R299 Rev 0

July 2011

LandCorp

Onslow Townsite Planning
Coastal Setbacks & Development Levels

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marinas boat harbours canals breakwaters jetties submarine pipelines seawalls dredging reclamation

Job J883/1, Report R299 Rev 0

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1. Introduction

1.1 General

LandCorp are working with the Shire of Ashburton and other agencies to release land for residential, commercial and industrial development around the existing Onslow Townsite in the Pilbara Region of Western Australia. The key features of the Onslow Townsite and its surroundings area are shown in Figure 1.1.

Figure 1.1 - Onslow Townsite and Surroundings

As part of this process, development areas are required to comply with the State Coastal Planning Policy (Western Australian Planning Commission; WAPC 2003). LandCorp therefore commissioned specialist coastal and ports engineers M P Rogers & Associates Pty Ltd (MRA) to assess the appropriate setback to account for the action of physical coastal processes in line with the State Coastal Planning Policy (SCPP) as well as to investigate potential coastal inundation in order to determine the appropriate development levels.

This report has been split into two parts, the first dealing with the coastal setback assessment while the second part investigates the extent of potential coastal inundation.

This report presents the data, methods and findings of the Onslow Coastal Setback and Development Levels study.

1.2 Site Setting

The area under consideration extends from 4 Mile Creek to Beadon Creek. In order to incorporate a detailed analysis and allow for easier identification of specific areas, the 10 km of Onslow coastline was divided into 200 m intervals.

The locations of these intervals are shown in Figure 1.2.

Figure 1.2 - Interval Locations

Where the shoreline characteristics, such as beach width, dune height and shoreline orientation, were considered to be relatively uniform the coastline was separated into sections. These sections are identified by the intervals shown in Figure 1.2 and are described in the following sections.

1.2.1 0 m Interval to 5,200 m Interval

This section extends from 4 Mile Creek to 1 km south of the Onslow Salt Jetty. The shoreline in this region is characterised as a relatively exposed section of beach, with a wide flat beach backed by low (+5 mAHD) sand dunes. The beach remains relatively uniform for the entire length of this section of shoreline.

A typical example of the shoreline in this section is given in Figure 1.3. It can be seen that the beach experiences heavy 4WD use.

Figure 1.3 - Typical Shoreline - Intervals 0 m to 5,200 m

1.2.2 5,200 m Interval to 7,200 m Interval

This region extends from the beach 1 km south of the Onslow Salt Jetty north towards Beadon Point where the beach narrows. This section has an exposed wide flat beach backed by low sand dunes. The height of these sand dunes increases as the beach progresses north with dune heights of approximately +7.5 mAHD achieved. An example of this region is given in Figure 1.4.

Figure 1.4 - Typical Shoreline - Intervals 5,200 m to 7,200 m

1.2.3 7,200 m Interval to 7,800 m Interval

This region covers the majority of Beadon Point and is characterised by a narrow flat beach in comparison to other sections with a wide rocky intertidal terrace. The beach is backed by dunes of approximately +5 to +7.5 mAHD which lead into a localised hill with heights of +18 mAHD. Figure 1.5 shows the typical shoreline around Beadon Point.

Figure 1.5 - Typical Shoreline - Intervals 7,200 m to 7,800 m

1.2.4 7,800 m Interval to 8,600 m Interval

This section of shoreline extends from the western end of the seawall near the narrow beaches of Beadon Point eastwards to the end of the seawall protecting the main townsite.

The majority of this region consists of a wide beach backed by a limestone rock seawall. The limestone seawall runs the length of the main townsite with a crest height of approximately +4.6 mAHD. Figure 1.6 shows the western and eastern sections of the seawall.

Figure 1.6 - (a) Western end of Seawall, (b) Eastern end of Seawall

1.2.5 8,600 m Interval to 10,200 m Interval

This area covers the remaining coastline between the end of the seawall and Beadon Creek to the east. It generally has flat wide sandy beaches backed by very low dunes. This can be seen in Figure 1.7.

Figure 1.7 - Typical Shoreline - Intervals 8,600 m to 10,200 m

The height of the dunes remains below +3 mAHD for a significant distance inland. Figure 1.8 shows a typical view of the region behind the primary dune system.

Figure 1.8 - Area Behind the Primary Dunes

1.3 State Coastal Planning Policy

In June 2003, the Western Australian State Government released Statement of Planning Policy No. 2.6 - The State Coastal Planning Policy (SCPP). The SCPP provides guidance for new development, including subdivision and strata subdivision, on the Western Australian coastline. Schedule One of the SCPP outlines the recommended criteria for use in determining the appropriate Physical Processes Setback (PPS). The PPS should provide a low level of risk to the development from coastal erosion over a 100 year planning horizon.

The PPS is measured from the horizontal setback datum (HSD). For a sandy shoreline the HSD is identified as the seaward extent of ephemeral vegetation on an accreting coast, or the toe of the erosion scarp on an eroding coast. As the only rock observed onsite at Onslow was located in the intertidal terrace, the shoreline for Onslow will be taken as sandy.

In 2010 a Position Statement (WAPC 2010) was released to update the requirements of the SCPP. This position statement related solely to the required allowances for climate change and is described in further detail below.

For the general case of development on an undeveloped sandy shoreline, the SCPP recommends using the following criteria to calculate the appropriate PPS:

- Severe Storm Erosion (S1) – Allowance for short-term erosion caused by a design storm event. S1 is calculated using the SBEACH profile change model to simulate the response of the shoreline to the design storm event.

- Historic Shoreline Movement Allowance (S2) – Allowance for chronic long-term trends caused by the local coastal dynamics. This needs to provide a buffer for the coming 100 years. This value is calculated from aerial photographs and surveys showing the movement of the vegetation line over at least a 40 year period.

- Sea Level Change Allowance (S3) – Allowance for possible recession of the shoreline as a result of anticipated sea level rise in the coming 100 years. The Position Statement released by the WAPC in 2010 introduced the requirement for a 0.9 m allowance for sea level rise by 2110. This allowance is based upon the Intergovernmental Panel on Climate Change (IPCC) AR4 model scenario and CSIRO (2008).

  The AR4 scenario tracks the highest IPCC predictions for sea level rise and is a large increase from the previous requirement of 0.38 m, which allowed for sea level rise predicted by the mean of the median model of the 2007 IPCC working group report.

Each of these criteria, as they relate to the subject site, are considered further in following sections.

It is also important to note that Onslow is located within an area that experiences cyclonic activity. As such, the SCPP specifies that development should be set back from the coast to afford development protection from the impact of cyclonic storms. This requires a further variation to the general case of development on an undeveloped sandy shoreline.

For areas north of latitude 30 degrees south, the SCPP recommends that the S1 component be calculated by modelling a category 5 cyclone tracking to maximise its associated storm surge at the subject location, coincident with a Mean High Water Spring (MHWS) tidal level.

The SCPP also includes a case for the development of land located between existing developments. This is known as an infill development case and would be applicable to any vacant lots or redevelopments that are to occur within the Onslow Townsite.

The policy states that the coastal processes setback for infill development should:

"*seek to provide immediate protection for new development while accepting the reasonable and likely future protective requirements of adjoining development…a minimum setback of S1 should apply*" (WAPC 2003).

On this basis it is reasonable to assume that any new development within the confines of the existing Onslow townsite should fall under the classification of infill development.

Lastly, it should be noted that the SCPP states that a foreshore reserve must also consider factors such as public beach access and ecological values. The scope of this report does not include consideration of these factors, but only the requirements to protect development from physical coastal processes.

2. Severe Storm Modelling (S1)

Severe storm events have the potential to cause increased erosion to a shoreline, through the combination of higher, steeper waves generated by sustained strong winds, and increased water levels. These two factors acting in concert allow waves to erode the upper parts of the beach not normally vulnerable to wave attack.

If the initial width of the surf zone is insufficient to dissipate the increased wave energy, this energy is often spent eroding the beach face, beach berm and sometimes the dunes. The eroded sand is transported offshore with the return water flow to form offshore bars. As these bars grow, they can cause incoming waves to break further offshore, decreasing the wave energy available to attack the beach. This is shown diagrammatically in Figure 2.1.

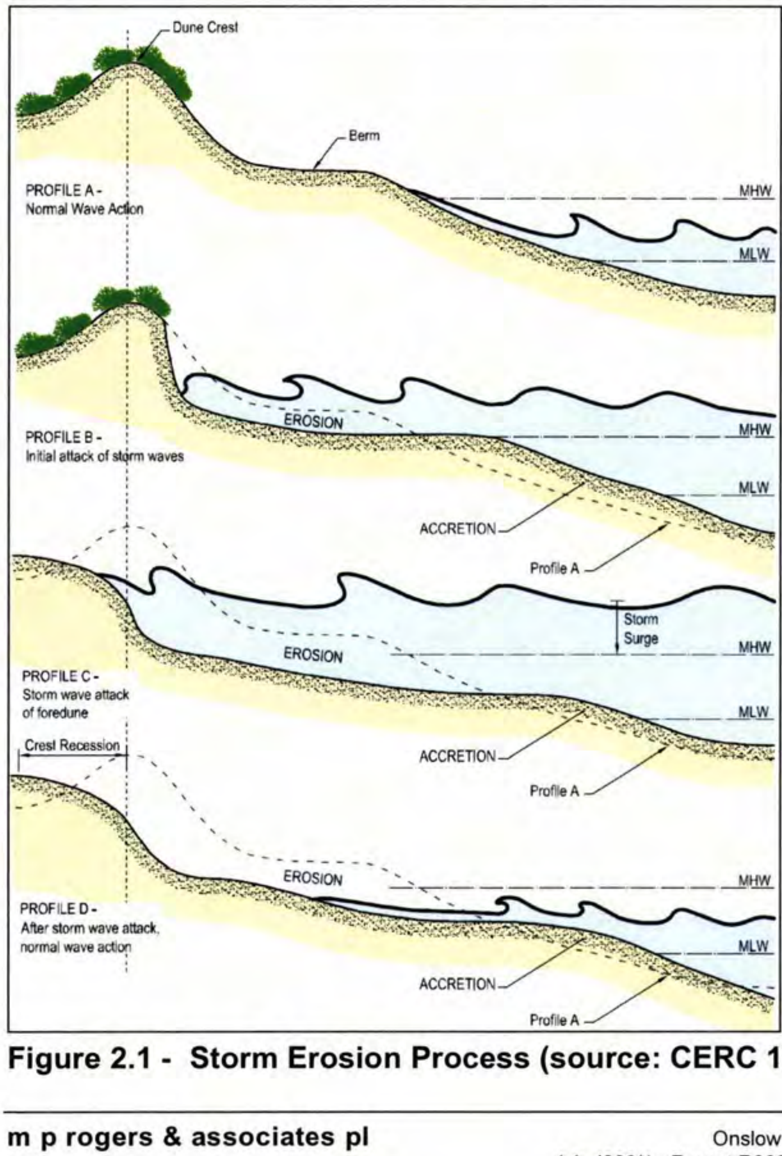

Figure 2.1 - Storm Erosion Process (source: CERC 1984)

Onslow is located north of latitude 30 degrees within the cyclone prone area identified by SCPP 2.6. Subsequently, the impact of cyclonic events is to be used for calculations of the S1 allowance at Onslow.

Cyclones are low pressure systems that form over warm tropical waters and have gale force winds (sustained winds of 63 km/h or greater and gusts in excess of 90 km/h) near the centre (BoM 2010). Cyclones generate gale force winds in a clockwise direction at their base in the southern hemisphere, as shown in Figure 2.2.

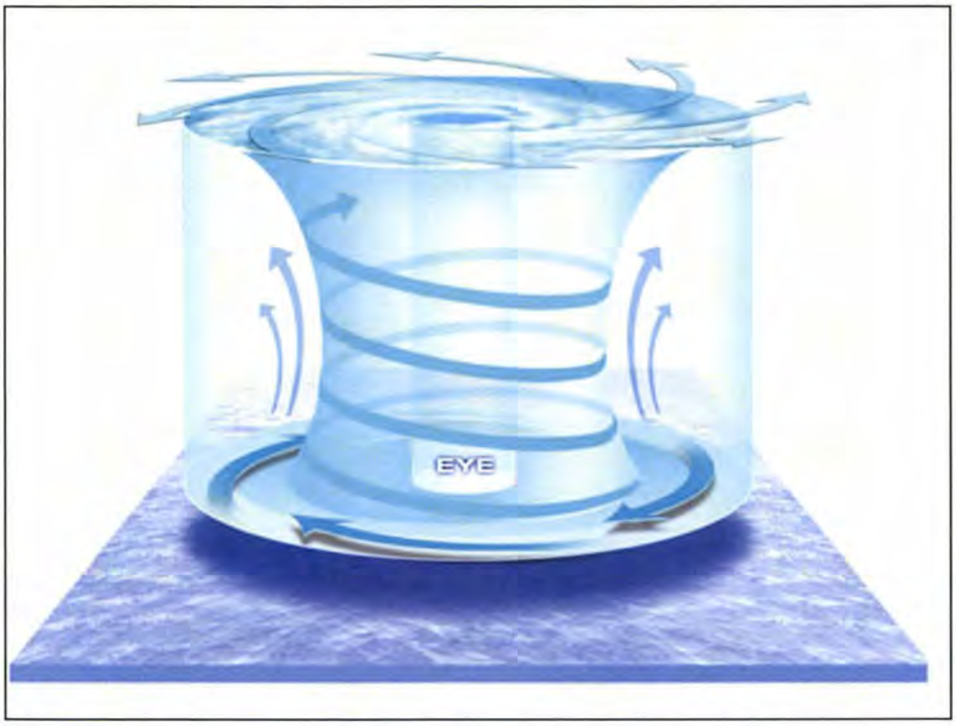

Figure 2.2 - Tropical Cyclone Structure (BoM 2009a)

The eye of a tropical cyclone is an area characterised by light winds and often by clear skies. Eye diameters are typically 40 km but can range from under 10 km to over 100 km. The eye is surrounded by a dense ring of cloud about 16 km high known as the eye wall which marks the belt of strongest winds and heaviest rainfall. Large waves and high water levels are also often associated with tropical cyclones.

2.1 Extreme Waves

Waves are created when winds blow over an area of water often referred to as the fetch. The main mechanism for wind wave generation is the interaction of wind stress with the surface tension of the water, creating waves in the general direction of the wind. The size of the waves created by the wind is determined by a number of factors, including:

- the length of the fetch;
- the period of time or duration the wind blows over the fetch;
- the speed of the wind; and
- the water depth.

For example a severe cyclone blowing for a number of days over a large fetch in deep water will create very large waves, while a light wind blowing over a small fetch in shallow water will create small wind waves.

The coastline around Onslow is relatively exposed with only a few small islands located offshore, therefore Onslow is expected to bear the majority of the force from an approaching cyclone.

2.2 Extreme Water Levels (Storm Surge)

The most extreme water levels generally occur when a storm surge coincides with a high tide and large wave climate, as shown in Figure 2.3.

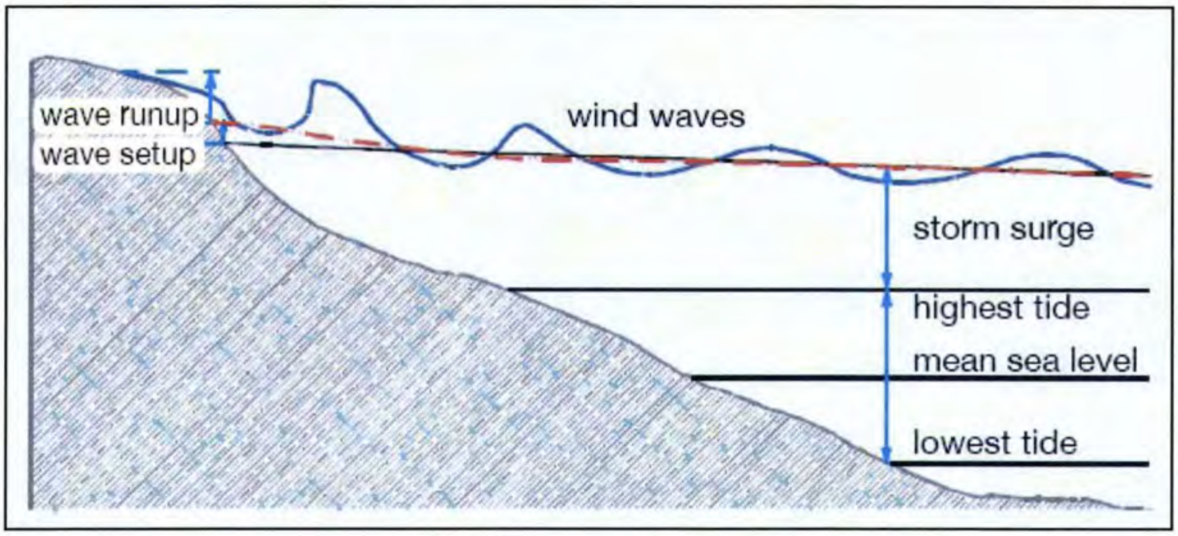

Figure 2.3 - Diagram of Extreme Sea Level

A storm surge occurs when a storm with high winds and low pressures, such as a tropical cyclone, approaches the coastline. The strong, onshore winds push water against the coastline (wind and wave setup) and the barometric pressure difference creates a region of high water level. These factors acting in concert create the storm surge. The size of the storm surge is influenced by the following factors:

- wind strength and direction;
- pressure gradient;
- seafloor bathymetry; and
- coastal topography.

Storm surges at Onslow are likely to be dominated by cyclonic activity. Cyclones and low pressure storms close to the Onslow coastline will create increased water levels due to the barometric pressure difference. The magnitude of this water level rise is dependent on the central pressure of the cyclone and the proximity to the cyclone's eye.

2.3 Cyclone Modelling

MRA believe that an appropriate design event for the severe storm erosion modelling of Onslow is to use Tropical Cyclone Vance scaled up to the 100 yr ARI event. Tropical Cyclone Vance (hereafter referred to as TC Vance) passed Onslow on the 23 March 1999 with wind gusts of 167 km/hr recorded at the town (BOM 2000).

Figure 2.4 shows an aerial photograph taken to the west of Onslow that was taken after TC Vance.

Figure 2.4 - Dune Scour After TC Vance (Source: BOM 2000)

2.3.1 Water Levels

Previous work conducted by GEMS consisted of modelling Tropical Cyclone events for the Onslow area. These GEMS reports, *Onslow Salt Storm Surge Inundation Study Stage 4 (1999)* and *Onslow Storm Surge Study (2000),* used a large number of simulated cyclones with varying parameters to determine the likely return period for various water levels.

From the *Onslow Storm Surge Study* the 100 yr ARI water level for an offshore point at the -1 mAHD contour is +4.2 mAHD. This offshore water level includes an allowance for error of +0.3 mAHD.

While the cyclone methodology and analysis used in these GEMS reports is sound, due to topographical data issues the nearshore water level conditions are not considered reliable. Therefore MRA conducted additional modelling to obtain the near shore water level conditions.

Using the recorded water levels for TC Vance, MRA were able to obtain tidal residuals for this event and apply them to a suitable spring tide period for Onslow. Care was taken to ensure that the combined residuals and spring tide allowed for the peak water level of +4.2 mAHD to be achieved.

Figure 2.5 shows the design event water levels used in the cyclone modelling.

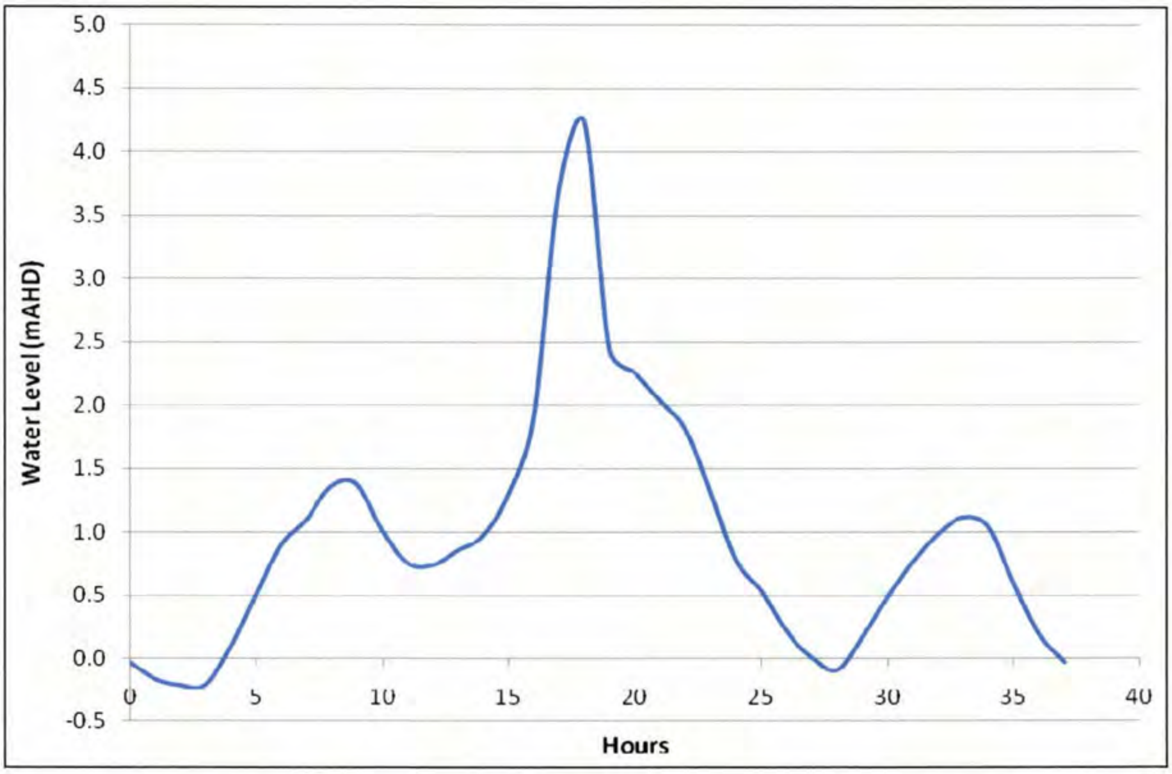

Figure 2.5 - Design Event Water Levels

2.3.2 Waves

MRA has developed a sophisticated wave model capable of properly modelling the changes in wave conditions as waves travel from deep water to the shore. This model is called 2GWAVE and is a highly modified version of Prof Ian Young's ADFA1 model. The modifications to ADFA1 ensure that 2GWAVE properly accounts for the complex changes in wave conditions caused by reefs, banks, seagrass meadows, nearshore bathymetry and atmospheric input. The physical processes explicitly modelled include:

- spectral wave refraction and shoaling;
- spectral wave generation by wind;
- spectral wave dissipation by turbulence in the bottom boundary layer with the ability to have different friction factors for different seabed conditions, for example sand, reef or seagrass;
- spectral wave dissipation by white-capping;
- spectral wave dissipation by depth limited breaking; and

- non linear wave / wave interactions.

The model is described in detail by MRA (1995) and has previously been calibrated and validated using comprehensive directional wave measurements south-west of Rottnest Island, on Success Bank, in Owen Anchorage and in Cockburn Sound (MRA 1995, 2005).

The 2GWAVE model can be used to simulate cyclonic conditions such as those associated with TC Vance. These conditions are generated within the model with the use of an inbuilt wind field generation system. The generated wind field then drives the development of the wave field through the standard model processes.

To optimise model accuracy and run time, the model was set up in a nested grid format, with a finer grid contained within the larger 'coarse' grid. The location and extents of the outer 'A' Grid and inner 'B' Grid are shown in Figure 2.6. The size and resolution of the grids are given in Table 2.1.

Table 2.1 - 2GWAVE Grid Sizes and Resolutions

Grid	Size (km)	Resolution (m)
A	99 x 75	20,000
B	61 x 61	1,000[1]

Notes: 1 – The B Grid uses a 500 m grid for refraction calculations

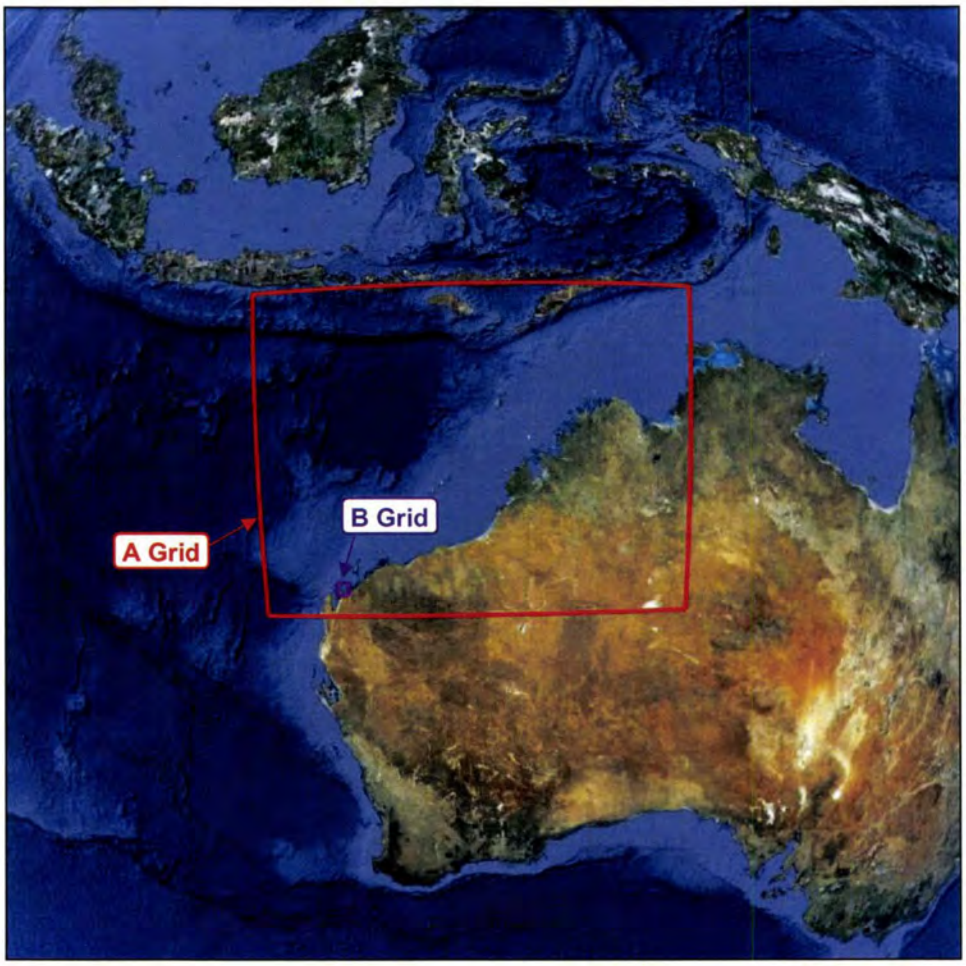

Figure 2.6 - 2GWAVE Model Grid Extent

The 2GWAVE model requires three types of grid input files. These file types are:

- bathymetry;

- bed friction factor codes; and
- model codes.

The bathymetry grid was created using available bathymetry information from the various navigational charts prepared by the Royal Australian Navy.

To properly account for the effects of bottom friction on the wave field the bed friction factor codes grid is used to differentiate between the different seabed types and assign each with a specific friction factor. Review of available geotechnical information for the area together with the different bottom conditions identified on the available charts suggested that bottom conditions were mainly sandy, with patches of reef present particularly around the islands. Friction factors were assigned to each of these seabed types using information gathered in previous modelling works completed by MRA combined with engineering judgement.

The final grid type, the model codes grid, is used to specify the particulars of the modelling including regions of land, grid boundaries and model input and output locations.

During simulation of cyclonic conditions within the model, a typical low energy background swell event was used as a boundary forcing condition for the model. This use of the typical background conditions in concert with the local generation associated with the cyclone wind field provides a more realistic estimation of the wave conditions than purely modelling the local generation of waves.

In order to complete the cyclonic modelling, cyclone track and meteorological data for TC Vance was obtained from the BOM cyclone track data base. This data was used to simulate the passage of TC Vance from the Timor Sea through to the shore-crossing in the Exmouth Gulf.

Aside from the cyclone location, inputs to the model included:

- forward speed;
- travel direction;
- radius to maximum winds; and
- maximum wind speed.

The output of the 2GWAVE model consists of full directional wave spectra and summary parameters of wave height, period and direction at all grid points at every time step. From this, a time history of the summary parameters can be created at any point on the grid. Spatial plots of these variables can be created for a specified time step in the model run, and directional spectra can also be created at specified grid points for any time step of the model run.

Output from the 2GWAVE A grid is provided below for the passage of TC Vance. This output shows that very significant wave heights, in excess of 12 m, are expected offshore. Nearshore wave heights appear to be depth limited.

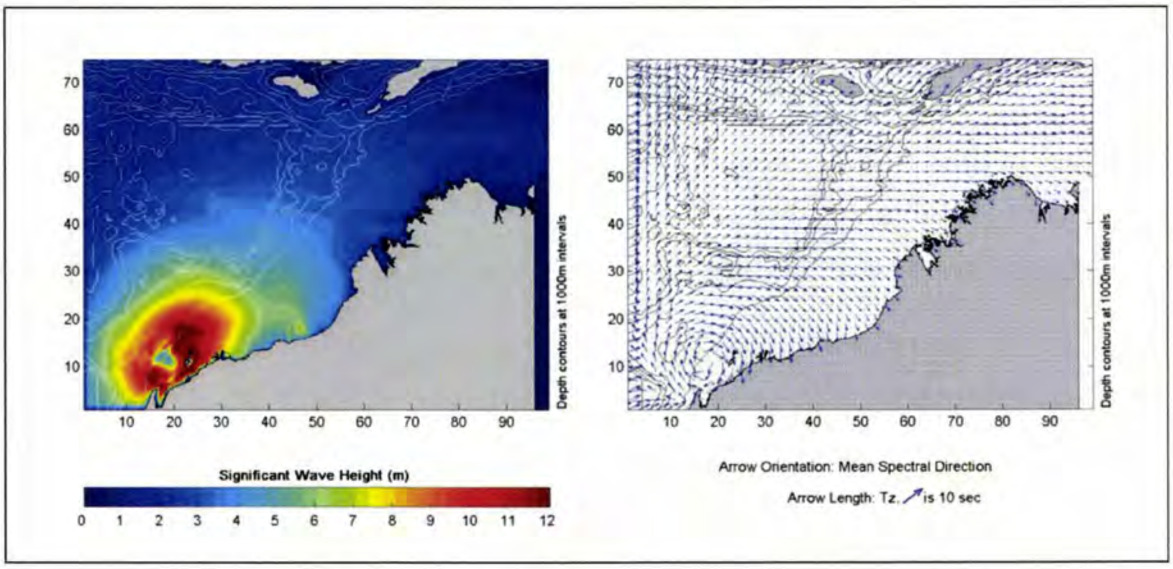

Figure 2.7 - 2GWAVE Simulation for TC Vance

Analysis of the nested B grid output shows that significant wave heights in the order of 4 to 6 m are calculated for the nearshore area landward of the 10 m contour. Using a 2GWAVE output point located at the -10.2 mAHD contour, wave data encompassing 36 hours of TC Vance offshore wave conditions was obtained.

2.4 SBEACH Modelling

The SBEACH computer model was developed by the Coastal Engineering Research Centre (CERC) to simulate beach profile evolution in response to storm events. It is described in detail by Larson & Kraus (1989). Since this time the model has been further developed, updated and verified based on field measurements (Wise et al 1996, Larson & Kraus 1998, Larson et al 2004).

SBEACH has also been validated locally by MRA, with results outlined in Rogers et al (2005). This local validation showed that SBEACH can provide useful and relevant predictions of the storm induced erosion provided the inputs to SBEACH, which include time histories of wave height, period and water elevation, as well as pre-storm beach profile and median sediment grain size, are correctly applied and care is taken to ensure that the model is accurately reproducing the recorded wave heights and water levels.

The SCPP recommends the allowance for severe storm erosion be determined by modelling the impact of an appropriate storm sequence using acceptable models such as SBEACH (WAPC 2003).

Recent studies in the Pilbara Region have modelled three repeats of the design event to model beach erosion. One such study is the Cardno (2011) report *Port Hedland Coastal Vulnerability Study (Rep1022p) – Appendix D* which details the severe storm modelling conducted at Port Hedland. As the two areas are considered similar in terms of cyclone risks this approach is believed to be an appropriate method for determining the beach erosion at Onslow. Therefore, as per the Cardno report the design event conditions will be repeated for three consecutive runs giving a severe storm duration of 108 hours.

The offshore wave and water level conditions determined for the design event were then run inshore by MRA to obtain the 100 yr ARI inshore conditions.

As previously mentioned in Section 1.2, the Onslow coastline varies in beach width, dune heights and beach orientation. In order to calculate appropriate setbacks for the shoreline around Onslow, SBEACH was used to simulate the beach profile change in each section due to the severe storm. The approximate locations of the profiles are indicated in Figure 2.8.

Figure 2.8 - SBEACH Profile Locations

The locations of these profiles were chosen to be representative of the Onslow shoreline.

The profiles used in the SBEACH simulations were taken to -10.2 mAHD which is the water depth at which the offshore conditions are input. The profiles were determined using local bathymetry taken from Nautical Charts Aus 743 and Aus 64 as well as survey profiles of the beach and nearshore area taken on site by MRA. Additional topographical survey information was also obtained for the site and provided elevations for the area behind the dune which allowed the profiles to be extended inland.

SBEACH requires as an input a representative sediment size in order to model profile evolution. MRA obtained sediment samples for the Onslow coastline while onsite. The results of the particle size distribution (PSD) analysis are included in Appendix A. The PSD analysis determined that the d_{50} for the Intervals 0 m to 5,200 was 0.25 mm, for Intervals 5,200 m to 7,800 it was 0.31 mm while from Intervals 7,800 m to 10,200 m there was a finer sediment size of 0.21 mm. Each SBEACH profile has been modelled with its relevant d_{50}.

As mentioned previously the extent of severe storm erosion is generally measured from the HSD, which in the case of Onslow is the vegetation line. This varies from +1.75 mAHD for Profile 5 near Interval 9,400 m to +2.80 mAHD near Interval 200 m.

When determining the S1 factor from the modelling it is important to consider how the factor is determined. The SCPP recommends that the S1 factor should be taken as the maximum recession of the mean sea level contour. However, the movement of the mean sea level contour has minimal direct effect on the safety of development located adjacent to the coast. The extent of the erosion that occurs behind the HSD is considered to be the critical factor for development. Therefore the S1 factor will be taken as the greater of erosion behind the HSD and the recession of the MSL.

Using the wave and beach parameters outline above the SBEACH modelling was run for the SBEACH profiles as follows. The SBEACH reports for all profiles are attached in Appendix B.

2.4.1 Profile 1 Erosion (Interval 0 m to 5,200 m)

Due to the high design event water levels and low primary dune heights Profile 1 had to be extended approximately 150 m inland from the Mean Sea Level (MSL) contour in order to map the erosion of the beach profile.

The SBEACH simulation for Profile 1 shows the initial and final beach profiles, peak water levels and peak wave heights and is provided in Figure 2.9. This SBEACH profile was modelled with a HSD of +2.8 mAHD and a d_{50} of 0.25 mm.

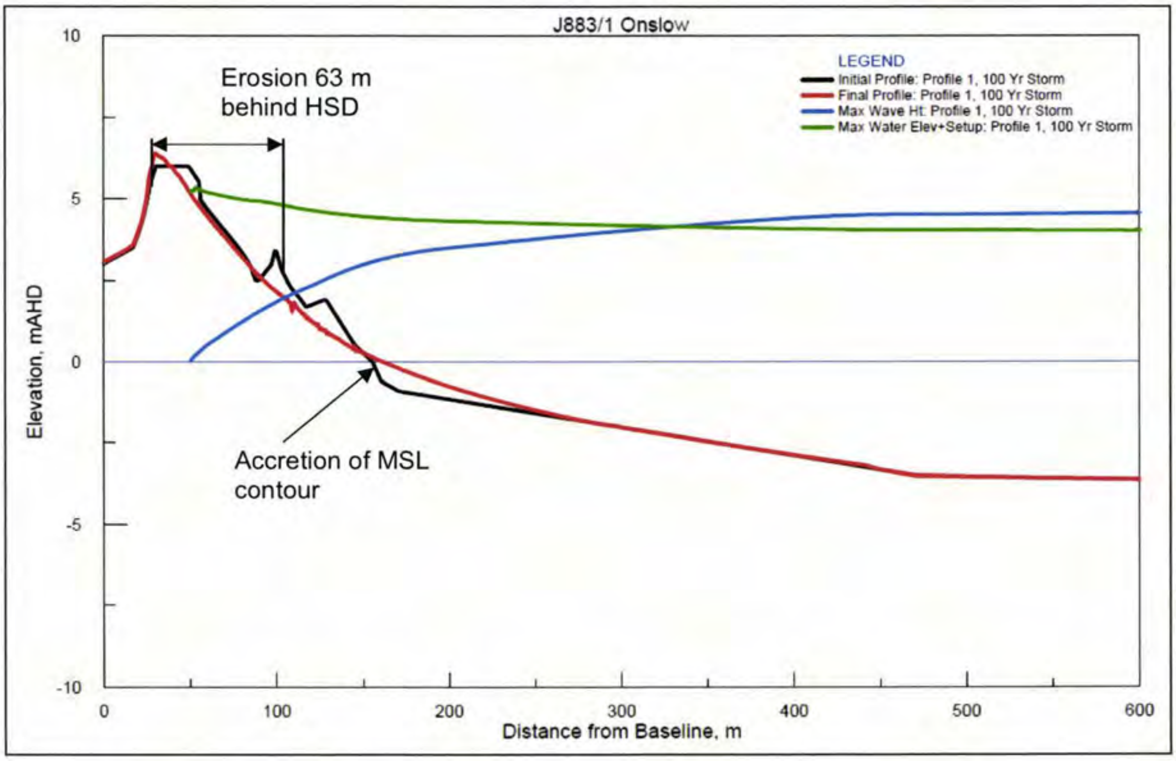

Figure 2.9 - Simulated Erosion Results for Profile 1

The output provided in Figure 2.9 shows that there is erosion of the beach berm and dune system and accretion of the MSL contour. It can be seen that the landward most extent of erosion is approximately 63 m behind the HSD. Further analysis shows that the erosion of the beach profile is relatively minimal with the extent of erosion mostly resulting from the highly elevated water levels. This relatively modest level of simulated erosion may be because the southern shoreline is in such an exposed location that it has, over time, developed a beach profile that is better able to resist the effect of severe storms.

MRA have previously proposed to use the larger recession of either the HSD or the MSL contour for this assessment. Therefore the severe storm allowance (S1) for Profile 1 is **63 m**.

2.4.2 Profile 2 Erosion (Interval 5,200 m to 6,400 m)

Due to the high design event water level and low primary dune heights Profiles 2 was extended approximately 150 m inland to map the erosion of the beach profile.

The SBEACH simulation for Profile 2, with initial and final beach profiles, peak water levels and peak wave heights is provided in Figure 2.10. This SBEACH profile was modelled with a HSD of +2.6 mAHD and a d_{50} of 0.31 mm.

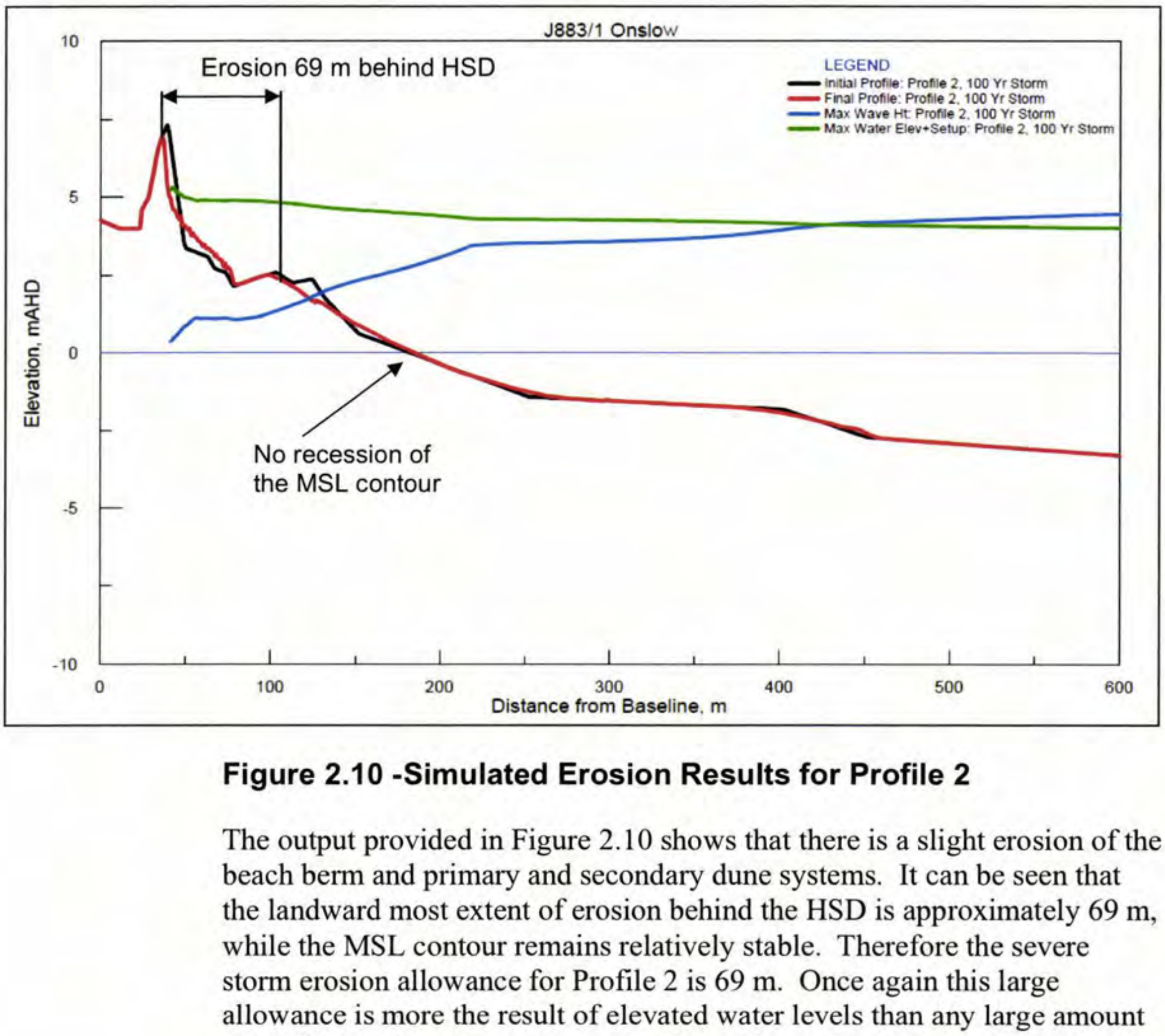

Figure 2.10 -Simulated Erosion Results for Profile 2

The output provided in Figure 2.10 shows that there is a slight erosion of the beach berm and primary and secondary dune systems. It can be seen that the landward most extent of erosion behind the HSD is approximately 69 m, while the MSL contour remains relatively stable. Therefore the severe storm erosion allowance for Profile 2 is 69 m. Once again this large allowance is more the result of elevated water levels than any large amount of profile erosion.

2.4.3 Profile 3 Erosion (Interval 6,400 m to 7,800 m)

The SBEACH simulation for Profile 3 showing the initial and final beach profiles, peak water levels and peak wave heights is provided in Figure 2.11. This SBEACH profile was modelled with a HSD of +2.3 mAHD and a d_{50} of 0.31 mm.

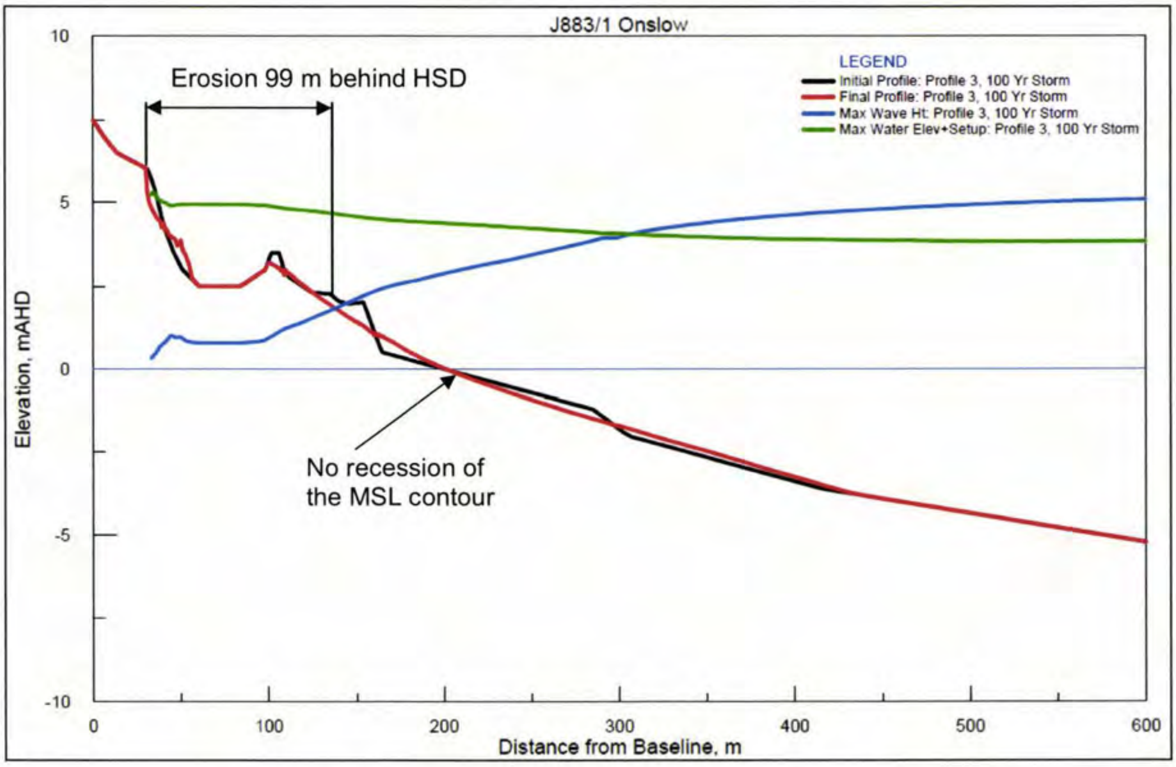

Figure 2.11 -Simulated Erosion Results for Profile 3

As Figure 2.11 shows, while SBEACH predicts limited erosion of the beach profile and dune system, the elevated water levels result in a landward most erosion extent approximately 99 m behind the HSD. For comparison, the MSL contour remained stable.

The S1 allowance for Profile 3 is **99 m**.

2.4.4 Profile 4 Erosion (Interval 7,800 m to 8,600 m)

The shoreline surrounding Profile 4 consists of a sandy beach fronting a limestone rock seawall with a crest at approximately 4.6 mAHD.

The SBEACH simulation for Profile 4 shows the initial and final beach profiles, peak water levels and peak wave heights in Figure 2.12. This SBEACH profile was modelled with a d_{50} of 0.21 mm.

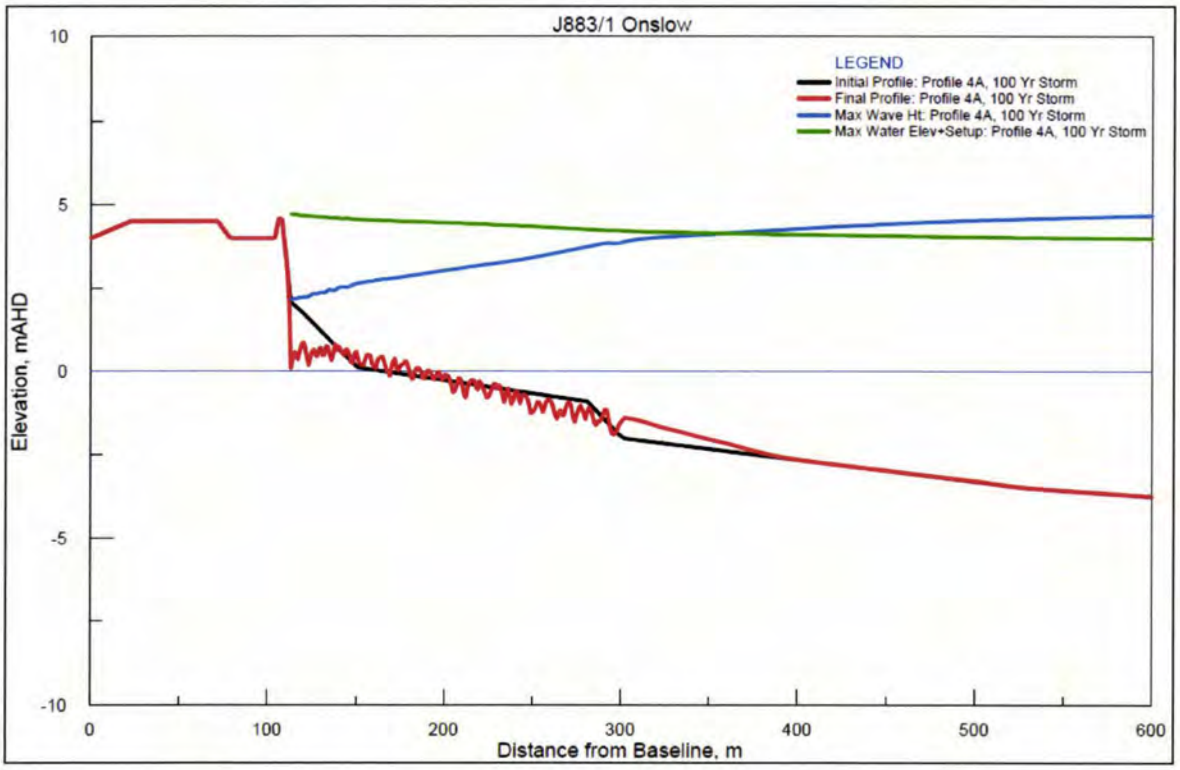

Figure 2.12 -Simulated Erosion Results for Profile 4

As Figure 2.12 shows, SBEACH predicts erosion of the beach in front of the seawall. This leads to the accretion of the MSL contour by approximately 30 m as the sand is transported offshore. As the seawall is founded at 0 mAHD the structure is not expected to fail due to scour. However it should be noted that the seawall is not designed for the 100 yr ARI event due to community requirements and economical considerations, therefore the structure may experience damage that would alter results of the erosion modelling.

It can be seen that the maximum water level approaches the crest height of the structure. Therefore, the seawall crest and splash apron, together with the seawall itself, should be monitored after any cyclone attack and maintained as required.

To account for any potential damage to the seawall during the design event as well as to allow for wave overtopping, it is proposed that a S1 allowance of **30 m** be used for Profile 4.

2.4.5 Profile 5 Erosion (Interval 8,600 m to 9,400 m)

For Profile 5 the secondary dune systems achieve relatively high dune heights within 150 m of the MSL contour. The SBEACH simulation of erosion for Profile 5 showing the initial and final beach profiles, peak water levels and peak wave heights is provided in Figure 2.13. This SBEACH profile was modelled with a HSD of +1.8 mAHD and a d_{50} of 0.21 mm.

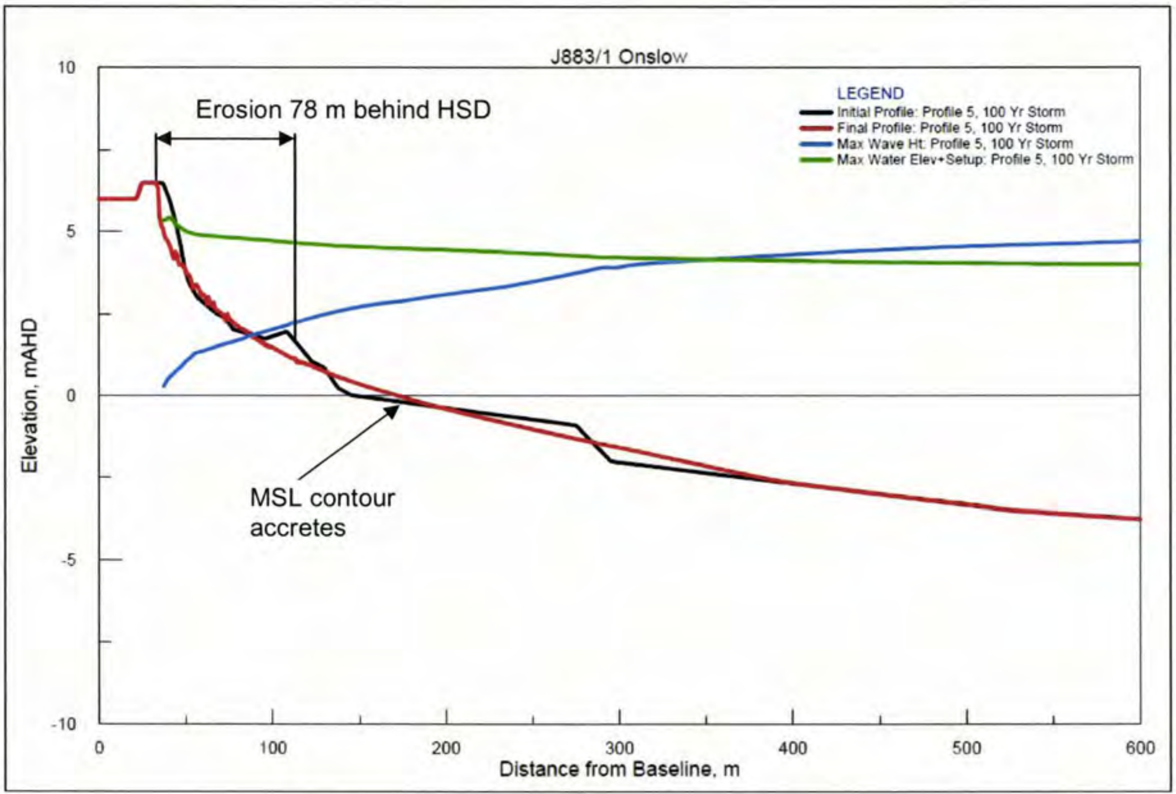

Figure 2.13 -Simulated Erosion Results for Profile 5

As Figure 2.13 shows, SBEACH predicts the landward most extent of erosion as being approximately 78 m behind the HSD. There is some erosion of the beach profile and dune system as well as a large accretion of the MSL contour. However most of the erosion extent for this profile is the result of high water levels.

Therefore the S1 allowance for Profile 5 is **78 m**.

2.4.6 Profile 6 Erosion (Interval 9,400 m to 10,200 m)

As a result of the high design event water levels and low dune heights Profile 6 had to be extended approximately 300 m inland to map the erosion of the beach profiles.

The SBEACH simulation for Profile 6 showing the initial and final beach profiles, peak water levels and peak wave heights is provided in Figure 2.14. This SBEACH profile was modelled with a HSD of +2.3 mAHD and a d_{50} of 0.21 mm.

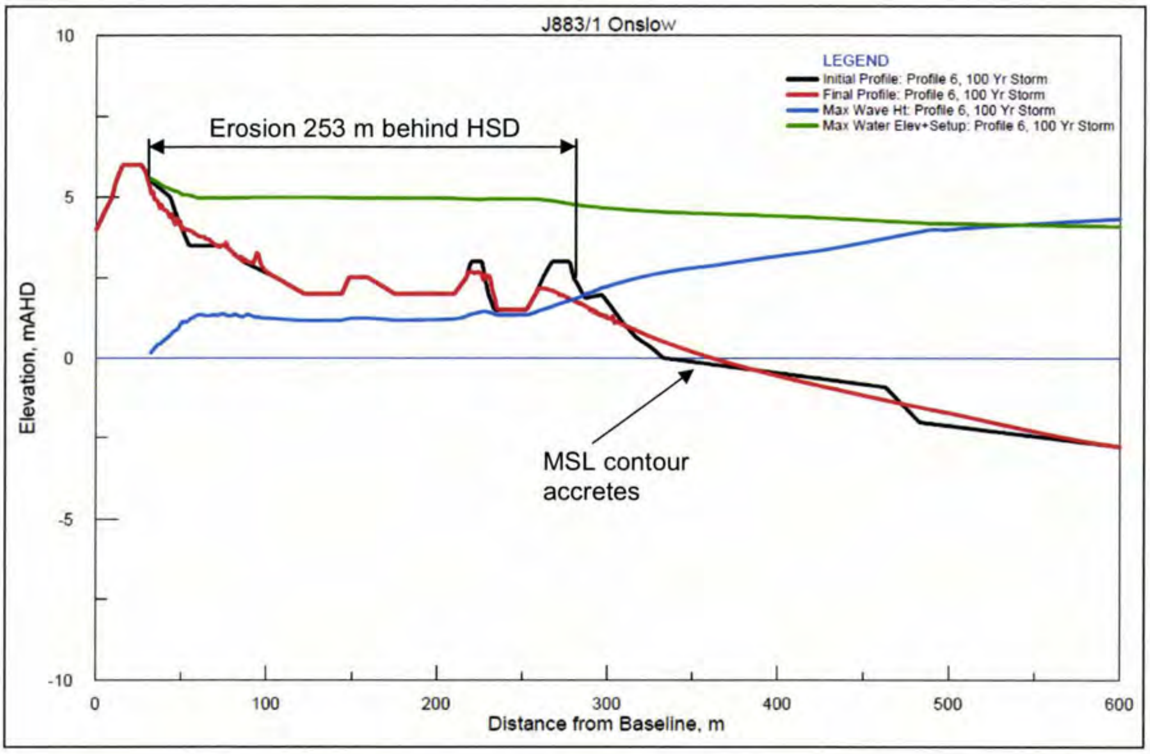

Figure 2.14 -Simulated Erosion Results for Profile 6

As Figure 2.14 shows, the combination of low dune heights and high water levels has led to the landward most extent of erosion being approximately 253 m behind the HSD. The MSL contour is shown to accrete while the erosion of the SBEACH profile behind the primary dune is relatively minor.

Therefore the S1 allowance for Profile 1 is **253 m**.

2.5 Severe Storm Erosion Summary

During the severe storm erosion modelling it was observed that the majority of the S1 allowance for Profile 6 (Intervals 9,400 m to 10,200 m) was caused by elevated water levels overtopping the +3 mAHD primary dune system. These low dune heights are believed to be the result of rapid shoreline accretion which has prevented the build up of substantial primary dune heights (as discussed in Section 3).

The large S1 value for Profile 6 (Intervals 9,400 m to 10,200 m) is therefore more attributed to inundation of the profile, rather than erosion. It follows therefore that if development of this area was required, filling and earthworks could be used to greatly reduce the inundation of the profile and therefore the S1 allowance. If this filling is undertaken it would be reasonable to expect an erosion response similar to that determined for Intervals 8,600 m to 9,400 m. As a result, a S1 allowance of between 78 and 253 m would be appropriate for this section of coast depending on the amount of filling and earthworks that would be completed.

Table 2.2 outlines the simulated severe storm erosions for Onslow using the SCPP storm.

Table 2.2 - Severe Storm Erosion Summary

Intervals	S1 Allowance
0 m to 5,200 m	63 m
5,200 m to 6,400 m	68 m
6,400 m to 7,800 m	99 m
7,800 m to 8,600 m	30[1] m
8,600 m to 9,400 m	78 m
9,400 m to 10,200 m	78[2] m to 253 m

Note:

1. 30 m recommended to allow for potential damage to the seawall and wave overtopping
2. 78 m S1 allowance is based upon the area being filled before development.

Where the required setback changes along a continuous section of coastline a 200 m transition zone is used. Changes to the required setback distance are linearly apportioned over this 200 m transition zone.

3. Historical Shoreline Movement (S2)

Historically, changes in shorelines occur on varying timescales from storm to post storm, seasonal and longer term (Short 1999). The S1 component accounts for the short term storm timescale of beach change. S2 is intended to account for the longer term movement of the shoreline that may occur within the planning timeframe. To determine the S2 allowance, historical shoreline movement trends are examined, and likely future shoreline movements predicted.

The SCPP recommends that shoreline movement analysis be carried out at roughly five yearly intervals over at least a 40 year period. Aerial photography of the area was obtained and the locations of the vegetation lines extracted. The years of the available aerial photography are given below.

- 1963
- 1973
- 1986
- 1993
- 2001
- 2004
- 2009

The relative movement of the shoreline was analysed over nearly 50 years in accordance with the SCPP. The 2009 photography was used to determine the current position of the HSD.

The accuracy of the resultant shoreline movement plan is believed to be about ±5 m in the horizontal plane. The shoreline movement plan for Onslow is included in Appendix C.

The position of the shoreline in each of the years outlined above was determined at 200 m intervals along the coast. The locations of these intervals were shown previously in Figure 1.2.

The movements of the shoreline relative to 1956 were estimated at each of these locations and are presented in Figure 3.1.

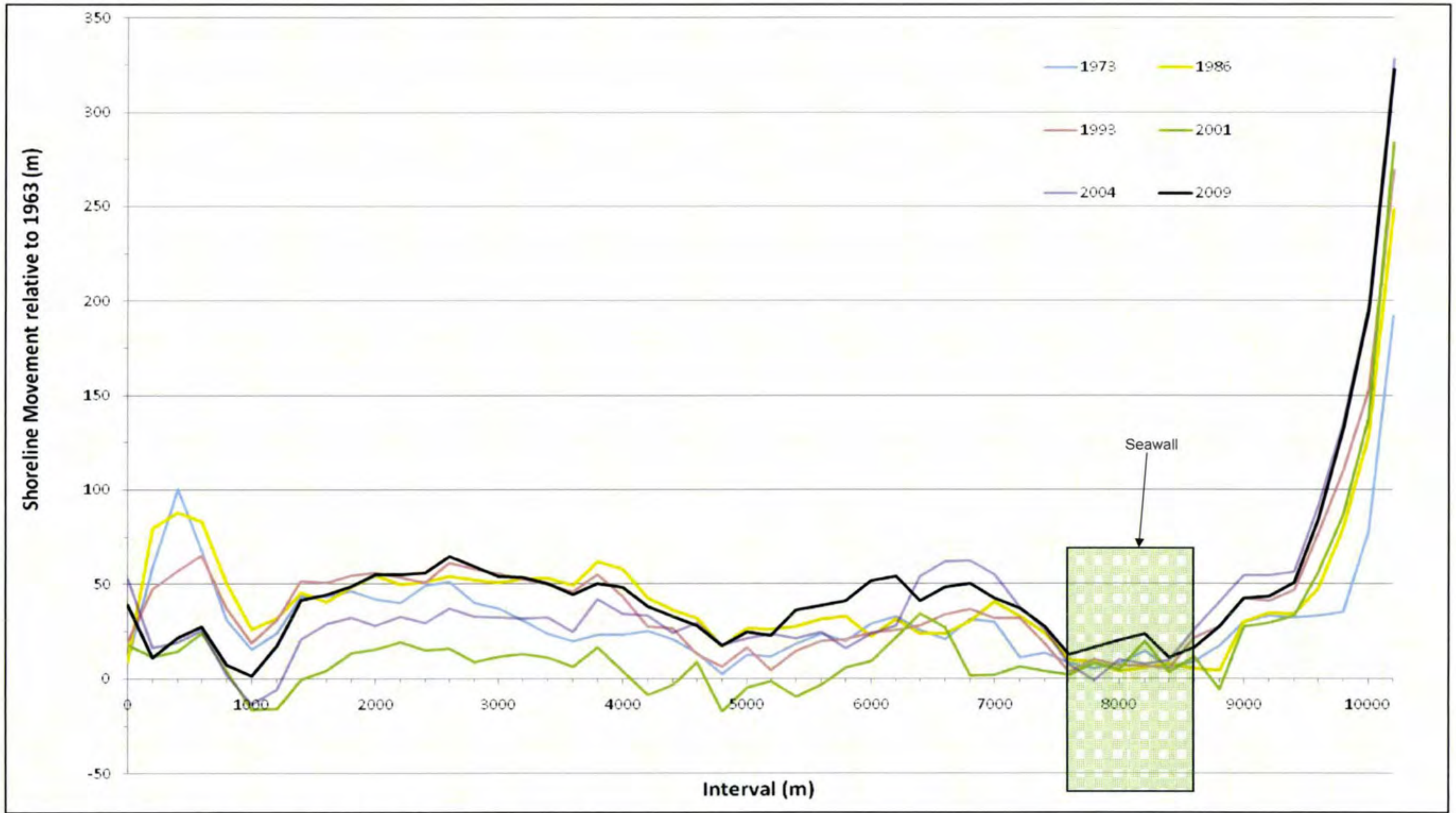

Figure 3.1 - Relative Shoreline Movement Since 1963

Figure 3.1 indicates that the shoreline has generally been stable or accreting in the longer term, with no net erosion between 1963 and 2009.

The greatest shoreline recession was experienced between 1993 and 2001. This coincides with the impact of TC Vance in 1999 which was known to have a large impact on the coast (refer Figure 2.4). As TC Vance occurred only 2 years before the 2001 aerial was taken there was little time for the vegetation and dunes to recover. Since this period the shoreline appears to have been steadily accreting. This trend was analysed further through the use of time history plots.

Time history plots of the coastline were taken at Intervals 400 m, 2,600 m, 6,800 m and 10,000 m and are presented in Figures 3.2 to 3.5.

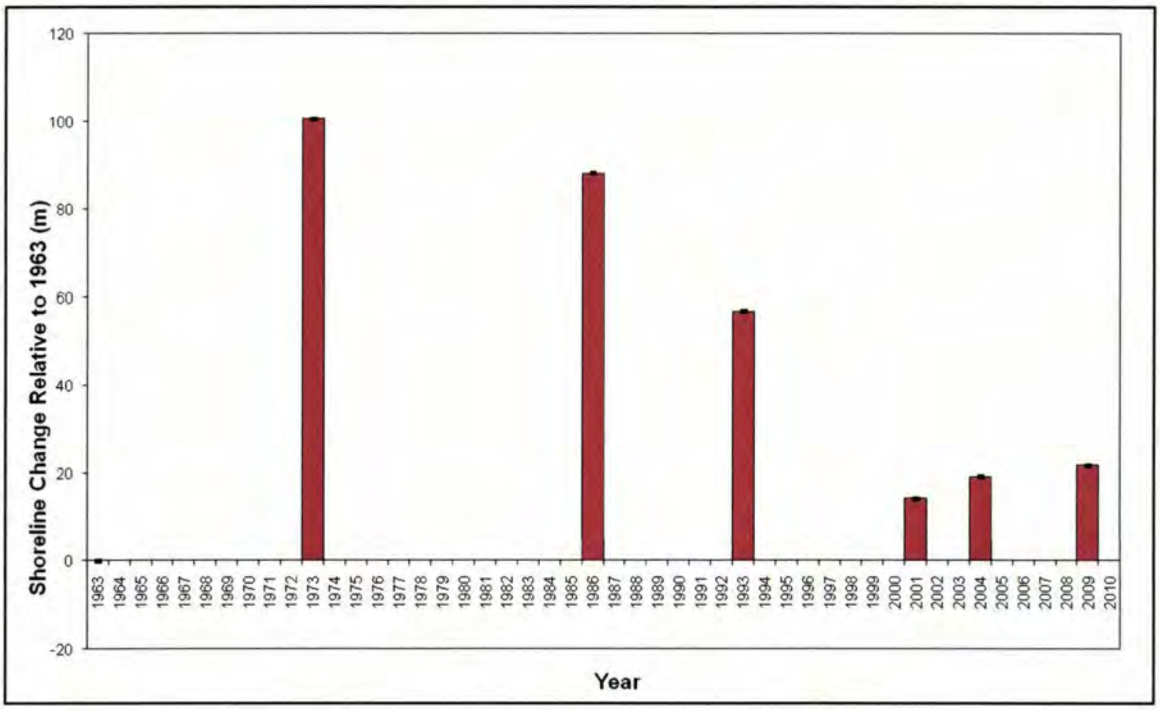

Figure 3.2 - Time History Plot for Interval 400 m

Figure 3.2 shows that there was a trend of shoreline recession at Interval 400 m from 1973 to 1993. There was also a large recession of shoreline position between 1993 and 2001 that could be attributed to TC Vance. Since 2001 there is a definite trend of accretion at Interval 400 m.

The large fluctuations in shoreline position shown on the time history could be a result of the proximity of Interval 400 m to the 4 Mile Creek ocean entrance. Changes in the entrance dynamics of 4 Mile Creek, such as movement of sand bars and river flooding, can affect the longshore sediment transport patterns which in turn can affect adjacent sections of coastline.

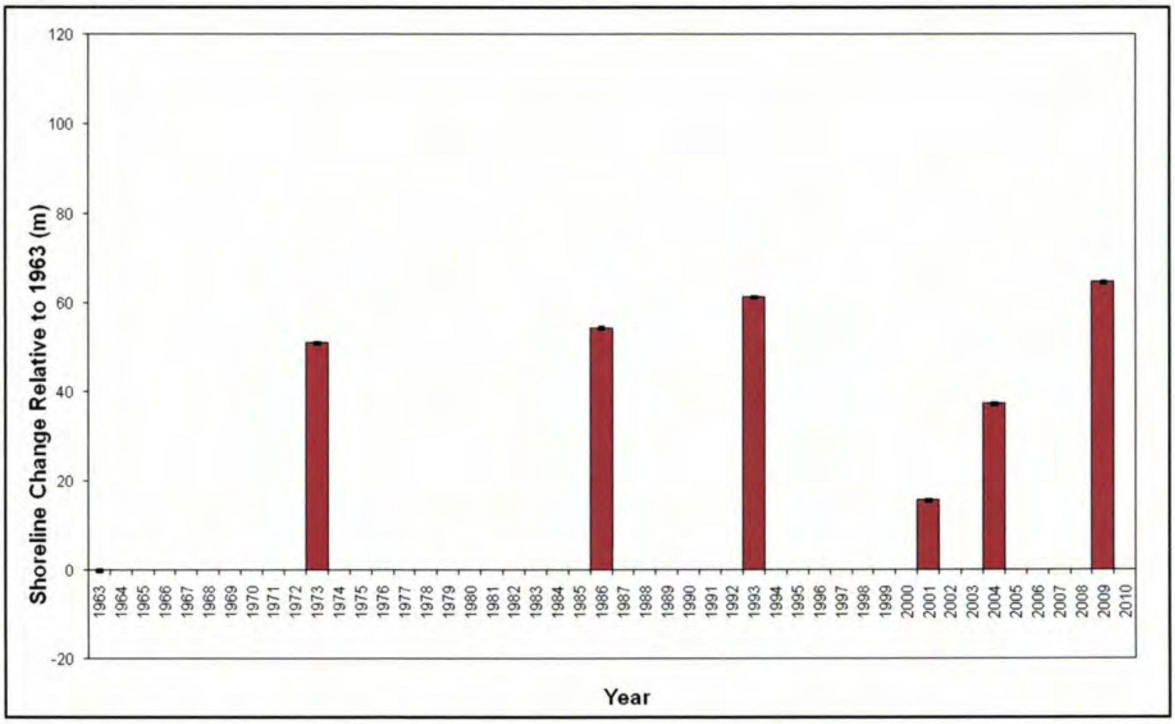

Figure 3.3 - Time History Plot for Interval 2,600 m

Figure 3.3 shows that the shoreline at Interval 2,600 m experiences a slight accretion to 1993 before a large recession of the shoreline that could be the result of TC Vance which affected Onslow in 1999. Since 2001 there has been substantial shoreline accretion.

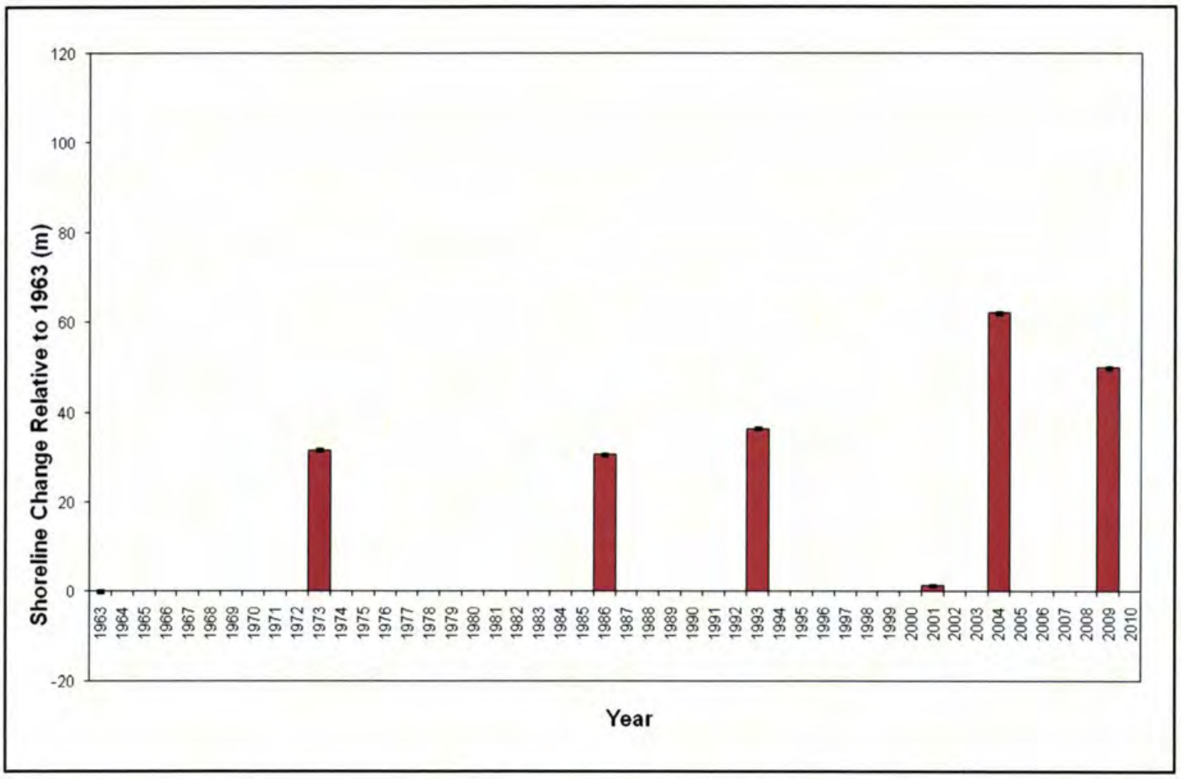

Figure 3.4 - Time History Plot for Interval 6,800 m

Figure 3.4 shows the same pattern as the previous time histories with a large recession of the shoreline between 1993 and 2001 that may have been caused by TC Vance. The large increase in shoreline position in 2004 may be the result of the reestablishment of vegetation in the intervening years. There has also been a recession of the shoreline position between 2004 and 2009 of approximately 12 m.

Figure 3.5 below shows the time history plot for Interval 10,000 m, note that the vertical axis has been extended to 200 m to allow for the larger accretions.

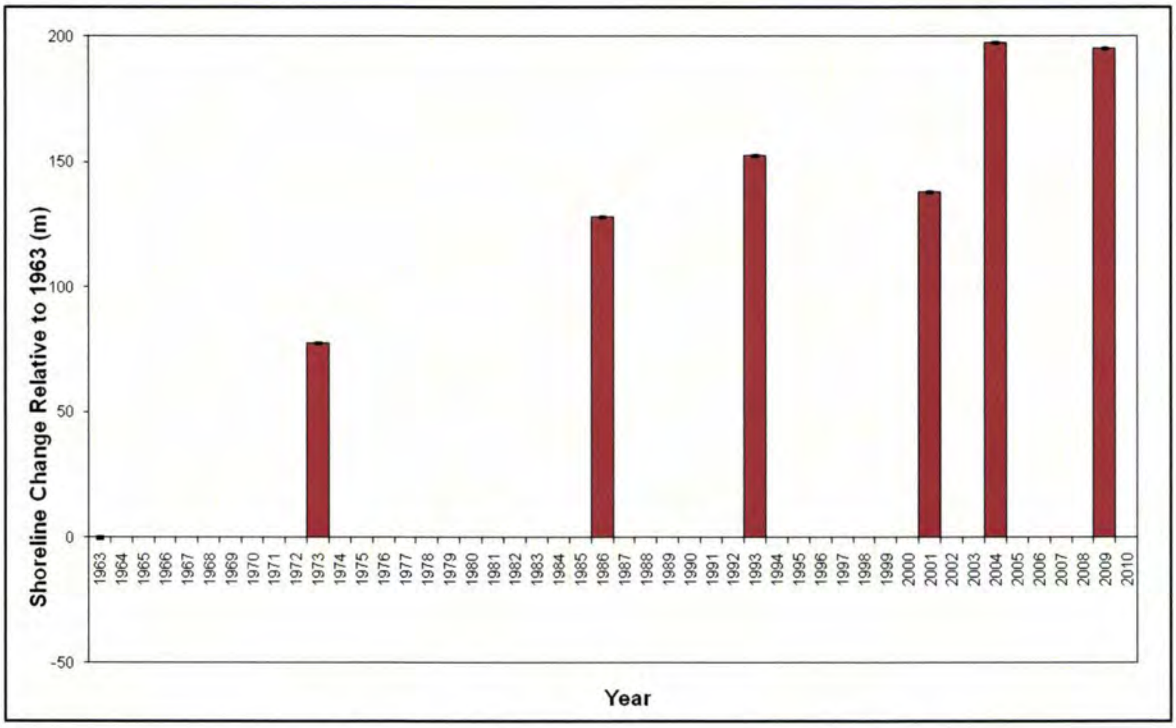

Figure 3.5 - Time History Plot for Interval 10,000 m

Figure 3.5 shows that large accretions have been experienced at this beach interval. There was less of a shoreline recession between 1993 and 2001 at this interval than the other time histories showed. Following 2004 the shoreline position is nearly 200 m seaward of the 1963 position. As the area is a popular beach and experiences high public use the lack of further shoreline accretion between 2004 and 2009 may be a result of the vegetation line being artificially constrained by human activity.

In addition to time history plots, the shoreline movement rates for the shoreline were determined for the period 1963 to 2009. These are shown in Figure 3.6.

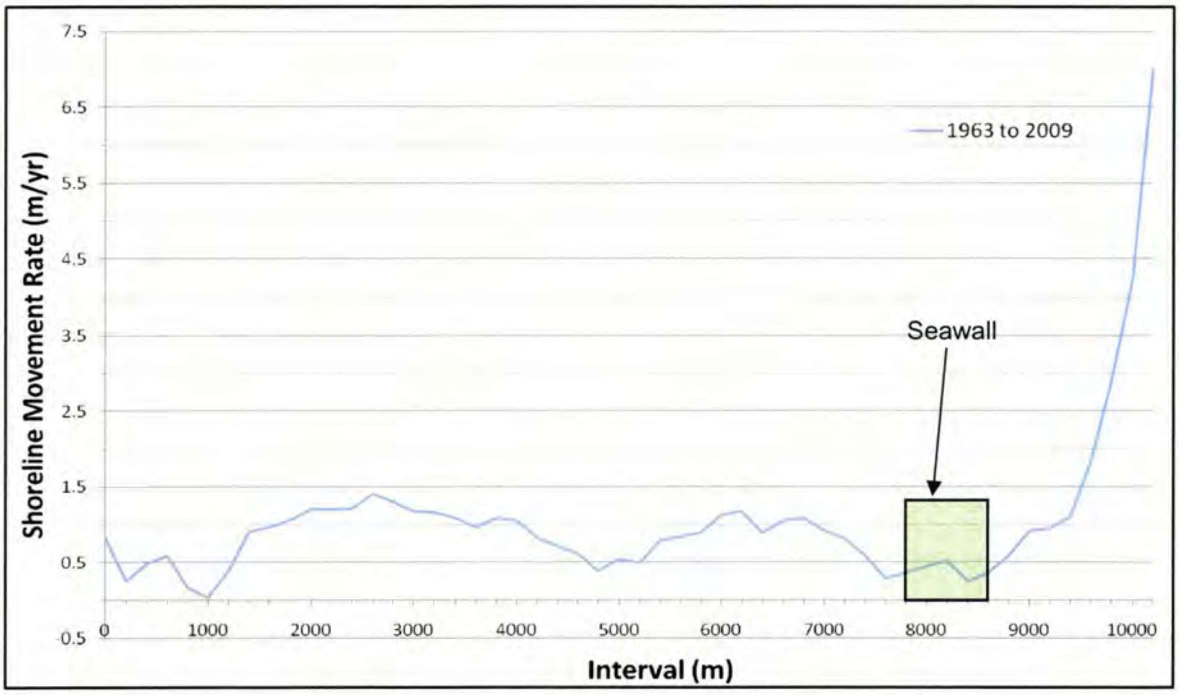

Figure 3.6 - Shoreline Movement Rates (1963 – 2009)

The SCPP recommends that on a relatively stable shoreline (where the rate of erosion or accretion is less than 0.2 m/yr) a 'safety' allowance of 20 m should be provided.

It should be noted that the shoreline between Intervals 7,800 and 8,600 is backed by a limestone seawall and therefore the S2 allowance for this section is **0 m**.

It can be seen from Figure 3.6 that the shoreline movement rates for Intervals 0 m to 1,200 m fluctuate between approximately 0 m/yr to close to +0.75 m/yr. Normally this would only call for a safety allowance of 20 m to be applied, however given the close proximity of these intervals to the 4 Mile Creek entrance a larger allowance is considered appropriate. Using the time history plot for Interval 400 m shown previously in Figure 3.2, MRA propose to use the rate of recession between 1973 and 2009 to determine the appropriate S2 allowance for the 100 year planning horizon. This results in an S2 allowance for Intervals 0 m to 1,200 m of **219 m**.

While Figure 3.6 indicates the majority of the shoreline at Onslow is well above the rate required for no S2 allowance, MRA propose to use the safety allowance of **20 m** for Intervals 1,200 m to 7,800 m and 8,600 m to 9,400 m. This is to account for uncertainties and unknown factors that may affect the shoreline position over the next 100 years.

4. Sea Level Change Allowance (S3)

The Intergovernmental Panel on Climate Change (IPCC) has presented various scenarios of possible climate change and the resultant sea level rise in the coming century (IPCC 2001, 2007). There is still some uncertainty as to which of these scenarios will occur. For example it is not known whether greenhouse gas emissions will fall, stay steady or increase in the coming decades and century. The atmospheric and oceanographic processes involved are complex, and numerical modelling of these processes is far from perfect. Due to these uncertainties, there are a wide range of predictions for global sea level rise in the coming century. These predictions are shown in Figure 3.1.

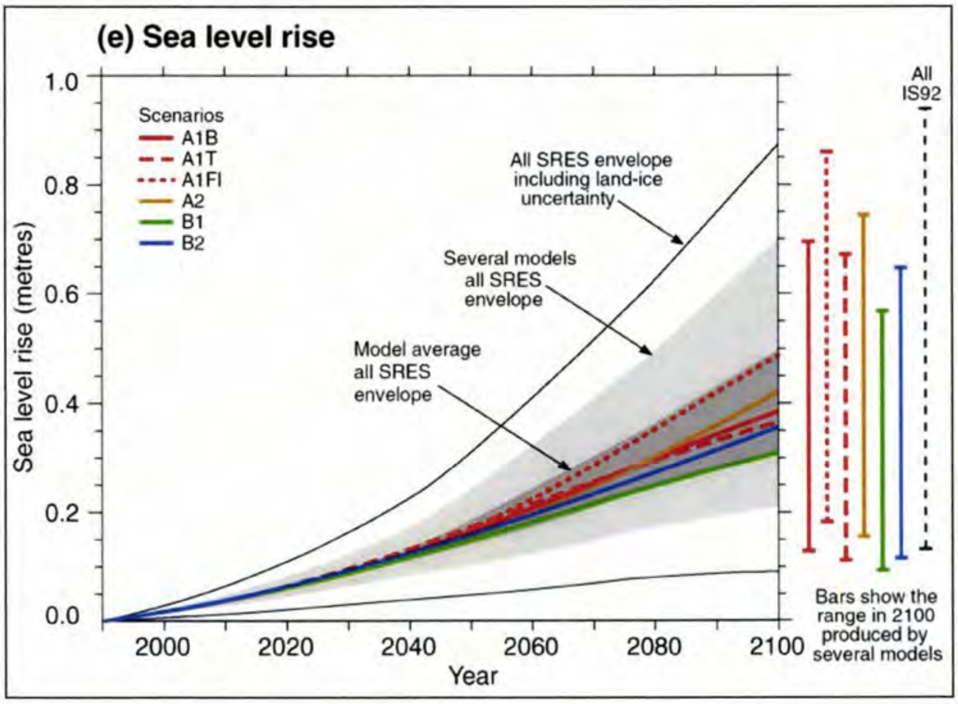

Figure 4.1 - IPCC Scenarios for Sea Level Rise

In 2007 the SCPP was recommending an estimate of sea level rise based on the mean of the median model of these scenarios. In the coming 100 years, this equated to a rise in sea level of approximately 0.38 m. However, the recent position statement released by WAPC (2010) requires that development allow for a 0.9 m sea level rise by 2110.

The effect of sea level rise on the coast is difficult to predict. Komar (1998) provides a reasonable treatment for sandy shores, including examination of the Bruun Rule (Bruun 1962). The Bruun Rule relates the recession of the shoreline to the sea level rise and slope of the nearshore sediment bed:

$$R = \frac{1}{\tan(\theta)} S$$

where: R = recession of the shore;

θ = average slope of the nearshore sediment bed; and

S = sea level rise.

Komar (1998) suggests that the general range for a sandy shore is $R = 50S - 100S$. The SCPP recommends that for sandy coasts the recession be taken as 100 times the estimated rise in sea level. This would be 90 m. The S3 factor is therefore taken to be **90 m** for the Onslow coastline except for that protected by the seawall. Due to the engineered nature of the structure and its founding at 0 mAHD it is believed the seawall would be able to withstand the higher prediction of 0.9 m sea level rise to 2110 provided it is maintained and upgraded as required. Therefore no S3 allowance is included for the shoreline between Intervals 7,800 m and 8,600 m.

5. Total Recommended Setback

The appropriate allowances for the S1, S2 and S3 factors as required by the SCPP have been calculated in previous sections of this report. The sum of these factors provides the required setback to development needed to adhere to the requirements for the general case within the SCPP. Table 5.1 summarises the required allowances and presents the required Physical Process Setback (PPS) for Onslow.

Table 5.1 - Total Recommended Physical Processes Setback

	Allowance For Intervals						
Factor	**0 m to 1,200 m**	**1,200 m to 5,200 m**	**5,200 m to 6,400 m**	**6,400 m to 7,800 m**	**7,800 m to 8,600 m**	**8,600 m to 9,400 m**	**9,400 m to 10,200 m**
S1 – Severe Storm Erosion	63	63 m	68 m	99 m	30[1] m	78 m	78[2] m to 253 m
S2 – Historic Shoreline Movement	219[3]	20 m	20 m	20 m	0 m	20 m	0 m
S3 – Climate Change	90	90 m	90 m	90 m	0 m	90 m	90 m
Total Recommended PPS	**372 m**	**173 m**	**178 m**	**209 m**	**30[4] m**	**188 m**	**168[2] m to 343 m**

Note:

1. Allowance for possible seawall damage and wave overtopping.
2. Based upon the area being filled before development.
3. Precautionary allowance for proximity to 4 Mile Creek entrance.
4. Relative to the rear of the seawall crest.

The PPS is to be measured from the HSD, which for this section of coast is the seaward extent of the ephemeral vegetation. Where the seawall is located the PPS is considered to be taken from the rear of the seawall crest.

Where the required setback changes along a continuous section of coastline a 200 m transition zone is used. Changes to the required setback distance are linearly apportioned over this 200 m transition zone.

In areas where the PPS crossed areas of potential infill development, the PPS was reduced to the S1 allowance as required by the SCPP.

A plan of the recommended PPS is attached in Appendix D. Note that this plan shows both the filled and unfilled setback line for Intervals 9,400 m to 10,200 m

As previously stated the total development setback must include consideration of a number of other factors such as public access and cultural and ecological values. In some cases the total setback may therefore be greater than the recommended PPS.

6. Severe Storm Inundation

As part of the investigation LandCorp requested that the inundation of the area surrounding Onslow be mapped for the 100 year event. This was done for both the current day scenario as well as the year 2110, which represents a 100 year planning horizon.

6.1 Model Setup

Modelling of the 100 year event conducted using numerous SBEACH profiles has shown that the total water level, including setup, for the design severe storm event is approximately +5.0 mAHD. Therefore the inundation modelling was undertaken using an expected water height at the coastline of +5 mAHD plus any additional factors such as climate change allowances.

LIDAR topographical data provided by LandCorp was used in conjunction with observations determined while MRA were on site to determine regions that would be vulnerable to inundation from +5.0 mAHD water levels.

Inland areas that were protected by high dunes were also considered to be inundated if water could flow into the area as a result of dune breaches in adjacent sections of shoreline.

Once the areas of inundation were determined from the initial flooding event consideration was given to the additional effects of localised setup due to increased fetch lengths and potential restrictions from hydraulic throttling.

Hydraulic throttling occurs when water attempts to flow through narrow cross sectional areas, this restriction on water flow results in a difference in the water levels on each side of the constriction. This reduces the instantaneous impact of the inundation and depending on the conditions of the storm, such as duration and phasing, can result in lower peak inundation water levels inland. Similarly hydraulic throttling reduces the speed at which inundation water levels can decrease as the water attempts to flow back to the ocean through narrow channels.

In general it is expected that the water levels inland would be lower than the water levels on the exposed coasts. However there are many factors which must be considered, such as:

- Width of available channels through which inundation could occur;
- Large areas of floodable land located behind the dunes;
- Potential for additional water level setup due to longer fetches; and

- Potential for Onslow Salt ponds to breach and contribute to flooding.

Therefore MRA believe that substantial hydrodynamic modelling would have to be undertaken to warrant any reduction in water levels experienced away from the coastline.

However, given the proximity of the Onslow Townsite and proposed development areas to the coastline it is expected that these regions would experience the full coastal inundation water levels. Therefore an inundation level of +5 mAHD is considered appropriate for this investigation.

6.2 2011 Estimated Inundation & Results

As stated previously the current day inundation was run using the 100 yr return period design event conditions, this resulted in an inundation water level of +5.0 mAHD being applied at the coastline. The expected inundation extents for Onslow are shown in Figure 6.1.

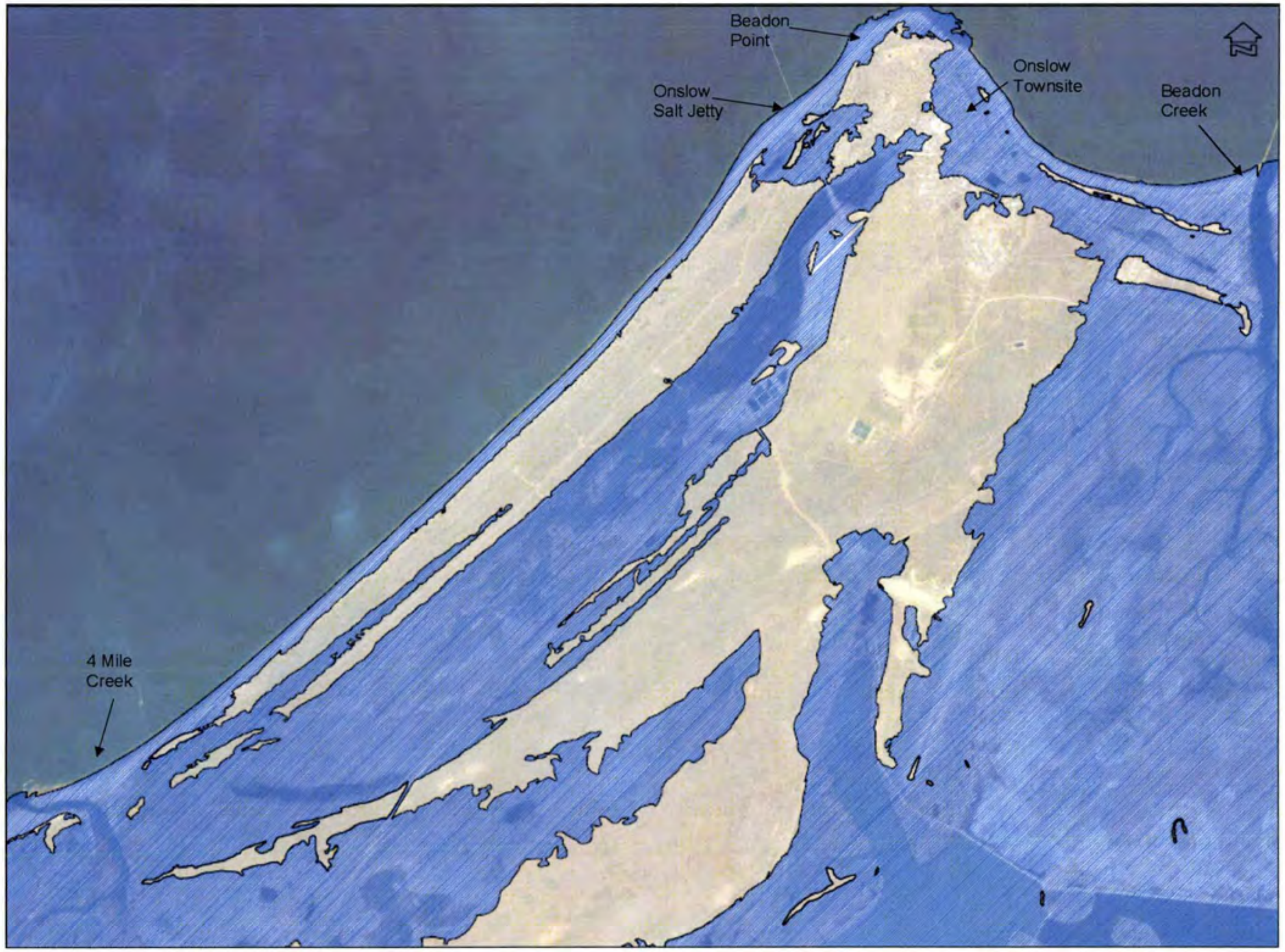

Figure 6.1 - 2011 Estimated Inundation Extents

As can be seen in Figure 6.1 a substantial area of the Onslow Townsite and its surroundings could be inundated under the +5 mAHD design event water level.

It can be seen that the Onslow Salt Jetty acts as a narrow channel allowing inundation to occur behind the dune systems. Even without this breach, the low lying area behind the western dunes would be inundated as flood waters flow north from 4 Mile Creek.

Beadon Creek also acts as an open floodway allowing inundation of the townsite from the east as well as inundation of the land surrounding the Onslow Airfield.

The exact elevation of water levels inland from the coastline would have to be determined through the use of extensive hydrodynamic modelling. However for those regions close to the coastline the +5 mAHD inundation level is believed to be accurate.

The 100 year water level inundation plan as at 2011 is attached as Appendix E.

6.3 2110 Estimated Inundation & Results

MRA also analysed the impact of potential climate change on the 100 year ARI inundation levels for Onslow. Using an allowance for sea level rise of 0.9 m to 2110, as is required by WAPC (2010), the expected inundation of the Onslow region would be as shown in Figure 6.2.

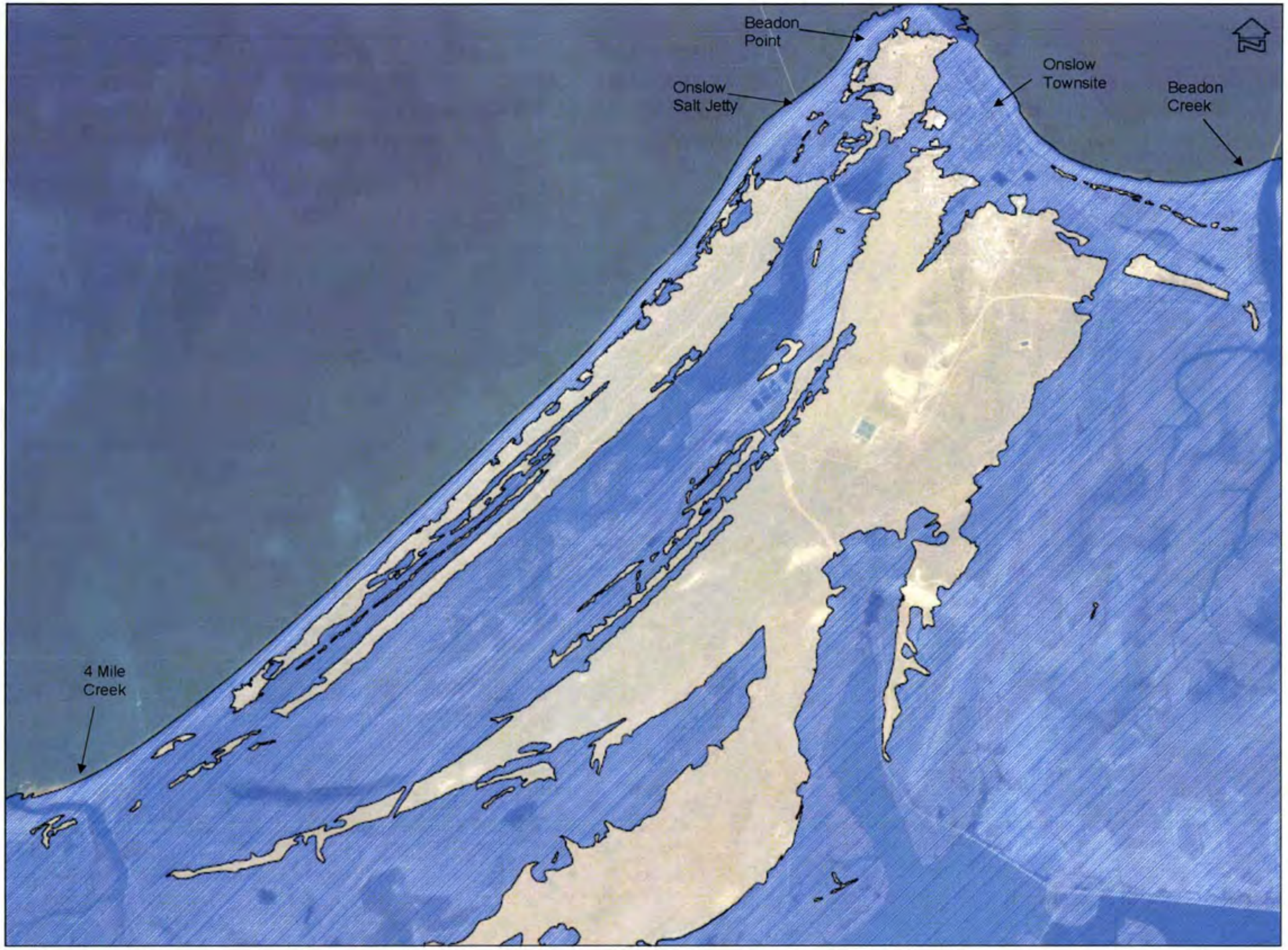

Figure 6.2 - 2110 Estimated Inundation Extents

Figure 6.2 shows the 2110 estimated inundation extents for Onslow and its surroundings, this inundation is based upon a coastal water level of +5.9 mAHD. This includes an allowance of 0.9 m for possible sea level rise to 2110.

It can be seen that there is substantially more channels through the dune systems surrounding Onslow than for the 2011 inundation modelling. This is likely to mean that that the inland inundation water levels are more similar to the coastal water levels.

4 Mile Creek and the breaches through the Beadon Point dunes will allow inundation of the land behind the western dune systems.

Beadon Creek continues to act as an open floodway allowing inundation of the townsite from the east as well as inundating the land surrounding the Onslow Airfield.

The exact elevation of water levels inland from the coastline would have to be determined through the use of extensive hydrodynamic modelling. However for those regions close to the coastline the +5.9 mAHD inundation level is believed to be accurate.

The 100 year water level inundation plan as at 2110 is attached as Appendix F.

6.4 Recommended Finished Floor Levels

Finished Floor Levels (FFL) for development should include a freeboard or Factor of Safety (FOS) above the design inundation level to minimise the risk of inundation during extreme events.

For residential or non emergency response infrastructure with a planning horizon of 100 years MRA recommend a FOS of 0.5 m. The recommended finished floor level for residential or non emergency infrastructure with a planning horizon of 100 years is outlined below.

• 100 year Water Level	5.0 mAHD
• Allowance for Climate Change to 2110	0.9 m
• Factor of Safety	0.5 m
• **Total Recommended FFL for Residential or Non-Emergency Response Infrastructure**	**6.4 mAHD**

The above finished floor level, based on a 100 year planning horizon and design event, is generally considered to provide an acceptable level of risk for residential and non emergency response infrastructure. However, it is generally accepted that a lower level of risk should be adopted for critical infrastructure, particularly that which would be required in response to an emergency. This would include infrastructure such as hospitals, evacuation centres, emergency services and the like. Given the above, it is recommended that an increased factor of safety be adopted above the 100 year water level to significantly reduce the risk to this critical infrastructure. The recommended finished floor level would be as follows.

• 100 year Water Level	5.0 mAHD
• Allowance for Climate Change to 2110	0.9 m
• Factor of Safety	1.5 m
• **Total Recommended FFL for Critical or Emergency Response Infrastructure**	**7.4 mAHD**

Conversely, for low value infrastructure, such as industrial land and transport lay down areas a higher level of risk could be adopted. A reduced planning horizon could also be considered, however each of these developments should be considered on a case by case basis.

It should also be noted that the recommended FFL's outlined above refer to the floor level of the infrastructure. It may be possible that the floor level of the infrastructure is elevated above the surrounding ground level; however, at a minimum it would be recommended that the ground level surrounding the development be sufficiently elevated to withstand the 100 year water level event at the end of the planning horizon (i.e. equal to or greater than 5.9 mAHD). On this basis, any land area that is at a level of 5.9 mAHD or above would be suitable for development provided the FFL for residential development was above 6.4 mAHD. Land above 6.4 mAHD would be unconstrained for residential development. These areas are shown in the plan provided in Appendix G.

If the recommended FFL's for residential development were achieved, but the surrounding ground elevations were lower than 5.9 mAHD management strategies would need to be put in place to outline things such as evacuation procedures that would be required to minimise risk to life during severe events.

7. Conclusions & Recommendations

LandCorp are working with the Shire of Ashburton and other agencies to release land for residential, commercial and industrial development around the existing Onslow Townsite in the Pilbara Region of Western Australia. MRA was commissioned to conduct an assessment of the required coastal setback to allow for the action of physical coastal processes, and also to investigate potential inundation of the region for the design event. This report outlined the methodology and results of these assessments.

The total recommended setbacks to allow for the action of physical coastal processes were calculated to range from 30 m for the area protected by the seawall up to 372 m for the land adjacent to 4 Mile Creek. The Physical Process Setback (PPS) Plan is attached as Appendix D.

Given the large setbacks determined in some locations, consideration could be given to methods for reducing these distances. If the low lying regions located near Beadon Creek were raised to a suitable height the elevated water levels associated with the design event would not penetrate as far inland. This would greatly reduce the S1 component of the PPS and could allow for greater development of the area. This low lying area could also be considered for the construction of facilities that have their own protection systems such as marinas. This would allow the development of land that might otherwise have remained unused.

Coastal inundation modelling was conducted using data obtained for Tropical Cyclone Vance. This data was scaled up to obtain the 100 yr ARI design event conditions. This inundation modelling showed that elevated water levels of +5.0 mAHD for current day and +5.9 mAHD for 2110 (including a 0.9 m allowance for sea level rise) could occur for the design event. Inundation plans for these water levels were produced and are attached as Appendix E and Appendix F.

These inundation plans showed that large areas of Onslow and its surrounds are vulnerable to inundation. Care must be taken to ensure that any future development is located safely above these inundation levels. MRA recommend that any future residential or non emergency response infrastructure have a finished floor level of +6.4 mAHD, which includes a factor of safety of 0.5 m above the predicted design inundation at 2110. For critical or emergency response infrastructure it is recommended that this factor of safety be increased to 1.5 m, resulting in a recommended finished floor level of +7.4 mAHD.

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9. Appendices

Appendix A	**Particle Size Distribution Results**
Appendix B	**SBEACH Modelling Reports**
Appendix C	**Shoreline Movement Plan**
Appendix D	**Physical Process Setback Plan**
Appendix E	**100 year Water Level Inundation Plan as at 2011**
Appendix F	**100 year Water Level Inundation Plan as at 2110**
Appendix G	**Elevation Requirements for Residential or Non Emergency Response Infrastructure Plan**

Appendix A Particle Size Distribution Results

STRUCterre consulting engineers

Chartered Consulting Engineers
Residential • Commercial • Site Services • Geotechnics • Civil
Perth • Bunbury • Geraldton • Albany • Brisbane • Gold Coast

Material Test Certificate

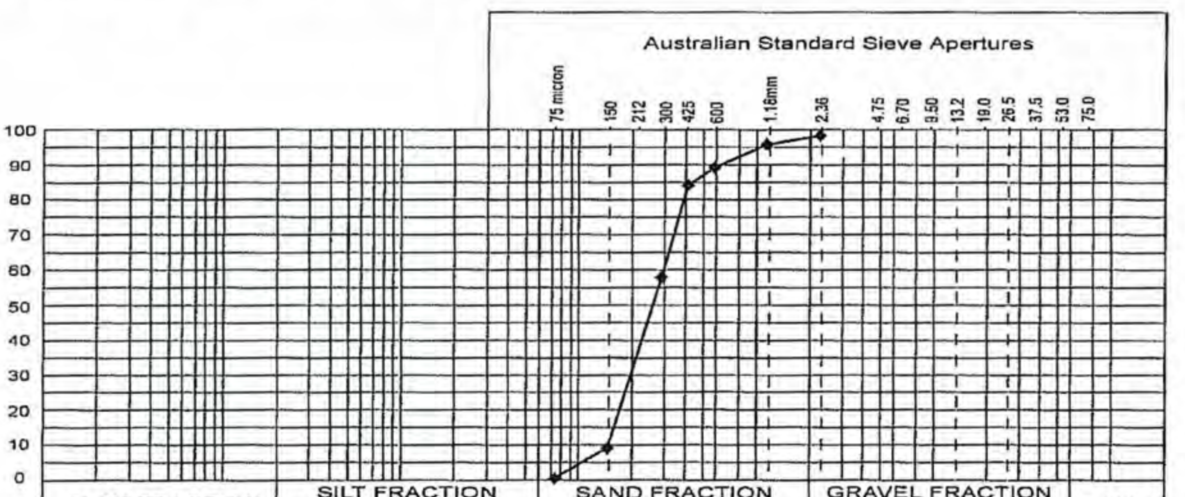
Report No:	14064	Client:	m p rogers & associates
Job No:	S536696	Project:	Onslow Town Planning

Laboratory Number: 14064
Sample ID: J883/1 Profile 1
Date Tested: 30-May-2011
Material Description: SAND trace silt

Particle Size Distribution & Atterberg Limits of a Soil

Partcle Size Distribution (AS1289 3.6.1)				Atterberg Limits (AS1289 3.1.2, 3.2.1, 3.3.1, 3.4.1)	
Sieve Size	% Passing	Sieve Size	% Passing	Liquid Limit (%)	Not obtainable
				Plastic Limit (%)	Non plastic
75.0mm	100	1.18 mm	97	Plasticity Index (%)	-
37.5 mm	100	0.6mm	91	Linear Shrinkage (%)	-
19.0 mm	100	0.425mm	86	Nature Of Shrinkage	-
9.50 mm	100	0.300mm	59	Sample History	Oven Dried
4.75 mm	100	0.150mm	9	Preparation Method	AS1289.1
2.36mm	100	0.075mm	1	Moisture Content (AS1289 2.1.1)	
				Moisture Content (%)	

Particle Size Distribution Graph



Remarks: Sampling Method/s - Submitted by client

Authorised Signature:
Colin Gatgens
Date: 31-May-2011

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Material Test Certificate

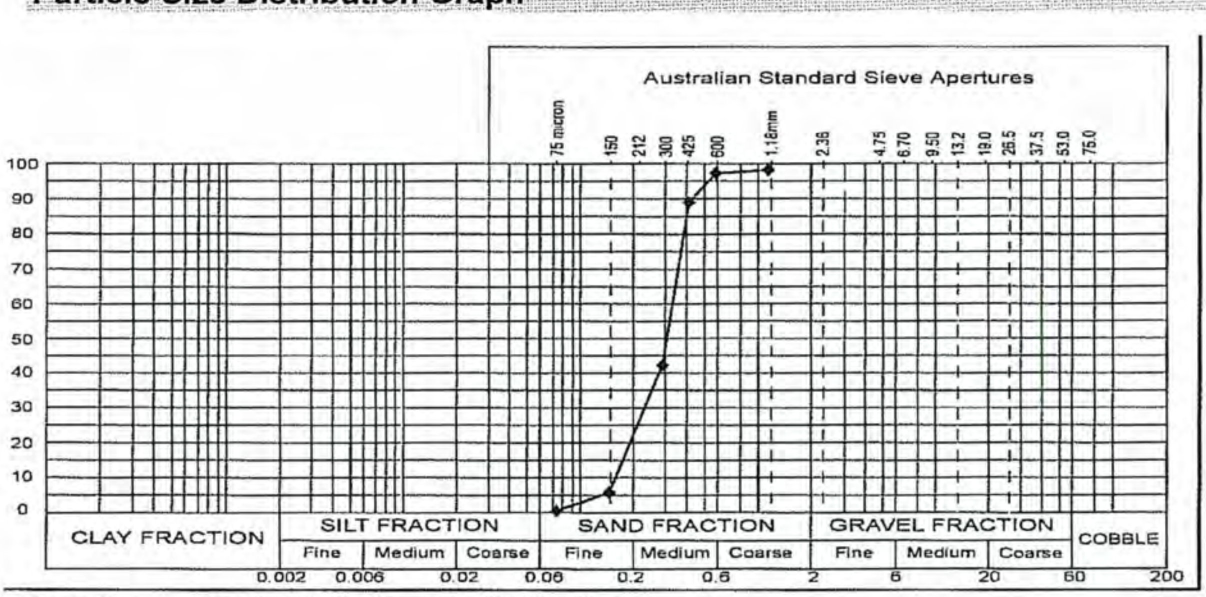
Report No:	14065	**Client:**	m p rogers & associates
Job No:	S536697	**Project:**	Onslow Town Planning

Laboratory Number:	14065
Sample ID: 883/1	Profile 3
Date Tested:	30-May-2011
Material Description:	SAND trace silt

Particle Size Distribution & Atterberg Limits of a Soil

Partcle Size Distribution (AS1289 3.6.1)				Atterberg Limits (AS1289 3.1.2, 3.2.1, 3.3.1, 3.4.1)	
Sieve Size	% Passing	Sieve Size	% Passing	Liquid Limit (%)	Not obtainable
				Plastic Limit (%)	Non plastic
75.0mm	100	1.18 mm	100	Plasticity Index (%)	-
37.5 mm	100	0.6mm	99	Linear Shrinkage (%)	-
19.0 mm	100	0.425mm	91	Nature Of Shrinkage	-
9.50 mm	100	0.300mm	43	Sample History	Oven Dried
4.75 mm	100	0.150mm	6	Preparation Method	AS1289.1
2.36mm	100	0.075mm	1	Moisture Content (AS1289 2.1.1)	
				Moisture Content (%)	

Particle Size Distribution Graph



Remarks: Sampling Method/s - Submitted by client

Authorised Signature:

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Date: 31-May-2011

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Material Test Certificate

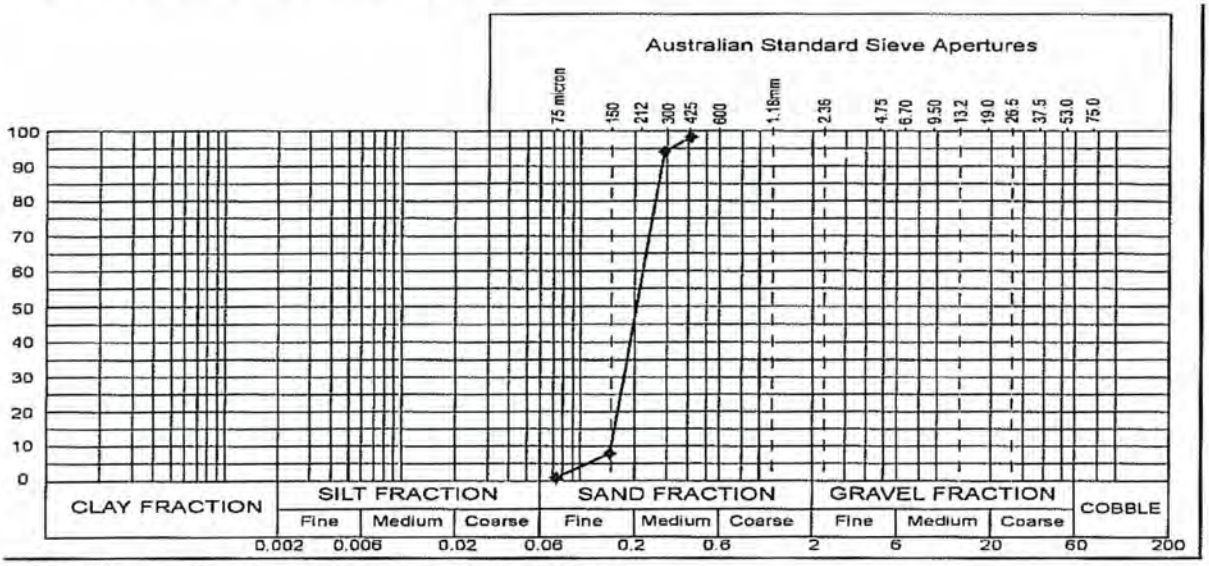
Report No:	14066	Client:	m p rogers & associates
Job No:	S536698	Project:	Onslow Town Planning

Laboratory Number: 14066
Sample ID: J883/1 Profile 4
Date Tested: 30-May-2011
Material Description: SAND trace silt

Particle Size Distribution & Atterberg Limits of a Soil

Partcle Size Distribution (AS1289 3.6.1)				Atterberg Limits (AS1289 3.1.2, 3.2.1, 3.3.1, 3.4.1)	
Sieve Size	% Passing	Sieve Size	% Passing	Liquid Limit (%)	Not obtainable
				Plastic Limit (%)	Non plastic
75.0mm	100	1.18 mm	100	Plasticity Index (%)	-
37.5 mm	100	0.6mm	100	Linear Shrinkage (%)	-
19.0 mm	100	0.425mm	100	Nature Of Shrinkage	-
9.50 mm	100	0.300mm	96	Sample History	Oven Dried
4.75 mm	100	0.150mm	8	Preparation Method	AS1289.1
2.36mm	100	0.075mm	1	Moisture Content (AS1289 2.1.1)	
				Moisture Content (%)	

Particle Size Distribution Graph



Remarks: Sampling Method/s - Submitted by client

Authorised Signature:

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Date: 31-May-2011

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Appendix B SBEACH Modelling Reports

Report
Project: J883/1 Onslow
Reach: Profile 1
Storm: 100 Yr Storm
MODEL CONFIGURATION

INPUT UNITS (SI=1, AMERICAN CUST.=2): 1
NUMBER OF CALCULATION CELLS: 1000
GRID TYPE (CONSTANT=0, VARIABLE=1): 1
NUMBER OF GRID CELL REGIONS: 4
NUMBER CELLS AND CELL WIDTH IN REGION 1: 300, 1.0
NUMBER CELLS AND CELL WIDTH IN REGION 2: 200, 2.0
NUMBER CELLS AND CELL WIDTH IN REGION 3: 200, 5.0
NUMBER CELLS AND CELL WIDTH IN REGION 4: 300, 27.4
NUMBER OF TIME STEPS AND VALUE OF TIME STEP IN MINUTES: 1320, 5.0
TIME STEP(S) OF INTERMEDIATE OUTPUT 1: 400
TIME STEP(S) OF INTERMEDIATE OUTPUT 2: 800
NO COMPARSION WITH MEASURED PROFILE.
PROFILE ELEVATION CONTOUR 1: 5.00
PROFILE ELEVATION CONTOUR 2: 0.00
PROFILE ELEVATION CONTOUR 3: -5.00
PROFILE EROSION DEPTH 1: 0.00
PROFILE EROSION DEPTH 2: 1.00
PROFILE EROSION DEPTH 3: 1.50
REFERENCE ELEVATION: 2.80
TRANSPORT RATE COEFFICIENT (m^4/N): 1.75E-6
COEFFICIENT FOR SLOPE DEPENDENT TERM (m^2/s): 0.0020
TRANSPORT RATE DECAY COEFFICIENT MULTIPLIER: 0.50
WATER TEMPERATURE IN DEGREES C : 20.0

WAVE TYPE (MONOCHROMATIC=1, IRREGULAR=2): 2
WAVE HEIGHT AND PERIOD INPUT (CONSTANT=0, VARIABLE=1): 1
TIME STEP OF VARIABLE WAVE HEIGHT AND PERIOD INPUT IN MINUTES: 60.0
WAVE ANGLE INPUT (CONSTANT=0, VARIABLE=1): 0
CONSTANT WAVE ANGLE: 0.0
WATER DEPTH OF INPUT WAVES (DEEP WATER = 0.0): 10.2
SEED VALUE FOR WAVE HEIGHT RANDOMIZER AND % VARIABILITY: 4567, 20.0
TOTAL WATER ELEVATION INPUT (CONSTANT=0, VARIABLE=1): 1
TIME STEP OF VARIABLE TOTAL WATER ELEVATION INPUT IN MINUTES: 60.0
WIND SPEED AND ANGLE INPUT (CONSTANT=0, VARIABLE=1): 0
CONSTANT WIND SPEED AND ANGLE: 46.2, 0.0

TYPE OF INPUT PROFILE (ARBITRARY=1, SCHEMATIZED=2): 1
DEPTH CORRESPONDING TO LANDWARD END OF SURF ZONE: 0.30
EFFECTIVE GRAIN SIZE DIAMETER IN MILLIMETERS: 0.25
MAXIMUM PROFILE SLOPE PRIOR TO AVALANCHING IN DEGREES: 45.0

NO BEACH FILL IS PRESENT.

NO SEAWALL IS PRESENT.

NO HARD BOTTOM IS PRESENT.

COMPUTED RESULTS

DIFFERENCE IN TOTAL VOLUME BETWEEN FINAL AND INITIAL PROFILES:

0.0 m^3/m

MAXIMUM VALUE OF WATER ELEVATION + SETUP FOR SIMULATION
5.36 m

TIME STEP AND POSITION ON PROFILE AT WHICH MAXIMUM VALUE
OF WATER ELEVATION + SETUP OCCURRED
217, 53.0 m
MAXIMUM ESTIMATED RUNUP ELEVATION: 6.72 m
(REFERENCED TO VERTICAL DATUM)

POSITION OF LANDWARD MOST OCCURRENCE OF A 0.00 m EROSION DEPTH:
40.0 m

DISTANCE FROM POSITION OF REFERENCE ELEVATION ON INITIAL PROFILE
TO POSITION OF LANDWARD MOST OCCURRENCE OF A 0.00 m EROSION DEPTH:
63.0 m

POSITION OF LANDWARD MOST OCCURRENCE OF A 1.00 m EROSION DEPTH:
99.0 m

DISTANCE FROM POSITION OF REFERENCE ELEVATION ON INITIAL PROFILE
TO POSITION OF LANDWARD MOST OCCURRENCE OF A 1.00 m EROSION DEPTH:
4.0 m

A 1.50 m EROSION DEPTH DID NOT OCCUR ANYWHERE ON THE PROFILE.

MAXIMUM RECESSION OF THE 5.00 m ELEVATION CONTOUR:
3.94 m

MAXIMUM RECESSION OF THE 0.00 m ELEVATION CONTOUR:
3.93 m

THE -5.00 m CONTOUR DID NOT RECEDE

J883/1 Onslow
Reach: Profile 2 Storm: 100 Yr Storm

Report

Project: J883/1 Onslow

Reach: Profile 2

Storm: 100 Yr Storm

MODEL CONFIGURATION

INPUT UNITS (SI=1, AMERICAN CUST.=2): 1
NUMBER OF CALCULATION CELLS: 1000
GRID TYPE (CONSTANT=0, VARIABLE=1): 1
NUMBER OF GRID CELL REGIONS: 4
NUMBER CELLS AND CELL WIDTH IN REGION 1: 300, 1.0
NUMBER CELLS AND CELL WIDTH IN REGION 2: 200, 5.0
NUMBER CELLS AND CELL WIDTH IN REGION 3: 250, 20.0
NUMBER CELLS AND CELL WIDTH IN REGION 4: 250,132.0
NUMBER OF TIME STEPS AND VALUE OF TIME STEP IN MINUTES: 1320, 5.0
TIME STEP(S) OF INTERMEDIATE OUTPUT 1: 400
TIME STEP(S) OF INTERMEDIATE OUTPUT 2: 800
NO COMPARSION WITH MEASURED PROFILE.
PROFILE ELEVATION CONTOUR 1: 5.00
PROFILE ELEVATION CONTOUR 2: 0.00
PROFILE ELEVATION CONTOUR 3: -5.00
PROFILE EROSION DEPTH 1: 0.50
PROFILE EROSION DEPTH 2: 1.00
PROFILE EROSION DEPTH 3: 1.50
REFERENCE ELEVATION: 2.60
TRANSPORT RATE COEFFICIENT (m^4/N): 1.75E-6
COEFFICIENT FOR SLOPE DEPENDENT TERM (m^2/s): 0.0020
TRANSPORT RATE DECAY COEFFICIENT MULTIPLIER: 0.50
WATER TEMPERATURE IN DEGREES C : 20.0

WAVE TYPE (MONOCHROMATIC=1, IRREGULAR=2): 2
WAVE HEIGHT AND PERIOD INPUT (CONSTANT=0, VARIABLE=1): 1
TIME STEP OF VARIABLE WAVE HEIGHT AND PERIOD INPUT IN MINUTES: 60.0
WAVE ANGLE INPUT (CONSTANT=0, VARIABLE=1): 0
CONSTANT WAVE ANGLE: 0.0
WATER DEPTH OF INPUT WAVES (DEEP WATER = 0.0): 10.2
SEED VALUE FOR WAVE HEIGHT RANDOMIZER AND % VARIABILITY: 4567, 20.0
TOTAL WATER ELEVATION INPUT (CONSTANT=0, VARIABLE=1): 1
TIME STEP OF VARIABLE TOTAL WATER ELEVATION INPUT IN MINUTES: 60.0
WIND SPEED AND ANGLE INPUT (CONSTANT=0, VARIABLE=1): 0
CONSTANT WIND SPEED AND ANGLE: 46.2, 0.0

TYPE OF INPUT PROFILE (ARBITRARY=1, SCHEMATIZED=2): 1
DEPTH CORRESPONDING TO LANDWARD END OF SURF ZONE: 0.30
EFFECTIVE GRAIN SIZE DIAMETER IN MILLIMETERS: 0.31
MAXIMUM PROFILE SLOPE PRIOR TO AVALANCHING IN DEGREES: 45.0

NO BEACH FILL IS PRESENT.

NO SEAWALL IS PRESENT.

NO HARD BOTTOM IS PRESENT.

COMPUTED RESULTS

DIFFERENCE IN TOTAL VOLUME BETWEEN FINAL AND INITIAL PROFILES:

0.0 m^3/m

MAXIMUM VALUE OF WATER ELEVATION + SETUP FOR SIMULATION
5.31 m

TIME STEP AND POSITION ON PROFILE AT WHICH MAXIMUM VALUE
OF WATER ELEVATION + SETUP OCCURRED
217, 42.0 m
MAXIMUM ESTIMATED RUNUP ELEVATION: 4.70 m
(REFERENCED TO VERTICAL DATUM)

POSITION OF LANDWARD MOST OCCURRENCE OF A 0.50 m EROSION DEPTH:
38.0 m

DISTANCE FROM POSITION OF REFERENCE ELEVATION ON INITIAL PROFILE
TO POSITION OF LANDWARD MOST OCCURRENCE OF A 0.50 m EROSION DEPTH:
34.8 m

POSITION OF LANDWARD MOST OCCURRENCE OF A 1.00 m EROSION DEPTH:
38.0 m

DISTANCE FROM POSITION OF REFERENCE ELEVATION ON INITIAL PROFILE
TO POSITION OF LANDWARD MOST OCCURRENCE OF A 1.00 m EROSION DEPTH:
34.8 m

POSITION OF LANDWARD MOST OCCURRENCE OF A 1.50 m EROSION DEPTH:
39.0 m

DISTANCE FROM POSITION OF REFERENCE ELEVATION ON INITIAL PROFILE
TO POSITION OF LANDWARD MOST OCCURRENCE OF A 1.50 m EROSION DEPTH:
33.8 m

MAXIMUM RECESSION OF THE 5.00 m ELEVATION CONTOUR:
5.04 m

MAXIMUM RECESSION OF THE 0.00 m ELEVATION CONTOUR:
0.87 m

MAXIMUM RECESSION OF THE -5.00 m ELEVATION CONTOUR:
0.00 m

Report

Project: J883/1 Onslow

Reach: Profile 3

Storm: 100 Yr Storm

MODEL CONFIGURATION

INPUT UNITS (SI=1, AMERICAN CUST.=2): 1
NUMBER OF CALCULATION CELLS: 1000
GRID TYPE (CONSTANT=0, VARIABLE=1): 1
NUMBER OF GRID CELL REGIONS: 4
NUMBER CELLS AND CELL WIDTH IN REGION 1: 300, 1.0
NUMBER CELLS AND CELL WIDTH IN REGION 2: 200, 5.0
NUMBER CELLS AND CELL WIDTH IN REGION 3: 250, 20.0
NUMBER CELLS AND CELL WIDTH IN REGION 4: 250,151.0
NUMBER OF TIME STEPS AND VALUE OF TIME STEP IN MINUTES: 1320, 5.0
TIME STEP(S) OF INTERMEDIATE OUTPUT 1: 400
TIME STEP(S) OF INTERMEDIATE OUTPUT 2: 800
NO COMPARSION WITH MEASURED PROFILE.
PROFILE ELEVATION CONTOUR 1: 5.00
PROFILE ELEVATION CONTOUR 2: 0.00
PROFILE ELEVATION CONTOUR 3: -5.00
PROFILE EROSION DEPTH 1: 0.00
PROFILE EROSION DEPTH 2: 1.00
PROFILE EROSION DEPTH 3: 1.50
REFERENCE ELEVATION: 2.30
TRANSPORT RATE COEFFICIENT (m^4/N): 1.75E-6
COEFFICIENT FOR SLOPE DEPENDENT TERM (m^2/s): 0.0020
TRANSPORT RATE DECAY COEFFICIENT MULTIPLIER: 0.50
WATER TEMPERATURE IN DEGREES C : 20.0

WAVE TYPE (MONOCHROMATIC=1, IRREGULAR=2): 2
WAVE HEIGHT AND PERIOD INPUT (CONSTANT=0, VARIABLE=1): 1
TIME STEP OF VARIABLE WAVE HEIGHT AND PERIOD INPUT IN MINUTES: 60.0
WAVE ANGLE INPUT (CONSTANT=0, VARIABLE=1): 0
CONSTANT WAVE ANGLE: 0.0
WATER DEPTH OF INPUT WAVES (DEEP WATER = 0.0): 10.2
SEED VALUE FOR WAVE HEIGHT RANDOMIZER AND % VARIABILITY: 4567, 20.0
TOTAL WATER ELEVATION INPUT (CONSTANT=0, VARIABLE=1): 1
TIME STEP OF VARIABLE TOTAL WATER ELEVATION INPUT IN MINUTES: 60.0
WIND SPEED AND ANGLE INPUT (CONSTANT=0, VARIABLE=1): 0
CONSTANT WIND SPEED AND ANGLE: 46.2, 0.0

TYPE OF INPUT PROFILE (ARBITRARY=1, SCHEMATIZED=2): 1
DEPTH CORRESPONDING TO LANDWARD END OF SURF ZONE: 0.30
EFFECTIVE GRAIN SIZE DIAMETER IN MILLIMETERS: 0.31
MAXIMUM PROFILE SLOPE PRIOR TO AVALANCHING IN DEGREES: 45.0

NO BEACH FILL IS PRESENT.

NO SEAWALL IS PRESENT.

NO HARD BOTTOM IS PRESENT.

COMPUTED RESULTS

DIFFERENCE IN TOTAL VOLUME BETWEEN FINAL AND INITIAL PROFILES:

0.0 m^3/m

MAXIMUM VALUE OF WATER ELEVATION + SETUP FOR SIMULATION
5.30 m

TIME STEP AND POSITION ON PROFILE AT WHICH MAXIMUM VALUE
OF WATER ELEVATION + SETUP OCCURRED
217, 34.0 m
MAXIMUM ESTIMATED RUNUP ELEVATION: 3.62 m
(REFERENCED TO VERTICAL DATUM)

POSITION OF LANDWARD MOST OCCURRENCE OF A 0.00 m EROSION DEPTH:
31.0 m

DISTANCE FROM POSITION OF REFERENCE ELEVATION ON INITIAL PROFILE
TO POSITION OF LANDWARD MOST OCCURRENCE OF A 0.00 m EROSION DEPTH:
98.8 m

A 1.00 m EROSION DEPTH DID NOT OCCUR ANYWHERE ON THE PROFILE.

A 1.50 m EROSION DEPTH DID NOT OCCUR ANYWHERE ON THE PROFILE.

MAXIMUM RECESSION OF THE 5.00 m ELEVATION CONTOUR:
5.02 m

MAXIMUM RECESSION OF THE 0.00 m ELEVATION CONTOUR:
0.98 m

MAXIMUM RECESSION OF THE -5.00 m ELEVATION CONTOUR:
0.00 m

J883/1 Onslow

Reach: Profile 4A Storm: 100 Yr Storm

Report

Project: J883/1 Onslow
Reach: Profile 4A
Storm: 100 Yr Storm

MODEL CONFIGURATION

INPUT UNITS (SI=1, AMERICAN CUST.=2): 1
NUMBER OF CALCULATION CELLS: 1000
GRID TYPE (CONSTANT=0, VARIABLE=1): 1
NUMBER OF GRID CELL REGIONS: 4
NUMBER CELLS AND CELL WIDTH IN REGION 1: 300, 1.0
NUMBER CELLS AND CELL WIDTH IN REGION 2: 200, 5.0
NUMBER CELLS AND CELL WIDTH IN REGION 3: 250, 20.0
NUMBER CELLS AND CELL WIDTH IN REGION 4: 250,223.0
NUMBER OF TIME STEPS AND VALUE OF TIME STEP IN MINUTES: 1320, 5.0
TIME STEP(S) OF INTERMEDIATE OUTPUT 1: 400
TIME STEP(S) OF INTERMEDIATE OUTPUT 2: 800
NO COMPARSION WITH MEASURED PROFILE.
PROFILE ELEVATION CONTOUR 1: 4.00
PROFILE ELEVATION CONTOUR 2: 0.00
PROFILE ELEVATION CONTOUR 3: -5.00
PROFILE EROSION DEPTH 1: 0.00
PROFILE EROSION DEPTH 2: 1.00
PROFILE EROSION DEPTH 3: 1.50
REFERENCE ELEVATION: 0.00
TRANSPORT RATE COEFFICIENT (m^4/N): 1.75E-6
COEFFICIENT FOR SLOPE DEPENDENT TERM (m^2/s): 0.0020
TRANSPORT RATE DECAY COEFFICIENT MULTIPLIER: 0.50
WATER TEMPERATURE IN DEGREES C : 20.0

WAVE TYPE (MONOCHROMATIC=1, IRREGULAR=2): 2
WAVE HEIGHT AND PERIOD INPUT (CONSTANT=0, VARIABLE=1): 1
TIME STEP OF VARIABLE WAVE HEIGHT AND PERIOD INPUT IN MINUTES: 60.0
WAVE ANGLE INPUT (CONSTANT=0, VARIABLE=1): 0
CONSTANT WAVE ANGLE: 0.0
WATER DEPTH OF INPUT WAVES (DEEP WATER = 0.0): 10.2
SEED VALUE FOR WAVE HEIGHT RANDOMIZER AND % VARIABILITY: 4567, 20.0
TOTAL WATER ELEVATION INPUT (CONSTANT=0, VARIABLE=1): 1
TIME STEP OF VARIABLE TOTAL WATER ELEVATION INPUT IN MINUTES: 60.0
WIND SPEED AND ANGLE INPUT (CONSTANT=0, VARIABLE=1): 0
CONSTANT WIND SPEED AND ANGLE: 46.2, 0.0

TYPE OF INPUT PROFILE (ARBITRARY=1, SCHEMATIZED=2): 1
DEPTH CORRESPONDING TO LANDWARD END OF SURF ZONE: 0.30
EFFECTIVE GRAIN SIZE DIAMETER IN MILLIMETERS: 0.21
MAXIMUM PROFILE SLOPE PRIOR TO AVALANCHING IN DEGREES: 45.0

NO BEACH FILL IS PRESENT.

POSITION OF SEAWALL RELATIVE TO INITIAL PROFILE: 112.9
SEAWALL FAILURE IS NOT ALLOWED.

NO HARD BOTTOM IS PRESENT.

COMPUTED RESULTS

J883/1 Onslow

Reach: Profile 4A Storm: 100 Yr Storm

DIFFERENCE IN TOTAL VOLUME BETWEEN FINAL AND INITIAL PROFILES:
0.0 m^3/m

MAXIMUM VALUE OF WATER ELEVATION + SETUP FOR SIMULATION
4.71 m

TIME STEP AND POSITION ON PROFILE AT WHICH MAXIMUM VALUE
OF WATER ELEVATION + SETUP OCCURRED
217, 113.0 m
MAXIMUM ESTIMATED RUNUP ELEVATION: 5.67 m
(REFERENCED TO VERTICAL DATUM)

POSITION OF LANDWARD MOST OCCURRENCE OF A 0.00 m EROSION DEPTH:
112.0 m

DISTANCE FROM POSITION OF REFERENCE ELEVATION ON INITIAL PROFILE
TO POSITION OF LANDWARD MOST OCCURRENCE OF A 0.00 m EROSION DEPTH:
53.1 m

POSITION OF LANDWARD MOST OCCURRENCE OF A 1.00 m EROSION DEPTH:
113.0 m

DISTANCE FROM POSITION OF REFERENCE ELEVATION ON INITIAL PROFILE
TO POSITION OF LANDWARD MOST OCCURRENCE OF A 1.00 m EROSION DEPTH:
52.1 m

POSITION OF LANDWARD MOST OCCURRENCE OF A 1.50 m EROSION DEPTH:
113.0 m

DISTANCE FROM POSITION OF REFERENCE ELEVATION ON INITIAL PROFILE
TO POSITION OF LANDWARD MOST OCCURRENCE OF A 1.50 m EROSION DEPTH:
52.1 m

THE 4.00 m CONTOUR DID NOT RECEDE

MAXIMUM RECESSION OF THE 0.00 m ELEVATION CONTOUR:
0.40 m

MAXIMUM RECESSION OF THE -5.00 m ELEVATION CONTOUR:
0.00 m

J883/1 Onslow

Reach: Profile 4B Storm: 100 Yr Storm

Report

Project: J883/1 Onslow

Reach: Profile 4B

Storm: 100 Yr Storm

MODEL CONFIGURATION

INPUT UNITS (SI=1, AMERICAN CUST.=2): 1
NUMBER OF CALCULATION CELLS: 1000
GRID TYPE (CONSTANT=0, VARIABLE=1): 1
NUMBER OF GRID CELL REGIONS: 4
NUMBER CELLS AND CELL WIDTH IN REGION 1: 300, 1.0
NUMBER CELLS AND CELL WIDTH IN REGION 2: 200, 5.0
NUMBER CELLS AND CELL WIDTH IN REGION 3: 250, 20.0
NUMBER CELLS AND CELL WIDTH IN REGION 4: 250,223.0
NUMBER OF TIME STEPS AND VALUE OF TIME STEP IN MINUTES: 1320, 5.0
TIME STEP(S) OF INTERMEDIATE OUTPUT 1: 400
TIME STEP(S) OF INTERMEDIATE OUTPUT 2: 800
NO COMPARSION WITH MEASURED PROFILE.
PROFILE ELEVATION CONTOUR 1: 5.00
PROFILE ELEVATION CONTOUR 2: 0.00
PROFILE ELEVATION CONTOUR 3: -5.00
PROFILE EROSION DEPTH 1: 0.00
PROFILE EROSION DEPTH 2: 1.00
PROFILE EROSION DEPTH 3: 1.50
REFERENCE ELEVATION: 0.00
TRANSPORT RATE COEFFICIENT (m^4/N): 1.75E-6
COEFFICIENT FOR SLOPE DEPENDENT TERM (m^2/s): 0.0020
TRANSPORT RATE DECAY COEFFICIENT MULTIPLIER: 0.50
WATER TEMPERATURE IN DEGREES C : 20.0

WAVE TYPE (MONOCHROMATIC=1, IRREGULAR=2): 2
WAVE HEIGHT AND PERIOD INPUT (CONSTANT=0, VARIABLE=1): 1
TIME STEP OF VARIABLE WAVE HEIGHT AND PERIOD INPUT IN MINUTES: 60.0
WAVE ANGLE INPUT (CONSTANT=0, VARIABLE=1): 0
CONSTANT WAVE ANGLE: 0.0
WATER DEPTH OF INPUT WAVES (DEEP WATER = 0.0): 10.2
SEED VALUE FOR WAVE HEIGHT RANDOMIZER AND % VARIABILITY: 4567, 20.0
TOTAL WATER ELEVATION INPUT (CONSTANT=0, VARIABLE=1): 1
TIME STEP OF VARIABLE TOTAL WATER ELEVATION INPUT IN MINUTES: 60.0
WIND SPEED AND ANGLE INPUT (CONSTANT=0, VARIABLE=1): 0
CONSTANT WIND SPEED AND ANGLE: 46.2, 0.0

TYPE OF INPUT PROFILE (ARBITRARY=1, SCHEMATIZED=2): 1
DEPTH CORRESPONDING TO LANDWARD END OF SURF ZONE: 0.30
EFFECTIVE GRAIN SIZE DIAMETER IN MILLIMETERS: 0.21
MAXIMUM PROFILE SLOPE PRIOR TO AVALANCHING IN DEGREES: 45.0

NO BEACH FILL IS PRESENT.

POSITION OF SEAWALL RELATIVE TO INITIAL PROFILE: 87.6
SEAWALL FAILURE IS NOT ALLOWED.

NO HARD BOTTOM IS PRESENT.

COMPUTED RESULTS

DIFFERENCE IN TOTAL VOLUME BETWEEN FINAL AND INITIAL PROFILES:
0.0 m^3/m

MAXIMUM VALUE OF WATER ELEVATION + SETUP FOR SIMULATION
4.67 m

TIME STEP AND POSITION ON PROFILE AT WHICH MAXIMUM VALUE
OF WATER ELEVATION + SETUP OCCURRED
217, 88.0 m
MAXIMUM ESTIMATED RUNUP ELEVATION: 5.67 m
(REFERENCED TO VERTICAL DATUM)

POSITION OF LANDWARD MOST OCCURRENCE OF A 0.00 m EROSION DEPTH:
87.0 m

DISTANCE FROM POSITION OF REFERENCE ELEVATION ON INITIAL PROFILE
TO POSITION OF LANDWARD MOST OCCURRENCE OF A 0.00 m EROSION DEPTH:
48.8 m

POSITION OF LANDWARD MOST OCCURRENCE OF A 1.00 m EROSION DEPTH:
88.0 m

DISTANCE FROM POSITION OF REFERENCE ELEVATION ON INITIAL PROFILE
TO POSITION OF LANDWARD MOST OCCURRENCE OF A 1.00 m EROSION DEPTH:
47.8 m

POSITION OF LANDWARD MOST OCCURRENCE OF A 1.50 m EROSION DEPTH:
88.0 m

DISTANCE FROM POSITION OF REFERENCE ELEVATION ON INITIAL PROFILE
TO POSITION OF LANDWARD MOST OCCURRENCE OF A 1.50 m EROSION DEPTH:
47.8 m

THE ENTIRE PROFILE WAS BELOW THE 5.00 m ELEVATION CONTOUR
AT SOME POINT DURING THE SIMULATION.

MAXIMUM RECESSION OF THE 0.00 m ELEVATION CONTOUR:
1.45 m

MAXIMUM RECESSION OF THE -5.00 m ELEVATION CONTOUR:
0.00 m

Report

Project: J883/1 Onslow
Reach: Profile 5
Storm: 100 Yr Storm

MODEL CONFIGURATION

INPUT UNITS (SI=1, AMERICAN CUST.=2): 1
NUMBER OF CALCULATION CELLS: 1000
GRID TYPE (CONSTANT=0, VARIABLE=1): 1
NUMBER OF GRID CELL REGIONS: 4
NUMBER CELLS AND CELL WIDTH IN REGION 1: 300, 1.0
NUMBER CELLS AND CELL WIDTH IN REGION 2: 200, 5.0
NUMBER CELLS AND CELL WIDTH IN REGION 3: 250, 20.0
NUMBER CELLS AND CELL WIDTH IN REGION 4: 250,223.0
NUMBER OF TIME STEPS AND VALUE OF TIME STEP IN MINUTES: 1320, 5.0
TIME STEP(S) OF INTERMEDIATE OUTPUT 1: 400
TIME STEP(S) OF INTERMEDIATE OUTPUT 2: 800
NO COMPARSION WITH MEASURED PROFILE.
PROFILE ELEVATION CONTOUR 1: 5.00
PROFILE ELEVATION CONTOUR 2: 0.00
PROFILE ELEVATION CONTOUR 3: -5.00
PROFILE EROSION DEPTH 1: 0.00
PROFILE EROSION DEPTH 2: 1.00
PROFILE EROSION DEPTH 3: 1.50
REFERENCE ELEVATION: 1.75
TRANSPORT RATE COEFFICIENT (m^4/N): 1.75E-6
COEFFICIENT FOR SLOPE DEPENDENT TERM (m^2/s): 0.0020
TRANSPORT RATE DECAY COEFFICIENT MULTIPLIER: 0.50
WATER TEMPERATURE IN DEGREES C : 20.0

WAVE TYPE (MONOCHROMATIC=1, IRREGULAR=2): 2
WAVE HEIGHT AND PERIOD INPUT (CONSTANT=0, VARIABLE=1): 1
TIME STEP OF VARIABLE WAVE HEIGHT AND PERIOD INPUT IN MINUTES: 60.0
WAVE ANGLE INPUT (CONSTANT=0, VARIABLE=1): 0
CONSTANT WAVE ANGLE: 0.0
WATER DEPTH OF INPUT WAVES (DEEP WATER = 0.0): 10.2
SEED VALUE FOR WAVE HEIGHT RANDOMIZER AND % VARIABILITY: 4567, 20.0
TOTAL WATER ELEVATION INPUT (CONSTANT=0, VARIABLE=1): 1
TIME STEP OF VARIABLE TOTAL WATER ELEVATION INPUT IN MINUTES: 60.0
WIND SPEED AND ANGLE INPUT (CONSTANT=0, VARIABLE=1): 0
CONSTANT WIND SPEED AND ANGLE: 46.2, 0.0

TYPE OF INPUT PROFILE (ARBITRARY=1, SCHEMATIZED=2): 1
DEPTH CORRESPONDING TO LANDWARD END OF SURF ZONE: 0.30
EFFECTIVE GRAIN SIZE DIAMETER IN MILLIMETERS: 0.21
MAXIMUM PROFILE SLOPE PRIOR TO AVALANCHING IN DEGREES: 45.0

NO BEACH FILL IS PRESENT.

NO SEAWALL IS PRESENT.

NO HARD BOTTOM IS PRESENT.

COMPUTED RESULTS

DIFFERENCE IN TOTAL VOLUME BETWEEN FINAL AND INITIAL PROFILES:

0.0 m^3/m

MAXIMUM VALUE OF WATER ELEVATION + SETUP FOR SIMULATION
5.42 m

TIME STEP AND POSITION ON PROFILE AT WHICH MAXIMUM VALUE
OF WATER ELEVATION + SETUP OCCURRED
212, 41.0 m
MAXIMUM ESTIMATED RUNUP ELEVATION: 5.67 m
(REFERENCED TO VERTICAL DATUM)

POSITION OF LANDWARD MOST OCCURRENCE OF A 0.00 m EROSION DEPTH:
34.0 m

DISTANCE FROM POSITION OF REFERENCE ELEVATION ON INITIAL PROFILE
TO POSITION OF LANDWARD MOST OCCURRENCE OF A 0.00 m EROSION DEPTH:
77.8 m

POSITION OF LANDWARD MOST OCCURRENCE OF A 1.00 m EROSION DEPTH:
35.0 m

DISTANCE FROM POSITION OF REFERENCE ELEVATION ON INITIAL PROFILE
TO POSITION OF LANDWARD MOST OCCURRENCE OF A 1.00 m EROSION DEPTH:
76.8 m

POSITION OF LANDWARD MOST OCCURRENCE OF A 1.50 m EROSION DEPTH:
38.0 m

DISTANCE FROM POSITION OF REFERENCE ELEVATION ON INITIAL PROFILE
TO POSITION OF LANDWARD MOST OCCURRENCE OF A 1.50 m EROSION DEPTH:
73.8 m

MAXIMUM RECESSION OF THE 5.00 m ELEVATION CONTOUR:
8.06 m

THE 0.00 m CONTOUR DID NOT RECEDE

THE -5.00 m CONTOUR DID NOT RECEDE

Report

Project: J883/1 Onslow

Reach: Profile 6

Storm: 100 Yr Storm

MODEL CONFIGURATION

INPUT UNITS (SI=1, AMERICAN CUST.=2): 1
NUMBER OF CALCULATION CELLS: 1000
GRID TYPE (CONSTANT=0, VARIABLE=1): 1
NUMBER OF GRID CELL REGIONS: 4
NUMBER CELLS AND CELL WIDTH IN REGION 1: 500, 1.0
NUMBER CELLS AND CELL WIDTH IN REGION 2: 100, 5.0
NUMBER CELLS AND CELL WIDTH IN REGION 3: 150, 20.0
NUMBER CELLS AND CELL WIDTH IN REGION 4: 250,232.0
NUMBER OF TIME STEPS AND VALUE OF TIME STEP IN MINUTES: 1320, 5.0
TIME STEP(S) OF INTERMEDIATE OUTPUT 1: 400
TIME STEP(S) OF INTERMEDIATE OUTPUT 2: 800
NO COMPARSION WITH MEASURED PROFILE.
PROFILE ELEVATION CONTOUR 1: 2.50
PROFILE ELEVATION CONTOUR 2: 0.00
PROFILE ELEVATION CONTOUR 3: -5.00
PROFILE EROSION DEPTH 1: 0.00
PROFILE EROSION DEPTH 2: 1.00
PROFILE EROSION DEPTH 3: 1.50
REFERENCE ELEVATION: 2.30
TRANSPORT RATE COEFFICIENT (m^4/N): 1.75E-6
COEFFICIENT FOR SLOPE DEPENDENT TERM (m^2/s): 0.0020
TRANSPORT RATE DECAY COEFFICIENT MULTIPLIER: 0.50
WATER TEMPERATURE IN DEGREES C : 20.0

WAVE TYPE (MONOCHROMATIC=1, IRREGULAR=2): 2
WAVE HEIGHT AND PERIOD INPUT (CONSTANT=0, VARIABLE=1): 1
TIME STEP OF VARIABLE WAVE HEIGHT AND PERIOD INPUT IN MINUTES: 60.0
WAVE ANGLE INPUT (CONSTANT=0, VARIABLE=1): 0
CONSTANT WAVE ANGLE: 0.0
WATER DEPTH OF INPUT WAVES (DEEP WATER = 0.0): 10.2
SEED VALUE FOR WAVE HEIGHT RANDOMIZER AND % VARIABILITY: 4567, 20.0
TOTAL WATER ELEVATION INPUT (CONSTANT=0, VARIABLE=1): 1
TIME STEP OF VARIABLE TOTAL WATER ELEVATION INPUT IN MINUTES: 60.0
WIND SPEED AND ANGLE INPUT (CONSTANT=0, VARIABLE=1): 0
CONSTANT WIND SPEED AND ANGLE: 46.2, 0.0

TYPE OF INPUT PROFILE (ARBITRARY=1, SCHEMATIZED=2): 1
DEPTH CORRESPONDING TO LANDWARD END OF SURF ZONE: 0.30
EFFECTIVE GRAIN SIZE DIAMETER IN MILLIMETERS: 0.21
MAXIMUM PROFILE SLOPE PRIOR TO AVALANCHING IN DEGREES: 45.0

NO BEACH FILL IS PRESENT.

NO SEAWALL IS PRESENT.

NO HARD BOTTOM IS PRESENT.

COMPUTED RESULTS

DIFFERENCE IN TOTAL VOLUME BETWEEN FINAL AND INITIAL PROFILES:

0.0 m^3/m

MAXIMUM VALUE OF WATER ELEVATION + SETUP FOR SIMULATION
5.55 m

TIME STEP AND POSITION ON PROFILE AT WHICH MAXIMUM VALUE
OF WATER ELEVATION + SETUP OCCURRED
217, 32.0 m
MAXIMUM ESTIMATED RUNUP ELEVATION: 5.67 m
(REFERENCED TO VERTICAL DATUM)

POSITION OF LANDWARD MOST OCCURRENCE OF A 0.00 m EROSION DEPTH:
30.0 m

DISTANCE FROM POSITION OF REFERENCE ELEVATION ON INITIAL PROFILE
TO POSITION OF LANDWARD MOST OCCURRENCE OF A 0.00 m EROSION DEPTH:
252.2 m

POSITION OF LANDWARD MOST OCCURRENCE OF A 1.00 m EROSION DEPTH:
271.0 m

DISTANCE FROM POSITION OF REFERENCE ELEVATION ON INITIAL PROFILE
TO POSITION OF LANDWARD MOST OCCURRENCE OF A 1.00 m EROSION DEPTH:
11.2 m

A 1.50 m EROSION DEPTH DID NOT OCCUR ANYWHERE ON THE PROFILE.

MAXIMUM RECESSION OF THE 2.50 m ELEVATION CONTOUR:
52.47 m

THE 0.00 m CONTOUR DID NOT RECEDE

THE -5.00 m CONTOUR DID NOT RECEDE

Appendix C Shoreline Movement Plan

REV	DATE	APPROVED	AMENDMENT	REV	DATE	APPROVED	AMENDMENT
0	22.07.11	C DOAK	ISSUED FOR REPORT				

This plan is not to be used for construction unless issued as Rev 0 and signed below

CLIENT: LANDCORP

DESIGNED: D HAMILTON — CHECKED: C DOAK — APPROVED:

DRAWN: D HAMILTON — CHECKED: C DOAK

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PROJECT: ONSLOW TOWNSITE PLANNING

TITLE: SHORELINE MOVEMENT PLAN

SCALE AT A1: 1:10,000 — DRAWING NUMBER: D8831-01-01 — REV: 0

Appendix D Physical Processes Setback Plan

REV	DATE	APPROVED	AMENDMENT	REV	DATE	APPROVED	AMENDMENT
0	22.07.11	C DOAK	ISSUED FOR REPORT				

This plan is not to be used for construction unless issued as Rev 0 and signed below

CLIENT: LANDCORP

DESIGNED: D HAMILTON | CHECKED: C DOAK | APPROVED:

DRAWN: D HAMILTON | CHECKED: C DOAK

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PROJECT: ONSLOW TOWNSITE PLANNING

TITLE: PHYSICAL PROCESSES SETBACK PLAN

SCALE AT A1: 1:10,000 | DRAWING NUMBER: D8831-02-01 | REV: 0

Appendix E 100 year Water Level Inundation Plan as at 2011

AT CORRECT SCALE THIS IS 100 mm

LEGEND:

- EXTENT OF +5.0 mAHD INUNDATION
- INUNDATED AREA

NOTES:

1. 2009 AERIAL PHOTOGRAPH

CAD:

REV	DATE	APPROVED	AMENDMENT	REV	DATE	APPROVED	AMENDMENT
0	22.07.11	C DOAK	ISSUED FOR REPORT				

This plan is not to be used for construction unless issued as Rev 0 and signed below

CLIENT: LANDCORP

DESIGNED	CHECKED	APPROVED
D HAMILTON	C DOAK	
DRAWN: D HAMILTON	CHECKED: C DOAK	

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PROJECT: ONSLOW TOWNSITE PLANNING

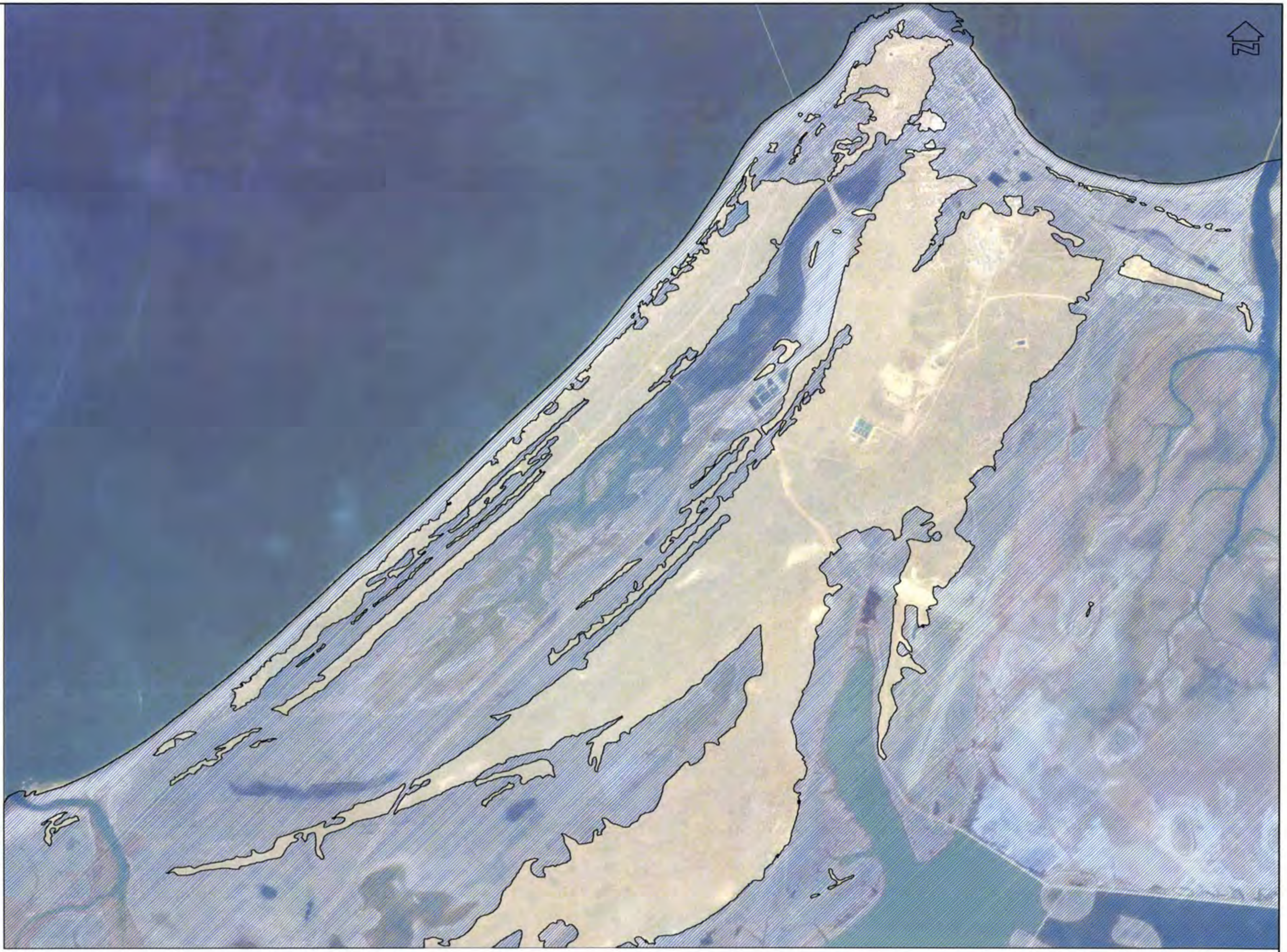
TITLE: 100 YEAR WATER LEVEL INUNDATION PLAN AS AT 2011

SCALE AT A1: 1:12,500

DRAWING NUMBER: D8831-03-01

REV: 0

Appendix F 100 year Water Level Inundation Plan as at 2110



LEGEND:

EXTENT OF +5.9 mAHD INUNDATION

INUNDATED AREA

NOTES:

1. 2009 AERIAL PHOTOGRAPH

REV	DATE	APPROVED	AMENDMENT
0	22.07.11	C DOAK	ISSUED FOR REPORT

This plan is not to be used for construction unless issued as Rev 0 and signed below

CLIENT: LANDCORP

DESIGNED: D HAMILTON | CHECKED: C DOAK

DRAWN: D HAMILTON | CHECKED: C DOAK

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CAD:

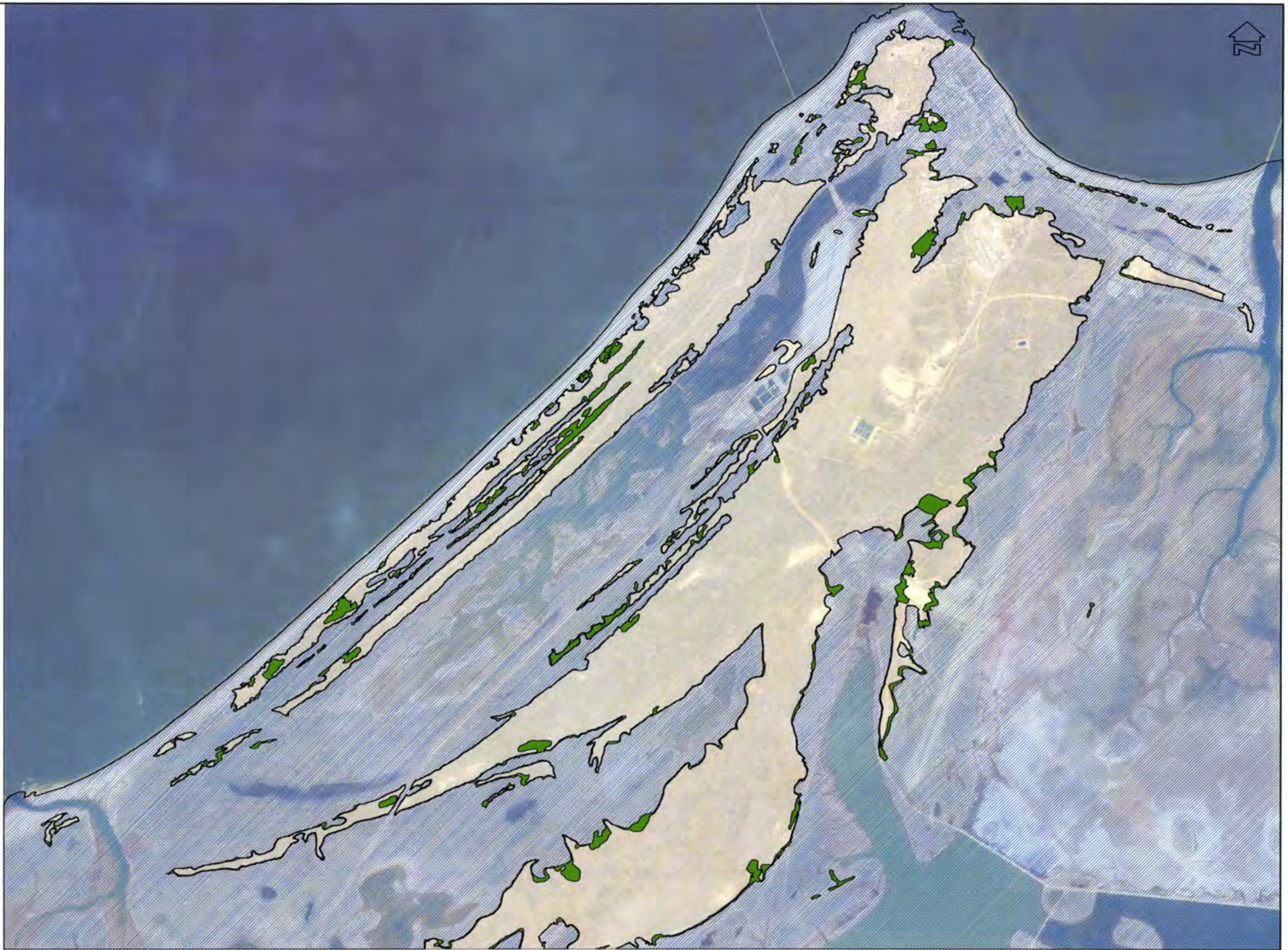
PROJECT: ONSLOW TOWNSITE PLANNING

TITLE: 100 YEAR WATER LEVEL INUNDATION PLAN AS AT 2110

SCALE AT A1: 1:12,500 | DRAWING NUMBER: D8831-04-01 | REV: 0

Appendix G Elevation Requirements for Residential or Non Emergency Response Infrastructure Plan

AT CORRECT SCALE THIS IS 100 mm



LEGEND:

- GROUND ELEVATION < +5.9mAHD (REQUIRES FILL FOR DEVELOPMENT)
- GROUND ELEVATION BETWEEN +5.9mAHD AND 6.4mAHD (MAY NOT REQUIRE FILL IF FINISHED FLOOR LEVEL IS >6.4mAHD)

NOTES:

1. 2009 AERIAL PHOTOGRAPH
2. UNSHADED AREAS HAVE NO DEVELOPMENT LEVEL CONSTRAINTS DURING 100 YEAR WATER LEVEL EVENT

AT CORRECT SCALE THIS IS 100 mm

CAD:

REV	DATE	APPROVED	AMENDMENT
0	22.07.11	C DOAK	ISSUED FOR REPORT

This plan is not to be used for construction unless issued as Rev 0 and signed below

CLIENT: LANDCORP

DESIGNED: D HAMILTON | CHECKED: C DOAK | APPROVED:

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PROJECT: ONSLOW TOWNSITE PLANNING

TITLE: ELEVATION REQUIREMENTS FOR RESIDENTIAL & NON EMERGENCY RESPONSE INFRASTRUCTURE

SCALE AT A1: 1:12,500 | DRAWING NUMBER: D8831-05-01 | REV: 0