

Dalhousie Creek Entrance Management Strategy

Part 1: Policy and Implementation



FINAL REPORT

Note:

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**18-033 DALHOUSIE CREEK ENTRANCE MANAGEMENT STRATEGY:
PART 1: POLICY AND IMPLEMENTATION**

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1. INTRODUCTION

The Entrance Management Strategy for the Dalhousie Creek entrance precinct (Figure 1) is comprised of two separate documents being:

Part 1: Entrance Management Policy and Implementation Plan.

Part 2: Background Information and Review of Environmental Factors.

Part 1 (this document) should be read in conjunction with Part 2. Part 1 documents the desired state of the entrance precinct formulated in consultation with stakeholders, details the action plan to address key issues, outlines implementation steps as well as monitoring measures.

Part 2 provides a summary of relevant information, regulatory considerations and approval requirements, as well as providing an assessment of likely impacts and identification of mitigation measures to support the entrance management strategy.

1.1 Background

Dalhousie Creek is located immediately south of Hungry Head on the NSW North Coast and is part of the Bellingen Heads State Park within the Bellingen Shire Council (BSC) Local Government Area (LGA). The creek, sometimes referred to as Hungry Head Lagoon, is classified as an Intermittently Closed and Open Lake or Lagoon (ICOLL) and has its entrance to the ocean at Hungry Head Beach.

The Urunga Surf Life Saving Club (USLSC) runs activities including 'Nippers' events throughout the year and has a lookout tower overlooking the beach. As a patrolled beach, with direct access to the creek, this location is popular with local residents and visitors. Pedestrian access to the beach is directly below the lookout tower and there is also emergency 4WD access to the beach between the lookout tower and the creek.

The position of the Dalhousie Creek entrance as well as water levels within the creek are critical in determining the accessibility, amenity and public safety of this section of beach. Until 1997, artificial entrance opening was undertaken annually for the purpose of controlling the entrance location, improving beach amenity and also to address community concerns regarding water quality and odour issues which were apparent when the creek remained closed for extended periods. Since 1997, the creek usually remains closed, but still opens naturally once or twice a year in response to rainfall, beach state and ocean conditions.

Significant erosion of Hungry Head beach, coupled with extended high water levels in the creek during 2015 resulted in creek inundation of most of the beach in front of the USLSC lookout tower and cut off USLSC and public access to the beach (Plate 1). A subsequent creek breakout event occurred toward the north of the entrance precinct, resulting in additional scour of the beach along the already eroded dune scarp. Further erosion of the dunes occurred during the January 2016 king tides, and informal pathways were created by the public to gain better access to the beach. This created additional issues through impacts to native vegetation, further erosion, reduction of the visual amenity and increasing public safety risk.

The Dalhousie Creek entrance area is a highly dynamic coastal environment and which is subject to a large range of influences including the effects of climate change and sea level rise. The *Bellingen Coastal Zone Management Plan* (BMT WBM, 2017) provides management actions to address long-term beach erosion issues and overall coastline management. The actions proposed in this Entrance Management Strategy will need to be adaptive to changing circumstances, but does not aim to address long-term erosion risk, but rather short-term entrance position and beach condition. The proposed works/strategy will be subject to a five-yearly review. This review will need to consider the

status of CZMP implementation as well as adjusting the strategy as necessary to meet the overall objectives for coastline management.

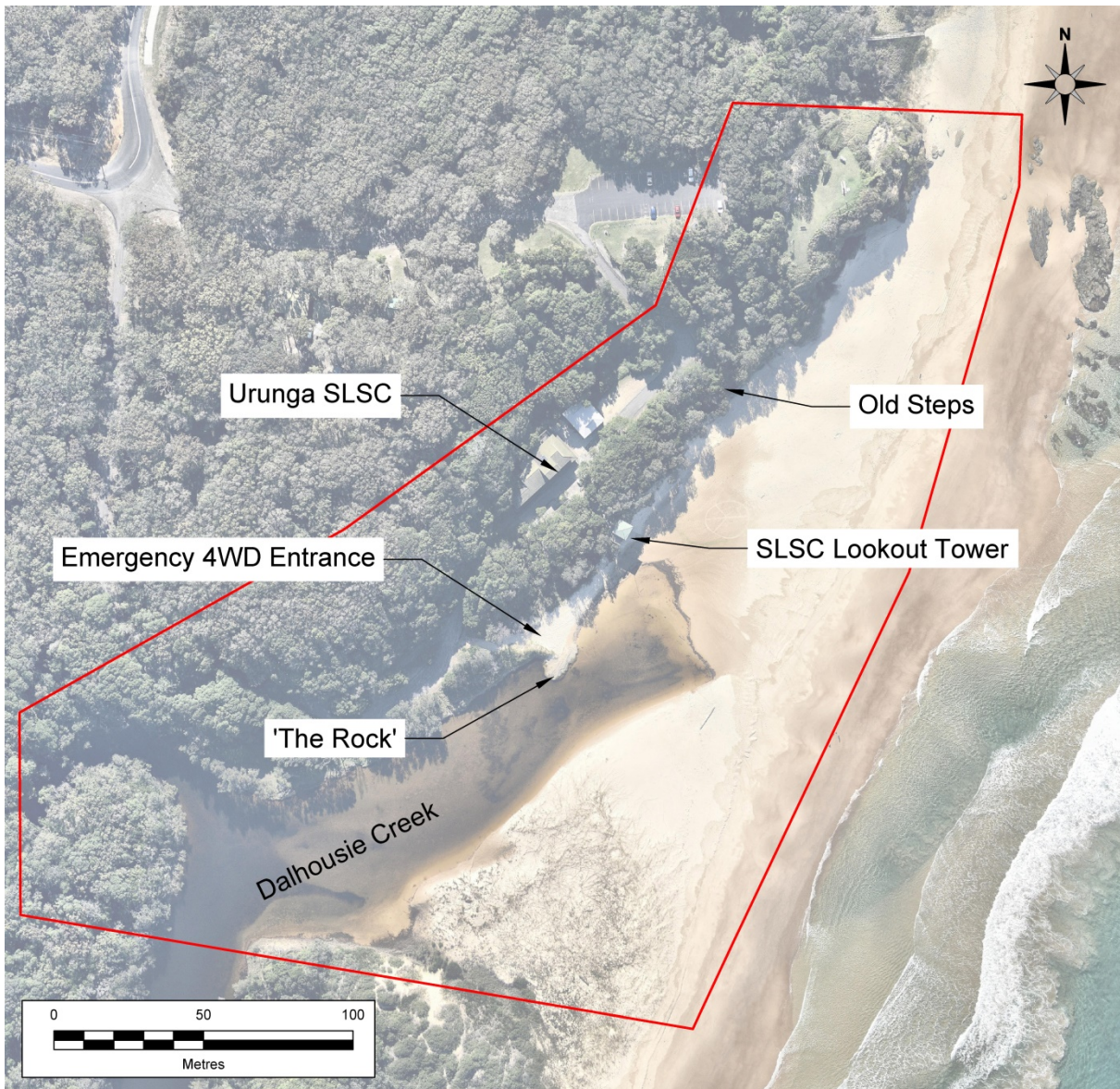


Figure 1. Dalhousie Creek entrance precinct (outlined) – (Photo: June 2018 supplied by Dol-Crown Lands).

1.2 Purpose

There has been significant community pressure to address on-going concerns relating to the entrance and state of the beach at Hungry Head. In response, Bellingen Shire Council (BSC) with the assistance of the Office of Environment & Heritage (OEH) and the Bellingen Heads State Park Trust (BHSPT) has developed this Entrance Management Strategy for Dalhousie Creek in order to:

- Identify opportunities to manage the entrance of the creek to ensure convenient and safe access to the beach for members of the public, the USLSC and emergency services;
- Improve the amenity of the beach and entrance area for the enjoyment of beach users; and
- Improve the ecological integrity and resilience of the Dalhousie Creek entrance precinct.



Plate 1. Extensive inundation of the beach in front of the USLSC and access ways (Photo: June 2015 supplied by BSC).

2. DESIRED CONDITION

The desired state of the Dalhousie Creek entrance precinct, as determined through discussion with key stakeholders (see Part 2 for details on consultation), is as follows:

1. The width of beach at high tide should be at least 50m measured from the eastern edge of the USLSC lookout.
2. The northern bank of the creek entrance should not extend northward of the tip of 'the rock' until at least 50m eastwards of this point.
3. Dunes should be established against the existing erosion scarp, (higher northward of the USLSC lookout), to provide a buffer against coastal erosion, enhance biodiversity, provide for greater public amenity and improve public safety.
4. The southern extent of the creek entrance should not be so far south such that erosion of dunes on Aboriginal land to the south occurs or the view of the entrance area from the USLSC lookout is diminished.
5. There should be no terminal pool at the northern end of the creek. Instead, the flow path of the creek should be continuous, such that wind-driven debris (during southerlies) does not accumulate within the northern section, but instead can flush to the ocean naturally.
6. The emergency/USLSC access track should be able to be easily traversed by 4WD and quadbike, with safe, clear access to the main part of Hungry Head Beach. As a guide, the entrance should follow an even grade of not more than 1 in 10.
7. The beach access pathway under the USLSC lookout tower should be safe, reliable and inviting. A suitable gradient between the path steps and the beach should be maintained to facilitate easy access.
8. Despite the above, the entrance should be in as natural state as possible, in keeping with the natural values of the area.



Figure 2: Approximation of desired entrance condition as evident August 2010. Photo: Google Earth

3. PREFERRED STRATEGY

The recommended strategy is to enhance and maintain the state of Hungry Head Beach immediately north of Dalhousie Creek and to implement a series of measures to control the location of the creek entrance.

3.1 General approach

The preferred strategy is to implement works in a series of stages, to allow evaluation of the efficacy of the each stage and to evaluate the need for escalation of the level of works required at the site.

Location of key action areas is provided in Drawing 1 in Appendix 1. Below is an outline of the general approach which is detailed in the following sections.

Stage 1:

1. Excavation/beach scraping for the purpose of maintaining a 'dry notch' at the desired entrance location for Dalhousie Creek as indicated in Drawing 1 (Appendix 1).
2. Inter-tidal (swash zone) beach scraping. Sand won from this activity as well as from management of the 'dry notch' is to be utilised to nourish and regenerate the beach and dunes at the emergency 4WD access, the beach in front of the surf club and public access ways.
3. Foreshore management activities including dune revegetation and path/ramp/step maintenance and improvements.
4. If necessary, at agreed trigger criteria, initiate artificial opening of the Dalhousie Creek ICOLL at the preferred location by excavation through the remaining beach berm.
5. Monitoring over time to determine the behaviour of the creek entrance during opening and subsequently in relation to hydrological and metocean conditions.

Stage 2:

5. If warranted by step 5 above, utilise geotextile sand containers (GSCs), to be filled with sand from the entrance area to artificially train the northern side of the entrance of Dalhousie Creek and/or protect critical areas of bank/beach/track. Although the intention is that this would be implemented as a trial, it is conceivable that this could form part of a more permanent strategy, if appropriate.
6. It is intended that activities of Stage 1 would be continued/repeated in conjunction with step 5.
7. Again, monitoring would be undertaken, to determine the efficacy of this measure and recommendations made regarding further actions.

Stage 3:

8. If warranted, the role of the geobag(s) would be replaced by permanent rock work. This measure would only be implemented following a five-year review of this entrance management policy.

3.2 Dry notch management

It is intended that a dry notch be maintained within the preferred entrance channel area as indicated in Drawing 1 (Appendix 1). The dry notch is to act as an initial 'spillway' during high creek water levels and is intended to provide a preferential creek opening location should breakout, in response to natural influences, occur. The location of the dry notch is also intended to stop the continued northward propagation of the low dunes on the southern side of the entrance, which is a key factor contributing to the northward migration of the entrance channel.

The base elevation of the dry notch is to be maintained marginally (0.1 to 0.2m) below the minimum berm level of the entrance management area as surveyed at the time. In this way, it is intended that the opening level of the creek reflects natural variability in the beach and that creek hydrology is minimally affected.

In addition, the base level of the dry notch should not exceed the historical maximum water level in Dalhousie Creek. There is no historic water level monitoring information available, however a high water level is estimated to be around +1.8m AHD which corresponds well with the 15% exceedance level of +1.6 m AHD estimated by BMT WBM (2015). Ensuring that the notch is below this level will ensure that beach enhancement activities do not artificially raise the creek level beyond historic high levels, once again with the aim of minimising hydrological impacts. The cross-section of the dry notch is to be battered (say 1 in 5) to ensure public safety and to blend in to the natural environment.

It is envisaged that maintenance excavation of the dry notch area will be undertaken at the same time that other sand scraping is undertaken (i.e. up to 4 times per year – see below) although the frequency should be as required in order to ensure breakout, if considered likely, occurs in the preferred area of beach.

Survey undertaken in June 2018 provides an indication of the likely volume of sand to initially be taken from the dry notch area which is in the order of 500 m³. Subsequent maintenance of the dry notch is likely to yield a fraction of this volume and will be highly variable according to preceding beach conditions. All sand from the dry notch should be utilised for beach and dune enhancement as outlined below.

3.3 Beach Scraping

Scraping of sand from the inter-tidal beach and from the 'dry notch' area is recommended to generate a source of sand suitable for nourishment of the upper beach and dunes. Scraping should be confined within the following parameters:

- Scraping is to only be undertaken within the southern and northern extents of the works area as identified in Drawing 1 (Appendix 1), equivalent to approximately 150 m of beach front.
- Scraping is to be confined above the elevation of –0.5 m AHD to reduce impacts on beach infauna and reduce the risk of stranding of machinery.

- Scraping (outside of the dry notch area) is to retain the elevation of the natural beach berm (as surveyed prior to each works event) and it is recommended that sand removal does not occur above +1.8m AHD.
- The depth of scraping is to be a maximum of 0.25 m below existing ground level.

Scraping should be undertaken periodically, when beach conditions are suitable (criteria are provided in section 4.2.2), such that sand is won gradually throughout the year. It is envisaged that up to four scraping events are undertaken per year, each yielding up to 1,500 m³ of sand from the main source area of the beach.

Utilising beach survey data collected in June 2018, it is estimated that the volume of sand likely to be generated within the above constraints will be around 1,500 m³ for each scraping event (i.e. 10 m³/m for the 150m of beach). This agrees well with data presented by Carley *et al.* (2010) which also suggests that a scraping depth of 0.25 m is likely to yield around 10 m³/m of sand for a typical NSW beach. For the nominated four scraping events this would yield up to 6,000 m³ of sand per annum which is around 10% of the total littoral sand supply along this part of the coast.

3.4 Beach Nourishment and Dune Building

Sand won from dry notch excavation and beach scraping is to be utilised to build up the beach immediately north of the Dalhousie Creek entrance as indicated in Drawing 1 (Appendix 1). The elevated beach will be less susceptible to inundation by high creek water levels, hence reducing the necessity to manage water levels by artificial entrance opening. The beach is to be built up in three broad tiers/areas as follows, which are presented in priority order:

1. Area 1 - 4WD entrance area. This section of beach abuts the designated creek entrance area and provides the main access for emergency and USLSC vehicles. Due to the need for vehicle access, the beach in this location is to be nourished such that it remains above potential creek water levels (i.e. >1.8m AHD), but exhibits shallow slopes (less than 1 in 10) to allow vehicle movement. It is not intended that this section of beach becomes vegetated, and it is envisaged that this section of beach, bordering both the creek and the ocean will have high public amenity.
2. Area 2 - Immediately in front of the USLSC lookout tower and beach access. Low dunes (<4 m AHD) are to be built up over time in this area to the level of the existing dune erosion scarp. This will allow relatively flat beach access between the concrete stairs and the sand, thereby negating the need for the current temporary wooden ramp. It is envisaged that the dunes in this area will also naturally build with onshore winds and vegetation will establish to stabilise this area.
3. Area 3 - North of the USLSC lookout, there is potential for higher (>4m AHD) dune development. Nourishment in this area should push sand against the existing dune scarp, and build a higher primary dune with the aim of building the reserve of sand in this area. This situation would mimic historical photos of the beach (e.g. taken in 1985) and provides a buffer against storm erosion, but also will allow for regeneration of the dune and hind-dune/littoral rainforest vegetation at this location.

During nourishment activities, the priority for sand is Area 1, followed by Areas 2 then 3 as sand becomes available. It should be recognised that Hungry Head Beach is subject to significant wave energy as well as the variable influence of the Dalhousie Creek entrance. There will be periods where the aims of beach nourishment cannot be maintained due to prevailing conditions, however the above is provided as a guide to best meet the aims of stakeholders.

3.5 Site Rehabilitation and Vegetation Management

The old steps, leading to the old surf club site have been out of service for several years and are considered to be redundant. It is recommended that they be permanently decommissioned, such that the existing temporary closure barrier and signage can also be removed and the site rehabilitated and

naturalised. There are also remnants of the old surf club foundations which are exposed at the existing erosion scarp (see Plate 6, Appendix 1 of Part 2).

A number of options to achieve rehabilitation of the site were considered, including complete removal of all concrete associated with the steps and old surf club foundations, however it is considered that the significant disturbance of the site, including damage to mature trees, destabilisation of soil, potential for unintended exposure of Aboriginal artefacts and overall cost would not be warranted.

Instead, it is proposed to:

1. Remove the stair hand rail by cutting off at ground level;
2. Break/cut off and remove the exposed eastern edge of the old surf club slab and steps at the beach scarp as much as practical;
3. Bury the steps and exposed areas of concrete with a minimum of 30cm of soil/sand; and
4. Stabilise and revegetate all areas of disturbed ground.

Removal of the hand rail would be easily achieved by hand-held grinders and poses minimal environmental risk, although the risk of bush fire from grinding sparks should be considered. All remaining metal is to be made safe by removal of edges, burrs, etc.

Removal of any concrete and debris at the beach scarp would be undertaken by heavy excavator (e.g. 20-30 tonne), which would gain access from the beach and would logically be undertaken in association with the beach scraping works. It is imperative that any remaining concrete is made safe in terms of sharp edges, exposed rebar, voids, rock shards, etc. and that all foreign material is removed for disposal off-site. The exposed concrete at the eastern end is to be buried by beach sand as outlined in section 3.4.

Burial of the steps would be undertaken by importing fill to site and dumping at the top end of the steps. The fill should be selected to match the surrounding soil types and should be weed-free. Imported fill is to be contoured to achieve the required depth of burial and blend into the existing topography. The re-contouring is to ensure that preferential drainage paths, that may give rise to erosion, are not created and this may need to consider the fate of runoff from the road. New fill will need to be stabilised and it is recommended that biodegradable products such as coir logs/blankets, brush matting, etc. are employed to reduce the risk of erosion.

Following all works, the disturbance area is to be rehabilitated. It is recommended that a detailed vegetation management plan is developed which will guide the stabilisation of disturbed areas, planting of suitable native hind-dune and littoral rainforest species and establish a weed maintenance schedule. New sand dunes formed during the works described in section 3.4 are likely to revegetate naturally. This may be accelerated by additional planting, which is considered optional, however weed monitoring and management is considered necessary to provide the best biodiversity outcomes. It should be recognised that any dunes established may still be subject to coastal erosion, and as such, artificial material such as fencing should either be avoided or used in a way that such construction can be easily removed.

3.6 Artificial entrance opening

Deliberate artificial opening of the creek is not expected to be required on a regular basis. It is intended that the beach enhancement activities outlined above will control the location of the entrance and ensure that the priority area of Hungry Head beach remains readily accessible for beach users and emergency vehicles. Despite this, there may be occasions on which artificial entrance opening is required to meet the stakeholder objectives.

Up until 1997, Council artificially opened the entrance on an annual basis prior to the December holiday season. There has been no historical recording of entrance opening events since that time although anecdotally the entrance is still considered to open naturally one to two times annually. It is expected that the ecology of the creek is well adapted to this opening frequency and it is therefore considered that ensuring opening on at least one occasion per year is desirable. Artificial opening of the entrance more than once in any 12 month period is not supported.

3.7 Creek Training - Geotextile Sand Containers

Use of geotextile sand containers (GSCs) as described in Stage 2 (see section 3.1) should only be considered if the implementation of Stage 1 alone is not achieving stakeholder objectives for maintaining the opening position of Dalhousie Creek and preserving beach access and amenity. Escalation to this level of management should only be undertaken after at least 2 years of implementation of Stage 1 activities.

The use of GSCs is seen as a semi-permanent measure which will allow artificial training of the northern bank of Dalhousie Creek and prevent northward migration. To achieve protection of the nominated width of beach, a groyne-like structure, approximately perpendicular to the beach would be established from 'the rock', to around 50m east of this point. There are numerous options available for GSCs and it is recommended that a detailed review of available products and detailed wall design is undertaken at the time of implementation, however it is envisaged that a similar configuration to the 2.5m³ bags shown in Plate 2 would be required to resist coastal processes.



Plate 2. GSCs used for coastal groyne construction (JBP 2017)

As the intent of the GSC wall would be to protect the northward beach from scour of the creek during breakout, the crest height of the wall could typically be below the estimated maximum creek water level of +1.8m AHD and hence remain buried, particularly on the northern face, through continued sand nourishment activities.

This mostly buried configuration is regarded as most in keeping with the natural setting of the entrance precinct, and would also reduce the risk of sand depletion and scour often observed up-drift from coastal groynes. To achieve this, installation of the GSC wall would likely require excavation at least to 0 m AHD to establish the bags at a stable level. Some survey data during a previous opening event (January 2018) shows bed levels of around +0.35 along part of this area, however the presence of higher rock outcroppings cannot be discounted outside of the surveyed boundaries. The likely presence of bed rock reduces the risk of undercutting, which could otherwise lead to deformation of the CSC arrangement. Without direct bedrock support, encapsulation of foundation bags, or other techniques to create a 'self healing' wall toe (Figure 3) should be employed. Further geotechnical work to determine the depth of bedrock along the wall alignment, and specification of bag sizes that best fit within the elevation constraints is required.

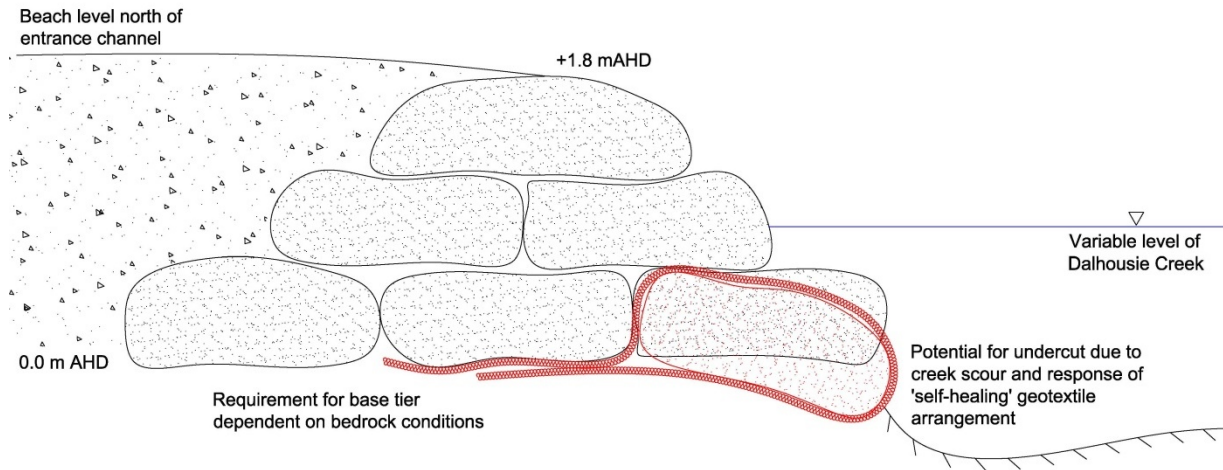


Figure 3. Example cross-section of GSC training wall

3.8 Creek Training – Permanent Rock Work

Use of permanent rock work to train the northern bank of Dalhousie Creek is only to be considered if justified by monitoring of the outcomes of a GSC wall as outlined above. If implemented, detailed design and specification of the rock work should be undertaken to ensure a long-term solution is produced. The rock should match the character of existing bed rock in the area and be subject to the same elevation considerations as outlined for the GSC placement, in that burial of the rock as far as practical within the beach is most likely to achieve stakeholder requirements to retain as natural setting as possible.

Although the intent is for the rock to remain buried, periodic exposure is likely. It is important to ensure that rocks of appropriate roundness and stability are used, such that the public hazard due to any rock exposure is minimised.

There are examples in other areas, such as the Sunshine Coast, Qld (see SCEC 2018), where the long-term use of geotextiles has been preferred over rock by the community, and therefore consideration of detailed design options should include community feedback as well as engineering design.

4. DECISION MAKING AND IMPLEMENTATION

Unlike many other NSW ICOLLs which have heavily developed foreshores, Dalhousie Creek does not have public or private infrastructure which is known to be susceptible to damage from inundation. So, whilst most entrance management strategies for other ICOLLs rely on specific water level triggers to initiate action, it is necessary to consider a range of factors in the case of Dalhousie Creek to ensure appropriate management.

4.1 Approvals

All components of the proposed works are permissible without consent, if undertaken by or on behalf of a public authority under Division 25, Clause 129 of the *State Environmental Planning Policy (Infrastructure) 2007*. Part 2: Background information and Review of Environmental Factors provides an assessment of this Entrance Management Strategy in accordance with Part 5 of the *Environmental*

Planning and Assessment Act, 1979. A determination of the activity under Part V is required by Bellingen Shire Council.

Additionally, the works are to be undertaken on Crown Land which is under the management of the Bellinger Heads State Park Trust. It is currently considered that a Crown Lands licence will be required to permit the recommended works although further confirmation with DoI – Crown Lands is required. In granting such as licence, DoI – Crown Lands are obligated under the *Crown Land Management Act 2016* to notify DPI – Fisheries of the intent to issue a licence and consider factors raised by that department.

In the instance that a Crown Lands licence is issued, a separate permit for Dredging and Reclamation, normally required under the *Fisheries Management Act 1994* is not required, however if saltmarsh, mangroves or saltmarsh are at risk then a permit to Harm Marine Vegetation would still be required. In reviewing the risks associated with the works and the mitigation measures recommended it is concluded that there is negligible potential for the harming of marine vegetation. On this basis, no permits issued under the *Fisheries Management Act* are considered to be necessary.

4.2 Implementation Procedure

Bellingen Shire Council is responsible for implementing this Entrance Management Strategy with support from OEH and the Bellinger Heads State Park Trust.

4.2.1 Notification protocols

Stakeholders should be informed at least one week prior to the commencement of any on-ground works. A stakeholder contact list is provided in Appendix 2.

In addition to specific stakeholder notifications, public signage, indicating the nature of the works, works area, period of works and contact details for enquiries should be attached to entry points to the beach for one week prior to commencement.

4.2.2 Survey and inspection

Beach elevation survey and photo monitoring should be undertaken immediately prior to works as outlined in sections 5.1 and 5.2. The survey is to establish the bounds of the works area, critical elevations and provide on-ground guidance for works. An inspection should be undertaken by a person with experience in coastal management and is to confirm that the scope of works is appropriate with reference to the following criteria.

Table 1. Beach earth moving considerations

Factors to consider	Criteria/Considerations
Metocean conditions and forecast	<p>Sand scraping should be undertaken during periods of low wave energy when the rate replenishment of sand in the swash zone is likely to be high.</p> <p>Sand scraping should not be undertaken immediately prior to conditions which are likely to cause beach erosion.</p>
Presence of nesting shorebirds or turtles	<p>During marine turtle breeding season (October-May) a survey for evidence of marine turtle nests (turtle tracks, hatchlings) should be undertaken across the site at the commencement of each day of operations.</p> <p>Similarly, an inspection for nesting threatened birds should be undertaken daily prior to works during September-February.</p>

4.2.3 Equipment and access

Earth moving equipment is to gain access to the works area via the Emergency 4WD access point. Liaison with the USLSC will be required as appropriate to ensure that emergency access during works periods can be maintained or that alternative arrangements are in place.

It is recommended that beach scraping works are undertaken with a combination of bulldozer and excavator although other combinations are possible. Availability of two items of plant reduces potential for stranding of equipment, maximises efficiency and reduces the overall duration of works. Gordon (2015) quotes information suggesting that a D6 bulldozer can typically move 94m³/hr, which suggests that the volume for each scraping event of up to 1,500m³ could be harvested in 2 days, although this would depend on tidal/swell conditions, the width of beach to be traversed as well the degree of dune shaping required at the time.

All equipment should be free of foreign soil and be degreased prior to work on the beach. An environmental management plan, addressing the risks identified in Part 2 of this strategy will need to be implemented.

4.2.4 Artificial Opening

Artificial entrance opening can be undertaken in accordance with the triggers listed in Table 2.

Table 2. Triggers for artificial entrance opening

Triggers for opening	Criteria/Considerations
Inability to prevent beach inundation in front of access ways through beach enhancement activities	<p>Inundation of beach northward of desired northern limit line and within 50m minimum beach width target.</p> <p>This is only to be considered a valid trigger under the following circumstances:</p> <ul style="list-style-type: none"> a) Opportunities for beach enhancement have been exhausted or are not available due to factors such as reduced sand availability; and b) Beach access and amenity will be compromised during the peak beach usage period, corresponding with USLSC patrols (late Sept – late April)
Time since closure	Duration of closure in excess of 12 months
High water level	<p>Water levels are identified to be threatening public or private infrastructure upstream of the entrance.</p> <p>As there are no known risks in this regard it is unlikely that this trigger will be activated.</p>
Other factors	<p>From time to time it is conceivable that other factors may be identified by Council, the community or regulatory agencies that justify the artificial opening of the creek.</p> <p>In such an instance, opening is permissible but should only be undertaken with the written agreement of:</p> <ul style="list-style-type: none"> a) DPI – Fisheries b) OEH c) Dol (Crown Lands) d) Bellingen Shire Council

The circumstances for artificial opening may vary, however a preferred procedure for artificial opening is as follows:

1. Ensure the configuration of the dry notch is as intended;
2. Harvest any sand within the beach scraping zone downslope of the dry notch and utilise sand as appropriate for beach nourishment;
3. With the aid of a spotter, ensure that there is no public safety risk associated with opening of the creek. This should include identification of people within the creek, moving along the beach as well as people within the surf;
4. An excavator should be utilised to establish a narrow (say 1m wide) pilot channel to initiate flow out of the creek. Typically it is recommended to dig the channel starting at the ocean and

grading toward the creek, thereby ensuring that the excavator is on high ground when the creek begins to flow, although this isn't strictly necessary. Prior to excavation, the operator should clearly identify the likely sequence of events when the pilot channel is established and plan the excavation sequence and equipment movements accordingly.

5. Artificial opening should occur during the early stages of a falling tide (ideally a spring tide) such that the resulting flows scour sufficiently to create a defined entrance channel at the desired location and adequately flush the waterbody.

The above factors should be documented in a safe work method statement and adapted as appropriate to the circumstances at the time.

4.2.5 Creek Training - Geotextile Sand Containers or Rock

Escalation of management activities to include training of the northern creek bank will require further investigation of geotechnical conditions to determine whether bedrock along the wall alignment will influence design or specification of the wall.

It is likely that conditions justifying the installation of a wall (i.e. continued northward creek migration) would also lead to exposure of shallow bedrock in the area of interest. Hence surveys should be undertaken of bedrock exposure during such incidences. In the absence of natural exposure, mechanical probing of the sand to determine bed rock depth is recommended to provide some rudimentary information.

If GSCs are to be utilised, the risk of container splitting, including the risk of vandalism, should be considered in the specification of the material, and filling of containers should follow the manufacturer's guidelines (under-filling is often a cause of failure). All GSCs should be placed to form a stable configuration at the appropriate elevation (to be determined). To avoid working in water, it is likely the creek would need to be open to allow works to occur and may necessitate artificial opening as allowed for by 'other factors' in Table 2.

5. MONITORING, REPORTING AND REVIEW

There is a lack of quantitative information in relation to the opening/closing regime of Dalhousie Creek, water level history within the creek and state of Hungry Head Beach.

Monitoring is recommended to assist in refining action triggers and to inform future revisions of this Entrance Management Strategy. Monitoring to be undertaken is as follows:

5.1 Entrance area elevation surveys

Topographic survey of the entrance area between the southern and northern extent of works as shown in Drawing 1 (Appendix 1) should be undertaken on a quarterly basis as well as before and after each period of works on the beach. Surveys should be undertaken to provide centimetre accuracy relative to AHD and should consist of a standard set of shore-normal cross-sections at nominal 20m spacing. Additional survey lines as appropriate should be included to capture details such as:

- Downstream margin of the Dalhousie Creek water line;
- Cross-sectional details of the entrance channel (when open);
- The extent and volume of works (if any) undertaken at that time; and
- High and low points of any dune development within the survey area.

The intention is to capture snapshots of sand volume and geomorphic features within the survey area to allow:

- Comparison of the current entrance state with the desired condition (Section 2);
- Document the scope of works undertaken, such as the volume of sand scraped and placed, depth of dry notch, etc.; and
- Determine the total change in sand volume within the entrance precinct since the last survey.

5.2 Photo Monitoring

Photo monitoring should be undertaken to provide a regular photographic record of the entrance. Photos should be taken from a standardised position (e.g. the USLSC lookout) with similar view angles to allow comparison over time. Photos should be taken:

- In conjunction with all entrance area elevation surveys;
- During periods of interest such as high swell activity, natural breakout events, high creek water levels, etc.

Ideally, overhead aerial views with surveyed ground control points of the entrance area are also captured by drone photography if available.

In addition to monitoring at specific times of interest, it would be highly beneficial to utilise initiatives such as the CoastSnap program (OEH 2018) to allow community members to submit photographs taken from within a fixed view frame on a random basis.

5.3 Dalhousie Creek Water Level

It is recommended that a water level recorder, referenced to AHD is installed permanently with Dalhousie Creek. The purpose of this recorder is to provide a long-term record of water level fluctuations in the creek to allow future evaluation of response to rainfall, large ocean swell events and to accurately document the timing and rates of all breakout events.

The location of the water level recorder is not critical, but needs to be indicative of water level at the entrance, be easily accessible for data transfers and maintenance, as well as be in a relatively secure location. The installation of the pressure meter needs to be such that the full extreme of potential water levels can be captured.

5.4 Dune Vegetation

Building of the dunes will encourage natural re-establishment of foredune vegetation and offer increased protection to the existing dune/cliffs north of the USLSC lookout tower. It is recommended that a vegetation management plan is prepared for vegetation corridor in front of the USLSC. This VMP should incorporate monitoring of new dune vegetation, through photographs as well as inspection for weed species (e.g. Bitou bush) is undertaken. Regular control of weeds is recommended.

5.5 Reporting and Review

An annual monitoring summary report should be prepared that documents the results of the above activities, including evaluation of data since the last report with reference to the full period of record. The report should include a summary of all physical works undertaken during the reporting year and should make conclusions/recommendations regarding:

Dalhousie Creek Entrance Management Strategy: Policy and Implementation

- The efficacy of the entrance management strategy and works undertaken;
- Insights gained from monitoring in relation to entrance dynamics, coastal processes and geotechnical conditions on the beach;
- The scope/frequency/timing of the on-going monitoring program components

This Entrance Management Strategy should be reviewed in 5 years, cognisant of the implementation of CZMP actions, and recommendations should be incorporated into future Coastal Management Program development for this section of coastline.

6. REFERENCES

- BMT WBM (2014) Bellingen Coastal Zone Management Study. Prepared for Bellingen Shire Council.
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- Carley, J.T., Shand, T.D., Coghlan, I.R., Blacka, M.J., Cox, R.J., Littman, A., Fitzgibbon, B., McLean, G. and Watson, P. (2010) 'Beach scraping as a coastal management option', in Beach scraping as a coastal management option, 19th NSW Coastal Conference 2010, Batemans Bay, NSW.
- Cummings, P., Gordon, A., Lord, D., Mariani, A., Nielsen, L., Panayotou, K., Rogers, M. and Tomlinson, R. (2012). *Climate Change Adaption Guidelines in Coastal Management and Planning*. Engineers Australia.
- Gordon, A. (2015) D. (2015) When did you last NABE a beach – beach scraping demystified for fun and profit, Paper prepared for Coastal Zone Management and Planning Conference, Sydney, 2015.
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- OEH (2018) CoastSnap Beach Monitoring. <https://www.environment.nsw.gov.au/research-and-publications/your-research/citizen-science/digital-projects/coastsnap>. Date accessed 2018-10-12.
- SCEC (2018) Sunshine Coast Environment Council. Maroochy River Groyne Renewal. https://www.scec.org.au/maroochy_river_groyne_renewal. Date accessed 2018-08-05.

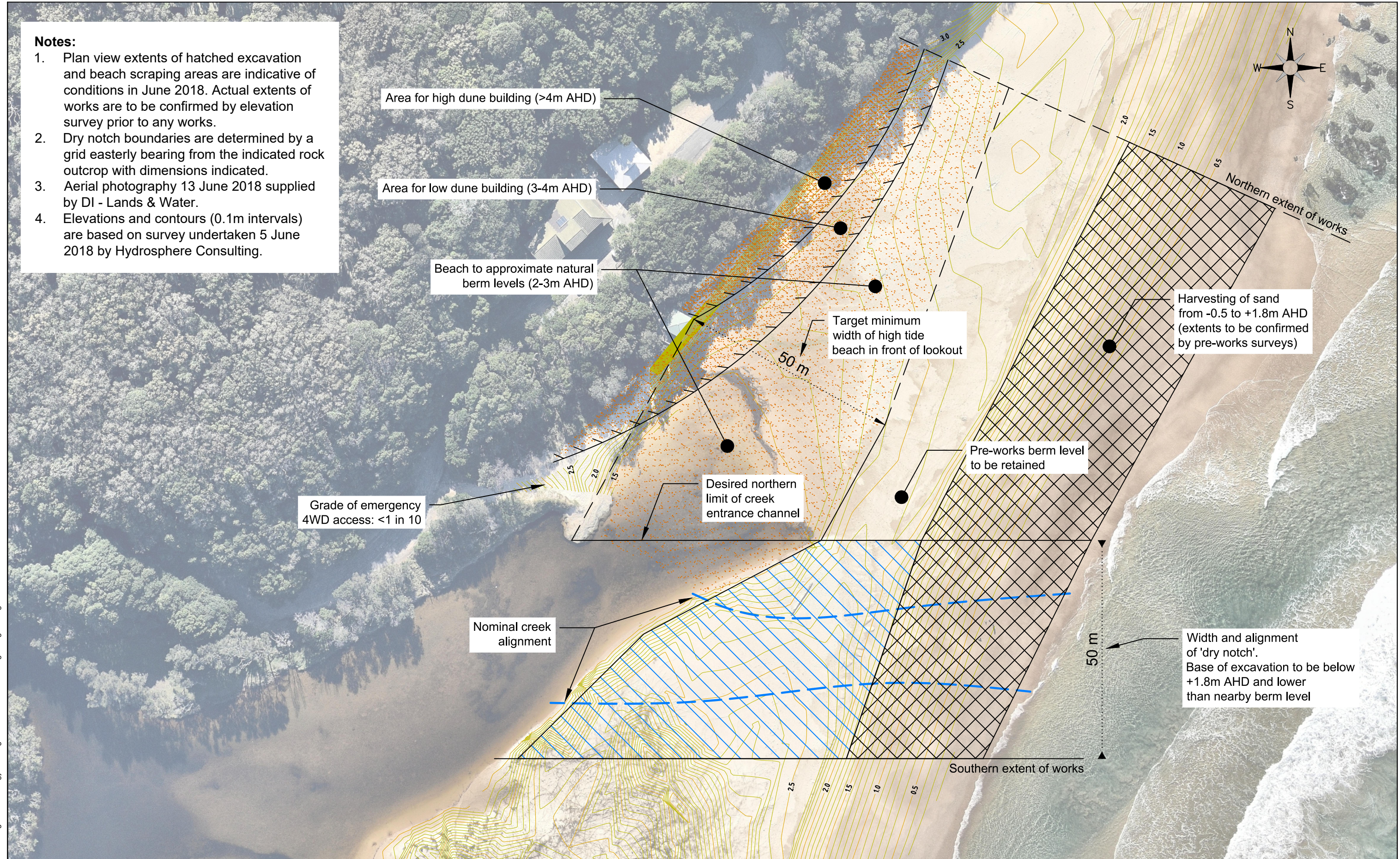
APPENDIX 1: DRAWINGS

Drawing 1: Location of Stage 1 Management Components

Drawing 2: Stage 2 Management

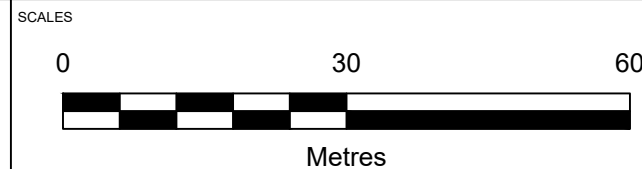
Notes:

1. Plan view extents of hatched excavation and beach scraping areas are indicative of conditions in June 2018. Actual extents of works are to be confirmed by elevation survey prior to any works.
2. Dry notch boundaries are determined by a grid easterly bearing from the indicated rock outcrop with dimensions indicated.
3. Aerial photography 13 June 2018 supplied by DI - Lands & Water.
4. Elevations and contours (0.1m intervals) are based on survey undertaken 5 June 2018 by Hydrosphere Consulting.



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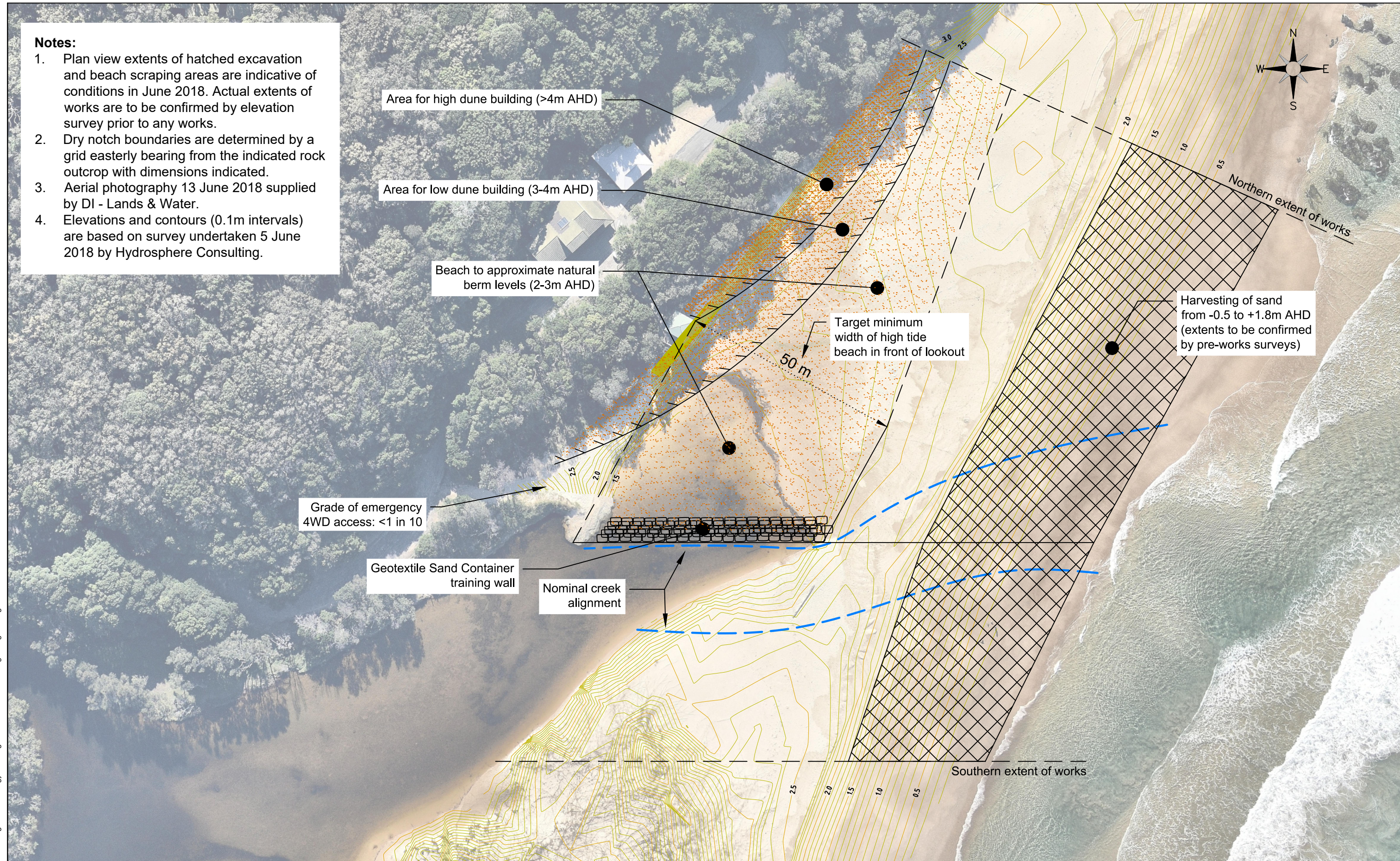
**DALHOUSIE CREEK ENTRANCE
 STAGE 1 MANAGEMENT COMPONENTS**

REVISION	DATE	DESCRIPTION	DRAWN
	2018-08-07	REV 0	MH

DRAWING NUMBER
DRAWING 1
 SHEET 1 OF 1

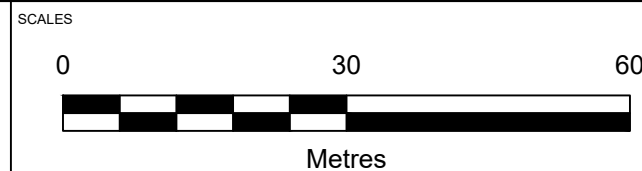
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**DALHOUSIE CREEK ENTRANCE
 STAGE 2 MANAGEMENT**

JOB NUMBER
 18-033

REVISION	DATE	DESCRIPTION	DRAWN
	2018-08-07	REV 0	MH

DRAWING NUMBER
DRAWING 2
 SHEET 1 OF 1

APPENDIX 2: STAKEHOLDER NOTIFICATION LIST

Organisation	Name	Phone	Email
NSW Department of Primary Industries – Fisheries NSW	Patrick Dwyer, Senior Fisheries Manager	02 6626 1397	patrick.dwyer@dpi.nsw.gov.au
NSW Office of Environment and Heritage – Coast, Estuary & Floods	John Schmidt, Senior Coast & Estuary Officer	02 6561 6726	john.schmidt@environment.nsw.gov.au
Coffs Harbour & District Local Aboriginal Land Council	AJ Perkins	02 6652 8740	programs@coffsharbourlalc.com.au
Bellinger Heads State Park Trust (Bellinger Shire Council representative)	Michelle McFadyen, Deputy General Manager	02 6655 7300	mmcfadyen@bellingen.nsw.gov.au
Bellinger Heads State Park Trust (NSW DoI Crown Lands representative)	Derek van Leest, Group Leader Property Management Far North Coast	02 6642 9236	derek.van.leest@crowland.nsw.gov.au
Urunga Surf Life Saving Club	Michael Dougherty, President	02 6655 6869	mdoc@citycentre.com.au