FIGURE 6

RMA-2 MODEL NETWORK

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fig6-network_rg.dgn

Table 3 RMA-2 MODEL ROUGHNESS PARAMETERS

ELEMENT TYPE	DESCRIPTION	ROUGHNESS VALUE
1	Creek channel and lake bed	0.035
2	Grassed overbank areas with pockets of light scrub	0.040
3	Channel and lake banks with dense vegetation	0.100
4	Existing roadway areas	0.012
5	Bed of lake entrance and back beach berm (*sand*)	0.025

3.3.3 Hydraulic Model Boundary Conditions

Boundary conditions simulate the physical boundaries of the model area as well as model inflows and outflows throughout the duration of the flood simulation.

For a flood model, the upstream boundary conditions are typically defined by the catchment runoff that enters the area of interest for flood level estimation. Upstream boundary conditions are typically represented by flood hydrographs which are specified at the upstream end of the hydraulic model.

Downstream boundary conditions are typically defined by a time varying water level. In the case of an ocean entrance, this time varying water level reflects ocean water levels and accounts for tidal variation, storm surge (*barometric setup and wind setup*) and wave setup.

Adopted Upstream Boundary Conditions

Upstream boundary conditions for the RMA-2 model of Hearns Lake and Double Crossing Creek were based on flood discharge hydrographs generated from the RAFTS hydrologic modelling discussed in **Section 3**. Positive element inflows were also used to simulate runoff generated across the development site at points within the network.

The RAFTS model nodes that correspond to the adopted upstream limits of the model are shown in **Figures 4** and **5**. The peak discharges for the 20 and 100 year recurrence events at these nodes / points of inflow are listed in **Table 4**. These flows and the associated discharge hydrographs were adopted as the upstream boundary conditions for the hydraulic model.

Adopted Downstream Boundary Conditions

As discussed, Hearns Lake is an ICOLL, but would typically be open and discharge to the Pacific Ocean during or following flood conditions. Accordingly, peak flood levels within the development site could be influenced by ocean water levels, or alternatively, by the capacity for floodwaters to discharge through the entrance to the ocean.

Therefore, it is necessary to develop an understanding of the variation in ocean water levels that could arise at the time of a flood.

Table 4 UPSTREAM BOUNDARY CONDITIONS FOR RMA-2 MODEL

LOCATION	RAFTS MODEL NODE	PEAK DISCHARGE (m^3/s)	
		20 Year Recurrence Event	100 Year Recurrence Event
Double Crossing Creek about 300 m upstream of the Pacific Highway	1.05	97.1	129.4
Eastern Drainage Easement at Southern Boundary of the Development Site	12.01	1.1	1.4
Western Drainage Easement at Southern Boundary of the Development Site	8.01	4.7	6.0
Inflow at Depression at South-Eastern Corner of the Site	13.01	0.7	1.0
Inflow at Hearns Lake	8.09	7.8	11.0
Inflow at Hearns Lake	8.13	4.2	5.8
Inflow at Hearns Lake	9.02	8.1	10.7
Inflow approx. 400 metres Upstream of Ocean Entrance	10.02	9.9	13.8

Flood producing storm cells generally produce increases in ocean levels, which are associated with a drop in atmospheric pressure. These storm cells can cause further increases in ocean levels through the combined impacts of wind and wave setup. Accordingly, the downstream boundary condition for the model has been defined by a sinusoidal tide curve that is representative of the combined effects of astronomical tide, storm surge and wave setup.

The peak ocean water levels used to develop the downstream boundary conditions for the design events were extracted from a coastal processes report prepared in 1987 for Park Beach at Coffs Harbour. The report was prepared by the then NSW Public Works Department, and is titled, *'An Assessment of Coastal Processes Affecting Park Beach, Coffs Harbour'*. Peak ocean water levels were extracted from this report for the design 20 and 100 year recurrence ocean storms. These are listed in **Table 5** and were adopted as defining the amplitude of the sinusoidal curve that was generated as the downstream boundary condition for the hydraulic model.

Table 5 PEAK DESIGN STORM OCEAN WATER LEVELS

DESIGN OCEAN STORM EVENT	PREDICTED PEAK WATER LEVEL AT PARK BEACH (*m AHD*)
20 year	2.2
100 year	2.6

Source: NSW Public Works Department (1987)

3.3.4 Design Flood Simulations

Combination of Ocean and Catchment Storm Conditions

The 2D hydrodynamic model of Hearns Lake and the lower reaches of Double Crossing Creek was used to simulate a number of design flood scenarios. These scenarios include combined catchment and ocean storm events, and various entrance blockage conditions.

It is difficult to establish a 'typical' design 100 year recurrence flood due to the various combinations of ocean level and catchment runoff conditions that could potentially occur in isolation or concurrently. For this investigation, two base scenarios were modelled. These are described as:

- the coincidence of a 20 year recurrence catchment storm event and a 100 year ocean storm event; and,
- the coincidence of a 100 year recurrence catchment storm event and 20 year ocean storm event.

Adopted Entrance Conditions

As outlined previously, Hearns Lake is an Intermittently Closed and Open Lake or Lagoon (*ICOLL*) which is typically closed at the ocean entrance at the northern end of Hearns Lake Beach.

The entrance is effectively closed by wave action along Hearns Lake Beach which deposits marine sand within the mouth of the entrance and creates a berm that "closes off" the entrance. Therefore, lake water levels would rise during and following catchment rainfall, until such time as the build-up of floodwaters led to the formation of a pilot channel through the mouth of the lake entrance. Lake water levels would then recede as floodwaters are discharged to the ocean.

In order to determine the worst flood conditions that could apply at the development site, both open and closed conditions were considered and modelled. In the case of the closed entrance condition, a number of additional simulations were undertaken to assess the potential impact of an entrance "breakout".

The "blocked" entrance condition was based on the adoption of a beach berm extending across the mouth of the lake entrance with a minimum crest elevation of 1.6 mAHD. This was based on topographic survey of the beach and entrance bathymetry undertaken by Asquith & deWitt Pty Ltd in June 2004 (*refer cross-sections XS 1, XS 1A and XS 2 shown in* **Figure 3**).

Several open entrance conditions were also modelled to analyse the sensitivity of the peak flood level at the site to a change in minimum bed elevation and channel width for entrance breakout. These conditions included minimum channel bed elevations 0 mAHD and -1 mAHD, and pilot channel widths of 20, 30 and 40 metres.

The full range of scenarios that were modelled are listed in the first column of **Table 6**.

3.3.5 Hydraulic Modelling Results

Peak Flood Levels

Predicted peak flood levels at the development site were extracted from the model results for each scenario and are listed in **Table 6**.

The hydraulic modelling results confirm that the entrance condition at the mouth of Hearns Lake will influence peak flood levels at the development site (*refer* **Table 6**). When the ocean entrance is blocked, the peak flood level is dominated by the discharge from catchment storm event.

However, when the entrance is open, the floodwaters from the catchment storm event are released through the ocean entrance, thereby lowering the flood level at the site. For example, for the scenario where there is a 20 year recurrence catchment storm event and a 100 year recurrence ocean storm event, and in which breakout occurs at the entrance creating a 20 metre wide pilot channel with a minimum bed elevation of 0 mAHD, it is predicted that the breakout will effectively reduce lake flood levels by about 150 mm.

The results of the modelling also show that the width and minimum bed elevation of the pilot channel under an entrance breakout condition, do not significantly alter the peak flood level across the site. That is, there is an optimum pilot channel width and scour depth that provides for efficient discharge of lake waters to the ocean. This suggests that the hydraulic control is probably the berm crest elevation which has been fixed for this analysis.

Table 6 PEAK FLOOD LEVELS ACROSS THE DEVELOPMENT SITE

CATCHMENT STORM EVENT (*years*)	OCEAN STORM EVENT (*years*)	ENTRANCE CONDITION	CHANNEL WIDTH (*m AHD*)	PEAK WATER LEVEL (*m AHD*)
20 year	100 year	Blocked	-	2.80
100 year	20 year	Blocked	-	2.73
20 year	100 year	Open (*Minimum bed elevation 0 mAHD*)	20m	2.76
			30m	2.75
			40m	2.74
20 year	100 year	Open (*Minimum bed elevation -1 mAHD*)	20m	2.74
			40m	2.73
100 year	**20 year**	**Open (*Minimum bed elevation 0 mAHD*)**	**20m**	**2.60**
			30m	2.58
			40m	2.56
100 year	20 year	Open (*Minimum bed elevation -1 mAHD*)	20m	2.54
			40m	2.52

Adopted Peak Flood Level for the Design 100 year Recurrence Flood

Based on an analysis of the results presented in **Table 6**, it is recommended that a peak design 100 year recurrence flood level of 2.6 mAHD be adopted for the development site. This level corresponds to the peak flood level that would arise should the design 100 year recurrence catchment storm event coincide with a 20 year recurrence ocean storm event, and result in a modest sized pilot channel being formed at the lake entrance (*i.e., the formation of a 20 metre wide pilot channel scoured to a minimum bed elevation of 0 mAHD*).

It is recognised that this scenario would not occur instantaneously during a flood and would occur as a dynamic response to elevated water levels within the lake and the associated hydrostatic head formed against the beach berm. Hence, it would take some time to achieve the modelled channel width of 20 metres.

Notwithstanding, it is considered that the size of the lake would sufficiently "damp" the impact of the progressive increase in pilot channel width and depth to result in there being no impact on the adopted peak 100 year recurrence flood level of 2.6 mAHD.

It should also be noted that the adopted peak 100 year recurrence flood level of 2.6 mAHD is equal to the peak ocean level for a 100 year recurrence ocean storm event determined in 1987 by the NSW Public Works Department for Park Beach. Therefore, it is considered that the adopted peak flood level is consistent with design 100 year recurrence storm conditions for both ocean and catchment dominated events.

Flood Extent and Peak Flood Depth

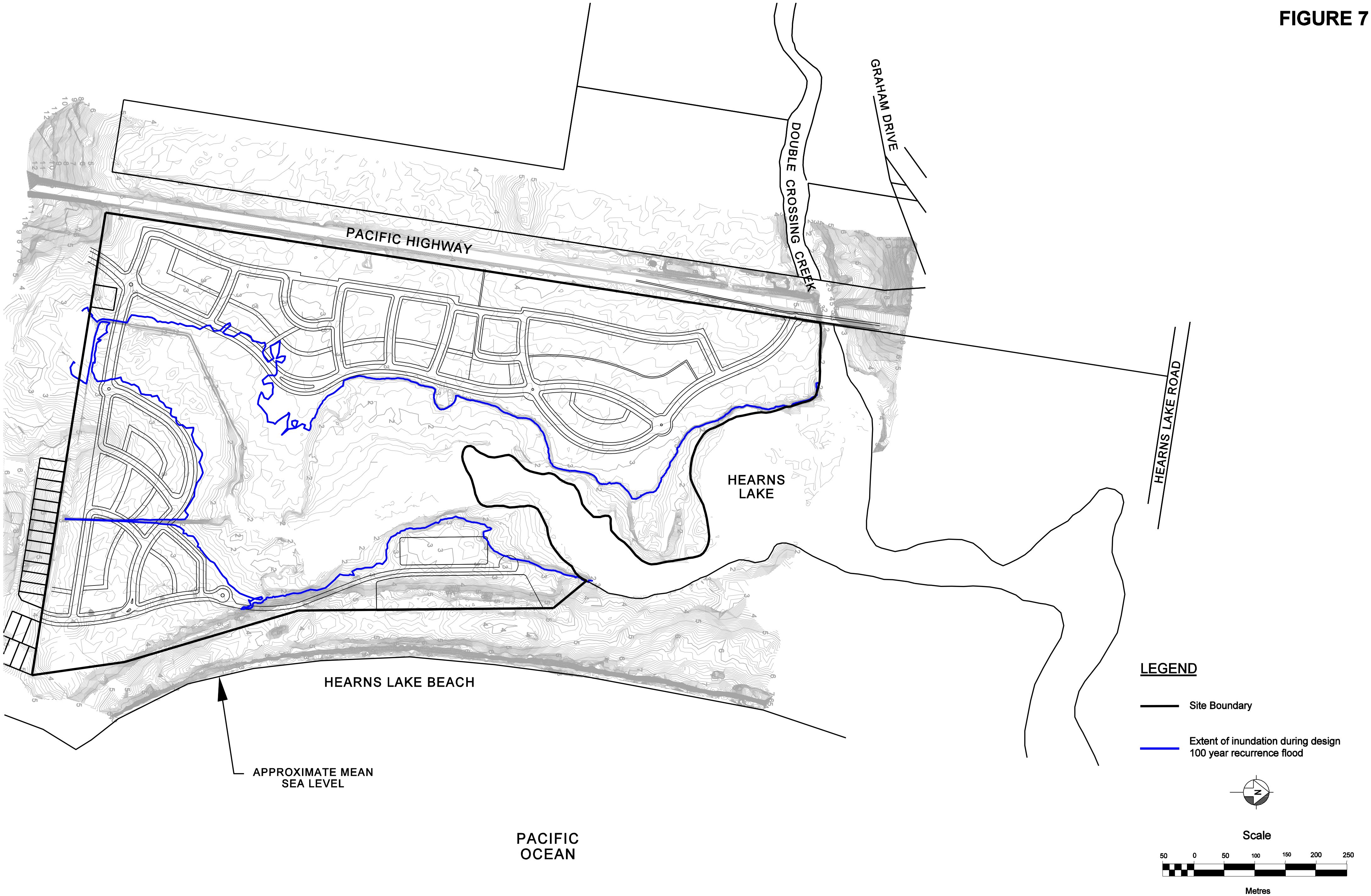
The flood extent for the design 100 year recurrence flood is shown in **Figure** 7. This is based on the results of modelling of the adopted design flood scenario referred to above which generated a uniform lake flood level of 2.6 mAHD.

The results indicated that at the peak of the design 100 year recurrence flood, about 27% of the Sandy Beach North development site would be inundated. As shown in **Figure** 7, the area that would be inundated is generally limited to the low lying overbank areas that adjoin the shoreline of Hearns Lake and the two drainage channels in the southern section of the development site.

Figure 8 shows the predicted depth of inundation across the development site at the peak of a design 100 year recurrence flood. Depths of inundation across the development site are predicted to vary between 0.1 and 1.8 metres. However, the deeper areas correspond to sections of the site that fall within the lake.

As discussed previously, the top of bank elevation of Hearns Lake within the development site is approximately 1.3 mAHD. As the peak flood level at the site is 2.6 mAHD, the peak floodwater depth outside Hearns Lake during the design 100 year recurrence flood is 1.3 mAHD. Floodwater depths across areas of the site that immediately adjoin the lake shoreline are typically 0.7 metres. However, floodwater depths are only 0.2 metres in areas that adjoin the open channels in the southern section of the site (*refer* **Figure 8**).

FIGURE 7



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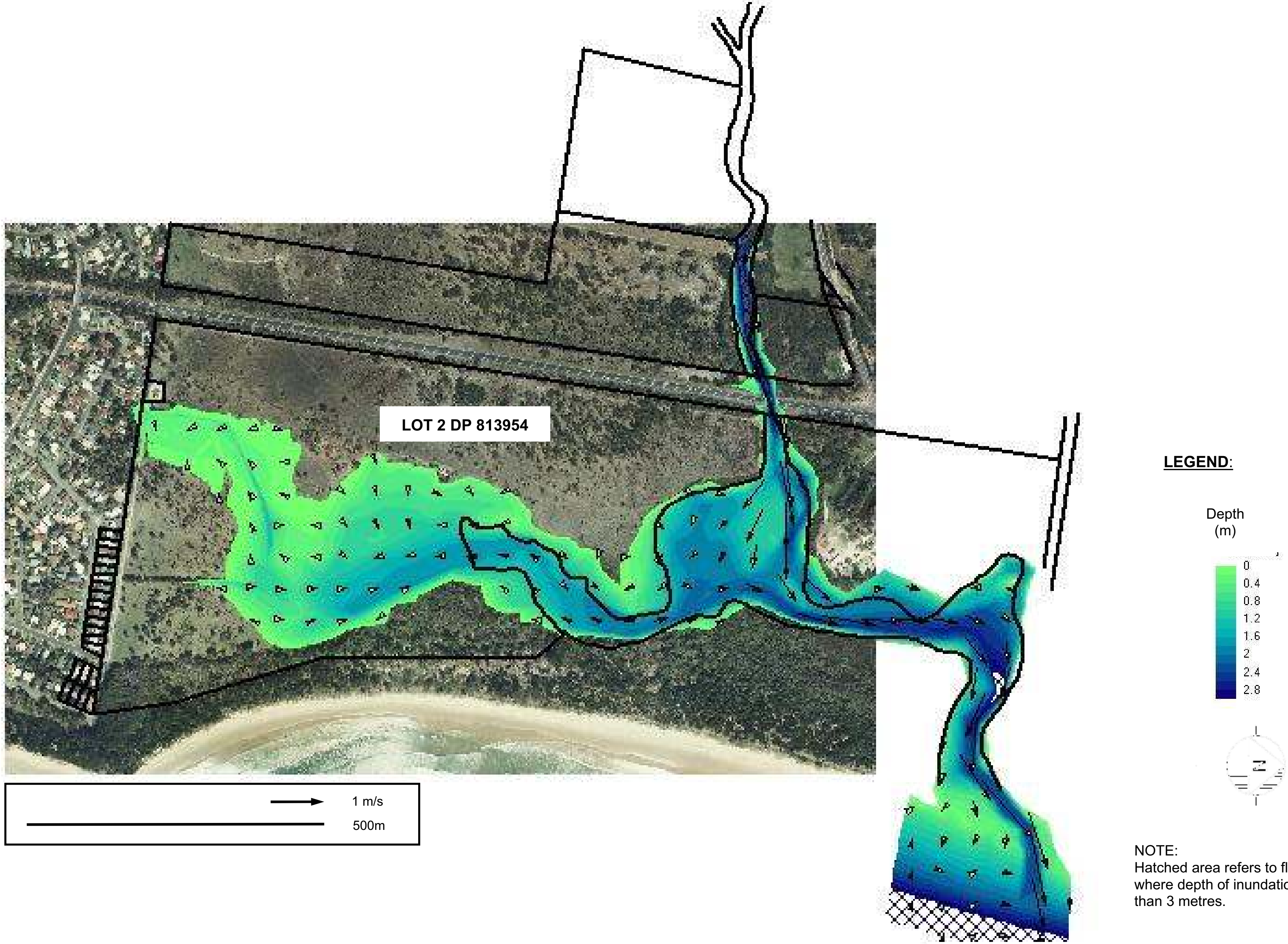
EXTENT OF INUNDATION DURING DESIGN 100 YEAR RECURRENCE FLOOD

FIGURE 8



NOTE:
Hatched area refers to flooded areas where depth of inundation is greater than 3 metres.

VARIATION IN DEPTH AND VELOCITY OF FLOODWATERS AT THE PEAK OF THE DESIGN 100 YEAR RECURRENCE FLOOD

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Peak Flood Velocity

As shown in **Figure 8**, predicted peak flow velocities across the development site during the design 100 year recurrence flood are relatively low. The peak design 100 year recurrence flow velocity is only 0.28 m/s, and is predicted to occur in a small area on the western floodplain of Hearns Lake, at the southern extent of the northern site boundary.

Generally, the peak flow velocity across the site is less than 0.15 m/s and reflects the impact of the lake in "damping" the velocity of floodwaters as they enter it.

Provisional Flood Hazard

Flood hazard is a measure of the degree of difficulty that pedestrians, cars and other vehicles will have in egressing flooded areas, and the likely damage to property and infrastructure. The NSW Government's *'Floodplain Management Manual'* (*2001*), characterises hazards associated with flooding into a combination of two hazard categories. These hazard categories are defined in **Table 7**.

Table 7 DEFINITIONS FOR HAZARD CATEGORIES

HAZARD CATEGORY	DEFINITION
HIGH	• possible danger to life and limb • evacuation by trucks difficult • potential for structural damage • social disruption • potentially high financial losses • velocity > 2 m/s, depth > 0.8 m and velocity x depth > 0.5 m^2/s*
LOW	• should it be necessary, people and their possessions could be evacuated by trucks • able-bodied adults would have little difficulty wading • velocity < 2 m/s, depth < 0.8 m and velocity x depth < 0.5 m^2/s*

* *Based on interpretation of Figure G2 from the 'Floodplain Management Manual' (2001).*

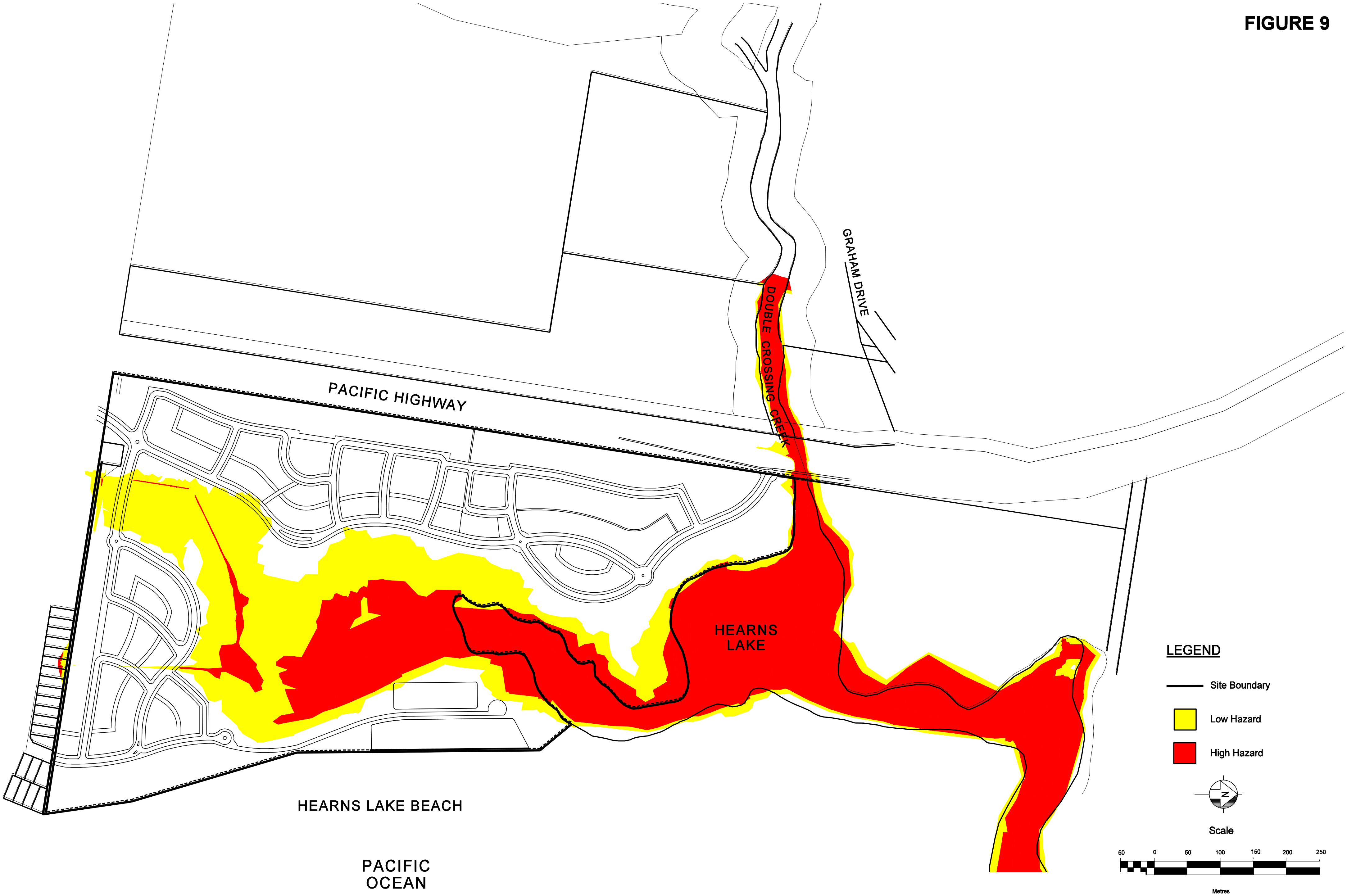
The flood hazard across the site varies as a function of the depth and velocity of floodwaters, and their product. As discussed, peak floodwater depths across areas of the site are predicted to vary up to a maximum depth of 1.8 metres and peak flow velocities are predicted to range up to 0.28 m/s.

The *'Floodplain Management Manual'* (*2001*) indicates that areas subject to floodwater depths of greater than 0.8 metres and/or flow velocities greater than 2 m/s should be classified as high hazard areas (*based on Figure G2 in the Manual*). As the flow velocities at the site only range up to 0.28 m/s, the floodwater depths will govern the hazard classification across the development site.

As the peak flood level for the design 100 year recurrence flood is 2.6 mAHD, any part of the site with an existing ground surface elevation less than or equal to 1.8 mAHD will have a depth of inundation greater than 0.8 metres and therefore be classified as high flood hazard areas.

Alternatively, areas of the site which have an existing ground surface elevation greater than 1.8 mAHD will have a low hazard classification. The provisional hazard categories for the site are shown in **Figure 9**.

FIGURE 9



PROVISIONAL FLOOD HAZARD CALSSIFICATION FOR THE DESIGN 100 YEAR RECURRENCE FLOOD

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4 CLIMATE CHANGE CONSIDERATIONS

Due to the proximity of the development site to Hearns Lake and the proximity of the lake to the ocean, there is potential for increased frequency of inundation due to the predicted impacts of climate change.

Climate change also has the potential to impact on existing flood characteristics, potentially leading to increased peak levels for floods of a specified frequency of occurrence or average recurrence interval. Increased peak flood levels could in turn result in a requirement for the minimum fill elevation to be raised by an amount commensurate with the projected increase in predicted peak flood level due to climate change.

In summary, climate change predictions could impact on design constraints such as the development footprint extent and minimum floor levels for dwellings. These constraints could be imposed due to either of the following mechanisms:

(i) increased peak flood levels within Hearns Lake due to an increase in predicted rainfall intensity for catchment storms combined with increased ocean water levels in storm events that lead to flooding; or,

(ii) an increase in the typical elevation of the entrance berm coincident with the projected increase in ocean water levels and the associated redefinition of the ICOLL extent upslope from the extent that is currently adopted and defined in the Patterson Britton & Partners Report titled, *'Scientific Assessment of Entrance Berm Elevation for Hearns Lake, Sandy Beach North'* (*January, 2007*).

In effect, climate change could result in:

(a) a reduction in the area of the site that can be developed, and;

(b) an increased depth of filling to achieve minimum floor level requirements for development on or adjacent to floodplain lands.

A discussion of additional investigations that have been undertaken to assess these issues is outlined in the following sections.

4.1 IMPACT OF CLIMATE CHANGE ON FLOOD CHARACTERISTICS

An assessment of the impact of climate change on flood characteristics in the vicinity of the Sandy Beach North Site was undertaken to establish the extent to which fill elevations and minimum floor levels may need to be raised to accommodate the projected impact of climate change to the year 2100.

This involved additional hydrologic and hydraulic flood modelling to investigate the impact of projected estimates for sea level rise and projected increases in storm rainfall intensity.

Specifically, the impact of climate change on peak flood level estimates was based on consideration of the following for a 100 year recurrence flood scenario:

- An averaged 12% increase in peak flows for the 100 year recurrence design storm event which reflected a 10% increase in peak rainfall intensity over the entire Double Crossing Creek catchment. The adoption of a 10% increase in rainfall intensity was based on application of the guidelines documented in the DECC's Floodplain Risk Management Guideline titled, *'Practical Consideration of Climate Change'* (*October 2007*).
- Increased tidal boundary conditions reflecting each of the lower, median, and upper bound scenarios of sea level rise predictions for Year 2100 as detailed in the DECC's Floodplain Risk Management Guideline titled, *'Practical Consideration of Climate Change'* (*October 2007*). The IPCC has set values of 0.18, 0.55 and 0.91 metres as the lower, median and upper bound values for sea level rise on the North Coast of NSW to Year 2100.

4.1.1 Flood Modelling

The RAFTS hydrologic model used for the prediction of flows for the 20 and 100 year recurrence storms was used to simulate the impact of the projected increase in peak rainfall on flood flows that would be discharged to Hearns Lake in a design 100 year recurrence storm event. As outlined above, the increase in peak flows is predicted to result in a 12% increase in discharge from the Double Crossing Creek catchment.

The RMA-2 flood model that was then used to simulate flooding for existing conditions at the site was modified to incorporate boundary conditions representing the adopted climate change scenarios described above. The analysis was undertaken in accordance with recommendations outlined in the Department of Environment & Climate Change (*DECC*) guideline titled, *'Floodplain Risk Management Guideline No 5 – Ocean Boundary Conditions'*.

Separate simulations were undertaken for each of the lower, median and upper bound ocean level increase projections, for each of the 20, 30 and 40 metre wide pilot channel configurations (*refer* **Table 6**). In addition, pilot channel invert levels of 0 mAHD and -1 mAHD were considered to assess the sensitivity of flood level estimates to entrance condition. All other parameters were assumed to be the same as adopted for simulations for existing conditions, as outlined in **Section 3**.

4.1.2 Impact of Climate Change Scenarios on Peak Flood Levels

The results of modelling show that the adopted climate change scenario will act to increase peak 100 year recurrence flood levels for Hearns Lake. Predicted peak flood levels at the development site were extracted from the model results for each scenario and are listed in **Tables 8** and **9**. For comparison purposes, predicted peak 100 year recurrence flood levels for each entrance configuration are highlighted in yellow for existing conditions.

The results from the analysis indicate that peak 100 year recurrence flood levels for Hearns Lake are insensitive to the width of the pilot channel that would form during a flood that led to draining of the lake. The results also show that peak lake flood levels are also insensitive to the minimum elevation to which the pilot channel would scour.

Table 8 PREDICTED PEAK FLOOD LEVELS ALLOWING FOR CLIMATE CHANGE IMPACTS AND ADOPTION OF A 0 mAHD MINIMUM PILOT CHANNEL ELEVATION

CATCHMENT STORM EVENT	OCEAN STORM EVENT	CHANNEL WIDTH (*metres*)	CLIMATE CHANGE SCENARIO	PEAK WATER LEVEL (*mAHD*)
100 year	20 year	20 m	No Consideration	2.60
			Lower	2.72
			Median	**2.97**
			Higher	3.25
		30 m	No Consideration	2.58
			Lower	2.71
			Median	**2.96**
			Higher	3.25
		40 m	No Consideration	2.56
			Lower	2.69
			Median	**2.95**
			Higher	3.24

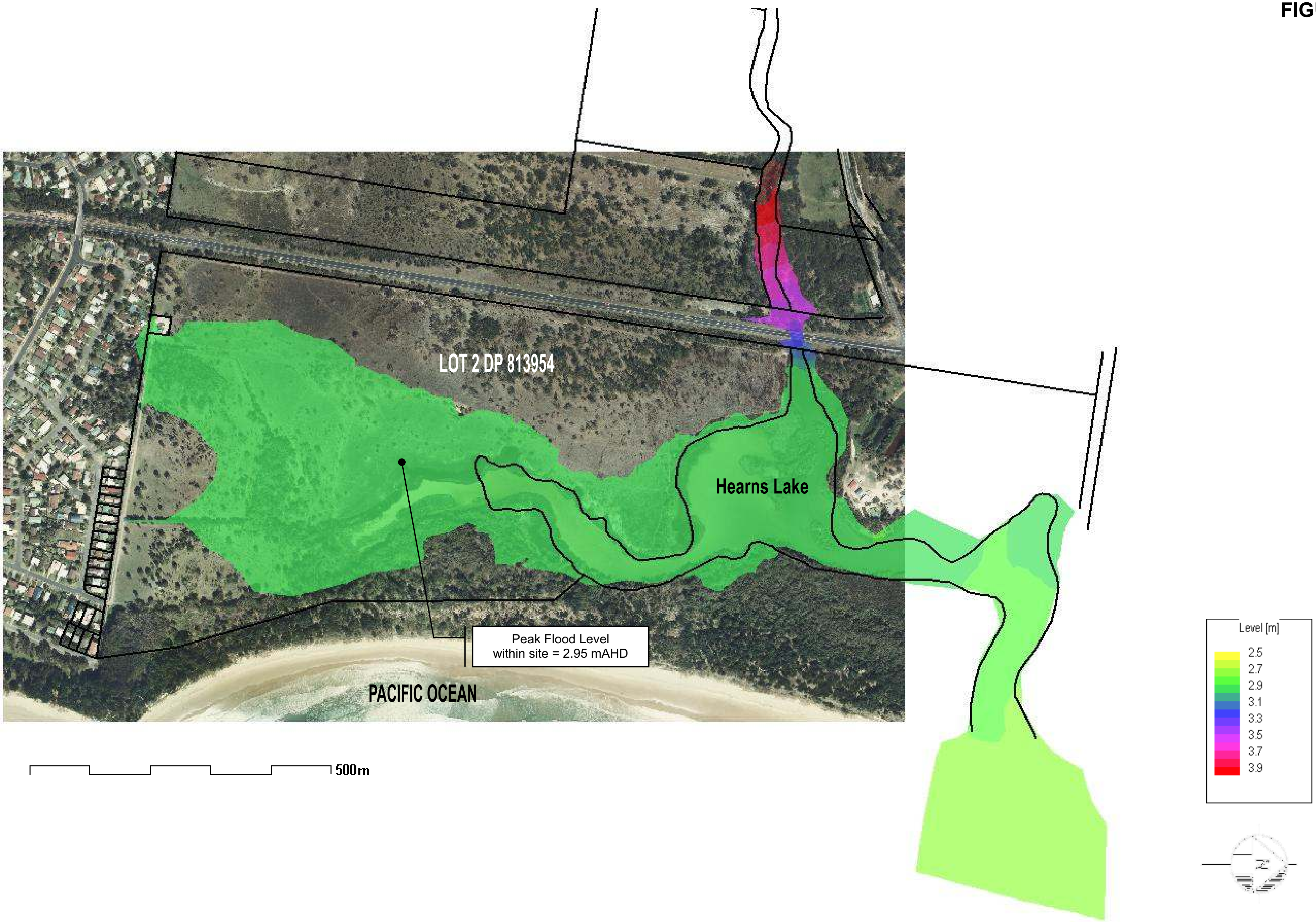
Table 9 PREDICTED PEAK FLOOD LEVELS ALLOWING FOR CLIMATE CHANGE IMPACTS AND ADOPTION OF -1 mAHD MINIMUM PILOT CHANNEL ELEVATION

CATCHMENT STORM EVENT	OCEAN STORM EVENT	CHANNEL WIDTH (*metres*)	CLIMATE CHANGE SCENARIO	PEAK WATER LEVEL (*mAHD*)
100 year	20 year	20	No Consideration	2.54
			Lower	2.68
			Median	**2.94**
			Higher	3.24
		40	No Consideration	2.52
			Lower	2.66
			Median	**2.93**
			Higher	3.23

As shown in **Tables 8** and **9**, the median Year 2100 climate change scenario generates peak 100 year recurrence levels that range from 2.93 to 2.97 mAHD.

Accordingly, it is considered appropriate to adopt an elevation of 2.95 mAHD as the Year 2100 estimate of the 100 year recurrence flood level for Hearns Lake.

The 100 year recurrence flood extent for the adopted Year 2100 climate change scenario is shown in **Figure 10**. The depth of flooding and peak flow velocity vectors are provided in **Figure 11**.



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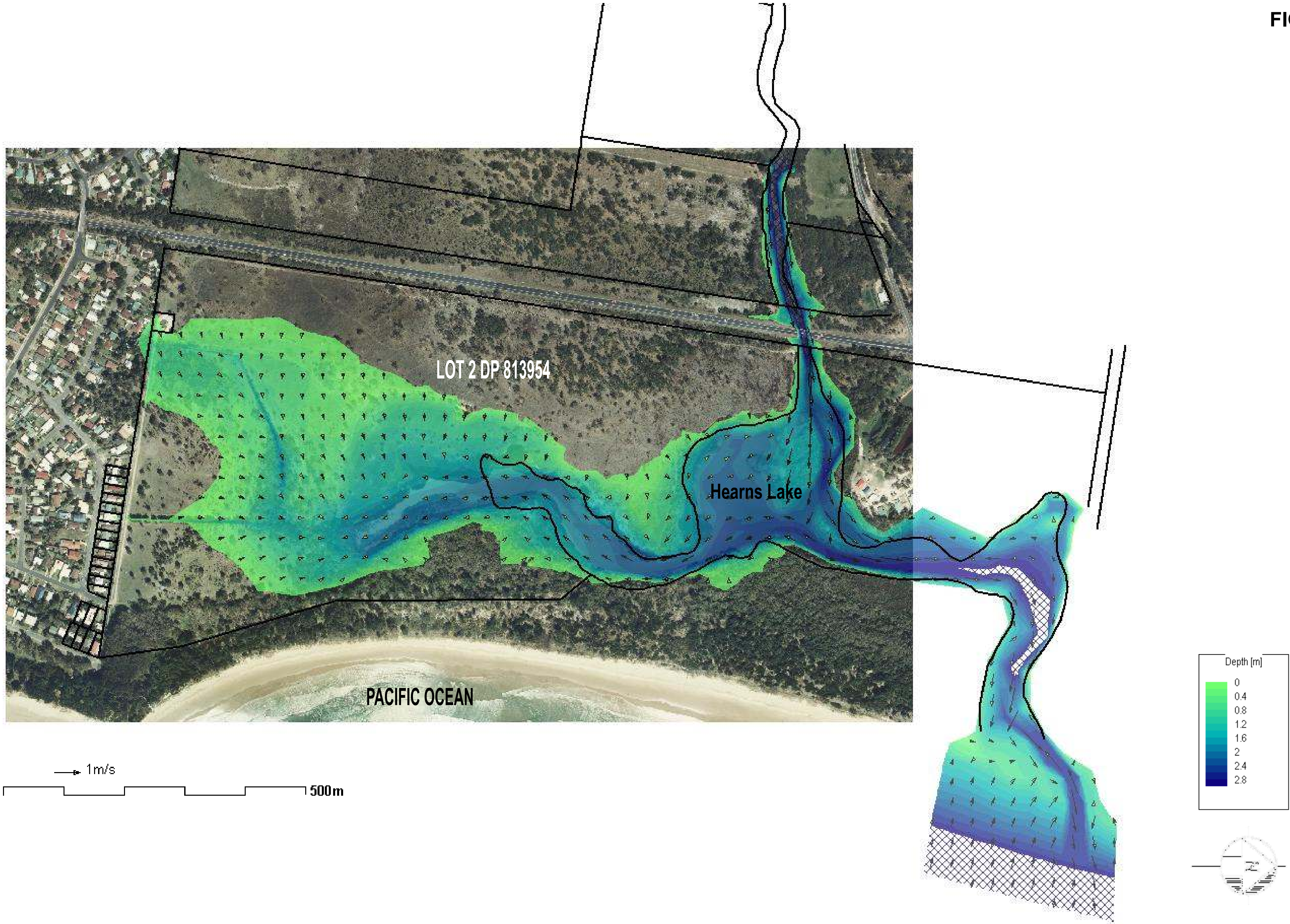
PREDICTED FLOOD LEVEL AT THE PEAK OF THE 100 YEAR RECURRENCE FLOOD WITH PROVISION FOR CLIMATE CHANGE

FIGURE 11



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VARIATION IN DEPTH AND VELOCITY OF FLOODWATERS AT THE PEAK OF THE 100 YEAR RECURRENCE FLOOD WITH PROVISION FOR CLIMATE CHANGE

5 IMPACT OF THE PROPOSED DEVELOPMENT

5.1 PROPOSED SITE CHANGES

It is proposed that the site be developed to create up to 280 residential lots set within a restored coastal landscape. The proposed layout for the subdivision is shown in **Figure 12**.

As shown, the lots are to be concentrated along the western and southern site boundaries within what is referred to as the Southern and South-western Precincts. However, several lots are also proposed along the rear of the dune at the eastern site boundary in what is being termed as the "Beach Precinct".

An internal road network is proposed to provide access to individual lots and will be linked to the Pacific Highway midway along the western boundary of the site. The road network will also connect the site to the existing village of Sandy Beach via Pine Crescent and Ti Tree Road at the southern boundary of the site (*refer* **Figure 12**).

All lots and roadways are set back at least 70 metres from the edge of Hearns Lake and Double Crossing Creek. Provision has also been made in the development layout to retain an existing drainage channel that runs through the southern section of the site and discharge surface runoff from Sandy Beach to the southern shoreline of Hearns Lake.

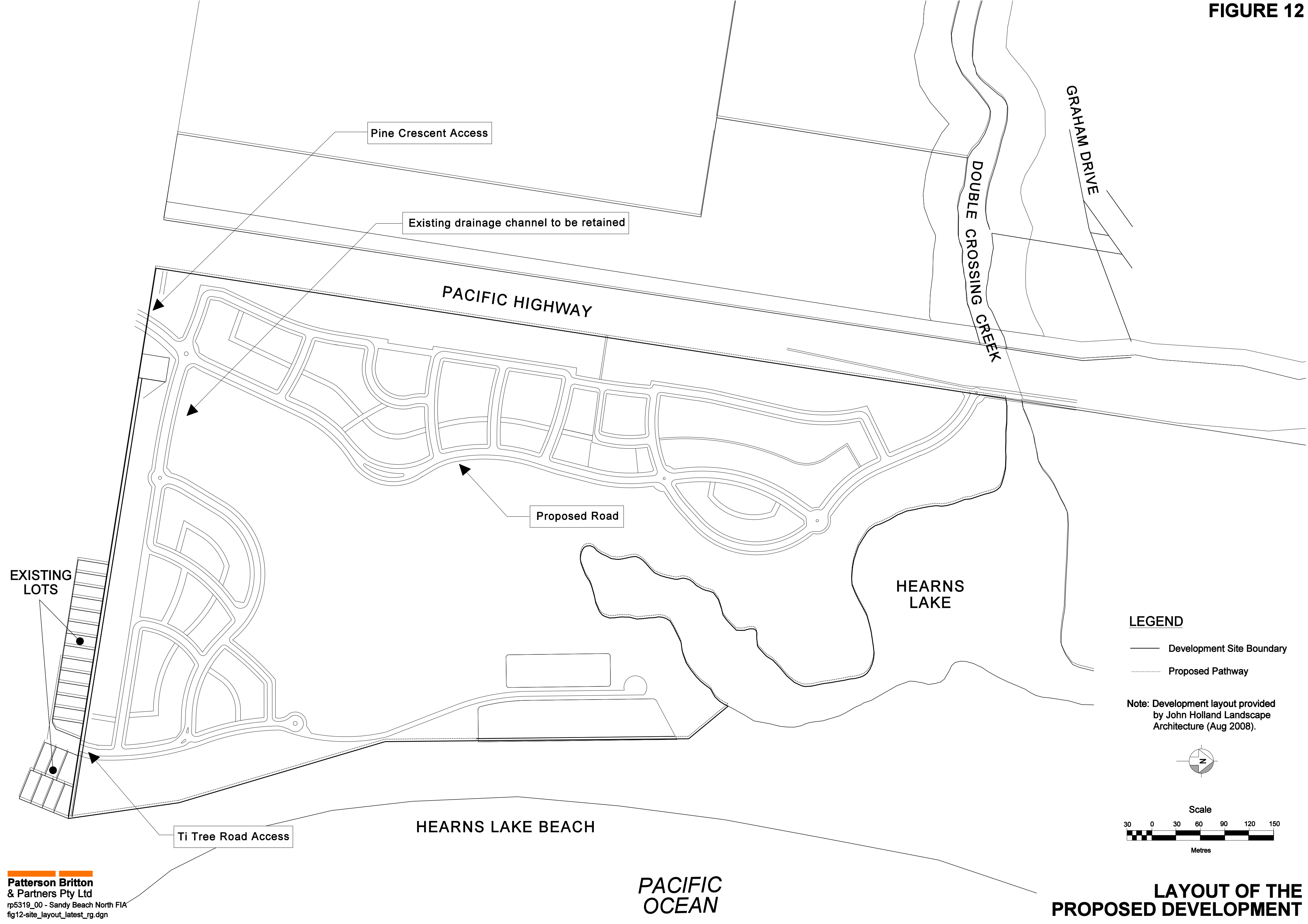
In order to comply with Council's current *Flood Policy*, the floor level of all habitable dwellings must be located at least 500 mm above the design 100 year recurrence flood level. However, it is considered appropriate to set the minimum floor level at 500 mm above the Year 2100 design 100 year recurrence flood level that incorporates an allowance for climate change. Therefore, based on an adopted Year 2100 design 100 year recurrence flood level of 2.95 mAHD, the floor level of all proposed dwellings will need to be set at or above 3.45 mAHD (*i.e., 2.95 mAHD plus 500 mm*).

It is understood that slab-on-ground dwelling construction is proposed for the site. Assuming a minimum slab thickness of 200 mm, low lying areas of the site that are proposed for development will need to be filled to an elevation of at least 3.25 mAHD. This would provide dwelling sites that would be 300 mm above the Year 2100 peak 100 year recurrence flood level and would allow easy construction of slabs for individual dwellings without significantly affecting the visual character of the development.

It is also proposed that the roads within the development be constructed to at least the peak level of the Year 2100 design 100 year recurrence flood level. Therefore, all roadways will have low points set at a minimum level of 2.95 mAHD. This will ensure that no flooding of the roadways would occur in the rare occurrence of coincident ocean and catchment storms of the magnitude of the adopted 100 year recurrence flood with provision for climate change impacts.

Accordingly, filling is proposed in some areas of the site to raise the level of the land surface so that roads and lots can be constructed to meet the above objectives.

FIGURE 12



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LAYOUT OF THE PROPOSED DEVELOPMENT

Figure 13 shows the approximate extent of filling required to raise levels to above 2.95 mAHD across areas where lots and roadways are proposed.

5.2 POTENTIAL IMPACT OF PROPOSED FILLING ON EXISTING FLOODING

5.2.1 Hydraulic Model Modifications

The proposed development will involve modification to the existing natural surface of the site and the construction of residential dwellings. The proposed filling will remove a portion of the flood storage area provided across areas that adjoin Hearns Lake and therefore, has the potential to cause localised increases in peak flood level.

Accordingly, the existing RMA-2 flood model was used to quantify any impacts and assess the potential for the proposed development to adversely impact flood behaviour on adjoining properties.

In order to quantify the potential impact (*i.e., in terms of altered flood level or velocity*), the model was updated to reflect the fill proposal. This was achieved by modifying the hydraulic model to reflect the proposed ground surface topography. The alterations involved adjusting the elevations assigned to nodes where the filling is proposed to an elevation of 2.95 mAHD or higher (*i.e., to above the Year 2100 peak 100 year recurrence flood level*). Land surfaces outside of the proposed extent of fill were not altered.

5.2.2 Hydraulic Modelling Results

The modified model was used to simulate the 100 year recurrence flood and to define flood behaviour under post-development conditions (*i.e., with the proposed filling and buildings in place*). The magnitude of any changes in flood behaviour arising from the proposed filling can be established by comparing flood modelling results for pre and post-development scenarios.

Impact on Peak Flood Level

The results of the simulation were extracted and compared with results generated from simulations for the existing scenario (*i.e., those shown in* **Figures 7** *and* **8**).

As shown in **Figure 14**, the proposed development will not cause a significant encroachment into the existing 100 year recurrence flood extent. This is to be expected, as the development layout and associated fill platforms have been designed according to a higher peak flood level that incorporates an allowance for climate change.

As expected, the flood model results for the post-development scenario confirm that the proposed development will not impact on the existing peak level of flooding in the lake during the 100 year recurrence event.

Impact on Peak Flow Velocity

Peak flow velocities were extracted from the *'post-development'* model results and compared with peak flow velocities from the pre-development scenario.