the two-dimensional SWAN wave transformation modelling undertaken by SMEC (2010), which takes into account the effects of wave refraction and the degree of exposure of the site to waves from different offshore directions. Runup has been determined for the 0.5 wave height coefficient calculated from the SMEC (2010) offshore-to-nearshore SWAN wave transformation analysis in 6 m water depth.

At the southern end of Shellharbour South Beach based on the most recent survey data at the site, wave runup was calculated to reach elevations of around 4.3 m AHD, taking into account some reduction of wave height that would occur due to the sheltering effect of the breakwaters. For present day conditions, therefore, if the crest of the dune is kept to at least this level, the dune would likely not be overtopped. In reality, any waves that overtopped the top of the dune onto the back-beach area would "fold over" the foreshore crest and travel as a sheet flow at shallow depth, spreading out and infiltrating over the landward areas. There would be expected to be a significant reduction in the velocity and depth of run-up within the order of 10 m from the foreshore crest.

Wave overtopping of the dune crest could be expected in a large storm event in the 2050 and 2100 timeframes. However, as the crest of the dune is some 50 m seaward of the seaward edge of Bass Point Tourist Road, it is not expected that the flow would reach as far as the road and would infiltrate into the sandy back-beach area. Wave overtopping of the dune in the present day scenario can be minimised by maintaining the dune crest at 4.5 m AHD. In addition to wave overtopping considerations, the interface between the dune and the adjacent breakwater has been considered in setting the appropriate crest levels for the dune.

Landscaping of the area on the seaward side of Bass Point Tourist Road (e.g. provision of a "swale" to capture overtopping flow) is recommended to reduce the risk of future wave runup flow onto the road and shared path.

In the future, with sea level rise, the dune could be overtopped with flow coming over the dune crest and onto the back dune area. However, the depth of flow would be shallow and would likely be absorbed into the sandy area on the landward side of the dune, prior to reaching the proposed

location of Bass Point Tourist Road. However, should the seaward face of the dune be eroded there is a higher risk that the dune would be overtopped and the risk of overtopping is increased for the years 2050 and 2100.

Wave runup levels with future sea level rise would increase by approximately the quantum of the sea level rise – for 2050, wave runup levels would be approximately 4.65 m AHD and approximately 5.15 m AHD by 2100.

2.1.1.1 Nourishment Frequency

The nourishment is proposed to be a one-off rather than recurring activity, and ongoing nourishment is not proposed to be undertaken beyond the completion of the works described in this Plan. The rationale for this is that existing three-monthly monitoring surveys of the beach have shown that the beach planform has readjusted to the construction of the Groyne and Breakwater, and has stabilised since commencement of the Breakwater construction in September 2016.

2.1.1.2 Beach Sand Compatibility

A significant consideration for the success of a beach nourishment campaign is the compatibility of the "borrow" and "native" beach sand. The "borrow" sand to be used as beach nourishment must be compatible with the native beach sand in the placement area, *i.e.* it must have a grain size distribution that is similar to the native beach sand in the placement area, and ideally should be sourced from within the same littoral compartment. As the sand source is from the same beach and immediately adjacent to the placement area, it is expected to be compatible for use as beach nourishment.

Figure 2 – Surveyed debris line, June 2016 (DPIE Unpublished data)

2.1.1.3 Expected and Observed Changes to Beach morphology

Following placement of sand for the dune works, all remaining available sand won from excavation of the harbour entrance would be used for beach nourishment extending as far north as possible and placed in a configuration that replicates as closely as possible the expected changes to beach morphology induced by the construction of the Breakwater and Groyne.

A physical modelling study of the Shell Cove Boat Harbour was undertaken in 1995 by AWACS to assess the physical impacts of construction of the harbour, including its breakwaters. The objectives of the study were:

- assessment of changes that may be occasioned by the boat harbour to the nearshore wave climates;
- assessing any re-alignment of the beach shoreline that may be occasioned by the proposed boat harbour;
- determining the degree of wave penetration into the harbour and its navigation channels so as to optimise the breakwater configuration; and,
- investigating possibilities of enhancing tidal flushing within the harbour mooring area.

As beaches are aligned to the direction of nearshore wave energy flux, any long term changes in this direction would result in a long term change in the beach alignment. The predicted changes in the alignment of Shellharbour South Beach north of the Breakwater are shown in , below. It can be seen that the beach would be expected to adjust with a 44 m progradation immediately adjacent to the breakwater, but up to a 14 m recession near the centre of the beach, due to the change in beach curvature induced by the nearshore changes in wave direction caused by the breakwater construction. Recent survey information and aerial photography following construction of the breakwaters has validated the expected beach response in the vicinity of the northern breakwater.

Following reconstruction of the dune which was removed to allow construction of the Breakwater, all remaining available sand won from excavation of the harbour entrance would be used for beach nourishment extending as far north as possible, to address the expected 14 m re-adjustment of the beach profile near the centre of the beach. The extent of beach nourishment to be undertaken would be limited by the quantity of nourishment sand available. It is estimated around 30,000 m^3 of sand is available from the harbour entrance, most of which would become available when the boat harbour is connected to the ocean, expected to be by the end of 2020. The locations and profiles of the sand to be placed are presented on drawings 301015-02681-MA-DWG-0130 and 301015-02681-MA-DWG-0120.

The beach nourishment profiles for the material on the beach for the area north of the Breakwater have been optimised to allow the sand to naturally readjust and redistribute along the beach. Sand is to be placed along the beach in a manner that closely approximates the predicted equilibrium planform of the beach, noting that the beach would realign naturally over time due to the prevailing wave climate. Effects from a disequilibrium beach plan profile following sand placement would be temporary, as the beach would rapidly realign into an equilibrium profile as has been observed in recent survey. Note that the beach equilibrium would self-adjust both in planform and

along the profile. The re-adjustment would likely occur in accordance with the planform predicted in the physical modelling study.

Analysis of survey undertaken to date indicates that the shorelines north of the Breakwater and south of the Groyne is responding to the construction of these structures by building seaward as shown on as predicted by the physical modelling study.

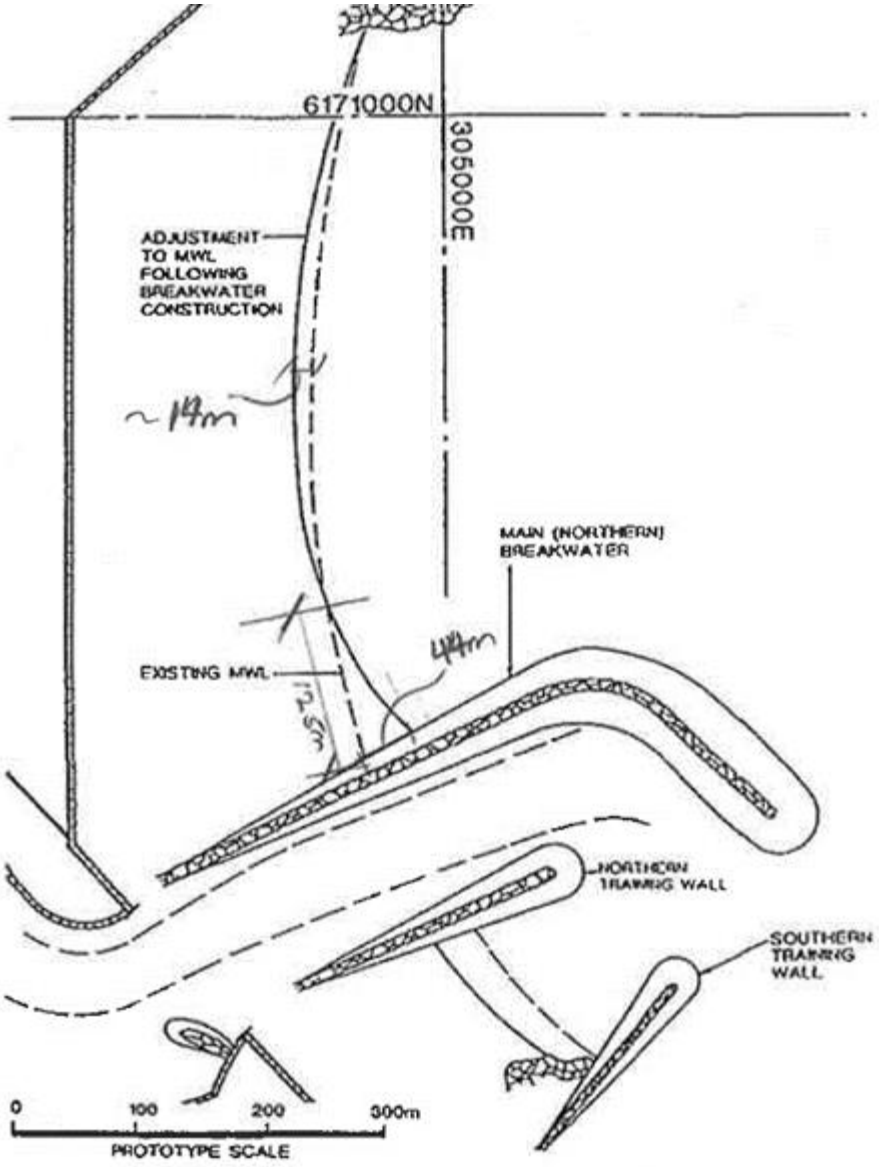

Figure 3 – Predicted adjustment to beach alignment following construction of breakwaters at Shell Cove (Nielsen *et al.* 1999)

Figure 4 - Shellharbour South Beach survey monitoring areas

2.1.1.4 Beach Nourishment Placement Locations

The dunes and berm at the back of the beach are deemed to be the most appropriate areas to place sand, as the Coastal Hazard Assessments (SMEC 2010) have identified that this area is subject to wave overtopping in large coastal storms. In addition, the dune would provide the appropriate buffer to compensate for the predicted reduction in beach volume as a result of the 14m recession and provide sufficient sand volume to cater for the storm erosion demand at this section of beach. Sand placed in accordance with the details as shown in the Drawings would be expected to readjust to a new equilibrium profile, both along the beach and in the cross-shore direction. For these reasons, subaqueous sand placement is not proposed.

Note that despite the prediction of 14 m beach recession at the centre of the beach, regular recent profile surveys of the beach have indicated that while the beach has realigned, a reduction in the beach volumes at the centre of the beach has not been observed in the data since the 2010 Coastal Hazard Assessments, and the predicted extent of coastal erosion in this area has not increased. This is likely due to continuing onshore sand transport along the entire beach length since 2010.

2.1.2 General Construction Details

Dune and beach profile works to be undertaken to the extents, levels, grades shown on the Design Drawings and in accordance with the Technical Specification provided in **Appendix A**.

As a priority, it is proposed to rebuild/raise the dunes north of the Breakwater (generally in the area of the old creek entrance) and south of the Groyne. Remaining available sand is proposed to

be used as beach nourishment immediately north of the Breakwaters, and extend as far north as possible (given that this is the area that is predicted in the physical mobile sand bed modelling to recede in response to construction of the Breakwater (Nielsen *et al* 1999)). However, following prioritised rebuilding/raising of the dunes, it remains uncertain at present how much sand would be available for beach nourishment activities.

It is estimated that sufficient and suitable clean sand is available from the Access Channel excavation that would forego the requirement to source sand from elsewhere. Disturbance to the existing dune system beyond the limits of the works shall be minimised. Adequate temporary protective barriers shall be erected and maintained around areas that are not to be disturbed such that they are clearly visible to all persons engaged on work on the site. Rehabilitation of temporary disturbance to the existing dune system as part of the works shall be undertaken in accordance with techniques set out in the Coastal Dune Management Manual (DLWC, 2001).

The crest level of the dune system shall generally be maintained to a minimum elevation of R.L. 4.7 m AHD, to cater for wave run-up and minimise wave overtopping of the dune. The dune level where it adjoins Groyne and Breakwater shall not exceed an elevation on R.L. 4.2 m AHD as shown on **Figure 5**. The seaward face of the beach is expected to reshape over time in response to construction of the Groyne and Breakwater, with the shoreline forming a new equilibrium planform over time. The beach nourishment profiles would be monitored into the future in accordance with the Monitoring section of this Plan.

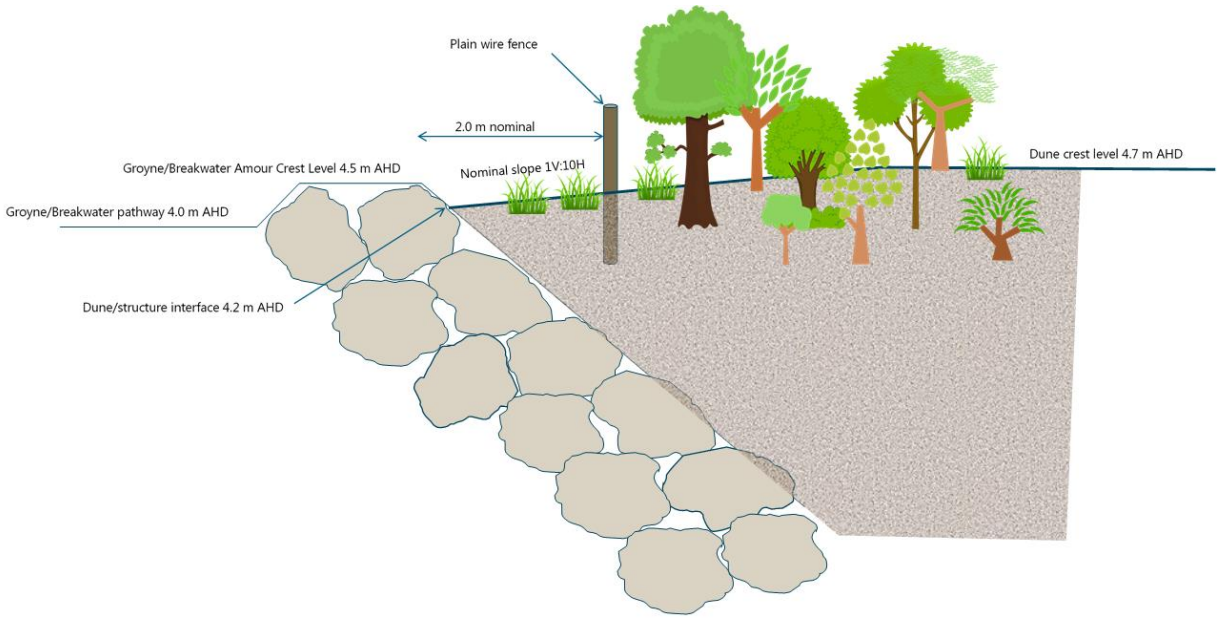

Figure 5 - Schematic of the Dune Crest and Groyne/Breakwater interfaces

Should the constructed dune and beach profiles not comply with the Design Drawings at the time of practical completion, the Contractor shall take measures to reshape and (and revegetate if required) the dune to achieve the specified outcome. Should protective barriers be damaged or become deteriorated they shall be immediately reconstructed. Should disturbance to the existing

dune system beyond the limits of the works occur these areas shall be immediately rehabilitated in accordance with techniques set out in the Coastal Dune Management Manual (DLWC, 2001).

2.1.3 South of the Groyne Construction Details

The beach and dune profile works south of the Groyne involves the following:

- removal of the stockpiled topsoil from the boat harbour excavation, with monitoring by representatives of the Aboriginal Community and qualified archaeologist undertaken in accordance with Permit #2534 pursuant to section 87 of the *National Parks and Wildlife Act 1974*;
- rebuilding the dune between the Groyne and the established dune to the south;
- minor raising of the established dune.

The beach profile and need for nourishment should be reviewed prior to commencing beach nourishment activities north of the Breakwater.

A "swale" or back-beach area shall be maintained on the landward side of the dune system of the beach at a level of 4.0 m AHD, to cater for possible future wave overtopping. This "swale" is not a formal constructed channel but is a relatively flat area behind the dune, close to existing ground elevation that can accommodate flow from waves that may overtop the main dune prior to reaching the roadway.

2.1.4 North of the Breakwater Construction Details

The beach and dune profile works north of the Breakwater involves the following:

- rebuilding the dune between the Breakwater and the established dune to the north; and
- nourishing the beach with surplus sand from the Access Channel works.

Rebuilding the dune will involve filling in the channel north of the Breakwater. Upstream flows from this channel will be permanently diverted into the Boat Harbour prior to the nourishment and rehabilitation works commencing north of the Breakwater.

The extent of beach nourishment will depend on the volume of sand available from excavation of the Access Channel following the prioritised dune works. The placed beach nourishment material is intended to redistribute along the beach and assist with beach realignment impacts. It should be noted that Shellharbour South Beach is undergoing long term accretion as defined in the Shellharbour Coastal Hazard Study (SMEC, 2010). Further analysis is required to ascertain the available volume of sand available for beach nourishment that is currently estimated at around 25,000 m^3. No sand is intended to be imported from offsite for dune restoration, reshaping and beach nourishment.

2.2 Archaeological Heritage Considerations

The Conditions of Consent required an Archaeological and Heritage Protection Plan to be prepared in consultation with the local Aboriginal community and DECC (now DPIE). The National Heritage Consultants (2009) prepared the report titled *Cultural Heritage Review Conceptual Master Plan for the Proposed Boatharbour Precinct Lands Shell Cove, NSW* and this report is referenced in the Archaeological and Heritage Protection Plan in the CEMP.

The Archaeological and Heritage Protection Plan includes the collection and clearance of AHIMS Site 52-5-436 located in the vicinity of the Breakwater. AHIMS Site 52-5-436 has been collected and cleared in accordance with Archaeological and Heritage Protection Plan as part of previous construction works.

The only remaining archaeological and heritage site in the vicinity of the proposed beach nourishment works is AHIMS Site 52-5-207 located south of the Groyne. Consent and Permit #2534 covers the area of AHIMS Site 52-5-207 shell midden, but only in relation to areas identified as being of relatively low or no archaeological value.

In accordance with the CEMP and Consent and Permit #2534 pursuant to section 87 of the *National Parks and Wildlife Act 1974* to disturb and move Aboriginal objects for the purpose of salvage, all portions of AHIMS Site 52-5-207 identified as being of relatively high archaeological value must not be disturbed, moved, damaged, defaced or destroyed and will therefore be preserved and protected from potential impact by development activities.

In accordance with the approvals for the Shell Cove Boat Harbour project, there would be no harm to AHIMS Site 52-5-207 as a result of the proposed beach nourishment works. For areas not identified as being of relatively high archaeological value, the special conditions relating to Permit #2534 state that representative(s) of the Aboriginal community and a qualified archaeologist should be present to ensure that the excavation of sediment is monitored. In the areas covered by the permit, therefore, excavation work associated with the boat harbour construction is permitted with monitoring by the Archaeologist and member(s) of the Aboriginal Community in accordance with the methodology outlined in the Archaeological and Heritage Protection Plan.

In 2013, the two midden sites of relatively low archaeological value were covered with topsoil to provide protection as directed onsite by a qualified archaeologist. The majority of the stockpiled topsoil is now required to be removed to rebuild the dune system with sand and form the back beach "swale", however, at least a 0.5 m buffer of topsoil to the depth of the middens will be preserved. While this can be confidently achieved with pre and post stockpile survey available, and using an excavator with GPS capability, representative(s) of the Aboriginal community and a qualified archaeologist would be engaged to monitor the excavation in accordance with the requirements of Permit #2534.

For areas of AHIMS Site 52-5-207 identified as being of relatively high archaeological value, during a site visit on 16 March 2018, ecologist Peter Dalmazzo observed the area was covered with buffalo grass, prickly pear and other weeds and mostly dead Coastal Wattle. Initial consultation with Allan Lance (the Archaeologist for Permit #2534) was undertaken for the proposed revegetation works. He indicated the following:

- from the list of introduced species, there is justification for a weed control program
- there are some weed control activities that could be undertaken without any risk of damaging the shell midden site. These would include cutting and poisoning woody weeds like lantana and blackberry. The woody weeds should not be grubbed out as this is likely to cause damage to the shell midden site.
- the herbaceous weeds could present more of a problem, if widespread poisoning resulted in erosion and localised mobilisation of the dunes, before native grasses repopulate the area
- The removal of the weeds should be undertaken without causing erosion or direct damage to the dune containing the buried shell midden.

DPIE advice has been sought on whether an Aboriginal cultural heritage Due Diligence Assessment is required for the weed control activities, and a summary of that advice is provided below:

> *It appears that the majority of activities are covered by the current section 90 permit (#2534) and AHMP. Weeding in the Conservation Area (including removing buffalo grass) should only be undertaken if it can be done in a way that complies with permit #2534 and the AHMP. If does not comply then the proponent could amend the works so they do comply, or apply to DPIE for a variation to the permit and to justify how it will support conservation of the archaeological site. In general, we support passive weed management methods that avoid ground disturbance. We also reiterate that if suspected human remains are found at any point, then work must stop and DPIE and the NSW Police must be contacted immediately.*

To avoid disturbance and damage to the areas of AHIMS Site 52-5-207 identified as being of relatively high archaeological value, the following is proposed for the revegetation works:

- undertake weed control activities that have minimal risk of damaging the shell midden site such as cutting and poisoning weeds with appropriate herbicides. Weeds such as prickly pear and woody weeds could be removed with minimal risk of destabilising the dune and damage to the shell midden site;
- seeding of native grass. However, the ecologist noted that the seeding of native grass may not work into well-established buffalo grass; and,
- planting of native seeds or root balls with additional sand and soil material by manual tools.

2.3 Beach Access

Disruption to beach access off Boollwarroo Parade and along the beach above low tide level shall be minimised consistent with public and worker safety. Persons shall be employed by the Contractor to control access to ensure safety.

All existing pedestrian access points north of the Breakwater shall be retained in their general location. New formalised board and chain accessways shall be installed in accordance with the Design Drawings and Technical Specification provided in **Appendix A** and shown on **Figure 6** respectively. This includes accommodating a "dog-leg" in the accessway alignment to minimise

erosion due to wind funnelling and wave run-up. It is suggested that the two accessways closest to the Breakwater and Groyne are made 3 m wide and designed accordingly to permit vehicle access. These accessways would need a secure gate or alternative system to prevent illegal vehicle access.

Board and chain accessways may be constructed using timber boards. Alternative products such as recycled plastic boards manufactured by Replas or Wagners are available and can be considered for use in the board and chain accessways.

Accessways are to be fenced on either side using plain wire fencing as per the detail shown on **Figure 7** to avoid pedestrian access onto the dune areas. Wire Mesh or Post and Rail fences (refer NSW DLWC, 2001) for the two higher-use accessways closest to the Breakwater and Groyne can be considered. One existing beach accessway on the southern side of the Groyne and the four existing beach accessways on the northern side of the Breakwater shall be retained and provided with board and chain covering to minimise the potential for erosion. Dune board-and-chain walkways shall be covered by between 100 to 200 mm depth of beach sand at installation.

Access points along the beach are to remain in their existing positions, with existing fence posts used where available. Two former accessways on the southern side of the Groyne would be decommissioned to prevent damage to areas of archaeological significance. Fencing is proposed only in the areas where there is existing fencing or which have been previously excavated for fencing of the accessways. No fencing through previously undisturbed areas is recommended, to prevent damage to areas of archaeological significance. Fencing will be located at least 5 m from the northern area of high archaeological value to maintain the required buffer area in accordance with Condition 8 of Permit #2534. In addition, dune fencing would not be located within the mapped boundary of the Conservation Area at site 52-5-0207.

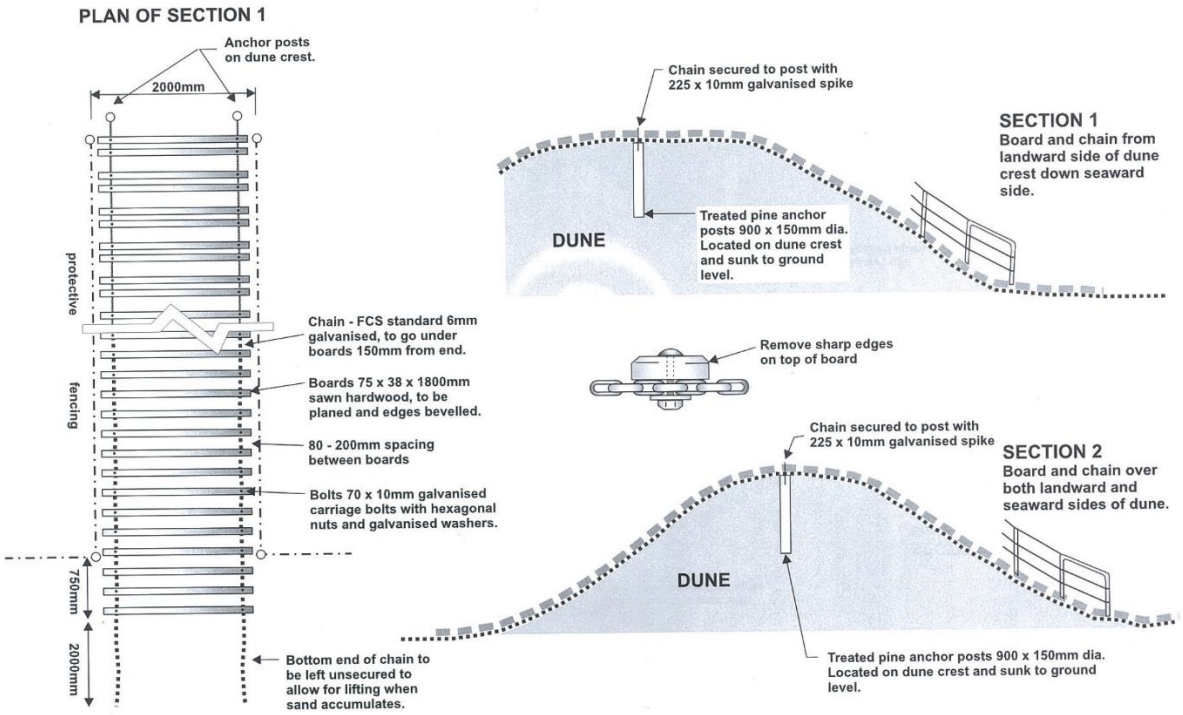

Figure 6 – Board and Chain accessway – Typical Detail (NSW DLWC, 2001)

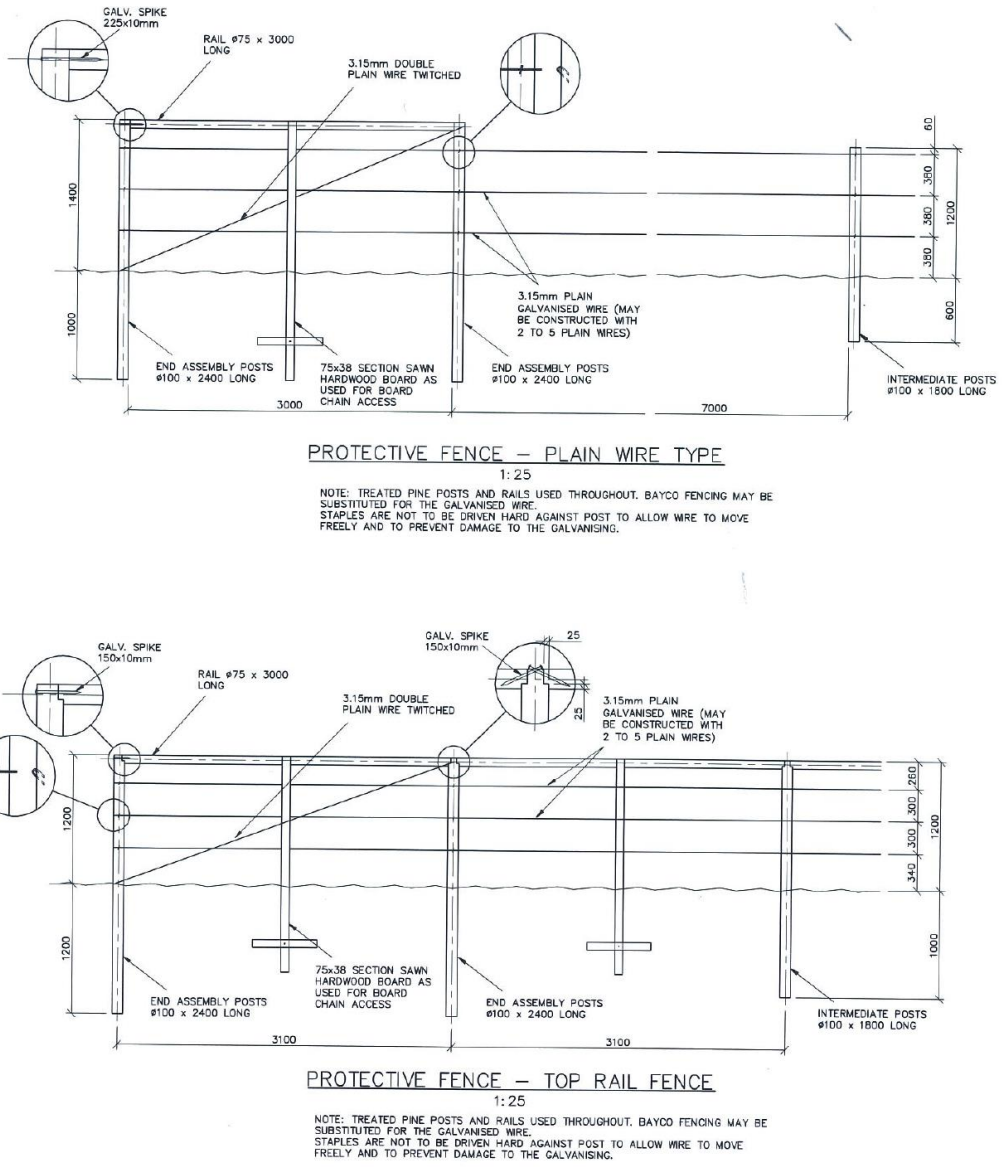

Figure 7 – Plain Wire Fence (Type 3 and Type 4 as per the Design Drawings) shown on the top and bottom respectively – Typical Detail (NSW DLWC, 2001)

2.4 Revegetation

Revegetation of the dunes, where required, shall be undertaken generally in accordance with the techniques set out in the Coastal Dune Management Manual (DLWC, 2001). Prior to revegetation, rebuilding and reshaping of dunes shall be undertaken to ensure a natural profile and smooth transition between existing and rehabilitated dunes and between the dune systems and the Breakwater and Groyne. A landscape detail near the dune crest interface with the Groyne and Breakwater is provided in **Figure 5**.

Revegetation involves the following activities that are described in the section:

- vegetating with local dune species;
- weeding;
- fencing;
- signage; and,
- maintenance.

Areas of existing dune vegetation and habitat shall not be removed. In the areas south of the Groyne, where the dune crest is to be raised (refer Design Drawings in Appendix A), existing native dune vegetation shall not be removed. The dune crest shall be raised using a long reach excavator with bucket, working from a sand stockpile outside the existing vegetated dune areas, to avoid disturbing areas that are already vegetated. No sand would be placed on top of the Conservation Area within site 52-5-0207 mapped as "high archaeological values". In the areas both south of the Groyne and north of the Breakwater, where there is existing dune vegetation and the dune is raised, bare areas of dune shall be stabilised in the first instance with brush matting obtained where available from locally cleared areas of the dune. The newly formed dune surface shall be planted with local dune species as described in **Section 2.4.1**.

The vegetated dune areas (including both the newly constructed and existing dune vegetation areas) shall be fenced using Plain Wire fencing and/or Top Rail fencing . The fencing shall extend along the seaward and landward side of the dune and along the board-and-chain accessways. Note that in some areas there are posts already in place from pre-existing fencing which can be re-used as part of the fencing if in good condition. Existing posts that are damaged or deteriorated are to be replaced.

The vegetation maintenance period for the Contractor shall be up to three years from the agreed completion of the planting of a particular completed area, in accordance with Shellharbour Council's guidelines for Vegetation Management Plans. This would be an appropriate time frame to control weeds and allow revegetation to establish to the point where the native vegetation is stabilizing the dunes and can outcompete exotic species The Contractor shall remain responsible for maintaining healthy and vigorous growth of all dune stabilisation vegetation at all times for the duration of the maintenance period. Following an initial establishment period of approximately three months, secondary follow-up planting would be required to replace plants that have not established and to infill areas that are only sparsely covered with initial fast-growing primary vegetation such as spinifex. In addition, the Contractor shall be responsible for the maintenance of dune fencing and access ways during the maintenance period. Ongoing maintenance of the dune vegetation beyond the initial three-year maintenance period would be required and this would be the responsibility of Council.

Signage shall be provided at the car park and principal access points to the beach, in accordance with the project wayfinding and signage Masterplan.

Should revegetation activities not comply with the Coastal Dune Management Manual (DLWC, 2001) and not provide natural smooth transitions, reshaping and/or revegetation works shall be undertaken to ensure compliance. Should dune vegetation not become established or not survive following placement, the dead dune vegetation shall be replaced. Should weeds be identified

within the revegetated areas, those areas shall be treated for weeds in accordance with the recommendations in **Section 2.4.3**.

2.4.1 Local Dune Species

The plant communities that would be incorporated into the dune restoration areas at Shell Cove are Beach Strand Grassland ('primary' dune vegetation) and Coastal Foredune Scrub ('secondary' dune vegetation) as described by Tozer *et al.* (2010). The geography of the site, including the proximity of urban infrastructure to the beach, does not lend itself to establishment of 'tertiary' plant communities such as Coastal Sand Forest or Temperate Littoral Rainforest.

The low-lying areas landward of the dune would be largely undisturbed by the dune restoration works, would be publicly accessible to foot traffic and are covered in existing grasses and vegetation and it is not proposed to replant these areas. However, in areas that would be disturbed it may be possible to include species that would grow in both dune and wetland habitats such as *Baumea juncea* or *Carex pumila*. *Ficinia nodosa* Knobby Club-rush and *Juncus kraussii* Sea Rush should be planted in the extended swale beside the road on the northern side of the boat harbour entrance.

The Beach Strand Grassland should be planted mostly with Beach Spinifex *Spinifex sericeus* and a smaller proportion (10%) of at least one other species from the following list, depending on availability of stock: *Austrofestuca littoralis*, *Carpobrotus glaucescens*, *Ficinia nodosa*. *Carpobrotus glaucescens* should be sourced from local naturally occurring plants as the variety commonly available through suppliers has recently been considered a separate sub species with much more rapid growth and weed potential.

The remainder of the restoration areas should be planted with species from the Coastal Foredune Scrub plant community. French (2010) studied this community of the NSW south coast and found no differences in species composition among subregions. She therefore concluded that Coastal Foredune Scrub is the same across the entire south coast region. She also found that small areas that are being restored (such as at Shell Cove) should have fewer species than larger areas and restoration activities at small sites do not need to include all species which might be normally found in the whole vegetation community.

Appendix B is a list of plant species that French identified in the plant community. The following species are recommended for Shell Cove on the basis that:

- they are the more common species that are found on most dunes and are therefore likely to be representative of plants in the Shellharbour area; and,
- they are most likely to be available as planting stock.

To provide for an appropriate level of species diversity and to provide for a diversity of ecological function, species from each growth form have been chosen. If additional species are readily available they could be added to the list. If any of the species listed in Table 2 are not available they can be replaced by another plant from the list in **Appendix B** provided it has the same growth form. It is expected that species diversity would increase over time through natural seed

dispersal from nearby areas. Additional species could also be added if community-based projects are developed in the future.

Table 2 – Local dune species

Vegetation Type	Species for planting
Tall shrub or tree	*Banksia integrifolia* subsp. *integrifolia* *Breynia oblongifolia*
Shrub	*Leucopogon parviflorus* *Monotoca elliptica* *Acacia longifolia* subsp. *sophorae* *Rhagodia candolleana* subsp. *candolleana* *Leptospermum laevigatum* *Lomandra longifolia*
Herb	*Carpobrotus glaucescens*
Grass or grass-like species	*Spinifex sericeus* *Ficinia (Isolepis) nodosa* *Austrofestuca littoralis*

French (2010) provided information on natural plant densities in Coastal Foredune Scrub (**Table 3**). This can be used to guide replanting of the dune at Shell Cove.

Table 3 – Average densities of plants found in 20 x 20 m plots assessed at 3 beaches on the south coast (after French 2010)

Life form	No. Plants
Shrubs	394
Tall shrubs	91
Herbs	190
Tussocking grasses	240
Vines	112
Stoloniferous grasses (grasses that spread from runners)	Aim for 20% cover at maturity
Stoloniferous herbs	373 *ramets*[*]

*A *ramet* is a tuft seen above ground that is connected by underground (or above ground) stems to other tufts. It is suggested that, in total, about 40 herbaceous plants are planted in each 20 x 20 m area. This equates to plants having on average 10 above-ground ramets per plant (French 2010).

Further specific detail on the rehabilitation techniques proposed for South Shellharbour Beach will be developed as part of the Technical Specification for the dune rehabilitation works.

2.4.2 Existing Vegetation

Existing vegetation on the dune is not planned to be removed for dune reshaping and impact on these areas must be minimised. For areas where vegetation including spinifex grasses would be covered in beach nourishment sand (north of the Breakwater), if the existing vegetation (especially Spinifex) is relatively weed free it can be left in place and will generally survive and find its way to the surface. In areas where weeds are present, native plants, such as grass runners and seed heads should be extracted where possible and stored for replanting.

In the areas where dune reshaping is proposed (*i.e.* south of the Groyne), the existing plants and taller shrubs would not be completely covered by raising of the dune as the raising would be less than 1 m above existing levels in localised areas south of the Groyne. Under these circumstances the vegetation should survive as partial burial of these plants can occur in nature and they have mostly adapted to respond. Works for dune reshaping would be carried out using equipment from outside the vegetated dune area so that existing vegetation is not trampled.

Any reshaping or raising of areas where native vegetation is intact must be supervised by a Bushland Restoration Contractor or Council's Environment Officer. Further information will be provided on this process in the Technical Specifications.

2.4.3 Weed Management

From site observations of the existing dune area south of the Groyne, a total of 51 plants were identified, including 19 native species and 32 introduced species. The existing dune area south of the Groyne is substantially infested with weeds with little healthy native vegetation. It is suggested that the area to be sprayed with herbicide and replanted with native dune species in lieu of selective weeding.

The area north of the Breakwater presents a healthier stand of native dune vegetation that can be managed with selective weeding. As a result, weeding and replanting of native species is to be undertaken as required throughout these dunes. Weeding beyond these areas is the responsibility of Council and is to be carried out in accordance with the recommendations of the Shellharbour Coastal Dune Management Manual.

The priority weeds to be targeted for weed control using established techniques specified in the NSW Dune Management Manual and Shellharbour Coastal Dunes Management Plan are outlined below. French (2010) noted that exotic species differ in their impact on native species, targeting weed control to those high risk weed species that compete strongly with native species, rather than low density exotic species, is likely to be economically and ecologically efficient. Based on information in French (2010) and advice from a locally based ecologist, the priority weeds to be targeted for weed control include:

- Bitou Bush *Chrysanthemoides monilifera*
- Lantana *Lantana camara*
- Turkey Rhubarb *Acetosa sagitta*
- Asparagus Fern *Asparagus aethiopicus*
- Prickly Pear *Opuntia stricta*
- Mother-of-millions *Bryophyllum*
- Blackberry *Rubus fruiticosus*
- Fireweed *Senecio madagascariensis*
- Dune Onion Weed *Trachyandra divaricata*

The list of priority weeds would be modified if necessary as new weeds emerge during site monitoring.

In addition, it is recommended that the biomass of significant weeds such as Buffalo Grass and Kikuyu be reduced.

Weed invasion would be minimised if native seedlings are replanted in dense planting schemes, *i.e.,* greater than the natural densities. This may assist in reducing weed establishment. Dense planting is likely to be more economical than the costs involved with weed management (French 2010). The methods of planting of native species could involve seeding grass and some method to stabilise native seeds or root balls, either into the existing material or by placement of additional material.

Weeds occurring within the dune areas shall be recognised and identified, with young weed seedlings to be removed as soon as possible. Weed removal shall be carried out over small areas at

any one time, to avoid destabilising large areas of dune. Areas cleared of weeds shall be replanted with the appropriate species depending on the area of the dune that has been cleared (refer to **Table 2** for species list).

Weeds shall be removed in the first instance by hand using an appropriate weeding tool, with seeds and the entire root system to be removed.

The Department of Primary Industry and Environment website, http://www.environment.nsw.gov.au/pestsweeds/aboutweeds.htm, should be consulted for specific recommendations and resources relating to specific weed species. Resources available include, among others:

- Bitou Bush and Boneseed Threat Abatement Plan, including Bitou Bush Management Manual; and,
- Asparagus Weeds Management Manual.

Further specific detail on the weed management techniques proposed for South Shellharbour Beach will be developed as part of the Technical Specification for the dune rehabilitation works.

2.5 Timing

The priority for the Works described in this Plan are:

1. Targeted weed control of priority weed species as outlined in **Section 2.4.3**
2. Rebuilding and reshaping of dunes to ensure a natural profile and smooth transition between existing and rehabilitated dunes and between the dune systems and the Breakwater and Groyne as per the Design Drawings in **Appendix A**
3. Temporary stabilisation of dunes with brush matting or by alternative means
4. Planting of primary vegetation, including grass or grass-like species from **Table 2**
5. Planting of secondary vegetation through tube stock at high densities (refer **Table 3** for recommended densities).
6. Fencing and provision of accessways
7. Ongoing monitoring of dune vegetation and beach behaviour.

Use of temporary dune stabiliser mean that staging of planting is not necessary. Tree-guards are not recommended for use on dunes, as these may blow away. Good survival rates can be achieved with no guards in this environment. With regard to temporary stabiliser, suitable alternatives to brush matting if there is not sufficient available at the site include (NSW Dune Management Manual, 2001):

- mulches (with no seeds);
- liquid sprays;
- cover crops (sterile); and,
- geotextiles (biodegradable).

Specific details will be outlined in the Technical Specification for the dune rehabilitation works.

2.6 Monitoring

Monitoring shall be undertaken during construction and comprise:

- monitoring of beach behaviour
- monitoring of dune disturbance
- monitoring of beach cleanliness.

Monitoring of beach behaviour shall include:

- survey of shore-normal beach profiles along Shellharbour South Beach for the survey profiles shown on **;**
- determination of the position of mean high water mark and mean low water mark along Shellharbour South Beach over a distance of 200 m north of the breakwater;
- completion of a survey prior to commencement of the works and then at maximum three monthly intervals and following significant beach erosion events (such events to be determined by the Superintendent) up to 6 months following completion of the works;
- graphical presentation of the surveys in a format to be agreed with the Superintendent; and,
- preparation of a report setting out the findings of the surveys on a progressive basis, i.e. including historical comparisons.

Monitoring of dune disturbance shall include visual inspection of temporary protective barriers and adjacent existing dune systems on a daily basis.

Monitoring of beach cleanliness shall include visual inspections of Shellharbour South Beach on a daily basis for identification of gross pollutants or other foreign matter that may be the result of the activities of the Contractor.

Should monitoring not be undertaken as specified, the monitoring activities should be immediately revised to ensure compliance.

The monitoring program for the beach is outlined in the separate CEMP for the Shell Cove project which provides for monitoring of the beach in accordance with the Ministerial concurrence. It is expected that as the beach is a dynamic environment, it will continue to respond in a dynamic fashion to storm events, as well as adjustment over time to the construction of the boat harbour.

Ongoing future beach monitoring is to be implemented in accordance with the requirements of the Shellharbour CZMP and in accordance with beach monitoring undertaken for beaches in urban areas elsewhere in NSW e.g. regular collection of LiDAR data, post-storm beach profile surveys, continued photogrammetric analysis, etc. It is understood that Council currently monitor the beach and dune dynamics with photopoint monitoring.

It is noted from Council's Hazard study (SMEC 2010) that this beach is naturally accreting over time and subsequently future beach nourishment would not be expected to be required in the short to medium term. This Plan covers the initial one-off beach nourishment activities for restoration of the dunes on the beach due to the construction activities associated with the Shell Cove Boat

Harbour. On-going beach nourishment is not proposed as suitable nourishment sources for future nourishment are not available for this beach.

2.7 Beach Cleaning

Shellharbour South Beach shall be kept free of gross pollutants or other foreign matter as the result of activities of the Contractor. This includes for gravel and cobbles within the sand stockpiled on the southern side of the Groyne from initial Access Channel excavation activities (**Figure 8**). All such gross pollutants or other foreign matter shall be collected regularly as they occur, including retrieval from adjacent waters if necessary, and disposed of appropriately. The gravel and cobbles within the beach berm area should be removed to 0.5 to1 m below the final surface level following beach and dune re-profiling works by manual means or an excavator with screening bucket. Initial cleaning of gravel that has contaminated the sand from construction activities is to be undertaken only from the existing stockpile of sand excavated from the channel. Subsequent cleaning of this gravel material shall only be allowed within the beach berm and not in the dunes, i.e. in the areas seaward of the archaeological area where sand has already been or will be placed. No excavation into the existing surface within the archaeological area shall be allowed to take place.

Should Shellharbour South Beach not be free of gross pollutants or other foreign material that, in the opinion of the Superintendent, are the result of activities by the Contractor, all such pollutants and materials shall be immediately removed including any in the adjacent waters.

Figure 8 – Gravel and cobbles from construction activities within stockpile on southern side of the Groyne.

2.8 Beach and Surf Patrolling

Council appointed lifeguards will patrol Shellharbour South Beach, north of the Boat Harbour entrance as determined by annual budget allocations. The current arrangements are:

- seven days a week, 9am – 5pm over the six week Christmas school holiday period;
- weekends, public holidays and school holidays between the end of Christmas school holidays to 25 April, 9:30am – 5pm;
- surveillance activity will be focussed on the area of the flags which are always located at the northern end of the Shellharbour South Beach; and,
- casual surveillance will be undertaken of the remainder of the beach areas further south.

The Contractor shall co-operate with Council appointed lifeguards and develop procedures, approved by the Superintendent, to ensure beach safety is not adversely impacted due to the works.

Should any incidents arise, due to the works, that lead to an actual or potential adverse impact on beach safety these shall be immediately investigated and reported to the Superintendent and existing procedures revised where required to ensure no reoccurrence.

2.9 Monitoring and Compliance Standards

Throughout the Contract period the Contractor shall ensure that work is undertaken in accordance with the Beach Nourishment / Rehabilitation Management Plan including the monitoring activities outlined in **Section 2.6**.

Compliance standards are set out in **Table 4**.

Table 4 Compliance Standards for Beach Nourishment / Rehabilitation

Requirement	**Compliance Standard**
General	Nourishment and rehabilitation works complies with the Construction Drawings at the time of practical completion.
Beach and Dune Profiles	Adequate protective barriers are installed and maintained, disturbance to the existing dune system beyond the limits of the nourishment and rehabilitation works are minimised and any disturbance is immediately rehabilitated. Beach sand compatibility and silt content shall be demonstrated by grain size analysis of both the borrow and native sand. All rehabilitation complies with techniques set out in the Coastal Dune Management Manual (DLWC, 2001)
Beach Access	Pedestrian access to the beach shall be as per the Drawings and Specification. Board and chain coverings to be provided to all accessways in the Plan area with

Requirement	Compliance Standard
	inclusion of a "kink" in the accessway planform to prevent erosion due to wave run-up and wind funnelling. Satisfactory level of beach access is maintained consistent with public and worker safety. Satisfactory access management is provided by the Contractor.
Revegetation	Techniques comply with the Coastal Dune Management Manual (DLWC, 2001) and provide natural smooth transitions between existing natural systems and completed works. Dune vegetation is established, dunes are stabilised and fencing is in place.
Monitoring	All specified monitoring activities are satisfactorily carried out.
Beach Cleaning	Shellharbour South Beach are free of gross pollutants or other foreign matter that, in the opinion of the Superintendent, are the result of activities by the Contractor. Reasonable access is provided to the Council operated purpose built beach cleaning machine.
Beach and Surf Patrolling	No avoidable impact on beach safety due to the works.

3 Management Strategy - Operation

Following Construction, Council shall continue to monitor the Shellharbour South Beach for damage to the beach and dune system, disruption to beach users, and beach amenity and safety. Council are responsible for meeting all the relevant management strategies and control measures, and implementing the corrective actions (if and when necessary) that are presented in this Section.

3.1 Beach and Dune Profiles

Beach and dune profiles should be initially be monitored in accordance with **Section 2.6** and be managed in accordance with the Shellharbour Coastal Zone Management Plan.

3.2 Beach Access

Pedestrian access to Shellharbour South Beach shall be as per the Drawings and Specification. Accessways should be inspected regular as part of Council's maintenance program and in accordance with the CZMP so they continue to function correctly and do not become a hazard to the public. It may be necessary to temporarily close accessways if they become eroded, undermined or damaged. Maintenance of accessways shall be in accordance with the Coastal Dune Management Manual (DLWC, 2001).

Access points along the beach are to be provided as per the Drawings and Specification, with existing fence posts used where available. Fencing is proposed only in the areas where there is existing fencing or which have been previously excavated for fencing of the accessways and shall maintain a buffer of at least 5 m from areas of high archaeological value in accordance with the conditions of Permit #2534. No fencing through previously undisturbed areas would be allowed, to prevent damage to areas of archaeological significance. In addition, dune fencing would not be located within the mapped boundary of the Conservation Area at site 52-5-0207.

3.3 Revegetation

Revegetation works undertaken within the dune system along Shellharbour South Beach that become degraded due to weed infestation of damaged due to storms or human impacts shall be reinstated in accordance with the CZMP and Coastal Dune Management Manual (DLWC, 2001). Consideration should be given to involve the Local Landcare Group or Illawarra Local Aboriginal Community (ILALC) bush regeneration team with suitable revegetation rehabilitation works.

3.4 Monitoring

Ongoing beach monitoring shall be undertaken by Council to gain further knowledge of beach behaviour and to assist in its future management. Monitoring shall be in accordance with the CZMP and should replicate the survey locations undertaken during the construction monitoring.

3.5 Beach Cleaning

Beach cleaning shall continue to be undertaken on a manual basis by Council appointed lifeguards as part of their normal duties and by a purpose built cleaning machine operated by Council on a needs basis for removal of substantial items such as litter and seaweed following major storms. Waste receptacles shall be positioned near the landward end of beach accessways.

3.6 Beach and Surf Patrolling

Council shall continue to appoint lifeguards to patrol Shellharbour South Beach (north of the Entrance Channel) seven days a week, 9am – 5pm over the six week Christmas holidays, and on weekends, public holidays and school holidays 9:30am – 5pm between the end of Christmas school holidays to 25 April. Flags shall continue to be placed on the northern end of the beach which is the area of community focus and the safest location for swimming.

In the case of the beach south of the entrance, Council may, subject to annual budget allocation and consistency with other beaches in the local government area:

- patrol the beach; or,
- declare the beach to be an un-patrolled beach.

The level of patrolling on along all of Shellharbour South Beach shall be subject to annual review having regard to patronage of the beaches, any safety incidents and other relevant factors determined by Council.

4 References

French, K (2010) *A Framework to Guide Ecological Restoration: Coastal Foredune Scrub and Temperate Littoral Rainforest. South Coast.* University of Wollongong, Wollongong.

NSW Department of Land and Water Conservation (2001), *Coastal Dune Management: A Manual of Coastal Dune Management and Rehabilitation Techniques*, Coastal Unit, DLWC, Newcastle, October.

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Nielsen, A.F; Treloar, P.D.; Tooker, M. (1999). *Comparing Numerical Methods with Physical Scale Modelling of Wave Penetration into a Small Harbour*, Proceedings of the 14th Australasian Coastal and Ocean Engineering Conference and the 7th Australasian Port and Harbour Conference, Perth.

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Shellharbour City Council (2016), *Shellharbour Coastal Dunes Management Plan*, February.

Shellharbour City Council (2017), *Shellharbour Coastal Zone Management Plan.*

SMEC (2010), *Shellharbour Coastal Hazard Study*, April 2010.

Tozer, M. G., Turner, K., Keith, D. A., Tindall, D., Pennay, C., Simpson, C., MacKenzie, B. and Cox, S. (2010) *Native vegetation of southeast NSW: a revised classification and map for the coast and eastern tablelands*. Cunninghamia 11(3).

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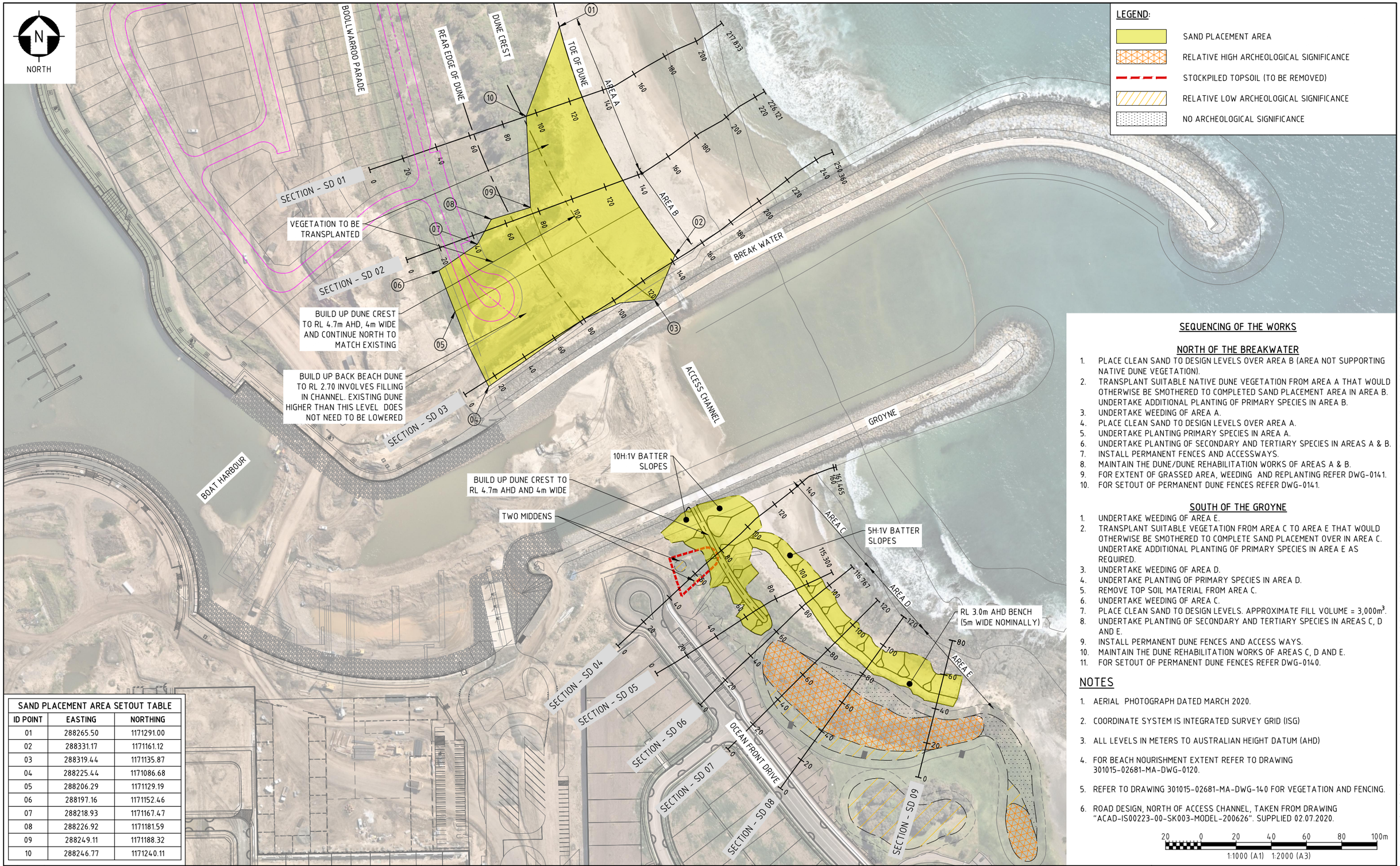
WorleyParsons Group

Appendix A DESIGN DRAWINGS AND TECHNICAL SPECIFICATION



SAND PLACEMENT AREA SETOUT TABLE		
ID POINT	EASTING	NORTHING
01	288265.50	1171291.00
02	288331.17	1171161.12
03	288319.44	1171135.87
04	288225.44	1171086.68
05	288206.29	1171129.19
06	288197.16	1171152.46
07	288218.93	1171167.47
08	288226.92	1171181.59
09	288249.11	1171188.32
10	288246.77	1171240.11

SEQUENCING OF THE WORKS

NORTH OF THE BREAKWATER

1. PLACE CLEAN SAND TO DESIGN LEVELS OVER AREA B (AREA NOT SUPPORTING NATIVE DUNE VEGETATION).
2. TRANSPLANT SUITABLE NATIVE DUNE VEGETATION FROM AREA A THAT WOULD OTHERWISE BE SMOTHERED TO COMPLETED SAND PLACEMENT AREA IN AREA B. UNDERTAKE ADDITIONAL PLANTING OF PRIMARY SPECIES IN AREA B.
3. UNDERTAKE WEEDING OF AREA A.
4. PLACE CLEAN SAND TO DESIGN LEVELS OVER AREA A.
5. UNDERTAKE PLANTING PRIMARY SPECIES IN AREA A.
6. UNDERTAKE PLANTING OF SECONDARY AND TERTIARY SPECIES IN AREAS A & B.
7. INSTALL PERMANENT FENCES AND ACCESSWAYS.
8. MAINTAIN THE DUNE/DUNE REHABILITATION WORKS OF AREAS A & B.
9. FOR EXTENT OF GRASSED AREA, WEEDING AND REPLANTING REFER DWG-0141.
10. FOR SETOUT OF PERMANENT DUNE FENCES REFER DWG-0141.

SOUTH OF THE GROYNE

1. UNDERTAKE WEEDING OF AREA E.
2. TRANSPLANT SUITABLE VEGETATION FROM AREA C TO AREA E THAT WOULD OTHERWISE BE SMOTHERED TO COMPLETE SAND PLACEMENT OVER IN AREA C. UNDERTAKE ADDITIONAL PLANTING OF PRIMARY SPECIES IN AREA E AS REQUIRED.
3. UNDERTAKE WEEDING OF AREA D.
4. UNDERTAKE PLANTING OF PRIMARY SPECIES IN AREA D.
5. REMOVE TOP SOIL MATERIAL FROM AREA C.
6. UNDERTAKE WEEDING OF AREA C.
7. PLACE CLEAN SAND TO DESIGN LEVELS. APPROXIMATE FILL VOLUME = 3,000m^3.
8. UNDERTAKE PLANTING OF SECONDARY AND TERTIARY SPECIES IN AREAS C, D AND E.
9. INSTALL PERMANENT DUNE FENCES AND ACCESS WAYS.
10. MAINTAIN THE DUNE REHABILITATION WORKS OF AREAS C, D AND E.
11. FOR SETOUT OF PERMANENT DUNE FENCES REFER DWG-0140.

NOTES

1. AERIAL PHOTOGRAPH DATED MARCH 2020.
2. COORDINATE SYSTEM IS INTEGRATED SURVEY GRID (ISG)
3. ALL LEVELS IN METERS TO AUSTRALIAN HEIGHT DATUM (AHD)
4. FOR BEACH NOURISHMENT EXTENT REFER TO DRAWING 301015-02681-MA-DWG-0120.
5. REFER TO DRAWING 301015-02681-MA-DWG-140 FOR VEGETATION AND FENCING.
6. ROAD DESIGN, NORTH OF ACCESS CHANNEL, TAKEN FROM DRAWING "ACAD-IS00223-00-SK003-MODEL-200626". SUPPLIED 02.07.2020.

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

REV	DATE	REVISION DESCRIPTION	DRAWN	DRAFT CHK	DESIGNED	ENG CHK	APPROVED	CUSTOMER	REF DRAWING No	REFERENCE DRAWING TITLE
E	06.07.20	REVISED ROAD DESIGN	BB	GT	GT	BSM	BSM			
D	29.05.20	REVISED SAND PLACEMENT AND NEW ROAD LOCATIONS	BB	VIP	GT	BSM	BSM			
C	24.04.20	ISSUED FOR REVIEW	VIP	GT	GT	BSM	BSM			
B	29.01.19	ISSUED FOR TENDER	KM	BW	MD	BSM	BSM			
A	23.10.18	ISSUED FOR CLIENT REVIEW	KM	VIP	MD	BSM	BSM			

A1 SHEET SCALE

OneWay™ empowered | enabled | ethical

WORLEYPARSONS PROJECT No. 301015-02681

ENGINEERING AND PERMIT STAMPS (As Required)

INFORMATION ONLY NOT TO BE USED FOR CONSTRUCTION

CUSTOMER

FRASERS PROPERTY

Shellharbour CITY COUNCIL

Advisian Worley Group

SHELL COVE BOATHARBOUR

DUNE REHABILITATION SAND PLACEMENT AND SEQUENCING PLAN

DRG No 301015-02681-MA-DWG-0130 REV E

WORLEYPARSONS_A1_REV2

LOCATION: \\AUSTDWPDFS01V\AUSTD\WORLEY_INFRASTRUCTURE\PROJECTS\301015\02681 SHELL COVE BOATHARBOUR STAGE 2\12.0 DRAWINGS\DRGS\BREAKWATER\301015-02681-MA-DWG-0130+0135+0136+0137_BB.DWG

USER NAME: brendon.boyle

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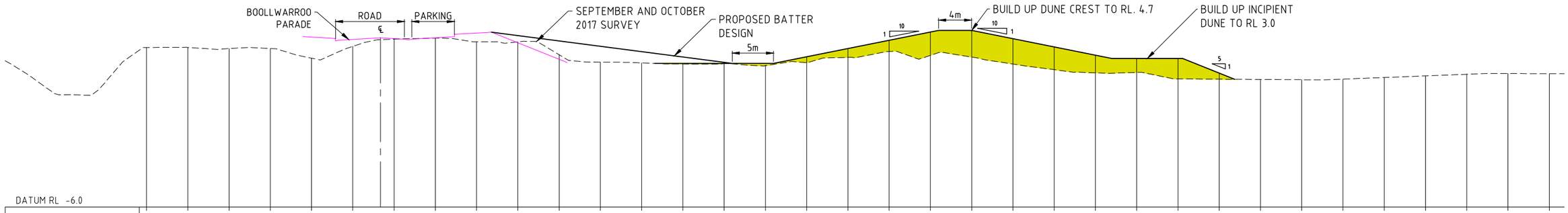
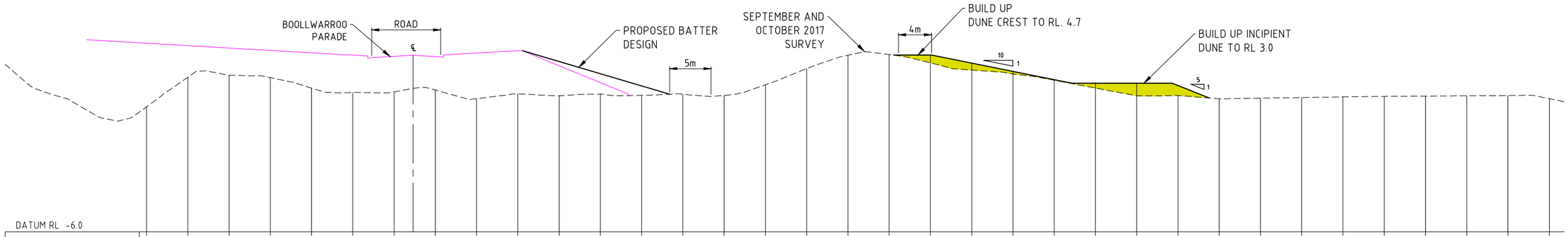


DATUM RL -6.0

CHAINAGE	DESIGN LEVEL	ISC00223 Design	SURVEY SEPT/OCT'17	DEPTH
0.00			3.67	
5.00			3.67	
10.00			3.61	
15.00			3.61	
20.00		4.30	3.02	
25.00		4.16	3.74	
30.00		4.21	4.17	
35.00		4.26	4.23	
40.00		4.55	4.01	
45.00		3.96	4.01	
50.00		2.96	3.23	
55.00			2.78	
60.00			2.73	
65.00			2.67	
70.00			2.69	
75.00	2.60		2.57	0.03
80.00	3.10		2.75	0.35
85.00	3.60		3.07	0.53
90.00	4.10		3.43	0.67
95.00	4.60		3.19	1.41
100.00	4.70		3.09	1.61
105.00	4.20		2.67	1.53
110.00	3.70		2.32	1.38
115.00	3.20		2.13	1.07
120.00	3.00		2.16	0.84
125.00	3.00		1.77	1.23
130.00	2.12		1.75	0.37
135.00			1.73	
140.00			1.72	
145.00			1.75	
150.00			1.85	
155.00			1.95	
160.00			2.04	
165.00			2.09	
170.00			2.08	

SECTION SD02

SCALE HORIZONTAL 1:250
SCALE VERTICAL 1:125



DATUM RL -6.0

CHAINAGE	DESIGN LEVEL	ISC00223 Design	SURVEY SEPT/OCT'17	DEPTH
0.00		5.42	1.57	
5.00		5.27	3.36	
10.00		5.13	3.48	
15.00		4.98	3.33	
20.00		4.84	2.70	
25.00		4.70	2.43	
30.00		4.62	2.47	
35.00		4.61	2.59	
40.00		4.82	2.06	
45.00		4.95	2.36	
50.00		4.06	2.24	
55.00		3.03	2.34	
60.00			2.26	
65.00			2.33	
70.00			2.26	
75.00			2.90	
80.00			3.89	
85.00			4.69	
90.00			4.74	
95.00	4.70		4.23	0.47
100.00	4.21		3.79	0.42
105.00	3.71		3.56	0.15
110.00	3.21		3.18	0.03
115.00	3.00		2.71	0.29
120.00	3.00		2.24	0.76
125.00	2.86		2.26	0.60
130.00			2.06	
135.00			2.09	
140.00			2.13	
145.00			2.17	
150.00			2.20	
155.00			2.22	
160.00			2.24	
165.00			2.26	
170.00			2.06	

SECTION SD01

SCALE HORIZONTAL 1:250
SCALE VERTICAL 1:125

NOTES:-

1. ALL LEVELS IN METERS TO AUSTRALIAN HEIGHT DATUM (AHD).
2. SURVEY UNDERTAKEN BY COASTWIDE CIVIL SEPTEMBER/OCTOBER 2017 AND APRIL 2020.
3. VEGETATION NOT SHOWN.
4. PROPOSED DUNE AND BEACH PROFILES TO BE COMPARED TO, AND CONFIRMED WITH, LATEST SURVEY PRIOR TO COMMENCING WORK.
5. SAND PLACEMENT PLAN SHOWN ON DRAWING 301015-02681-MA-DWG-0130.
6. ROAD DESIGN, NORTH OF ACCESS CHANNEL, TAKEN FROM DRAWING "ACAD-ISC00223-00-SK003-MODEL-200626'. SUPPLIED 02.07.2020.

LEGEND:

SAND PLACEMENT AREA

2.5 0 2.5 5 7.5 10 12.5m
VERTICAL SCALE 1:125 (A1) 1:250 (A3)

5 0 5 10 15 20 25m
HORIZONTAL SCALE 1:250 (A1) 1:500 (A3)

REV	DATE	REVISION DESCRIPTION	DRAWN	DRAFT CHK	DESIGNED	ENG CHK	APPROVED	CUSTOMER	REF DRAWING No	REFERENCE DRAWING TITLE
D	07.07.20	REVISED ROAD DESIGN ADDED	BB	GT	GT	BSM	BSM			
C	29.05.20	REVISED SAND PLACEMENT AND NEW ROAD LOCATIONS	BB	VIP	GT	BSM	BSM			
B	29.01.19	ISSUED FOR TENDER	KM	BW	MD	BSM	BSM			
A	23.10.18	ISSUED FOR CLIENT REVIEW	KM	VIP	MD	BSM	BSM			

A1 SHEET SCALE

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WORLEYPARSONS PROJECT No.
301015-02681

ENGINEERING AND PERMIT STAMPS (As Required)

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Shellharbour CITY COUNCIL

Advisian Worley Group

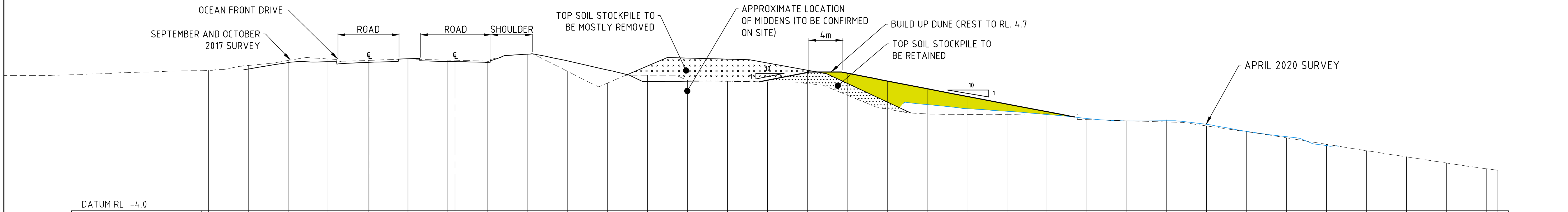
SHELL COVE BOATHARBOUR

DUNE REHABILITATION
SECTIONS SD01 AND SD02

DRG No 301015-02681-MA-DWG-0135
REV D

WORLEYPARSONS_A1_REV2

LOCATION: \\AUSTDWPDFS01VVAU\STDWORLEY_INFRASTRUCTURE\PROJECTS\301015\02681 SHELL COVE BOATHARBOUR STAGE 2\12.0 DRAWINGS\DRGS\BREAKWATER\301015-02681-MA-DWG-0130-0135-0136-0137_BB.DWG
USER NAME: brendon.boyle
PLOT DATE & TIME: 7/7/2020 7:39:18 AM
SAVE DATE & TIME: 6/7/2020 5:47:22 PM



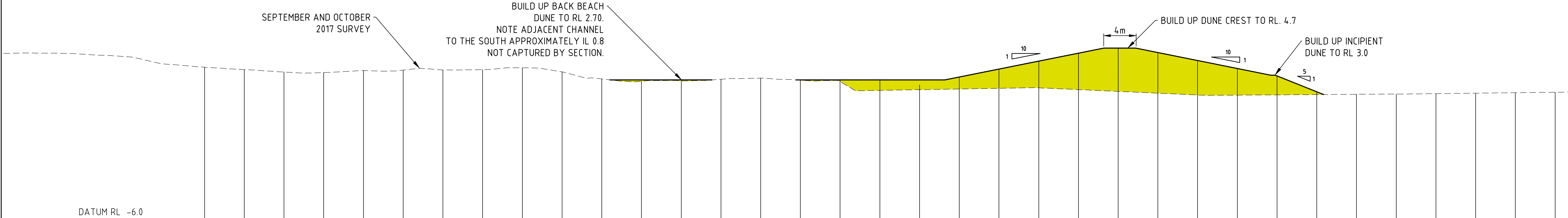
	0.00	5.00	10.00	15.00	20.00	25.00	30.00	35.00	40.00	45.00	50.00
DESIGN LEVEL											
SURVEY APR'20											
SURVEY SEPT/OCT'17	4.80	5.12	5.43	5.52	5.43	5.52	5.45	5.37	5.83	4.74	4.02
DEPTH											
CHAINAGE	0.00	5.00	10.00	15.00	20.00	25.00	30.00	35.00	40.00	45.00	50.00

	55.00	60.00	65.00	70.00	75.00	80.00	85.00	90.00	95.00	100.00	105.00	110.00
DESIGN LEVEL												
SURVEY APR'20								2.66	2.41	2.24	2.04	1.79
SURVEY SEPT/OCT'17	4.50	4.17	4.12	4.09	3.99	3.25	2.38	2.07	2.04	2.04	2.08	1.72
DEPTH												
CHAINAGE	55.00	60.00	65.00	70.00	75.00	80.00	85.00	90.00	95.00	100.00	105.00	110.00

	115.00	120.00	125.00	130.00	135.00	140.00	145.00	150.00	155.00	160.00	161.46
DESIGN LEVEL											
SURVEY APR'20	1.63	1.64	1.42	0.98	0.64	0.09					
SURVEY SEPT/OCT'17	1.64	1.57	1.32	0.96	0.57	0.17	-0.24	-0.62	-1.01	-1.37	-1.47
DEPTH											
CHAINAGE	115.00	120.00	125.00	130.00	135.00	140.00	145.00	150.00	155.00	160.00	161.46

SECTION SD04

SCALE HORIZONTAL 1:250
SCALE VERTICAL 1:125



	0.00	5.00	10.00	15.00	20.00	25.00	30.00	35.00	40.00	45.00	50.00
DESIGN LEVEL											
SURVEY SEPT/OCT'17	3.50	3.35	3.20	3.16	3.29	3.32	3.32	3.34	3.46	3.20	2.76
DEPTH											
CHAINAGE	0.00	5.00	10.00	15.00	20.00	25.00	30.00	35.00	40.00	45.00	50.00

	55.00	60.00	65.00	70.00	75.00	80.00	85.00	90.00	95.00	100.00	105.00	110.00
DESIGN LEVEL	2.70	2.70			2.70	2.70	2.70	2.38	2.88	3.38	3.88	4.38
SURVEY SEPT/OCT'17	2.61	2.63	2.74	2.81	2.68	2.59	2.04	2.09	2.13	2.17	2.20	2.09
DEPTH	0.09	0.07			0.02	0.11	0.68	0.29	0.79	1.21	1.68	2.29
CHAINAGE	55.00	60.00	65.00	70.00	75.00	80.00	85.00	90.00	95.00	100.00	105.00	110.00

	115.00	120.00	125.00	130.00	135.00	140.00	145.00	150.00	155.00	160.00	165.00	170.00
DESIGN LEVEL	4.70	4.42	3.92	3.42	2.95	1.95						
SURVEY SEPT/OCT'17	1.98	1.86	1.75	1.74	1.76	1.78	1.79	1.81	1.83	1.86	1.89	1.92
DEPTH	2.72	2.58	2.17	1.68	1.19	1.17						
CHAINAGE	115.00	120.00	125.00	130.00	135.00	140.00	145.00	150.00	155.00	160.00	165.00	170.00

SECTION SD03

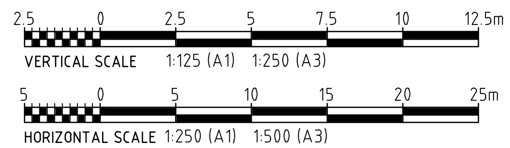
SCALE HORIZONTAL 1:250
SCALE VERTICAL 1:125

NOTES:-

1. ALL LEVELS IN METERS TO AUSTRALIAN HEIGHT DATUM (AHD).
2. SURVEY UNDERTAKEN BY COASTWIDE CIVIL SEPTEMBER/OCTOBER 2017 AND APRIL 2020.
3. VEGETATION NOT SHOWN.
4. PROPOSED DUNE AND BEACH PROFILES TO BE COMPARED TO, AND CONFIRMED WITH, LATEST SURVEY PRIOR TO COMMENCING WORK.
5. SAND PLACEMENT PLAN SHOWN ON DRAWING 301015-02681-MA-DWG-0130.

LEGEND:

SAND PLACEMENT AREA



REV	DATE	REVISION DESCRIPTION	DRAWN	DRAFT CHK	DESIGNED	ENG CHK	APPROVED	CUSTOMER
D	06.07.20	REVISED ROAD DESIGN ADDED	BB	GT	GT	BSM	BSM	
C	29.05.20	REVISED SAND PLACEMENT AND NEW ROAD LOCATIONS	BB	VIP	GT	BSM	BSM	
B	29.01.19	ISSUED FOR TENDER	KM	BW	MD	BSM	BSM	
A	23.10.18	ISSUED FOR CLIENT REVIEW	KM	VIP	MD	BSM	BSM	

REF DRAWING No	REFERENCE DRAWING TITLE

A1 SHEET SCALE

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WORLEYPARSONS PROJECT No. 301015-02681

ENGINEERING AND PERMIT STAMPS (As Required)

INFORMATION ONLY NOT TO BE USED FOR CONSTRUCTION

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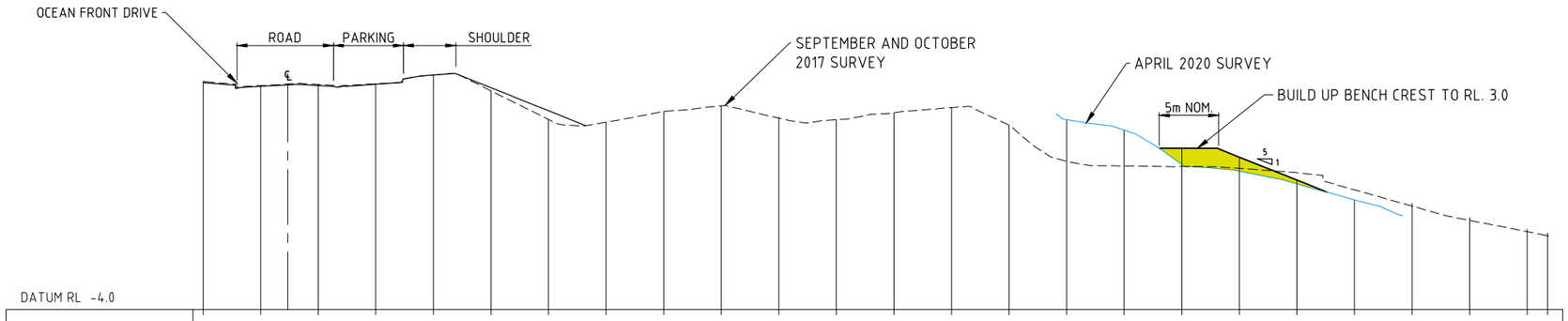
Advisian Worley Group

SHELL COVE BOATHARBOUR

DUNE REHABILITATION PROFILE SD03 & SD04

DRG No 301015-02681-MA-DWG-0136 REV D

LOCATION: \\AUSYDWPDFS01V\AU\SYD\WORLEY_INFRASTRUCTURE\PROJECTS\301015\02681 SHELL COVE BOATHARBOUR STAGE 2\12.0 DRAWINGS\DRGS\BREAKWATER\301015-02681-MA-DWG-0130+0135+0136+0137_BB.DWG
USER NAME: brendon.boyle
PLOT DATE & TIME: 6/7/2020 5:38:09 PM
SAVE DATE & TIME: 6/7/2020 5:35:56 PM

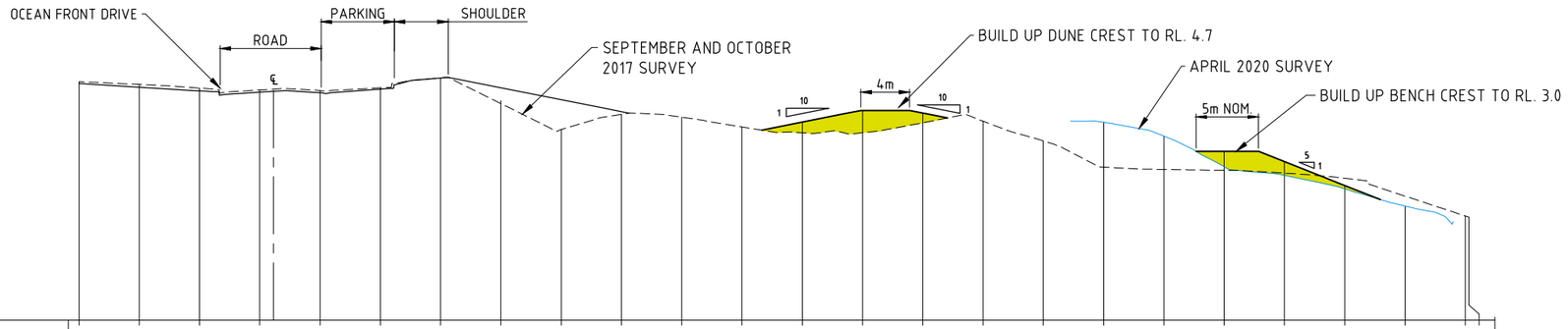


DATUM RL -4.0

DESIGN LEVEL																			3.00	2.62	1.62					
SURVEY APR'20																4.24	3.79	2.30	2.01	1.46	0.76					
SURVEY SEPT/OCT'17	5.89	5.72	5.77	5.80	6.19	5.47	4.23	4.14	4.60	4.85	4.30	4.24	4.55	4.78	3.97	2.42	2.23	2.20	2.12	1.94	1.18	0.48	-0.14	-0.63	-0.80	
DEPTH																		0.70	0.61	0.16						
CHAINAGE	0.00	5.00	10.00	15.00	20.00	25.00	30.00	35.00	40.00	45.00	50.00	55.00	60.00	65.00	70.00	75.00	80.00	85.00	90.00	95.00	100.00	105.00	110.00	115.00	116.77	

SECTION SD06

SCALE HORIZONTAL 1:250
SCALE VERTICAL 1:125



DATUM RL -4.0

DESIGN LEVEL													4.22	4.70	4.59					3.00	2.57	1.59				
SURVEY APR'20																		4.21	3.64	2.36	2.01	1.45	0.73			
SURVEY SEPT/OCT'17	5.89	5.78	5.62	5.55	5.53	5.64	6.04	4.99	3.91	4.54	4.42	4.02	3.77	3.77	4.19	4.25	3.43	2.34	2.25	2.22	2.10	1.88	1.14	0.32	0.27	
DEPTH													0.45	0.93	0.40					0.64	0.56	0.14				
CHAINAGE	0.00	5.00	10.00	15.00	20.00	25.00	30.00	35.00	40.00	45.00	50.00	55.00	60.00	65.00	70.00	75.00	80.00	85.00	90.00	95.00	100.00	105.00	110.00	115.00	115.30	

SECTION SD05

SCALE HORIZONTAL 1:250
SCALE VERTICAL 1:125

2.5 0 2.5 5 7.5 10 12.5m
VERTICAL SCALE 1:125 (A1) 1:250 (A3)

5 0 5 10 15 20 25m
HORIZONTAL SCALE 1:250 (A1) 1:500 (A3)

NOTES:-

1. ALL LEVELS IN METERS TO AUSTRALIAN HEIGHT DATUM (AHD).
2. SURVEY UNDERTAKEN BY COASTWIDE CIVIL SEPTEMBER/OCTOBER 2017 AND APRIL 2020.
3. VEGETATION NOT SHOWN.
4. PROPOSED DUNE AND BEACH PROFILES TO BE COMPARED TO, AND CONFIRMED WITH, LATEST SURVEY PRIOR TO COMMENCING WORK.
5. SAND PLACEMENT PLAN SHOWN ON DRAWING 301015-02681-MA-DWG-0130.

LEGEND:

SAND PLACEMENT AREA

REV	DATE	REVISION DESCRIPTION	DRAWN	DRAFT CHK	DESIGNED	ENG CHK	APPROVED	CUSTOMER	REF DRAWING No	REFERENCE DRAWING TITLE
C	29.05.20	REVISED SAND PLACEMENT AND NEW ROAD LOCATIONS	BB	VIP	GT	BSM	BSM			
B	29.01.19	ISSUED FOR TENDER	KM	BW	MD	BSM	BSM			
A	23.10.18	ISSUED FOR CLIENT REVIEW	KM	VIP	MD	BSM	BSM			

A1 SHEET SCALE

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WORLEYPARSONS PROJECT No.
301015-02681

ENGINEERING AND PERMIT STAMPS (As Required)

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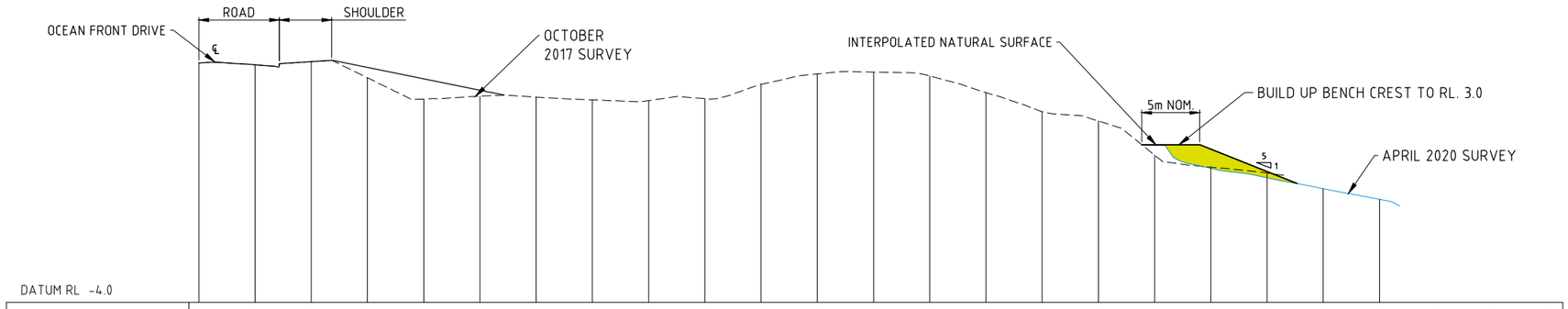
SHELL COVE BOATHARBOUR

DUNE REHABILITATION
PROFILE SD05 & SD06

DRG No 301015-02681-MA-DWG-0137
REV C

WORLEYPARSONS_A1_REV2

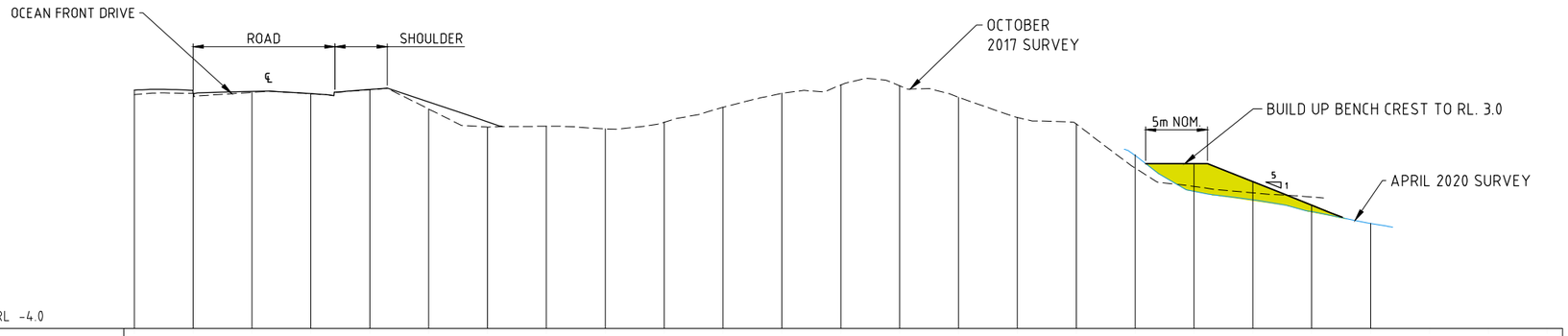


DATUM RL -4.0

CHAINAGE	0.00	5.00	10.00	15.00	20.00	25.00	30.00	35.00	40.00	45.00	50.00	55.00	60.00	65.00	70.00	75.00	80.00	85.00	90.00	95.00	100.00	105.00	110.00	115.00	120.00
DESIGN LEVEL																		3.00	2.81	1.81					
SURVEY APR'20																			1.96	1.54	1.05	0.58			
SURVEY OCT'17	6.64	6.56	6.70	5.98	5.03	5.16	5.12	5.00	4.97	5.05	5.68	6.15	6.23	6.06	5.31	4.47	4.06	2.54	2.01	1.74					
DEPTH																		0.46	0.85	0.27					

SECTION SD08

SCALE HORIZONTAL 1:250
SCALE VERTICAL 1:125



DATUM RL -4.0

CHAINAGE	0.00	5.00	10.00	15.00	20.00	25.00	30.00	35.00	40.00	45.00	50.00	55.00	60.00	65.00	70.00	75.00	80.00	85.00	90.00	95.00	100.00	105.00	110.00	115.00	120.00
DESIGN LEVEL																			3.00	2.23	1.23				
SURVEY APR'20																		3.34	1.83	1.46	0.96	0.46			
SURVEY OCT'17	5.93	5.98	6.02	5.96	6.14	5.32	4.55	4.58	4.48	4.75	5.39	5.99	6.34	6.30	5.82	4.96	4.68	2.81	2.03	1.76	1.58				
DEPTH																			1.17	0.77	0.27				

SECTION SD07

SCALE HORIZONTAL 1:250
SCALE VERTICAL 1:125

2.5 0 2.5 5 7.5 10 12.5m
VERTICAL SCALE 1:125 (A1) 1:250 (A3)

5 0 5 10 15 20 25m
HORIZONTAL SCALE 1:250 (A1) 1:500 (A3)

NOTES:-

1. ALL LEVELS IN METERS TO AUSTRALIAN HEIGHT DATUM (AHD).
2. SURVEY UNDERTAKEN BY COASTWIDE CIVIL SEPTEMBER/OCTOBER 2017 AND APRIL 2020.
3. VEGETATION NOT SHOWN.
4. PROPOSED DUNE AND BEACH PROFILES TO BE COMPARED TO, AND CONFIRMED WITH, LATEST SURVEY PRIOR TO COMMENCING WORK.
5. SAND PLACEMENT PLAN SHOWN ON DRAWING 301015-02681-MA-DWG-0130.

LEGEND:

SAND PLACEMENT AREA

REV	DATE	REVISION DESCRIPTION	DRAWN	DRAFT CHK	DESIGNED	ENG CHK	APPROVED	CUSTOMER	REF DRAWING No	REFERENCE DRAWING TITLE
A	29.05.20	REVISED SAND PLACEMENT AND NEW ROAD LOCATIONS	BB	VIP	GT	BSM	BSM			

A1 SHEET SCALE

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WORLEYPARSONS PROJECT No.
301015-02681

ENGINEERING AND PERMIT STAMPS (As Required)

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Advisian Worley Group

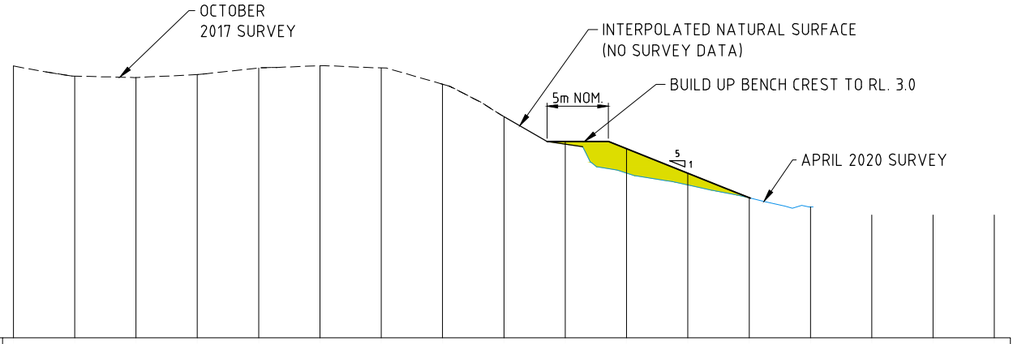
SHELL COVE BOATHARBOUR

DUNE REHABILITATION
PROFILE SD07 & SD08

DRG No 301015-02681-MA-DWG-0138
REV A

WORLEYPARSONS_A1_REV2

LOCATION: \\AUSTDWPDFS01V\AUSTD\WORLEY_INFRASTRUCTURE\PROJECTS\301015\02681 SHELL COVE BOATHARBOUR STAGE 2\12.0 DRAWINGS\DRGS\BREAKWATER\301015-02681-MA-DWG-0130-0135+0138+0137.DWG
USER NAME: brendon.boyle
PLOT DATE & TIME: 29/5/2020 2:32:01 PM
SAVE DATE & TIME: 29/5/2020 12:41:27 PM



DATUM RL -5.0

DESIGN LEVEL									3.00	2.71	1.71	0.71						
SURVEY APR'20										1.71	1.23	0.70	0.33					
SURVEY OCT'17	6.07	5.65	5.60	5.72	5.99	6.08	5.99	5.33	4.01									
DEPTH										1.00	0.48	0.01						
CHAINAGE	0.00	5.00	10.00	15.00	20.00	25.00	30.00	35.00	40.00	45.00	50.00	55.00	60.00	65.00	70.00	75.00	80.00	

SECTION SD09

SCALE HORIZONTAL 1:250
SCALE VERTICAL 1:125

2.5 0 2.5 5 7.5 10 12.5m

VERTICAL SCALE 1:125 (A1) 1:250 (A3)

5 0 5 10 15 20 25m

HORIZONTAL SCALE 1:250 (A1) 1:500 (A3)

NOTES:-

1. ALL LEVELS IN METERS TO AUSTRALIAN HEIGHT DATUM (AHD).
2. SURVEY UNDERTAKEN BY COASTWIDE CIVIL SEPTEMBER/OCTOBER 2017 AND APRIL 2020.
3. VEGETATION NOT SHOWN.
4. PROPOSED DUNE AND BEACH PROFILES TO BE COMPARED TO, AND CONFIRMED WITH, LATEST SURVEY PRIOR TO COMMENCING WORK.
5. SAND PLACEMENT PLAN SHOWN ON DRAWING 301015-02681-MA-DWG-0130.

LEGEND:

SAND PLACEMENT AREA

REV	DATE	REVISION DESCRIPTION	DRAWN	DRAFT CHK	DESIGNED	ENG CHK	APPROVED	CUSTOMER	REF DRAWING No	REFERENCE DRAWING TITLE
A	29.05.20	REVISED SAND PLACEMENT AND NEW ROAD LOCATIONS	BB	VIP	GT	BSM	BSM			

A1 SHEET SCALE

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WORLEYPARSONS PROJECT No.
301015-02681

ENGINEERING AND PERMIT STAMPS (As Required)

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SHELL COVE BOATHARBOUR

DUNE REHABILITATION
PROFILE SD09

DRG No 301015-02681-MA-DWG-0139

REV A

WORLEYPARSONS_A1_REV2

LOCATION: \\AUSTYDWPDFS01V\AUSTYD\WORLEY_INFRASTRUCTURE\PROJECTS\301015\02681 SHELL COVE BOATHARBOUR STAGE 2\12.0 DRAWINGS\DRGS\BREAKWATER\301015-02681-MA-DWG-0130+0135+0136+0137.DWG
USER NAME: brendon.boyle
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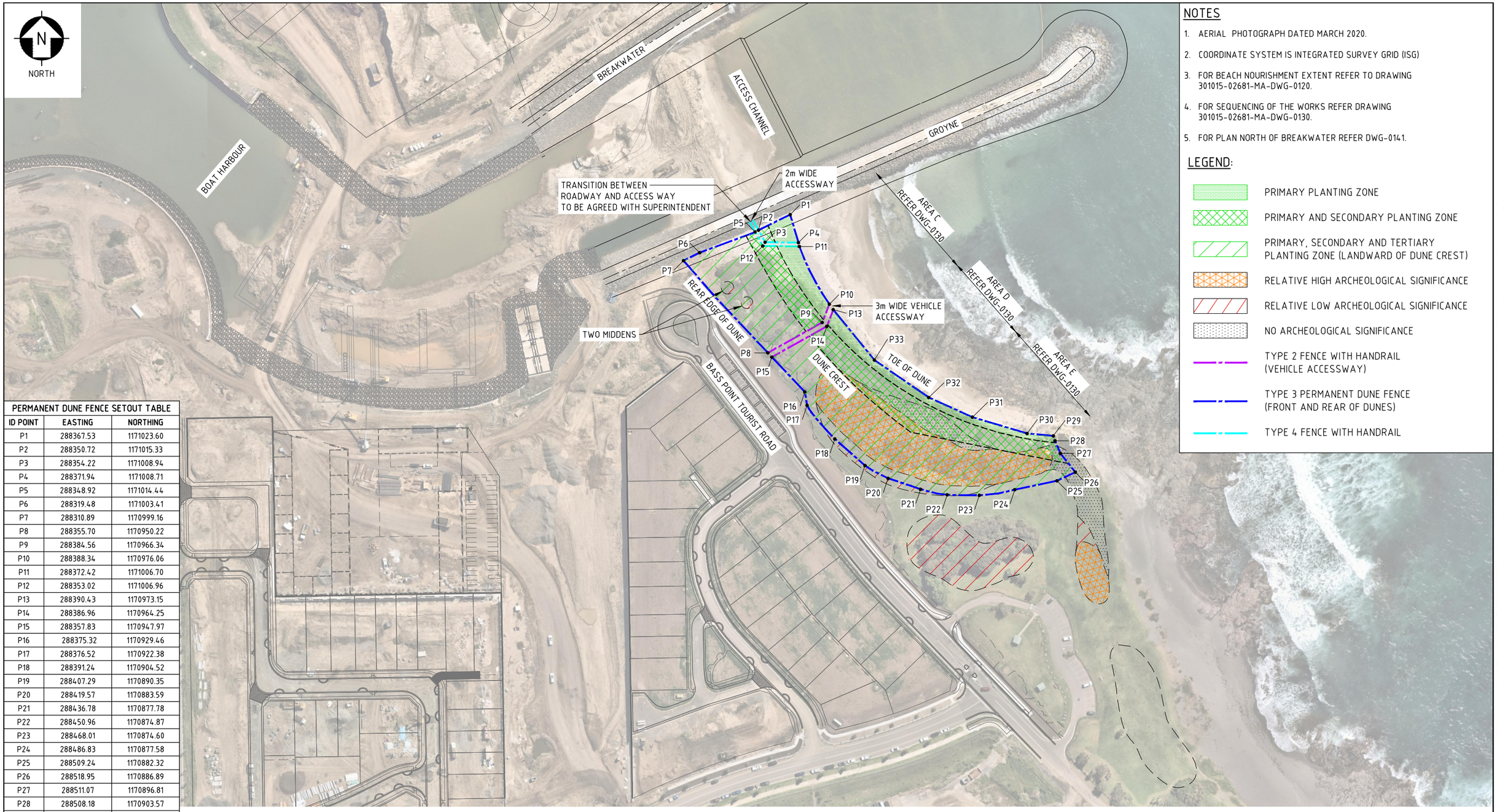


NOTES

1. AERIAL PHOTOGRAPH DATED MARCH 2020.
2. COORDINATE SYSTEM IS INTEGRATED SURVEY GRID (ISG)
3. FOR BEACH NOURISHMENT EXTENT REFER TO DRAWING 301015-02681-MA-DWG-0120.
4. FOR SEQUENCING OF THE WORKS REFER DRAWING 301015-02681-MA-DWG-0130.
5. FOR PLAN NORTH OF BREAKWATER REFER DWG-0141.

LEGEND:

- PRIMARY PLANTING ZONE
- PRIMARY AND SECONDARY PLANTING ZONE
- PRIMARY, SECONDARY AND TERTIARY PLANTING ZONE (LANDWARD OF DUNE CREST)
- RELATIVE HIGH ARCHEOLOGICAL SIGNIFICANCE
- RELATIVE LOW ARCHEOLOGICAL SIGNIFICANCE
- NO ARCHEOLOGICAL SIGNIFICANCE
- TYPE 2 FENCE WITH HANDRAIL (VEHICLE ACCESSWAY)
- TYPE 3 PERMANENT DUNE FENCE (FRONT AND REAR OF DUNES)
- TYPE 4 FENCE WITH HANDRAIL

PERMANENT DUNE FENCE SETOUT TABLE

ID POINT	EASTING	NORTHING
P1	288367.53	1171023.60
P2	288350.72	1171015.33
P3	288354.22	1171008.94
P4	288371.94	1171008.71
P5	288348.92	1171014.44
P6	288319.48	1171003.41
P7	288310.89	1170999.16
P8	288355.70	1170950.22
P9	288384.56	1170966.34
P10	288388.34	1170976.06
P11	288372.42	1171006.70
P12	288353.02	1171006.96
P13	288390.43	1170973.15
P14	288386.96	1170964.25
P15	288357.83	1170947.97
P16	288375.32	1170929.46
P17	288376.52	1170922.38
P18	288391.24	1170904.52
P19	288407.29	1170890.35
P20	288419.57	1170883.59
P21	288436.78	1170877.78
P22	288450.96	1170874.87
P23	288468.01	1170874.60
P24	288486.83	1170877.58
P25	288509.24	1170882.32
P26	288518.95	1170886.89
P27	288511.07	1170896.81
P28	288508.18	1170903.57
P29	288507.25	1170906.14
P30	288493.37	1170907.41
P31	288464.30	1170916.08
P32	288441.15	1170926.50
P33	288412.26	1170946.38

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

REV	DATE	REVISION DESCRIPTION	DRAWN	DRAFT CHK	DESIGNED	ENG CHK	APPROVED	CUSTOMER	REF DRAWING No	REFERENCE DRAWING TITLE
F	07.07.20	PERMANENT DUNE FENCE AMENDED	BB	GT	GT	BSM	BSM			
E	30.06.20	ACCESSWAYS LOCATIONS REVISED, POINT NUMBERS REVISED	VIP	GT	GT	BSM	BSM			
D	01.05.20	ISSUED FOR TENDER	VIP	GT	GT	BSM	BSM			
C	24.04.20	ISSUED FOR TENDER	VIP	GT	GT	BSM	BSM			
B	29.01.19	ISSUED FOR TENDER	KM	BW	MD	BSM	BSM			
A	23.10.18	ISSUED FOR REVIEW	KM	VIP	MD	BSM	BSM			

A1 SHEET SCALE

OneWay™ empowered | enabled | ethical

WORLEYPARSONS PROJECT No. 301015-02681

ENGINEERING AND PERMIT STAMPS (As Required)

ISSUED FOR TENDER

CUSTOMER

FRASERS PROPERTY

Shellharbour CITY COUNCIL

Advisian Worley Group

SHELL COVE BOATHARBOUR DUNE REHABILITATION VEGETATION AND FENCING PLAN SOUTH OF GROYNE

DRG No 301015-02681-MA-DWG-0140

REV F

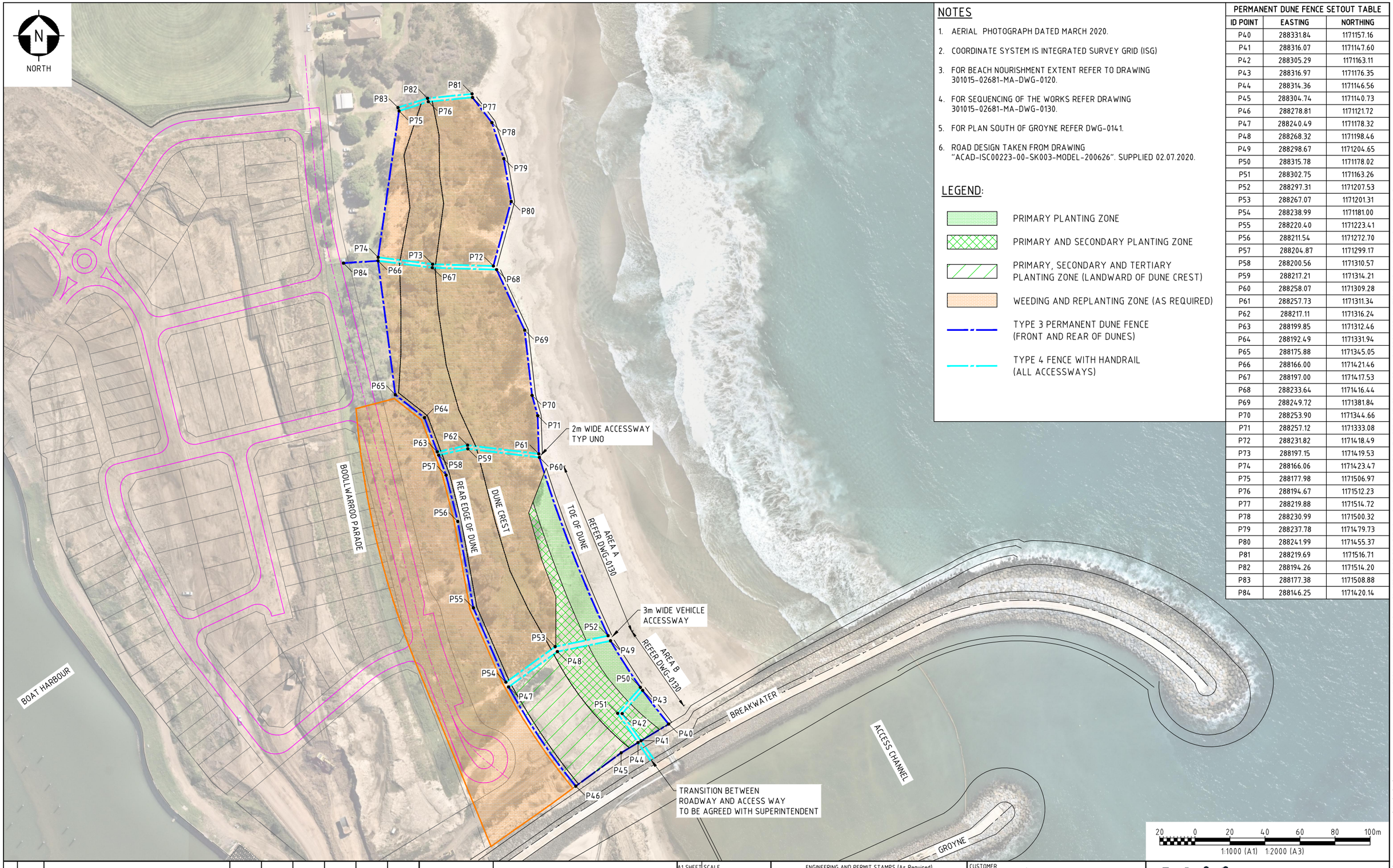
WORLEYPARSONS_A1_REV2

LOCATION: \\AUSYDWPDFS01V\AUSYD\WORLEY_INFRASTRUCTURE\PROJECTS\301015\02681 SHELL COVE BOATHARBOUR STAGE 2\12.0 DRAWINGS\DRGS\BREAKWATER\301015-02681-MA-DWG-0140-0141.DWG

USER NAME: brendon.boyle

PLOT DATE & TIME: 7/7/2020 2:29:44 PM

SAVE DATE & TIME: 7/7/2020 1:57:15 PM



NOTES

1. AERIAL PHOTOGRAPH DATED MARCH 2020.
2. COORDINATE SYSTEM IS INTEGRATED SURVEY GRID (ISG)
3. FOR BEACH NOURISHMENT EXTENT REFER TO DRAWING 301015-02681-MA-DWG-0120.
4. FOR SEQUENCING OF THE WORKS REFER DRAWING 301015-02681-MA-DWG-0130.
5. FOR PLAN SOUTH OF GROYNE REFER DWG-0141.
6. ROAD DESIGN TAKEN FROM DRAWING "ACAD-ISC00223-00-SK003-MODEL-200626". SUPPLIED 02.07.2020.

LEGEND:

- PRIMARY PLANTING ZONE
- PRIMARY AND SECONDARY PLANTING ZONE
- PRIMARY, SECONDARY AND TERTIARY PLANTING ZONE (LANDWARD OF DUNE CREST)
- WEEDING AND REPLANTING ZONE (AS REQUIRED)
- TYPE 3 PERMANENT DUNE FENCE (FRONT AND REAR OF DUNES)
- TYPE 4 FENCE WITH HANDRAIL (ALL ACCESSWAYS)

PERMANENT DUNE FENCE SETOUT TABLE

ID POINT	EASTING	NORTHING
P40	288331.84	1171157.16
P41	288316.07	1171147.60
P42	288305.29	1171163.11
P43	288316.97	1171176.35
P44	288314.36	1171146.56
P45	288304.74	1171140.73
P46	288278.81	1171121.72
P47	288240.49	1171178.32
P48	288268.32	1171198.46
P49	288298.67	1171204.65
P50	288315.78	1171178.02
P51	288302.75	1171163.26
P52	288297.31	1171207.53
P53	288267.07	1171201.31
P54	288238.99	1171181.00
P55	288220.40	1171223.41
P56	288211.54	1171272.70
P57	288204.87	1171299.17
P58	288200.56	1171310.57
P59	288217.21	1171314.21
P60	288258.07	1171309.28
P61	288257.73	1171311.34
P62	288217.11	1171316.24
P63	288199.85	1171312.46
P64	288192.49	1171331.94
P65	288175.88	1171345.05
P66	288166.00	1171421.46
P67	288197.00	1171417.53
P68	288233.64	1171416.44
P69	288249.72	1171381.84
P70	288253.90	1171344.66
P71	288257.12	1171333.08
P72	288231.82	1171418.49
P73	288197.15	1171419.53
P74	288166.06	1171423.47
P75	288177.98	1171506.97
P76	288194.67	1171512.23
P77	288219.88	1171514.72
P78	288230.99	1171500.32
P79	288237.78	1171479.73
P80	288241.99	1171455.37
P81	288219.69	1171516.71
P82	288194.26	1171514.20
P83	288177.38	1171508.88
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REV	DATE	REVISION DESCRIPTION	DRAWN	DRAFT CHK	DESIGNED	ENG CHK	APPROVED	CUSTOMER	REF DRAWING No	REFERENCE DRAWING TITLE
C	07.07.20	REVISED ROAD DESIGN ADDED	BB	GT	GT	BSM	BSM			
B	30.06.20	TYP 2 DUNE FENCE ADDED, POINT NUMBERS REVISED	VIP	GT	GT	BSM	BSM			
A	24.04.20	ISSUED FOR TENDER	VIP	GT	GT	BSM	BSM			

A1 SHEET SCALE

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WORLEYPARSONS PROJECT No.
301015-02681

ENGINEERING AND PERMIT STAMPS (As Required)

ISSUED FOR TENDER

CUSTOMER

FRASERS PROPERTY

Shellharbour CITY COUNCIL

Advisian Worley Group

SHELL COVE BOATHARBOUR DUNE REHABILITATION VEGETATION AND FENCING PLAN NORTH OF BREAKWATER

DRG No 301015-02681-MA-DWG-0141

REV C

WORLEYPARSONS_A1_REV2

LOCATION \\AUSTDWPDFS01V\AUSTD\WORLEY_INFRASTRUCTURE\PROJECTS\301015\02681 SHELL COVE BOATHARBOUR STAGE 2\12.0 DRAWINGS\DRGS\BREAKWATER\301015-02681-MA-DWG-0140-0141.DWG

USER NAME brendon.boyle

PLOT DATE & TIME 7/7/2020 2:36:29 PM

SAVE DATE & TIME 7/7/2020 1:57:15 PM

TYPICAL BEACH NOURISHMENT PLACEMENT SECTION

NTS

LEGEND

- AREA AVAILABLE FOR BEACH NOURISHMENT
- APPROXIMATE DREDGE FOOTPRINT
- BOUNDARY OF STAGE 2 BOATHARBOUR DEVELOPMENT
- FUTURE ROADS (NOT PART OF THIS CONTRACT)

NOTES

1. AERIAL PHOTOGRAPH DATED JULY 2013.
2. BEACH AND DUNE LEVELS TO BE RAISED UP TO +3.0m AHD.
3. MATERIAL TO BE PLACED AND REWORKED LANDWARD OF THE MEAN HIGH WATER MARK.
4. REWORKED SIDE SLOPES TO BE NO STEEPER THAN 1:3.
5. SECONDARY DUNE VEGETATION IS NOT TO BE SMOTHERED
6. SETOUT TO BE CONFIRMED BY SUPERINTENDENT.

80 0 80 160 240 320 400m

1:4000 (A1) 1:8000 (A3)

REV	DATE	REVISION DESCRIPTION	DRAWN	DRAFT CHK	DESIGNED	ENG CHK	APPROVED	CUSTOMER	REF DRAWING No	REFERENCE DRAWING TITLE
0	30.05.16	ISSUED FOR CONSTRUCTION	EN	PBC	BSM	AFN	BSM			
A	13.05.16	ISSUED FOR CLIENT REVIEW	VIP	ARG	BSM	AFN	BSM			

A1 SHEET SCALE

OneWay to zero harm

WORLEYPARSONS PROJECT No. 301015-02681

ENGINEERING AND PERMIT STAMPS (As Required)

APPROVED FOR CONSTRUCTION

CUSTOMER

FRASERS PROPERTY SHELL COVE

WorleyParsons resources & energy

SHELL COVE BOATHARBOUR

DREDGE AND BEACH NOURISHMENT PLAN

DRG No 301015-02681-MA-DWG-0120 REV 0

WORLEYPARSONS_A1_REV2

LOCATION: W:_INFRASTRUCTURE\PROJECTS\301015\02681 SHELL COVE BOATHARBOUR STAGE 2\12.0 DRAWINGS\DRGS\BREAKWATER\301015-02681-MA-DWG-0120_A.DWG

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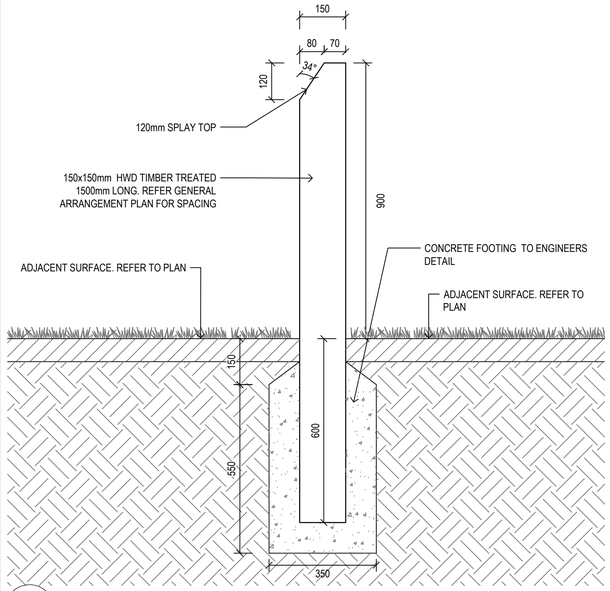
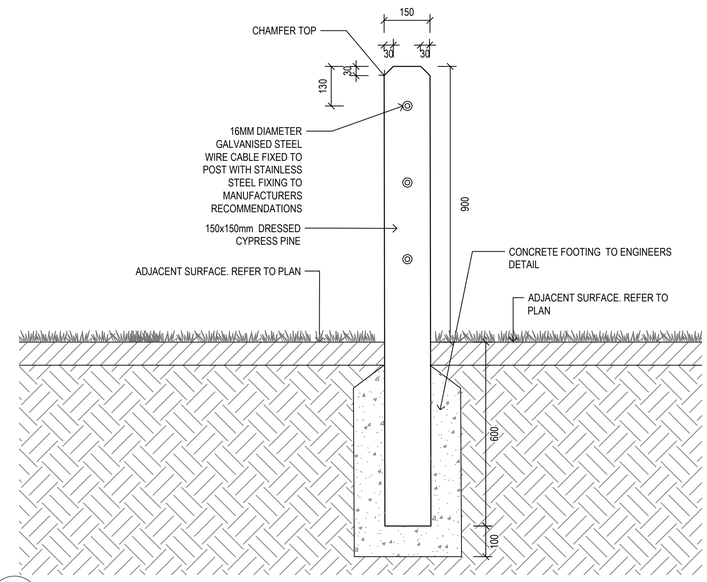
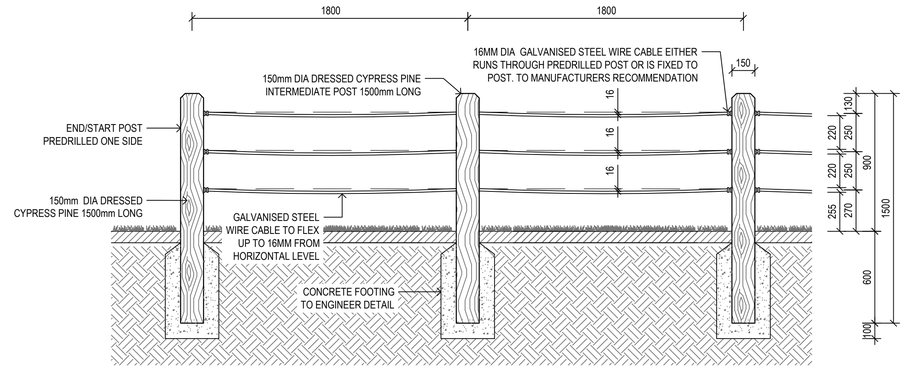
SAVE DATE & TIME: 30/5/2016 4:12:47 PM



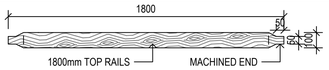
01 4006 TP-TIMBER BOLLARD
SCALE 1:10

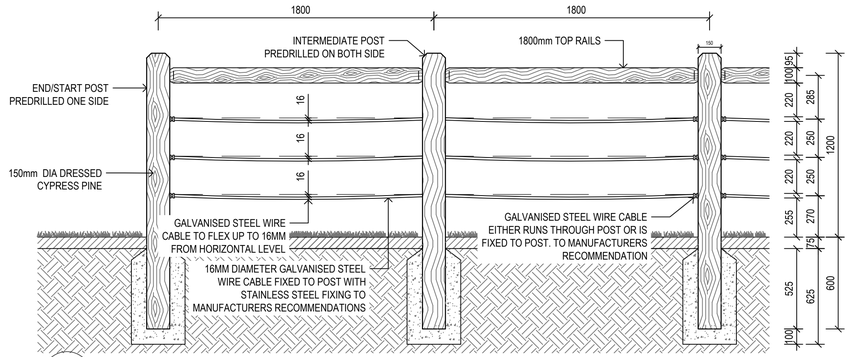


02 4006 TPW1-DUNE FENCE TYPE 1 - TIMBER POST WITH WIRE 16mm CABLE FENCE POST SIDE DETAIL
SCALE 1:10

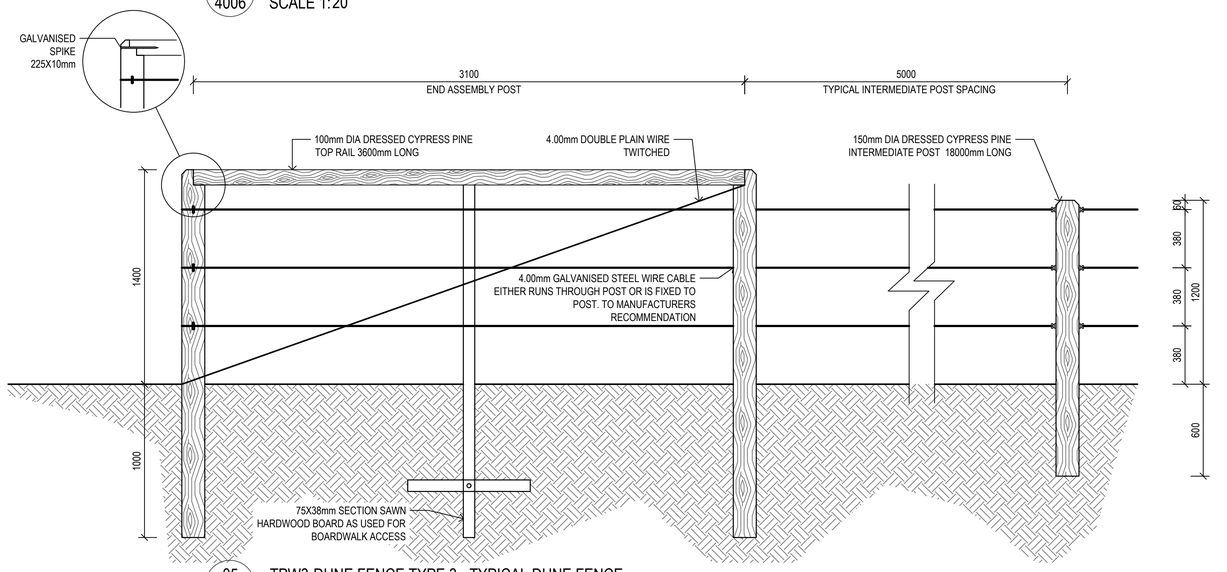


03 4006 TPW1-DUNE FENCE TYPE 1 - TIMBER POST WITH WIRE 16mm CABLE FENCE ELEVATION
SCALE 1:20

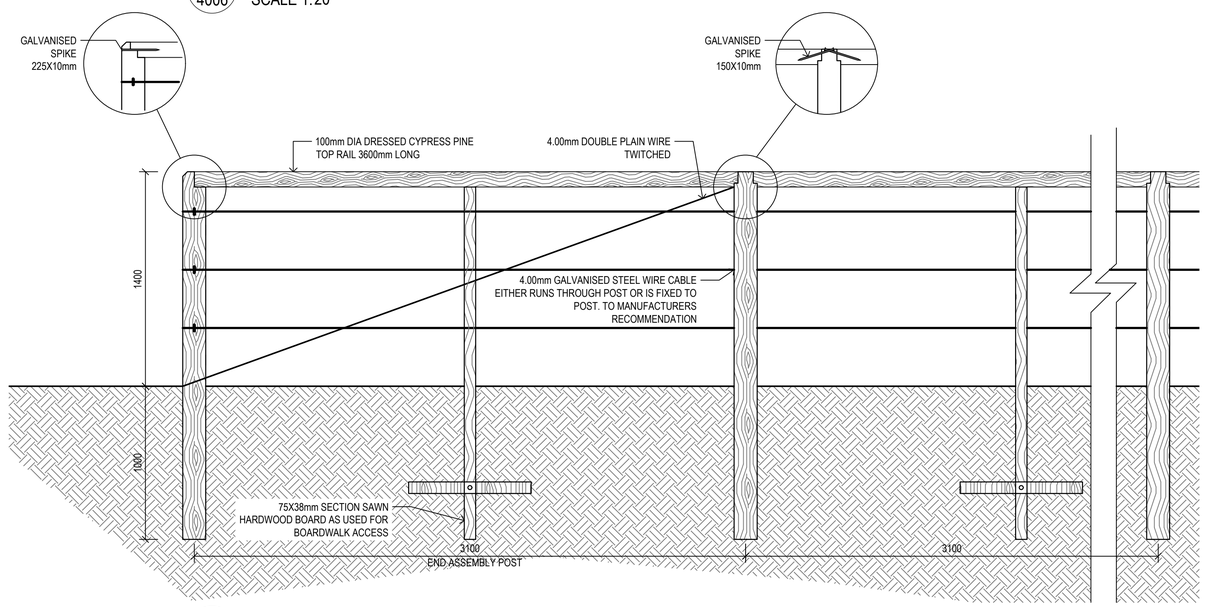




04 4006 TPW2-DUNE FENCE TYPE 2 - TIMBER POST AND TOP RAIL WITH WIRE 16mm CABLE FENCE ELEVATION
SCALE 1:20



05 4006 TPW3-DUNE FENCE TYPE 3 - TYPICAL DUNE FENCE
SCALE 1:20



06 4006 TPW4- DUNE FENCE TYPE 4 - TYPICAL DUNE FENCE WITH TIMBER TOP RAIL
SCALE 1:20

Amendments

Issue	Description	Date
A	PRELIMINARY CONSTRUCTION	31/03/2020

NOTE:
LANDSCAPE WORKS OUTSIDE THE EXTENT OF WORKS ARE INDICATIVE ONLY AND DO NOT FORM PART OF THIS SUBMISSION DRIVEWAY POSITIONS TO BE CONFIRMED DURING DESIGN DEVELOPMENT STAGE

TREE PLACEMENT TO PROPOSED SUPERLOTS SUBJECT TO FINAL LAYOUT AND APPROVAL OF SUBSEQUENT DA. INDICATIVE LAYOUT SHOWN.

Civil and Structual Engineer
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Shellharbour CITY COUNCIL

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Group GSA Pty Ltd ABN 76 002 113 779
Level 7, 80 William St East Sydney NSW Australia 2011 www.groupgsa.com
T +612 9361 4144 F +612 9332 3458
architecture interior design urban design landscape
nom architect M. Sheldon 3990

Project Title
Precinct A - CC
Shell Cove

Drawing Title
LANDSCAPE DETAILS
DUNE

Scale	as shown @ A1
Drawing created (date)	28/02/2017
By	FZ
Plotted and checked by	FZ
Verified	SH
Approved	SH
Drawing No	Issue
13294 - LPA-4006	A
File	Plot Date
P:\13294 Shell Cove	$DATE$

WorleyParsons
resources & energy

Level 17 / 141 Walker Street
North Sydney NSW 2060 Australia
Telephone: +61 2 8923 6866
Facsimile: +61 2 8923 6877
worleyparsons.com
WorleyParsons Services Pty Ltd
ABN 61 001 279 812

29 April 2020 301015-02681-ma-add-001_sand dune rehabilitation rev c.doc

Mr Pieter Goldie
Superintendent

c/o Frasers Property Group
PO Box 4148
SHELL COVE NSW 2529

Dear Pieter,

SHELL COVE BOATHARBOUR BREAKWATER, GROYNE AND DREDGING WORKS
ADDENDUM NO. 1 – TECHNICAL SPECIFICATION

We refer to the Shell Cove Boatharbour Breakwater, Groyne and Dredging Works Technical Specification (301015-02681-MA-SPC-0003 REV C.pdf) and hereby issue Addendum No. 1 for the construction works.

Addendum No. 1 comprises the addition of Section 14 Dune Rehabilitation to the Technical Specification.

Addendum No. 1 Item 1

Technical Specification (301015-02681-MA-SPC-0001 REV C.pdf)

Add Section 14

14. DUNE REHABILIATION

14.1 General

Dune rehabilitation Works shall be undertaken in accordance with the following documents:

- this section of the *Shell Cove Boatharbour Breakwater, Groyne and Dredging Works Technical Specification* (WorleyParsons, 2016), also referred to as the Technical Specification;
- *Shell Cove Boat Harbour Beach Nourishment/Rehabilitation Management Plan* (Advisian, 2018); and,

- *Coastal Dune Management, A Manual of Coastal Dune Management and Rehabilitation Techniques* (NSW Department of Land and Water Conservation, 2001), also referred to as the Dune Management Manual.

The following dune rehabilitation drawings shall be read in conjunction with the Technical Specification.

301015-02681-MA-DWG-0130 Sand Placement and Sequencing Plan

301015-02681-MA-DWG-0135 Sections SD01 & SD02

301015-02681-MA-DWG-0136 Sections SD03 & SD04

301015-02681-MA-DWG-0137 Sections SD05 & SD06

301015-02681-MA-DWG-0140 Vegetation and Fencing Plan South of the Groyne

301015-02681-MA-DWG-0141 Vegetation and Fencing Plan North of the Breakwater

L-13294-LPA-DETAILS-L-4006-A (prepared by Group GSA)

In the event of any discrepancies between the abovementioned documents, the Technical Specification shall apply. Environmental controls shall be implemented in accordance with **Section 5** of the Technical Specification that generally refers to the Construction Environmental Management Plan (CEMP). Beach nourishment activities shall be undertaken in accordance with **Section 8.5** of the Technical Specification.

The extent of the dune rehabilitation area is generally bound by the sand placement areas and planting zones shown on the **Drawings**. The activities associated with dune rehabilitation generally comprise:

- removal of sand from the Access Channel, transport to the dune rehabilitation area, and placement;
- shaping the placed sand to the specified dune profile;
- removal of previously placed topsoil (south of Groyne);
- controlling of weeds;
- initial stabilisation of the shaped dune;
- installation of temporary fencing and signs (if required);
- vegetating the area with primary, secondary, and tertiary species;
- installation of permanent dune fences and accessways; and,
- maintaining the area.

The Contractor shall prepare a Method Statement for the dune rehabilitation works to be approved by the Superintendent prior to commencing the Works. The Contractor's Method Statement shall clearly outline dune rehabilitation techniques, plant and equipment, vegetation species, and materials to be used. Additional specific requirements for the Contractor's Method Statement are contained within this **Section**.

14.2 Sequencing and Program of the Works

Refer to the **Drawings** for the sequencing of the Works. The sequencing is separated into Works north of the Breakwater and South of the Groyne that can occur simultaneously if permitted by the overall project staging. Changes to the proposed sequencing are permitted if approved by the Superintendent.

The Contractor shall provide a program of the Works that is to be reviewed by the Superintended prior to commencement. The program shall capture all of the Works including maintenance (refer **Section 14.13**).

14.3 Archaeological Heritage

The archaeological and heritage site in the vicinity of the Works is AHIMS Site 52-5-207 located south of the Groyne. Consent and Permit #2534 covers the area of AHIMS Site 52-5-207 shell midden, but only in relation to areas identified as being of relatively low or no archaeological value.

In accordance with the approvals for the Shell Cove Boat Harbour project, there shall be no harm to AHIMS Site 52-5-207 as a result of the Works. For areas not identified as being of relatively high archaeological value, the special conditions relating to Permit #2534 state that representative(s) of the Aboriginal community and a qualified archaeologist should be present to ensure that the excavation of material is monitored. This specifically applies to the partial removal of topsoil stockpile as shown on the **Drawings**.

The following measures shall be implemented by the Contractor for areas mapped as high and low archaeological significance as shown on the **Drawings**:

- retain cover of Buffalo Grass for dune stabilisation in areas where there are no native plants occurring. Spot spray to prevent Buffalo Grass from spreading beyond the current extent;
- use bush regeneration methods to handweed and spot spray around native shrubs and groundcovers to encourage these to spread;
- limit herbicide spraying to patches no more than 5 m^2 and less than 50% of the ground layer;
- avoid pulling out woody weeds. Cut and paint leaving roots intact; and,
- planting can occur in areas of high and low archaeological sensitivity however this must be done in manner that minimises ground disturbance by planting tubestock using small hand tools. Avoid the use of mattocks augers or any machinery.

14.4 Earthworks and Dune Design Profiles

Material placed in the dune rehabilitation area shall be clean sand (*i.e.* free of clay and imported rock material). Cobbles that formed part of the natural cobble layer below the sand are permitted to be used. Concentration of cobbles shall be spread through the sand material used for the dune rehabilitation.

The sand shall be placed in the location shown and to the levels, widths and side slopes indicated on the Drawings. The sand shall be placed and reworked to a construction tolerance of 200 mm above or below the nominated design levels.

Topsoil previously placed south of the Groyne shall be partially removed to the profile indicated on the **Drawings** and transported to the landscape mound. Partial removal of the topsoil is to consider the presence of the underlying middens by preserving a 0.5 m deep buffer of topsoil. The level of the buffer shall be confirmed by the Contractor by comparing pre and post surveys of the topsoil stockpile.

14.5 Initial Stabilisation of Sand Dune

Following the creation of a discrete section of sand dune it shall be initially stabilised prior to the planting of vegetation. Stabilisation methods shall use brush matting and/or a spray treatment of the sand surface with a binding agent or stabilisation compound such as Curasol, or other approved equivalent.

If brush matting is proposed, it is to be undertaken in accordance with the Dune Management Manual. Details of the type and distribution of the brush matting proposed is to be provided in the Contractors Method Statement.

If a sprayed stabilisation compound is proposed, details of the stabilisation compound, including manufacturers recommendations and specification and the Contractors proposed methods for storage and application shall be provided in the Contractors Method Statement.

14.6 Temporary Fencing and Signage

Areas undergoing dune rehabilitation are to be secured to notify and exclude the general public from all work areas. The installation of temporary fencing shall comprise a 900 mm high galvanised wire mesh between 1.8 m long metal star pickets securely embedded a minimum of 600 mm into firm ground at a spacing of 3 m, with three wires fitted through the posts to secure the galvanised mesh.

If the dune rehabilitation area is already secured from the public with appropriate fences and signage due to other construction activities, additional construction fences and signs are not required.

14.7 Control of Weeds

Control of noxious and environmental weeds shall be undertaken across all of the dune rehabilitation area and extend a further 15 m into the dune system to create a buffer zone as shown on **Drawings.** The Contractor shall ensure all weeds in the dune rehabilitation area are controlled according to the NSW DPI Weed Control Handbook and the Dune Management Manual. Weed control must be carried out in a manner that minimises over clearing, resulting in soil erosion, and/or destruction of fauna habitats. Weed monitoring shall occur to identify new species that may minimise the success of the rehabilitation effort.

Weeds shall be taken off site to be recycled or composted. Appropriate light mechanical or hand weeding shall be used to remove weeds. Eradication of weeds and the like shall continue throughout the course of the Works and during the maintenance period. Bitou bush control shall be undertaken in accordance with the methods recommended in *Bitou Bush Management Manual, Current Management and Control Options for Bitou Bush (Chrysanthemoides monilifera ssp. rotundata) in Australia*, Department of Environment and Climate Change, 2008).

The Contractor shall provide a Method Statement for approval by the Superintendent, prior to weed control works. In particular, the Contractor's Method Statement shall detail weed control techniques in accordance with mitigation measures in **Section 14.3** for areas of archaeological significance.

14.8 Sourcing and Inspection of Plants

Suitable native dune plants may be sourced from site in consultation with, and with consent from a Council Environment Officer. This may include sourcing brush matting material from established vegetation as well as transplanting Spinifex and Pigface from areas to be disturbed as part of the sand placement activities. The Contractor shall be responsible for obtaining the appropriate permits/licenses if required to harvest nominated plant species.

The Superintendent may elect to inspect the plants prior to installation. If, during inspection, any plantings, in the opinion of the Superintendent, are unsuitable for inclusion in the Works, the Contractor shall replace them at his own expense.

The Contractor shall give the Superintendent 24 hours' notice before any planting so that an inspection can be organised.

14.9 Planting of Primary Species

Planting of primary species shall be undertaken where practicable between the months of October and March.

Prior to the planting of primary species, the reformed surface of the dune shall be evenly watered with 50 litres/m^2 of potable water to leach salt from the root zone unless otherwise agreed with the Superintendent that watering is not required (due to previous rainfall event/s).

Over the full extent of the dune rehabilitation area mostly Spinifex (*Spinifex sericeus*) shall be planted with a smaller proportion (around 10%) of at least one other species as follows:

- Coastal Pigface (*Carpobrotus glaucescens*);
- *Knobby Club Rush (Ficinia nodosa);* and,
- Beach Fescue (*Austrofestuca littoralis*).

Spinifex and other primary species planting techniques and densities shall be in accordance with the Dune Management Manual and outlined in the Contractors Method Statement.

14.10 Secondary Species

Planting of secondary species shall be undertaken six to twelve months after the initial stabilisation and planting of primary vegetation. The species of secondary vegetation to be planted on the dune shall be as follows:

- Coast Wattle (*Acacia longifolia subsp. sophorae*);
- Coffee Bush (*Breynia oblongifolia*); and,
- Coast Tea-Tree *(Leptospermum laevigatum).*

Additional species that may be added to maintain a biodiversity consistence with the region include:

- Sword or Mat Grass (*Lomandra longifolia*);
- Coastal Beard Heath (*Leucopogon parviflorus*);
- Tree Broom Heath (*Monotoca elliptica*); and,
- Seaberry Saltbush (*Rhagodia candolleana subsp. Candolleana*).

All secondary species shall be planted from tube stock on a 3 m grid aligned at 45 degrees to the main axis of the sand dune. Planting techniques shall be in accordance with the Dune Management Manual and outlined in the Contractors Method Statement. Tree guards shall not be used.

The Contractor shall not plant secondary species any closer than 3 m to future accessway locations as shown on the **Drawings** and as nominated by the Superintendent.

14.11 Tertiary Species

Planting of tertiary species shall also be undertaken with the planting of secondary species. A larger spacing is required to assist the regeneration of the primary and secondary species.

The species of tertiary vegetation to be planted on the dune shall be as follows:

- Coast Banksia *(Banksia Integrifolia).*

All tertiary species shall be planted from tube stock on a 15 m grid aligned at 45 degrees to the main axis of the sand dune. Planting techniques shall be in accordance with the Dune Management Manual and outlined in the Contractors Method Statement. The Contractor shall not plant tertiary species any closer than 3 m to future access way locations shown on the **Drawings** and as nominated by the Superintendent.

14.12 Permanent Dune Fencing

The Contractor shall construct permanent fencing around the vegetated areas at the locations shown on the **Drawings**. Dune fences will comprise two different types as follows:

- Plain Wire Fence Type (Type 3) - situated around the permitter of the dune areas; and
- Top Rail Fence Type (Type 4) - along the accessways.

The construction of fencing and materials used shall be in accordance with the Dune Management Manual, except where altered by this Specification. Dune fences shall include treated pine posts and rails... Post and rail dimensions and spacings and embedment details are provided in the Dune Management Manual.

14.12.1 Accessways

Board and chain accessways shall be constructed in the locations shown on the **Drawings**.

The two accessways closest to the Breakwater and Groyne shall be 3 m wide and each fitted with a steel lockable gate to restrict vehicular access. All other accessways shall be 2 m wide.

The construction of accessways and materials used shall be in accordance with the Dune Management Manual, except where altered by this Specification. Accessways shall be constructed using hardwood timber boards. Accessway dimensions and spacings are provided in the Dune Management Manual. The accessways are to be covered with 100 to 200 mm of beach sand following installation.

14.12.2 Exclusion of Rabbits from Planted Areas

Rabbits are not considered a threat in the area. However, if suspected that damage to planted areas has resulted from rabbits, and as directed by the Superintendent, the Contractor shall incorporate a suitable barrier into the constructed fences to ensure that rabbits are excluded from planted areas. Details of these barriers shall be provided in the Contractors Method Statement.

14.13 Maintenance

The length of the contracted maintenance period is 36 months from the completion of the primary species planting of a particular completed area of the sand dune.

The Contractor shall remain responsible for maintaining healthy and vigorous growth of all dune stabilisation vegetation at all times for the duration of the maintenance period. In addition, the Contractor shall be responsible for the general upkeep of all fencing and signage during the maintenance period.

The Contractor shall submit as part of the Method Statement details of the proposed maintenance program. The Contractor shall make their own assessment of the quantity and frequency of maintenance activities required. As a minimum, maintenance activities shall be undertaken at least every 6 months during the maintenance period. The maintenance program shall be in accordance with the Dune Management Manual and shall, as a minimum, provide for the following items:

- watering: outlining quantity and frequency;
- fertilising: outlining quantity and frequency;
- weeding: outlining weeds to be sprayed in dormant growth periods and summer;
- inspection, removal and replacement of stolen, dead and dying vegetation;
- maintenance of fencing; and,
- ongoing stabilisation of all exposed dune surface areas.

During and up to the completion of the maintenance period, the Contractor shall ensure that the entire dune surface is stable, all plants are healthy, and all weeds removed. At the following milestones during the maintenance period, the minimum native dune vegetation cover is required:

- 12 months – 50%;
- 24 months – 60%; and,
- 36 months – 70%.

Within 1 month following each of the maintenance milestones, the Contractor shall submit a brief progress report on the status of the dune rehabilitation area. The progress report shall be prepared by a suitably qualified person/s with experience in dune rehabilitation projects. The progress report is to include the cover percentage and general health the native dune vegetation cover, stability of the dune surface, maintenance undertaken since the previous millstone, and additional works required if the specified maintenance requirements are not met or if other issues arise (eg damage by rabbits). The progress report is to be supported with aerial photography/mapping, and outcomes of a site walkover with photographs included. The progress report is to be approved by the Superintendent prior to payment for maintenance up to each maintenance milestone.

If the maintenance requirements are not met at each maintenance milestone, the Contractor shall undertake additional works (eg weeding and planting) to meet the requirements at no additional cost to the Principal and to the satisfaction of the Superintendent.

Please contact me should you require any further information or clarification.

Yours faithfully
WorleyParsons

Ben Morgan
Associate

Review / Verification by

Chris Adamantidis
Associate

Advisian
WorleyParsons Group

Appendix B Representative Species in Coastal Foredune Scrub (French 2010)

REPRESENTATIVE SPECIES IN COASTAL FOREDUNE SCRUB

VERY COMMON SPECIES	Life Form	DISPERSAL Long/short
Acacia longifolia subsp. sophorae	S	Long – verte/ant
Actites megalocarpa	H	Long - wind
Banksia integrifolia subsp. integrifolia	TS	Long - wind
Carpobrotus glaucescens	H	Long - vertebrate
Dichondra repens	H	Short - none
Isolepis nodosa	G	Short - none
Leucopogon parviflorus	S	Long - vertebrate
Lomandra longifolia	G	Short - ant
Monotoca elliptica	S	Long - vertebrate
Rhagodia candolleana subsp. *candolleana*	S	Long - vertebrate
Spinifex sericeus	G	Long - wind

COMMON SPECIES		
Poa billardierei	G	Long - wind
Breynia oblongifolia	TS	Long - vertebrate
Calystegia soldanella	H	Short - none
Commelina cyanea	H	Long - water
Correa alba var. alba	S	Short - ballistic
Correa reflexa	S	Short - ballistic
Cynodon dactylon	G	Short - none
Imperata cylindrica var. major	G	Long - wind
Leptospermum laevigatum	S	Short - none
Oxalis perennans	H	Short - ballistic
Pelargonium australe	H	Short - ballistic
Senecio lautus subsp. maritimus	S	Long - wind
Zoysia macrantha	G	Long - wind

QUITE COMMON SPECIES		
Acaena novae-zelandiae	H	
Banksia serrata	TS	Long - wind
Carex pumila	G	Short - none
Dianella caerulea	H	Long - vertebrate
Dichelachne crinita	H	Long - vertebrate
Entolasia stricta	G	Short - none
Eucalyptus botryoides	TS	Short - none
[1]*Glycine clandestina*	V	Short - none
Kennedia rubicunda	V	Short - ant
Melaleuca armillaris subsp. armillaris	TS	Short - none
[2]*Pittosporum undulatum*	TS	Long - vertebrate
Pratia purpurascens	H	Short - none
Solanum stelligerum	S	Long - vertebrate
[1]*Stephania japonica var. discolor*	V	Long - vertebrate
Themeda australis	G	Long - vertebrate
Viola hederacea	H	Short - ant
Westringia fruticosa	S	Short - none

UNCOMMON SPECIES	Life Form	DISPERSAL Long/short
Alyxia buxifolia	S	Short - ballistic
Atriplex cinerea	S	
Austrostipa flavescens	G	
Baumea juncea	G	Short - none
Casuarina glauca	TS	Long - wind
Centella asiatica	H	
Cynoglossum australe	H	Long - vertebrate
Desmodium varians	H	Long - vertebrate
Elaeocarpus reticulatus	TS	Long - vertebrate
[1]*Glycine tabacina*	V	Short - none
Gonocarpus teucrioides	S	Short - none
Hibbertia acicularis	S	Short - none
Hibbertia scandens	V	Long - vertebrate
Lepidosperma laterale	G	Short - ant
Macrozamia communis	S	Long - vertebrate
Microlaena stipoides	G	Short - none
[3]*Muehlenbeckia adpressa*	V	
Olearia axillaris	S	Long - wind
Opercularia aspera	S	Short - ant
Oplismenus imbecillis	G	Short - none
Oxalis radicosa	H	Short - ballistic
Oxalis rubens	H	Short - ballistic
Pittosporum revolutum	S	Long - vertebrate
Poa meionectes	G	
Poa poiformis var. poiformis	G	Long - wind
Pteridium esculentum	H	Long - wind
Rhodamnia rubescens	TS	Long - vertebrate
Rubus parvifolius	V	Long - vertebrate
Scaevola calendulacea	V	Long - vertebrate
Senecio linearifolius	H	Long - wind
Solanum opacum	H	Long - vertebrate
Solanum prinophyllum	H	Long - vertebrate
Solanum pungetium	H	Long - vertebrate
Sporobolus virginicus	G	Short - none

[1] Vines which often establish easily from bird dispersal and can be weedy
[2] Species often considered weedy and may be avoided if abundant in nearby areas.
[3] Species has limited distribution in far south coast

Table 2. Plant species in each commonness category and their dispersal modes, where known, for Coastal Foredune Scrub TS – tall shrub or tree, S – shrub, H – herb, V – vine, G – grass or grass-like species.