SANDY SHORES DEVELOPMENTS PTY LTD

CLIMATE CHANGE ASSESSMENT FOR PROPOSED DEVELOPMENT AT SANDY BEACH NORTH

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Patterson Britton
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consulting engineers

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1 INTRODUCTION

Sandy Shores Development Pty Ltd (*Sandy Shores*) plans to develop a 49 hectare (*ha*) parcel of land near Sandy Beach on the North Coast of New South Wales. The site is located adjacent to the Pacific Highway, about 20 kilometres north of Coffs Harbour. It is referred to as Lot 2 in DP 813954 and adjoins the northern boundary of the existing residential area of Sandy Beach. The site also adjoins the southern shoreline of Hearns Lake and extends to the rear of the back beach dunes along Hearns Lake Beach.

Hearns Lake is an Intermittently Closed and Open Lake or Lagoon (*ICOLL*) which drains to the ocean at the northern end of Hearns Lake Beach. An oblique aerial view of the lake showing the ocean entrance in its partially 'closed' state is shown overleaf in **Plate 1**. The lake has a surface area of about 15 hectares and is fed by catchment runoff that is discharged to the lake via Double Crossing Creek. The lake is usually closed to the ocean but opens following significant rainfall in the catchment.

The development site extends around the southern shoreline of Hearns Lake and comprises coastal heath that is currently used for grazing and which has previously been mined for rutile. Sandy Shores plans to develop the land and create up to 280 residential lots within an integrated landscape comprising a balanced mix of open space, leafy streetscapes and gardens, and set within a restored coastal landscape.

Plate 1 OBLIQUE AERIAL VIEW OF HEARNS LAKE SHOWING THE PARTIALLY CLOSED OCEAN ENTRANCE AND EXTENT OF THE DEVELOPMENT SITE

Double Crossing Creek and Hearns Lake form the northern boundary of the site. Double Crossing Creek drains a 526 ha catchment that extends west of the Pacific Highway and discharges into Hearns Lake.

During major storms, there is potential for floodwaters to overtop the banks of Double Crossing Creek and Hearns Lake, and inundate low lying areas of the development site. The potential for inundation varies as a function of one or a combination of the following:

- the frequency of the storm that causes flooding of Double Crossing Creek;
- the entrance conditions at the mouth of Hearns Lake; and,
- the ocean water level at the time of catchment flooding.

The extent to which flooding, entrance berm elevation and ocean conditions could constrain development of the site have been documented in a number of investigations that have been prepared for the Environmental Assessment for the project. These investigations are documented in the following reports, which should be read in conjunction with this report:

- *'Sandy Beach North Residential Development – Flood Impact Assessment'* (*November, 2005*); prepared by Patterson Britton & Partners Pty Ltd.
- *'Scientific Assessment of Entrance Berm Elevation for Hearns Lake, Sandy Beach North'* (*January, 2007*); prepared by Patterson Britton & Partners Pty Ltd.

It is understood that the EA has been prepared to address the requirements of the Director General of the Department of Planning and has taken into account the recommendations outlined in these reports.

In March 2008, the NSW Department of Planning issued a supplementary Director-General's Requirement. The supplementary DGR is referred to as Item 7.7 and requires that:

> A risk management assessment of climate change impacts to the year 2100 is to be undertaken using the latest available information from the International Panel on Climate Change (*IPCC*), the Department of Environment and Climate Change (*DECC*) and the CSIRO. This should include sensitivity analyses for low level, mid range and high level ocean impacts as set out in the DECC Floodplain Risk Management Guideline titled *'Practical Consideration of Climate Change'*.

Accordingly, this report documents additional investigations that have been undertaken to address the supplementary DGR.

2 CLIMATE CHANGE CONSIDERATIONS

2.1 BACKGROUND

The development site is located on the perimeter of Hearns Lake which is an Intermittently Closed and Open Lake or Lagoon (*ICOLL*). Due to its proximity to the lake and the proximity of the lake to the ocean, there is potential for increased frequency of inundation due to the 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 January 2007 Patterson Britton & Partners Report.

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.

2.2 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 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'*.
- 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.

2.2.1 Flood Modelling

The RAFTS hydrologic model that was developed as part of work that was undertaken to develop the Flood Impact Assessment (*November 2005*) 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 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 November 2005 Flood Impact Assessment Report*). 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 the November 2005 Flood Impact Assessment Report.

2.2.2 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 1 and 2**. 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 to drain the lake. The results are also insensitive to the minimum elevation to which the pilot channel would scour.

Table 1 PREDICTED PEAK FLOOD LEVELS ALLOWING FOR CLIMATE CHANGE IMPACTS AND ADOPTION OF A 0 mAHD MINIMUM PILOT CHANNEL ELEVATION

CATCHMENT STORM EVENT (*years*)	OCEAN STORM EVENT (*years*)	CHANNEL WIDTH (*m AHD*)	CLIMATE CHANGE SCENARIO	PEAK WATER LEVEL (m AHD)
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 2 PREDICTED PEAK FLOOD LEVELS ALLOWING FOR CLIMATE CHANGE IMPACTS AND ADOPTION OF -1 mAHD MINIMUM PILOT CHANNEL ELEVATION

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

As shown in **Tables 1** and **2**, 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.

2.3 IMPACT OF CLIMATE CHANGE ON ICOLL EXTENT

Investigations undertaken for the PBP January 2007 Report documented the extent of available photogrammetric data that defines the typical elevation of the entrance berm at the mouth of Double Crossing Creek. The report also documents the recorded water level data, which combined with the photogrammetric data indicates that entrance berm elevations for Hearns Lake over the last 60 years have typically ranged between 1 and 2 mAHD. On this basis, it was determined that an elevation of 2 mAHD was considered to provide a conservative estimate of the maximum contemporary entrance berm elevation for the mouth of Hearns Lake (*Patterson Britton & Partners, 2007*).

The International Panel on Climate Change (*IPPC, 2001*) currently recommends a mid range sea level rise over the next 100 years of 0.55 metres. A mid range level of 0.55 metres is widely used in floodplain management practice to consider the implications of sea level rise under a Year 2100 sea level rise scenario.

The nexus between mean sea level and the average height of the natural beach berm is unlikely to change. As sea level rises, the beach berm will maintain the same height above ambient sea level. Hence, under a Year 2100 sea level rise of 0.55 metres, the average level of the entrance berm at Hearns Lake is likely to increase by 0.55 metres; that is, to approximately 2.55 mAHD.

Therefore, application of the procedures employed by Sainty & Associates and recommended by Haines indicate that a vertical buffer up to 2.55 mAHD (*not 3.5 mAHD*) would be appropriate for the development site.

3 CONCLUSIONS

Additional investigations undertaken for the Sandy Beach North Development at Hearns Lake have established that climate change considerations to the Year 2100 could impact on the development site in the following ways:

(1) by increasing the peak level of the design 100 year recurrence flood for Hearns Lake from the current estimate of 2.60 mAHD to an elevation of 2.95 mAHD; and,

(2) by increasing the extent of the ICOLL based on Year 2100 projections and application of the methodology proposed by Haines and supported by Sainty, so that it is effectively defined by the area below the 2.55 mAHD contour.

On this basis, it is considered that the adoption of a peak 100 year recurrence flood level of 2.95 mAHD will provide sufficient redundancy over the design life of the project. Accordingly, it is recommended that an elevation of 2.95 mAHD be adopted as the Year 2100 design 100 year recurrence flood level and that building controls for development be based on this. Accordingly, minimum habitable floor levels should be set 3.45 mAHD.

It is also recommended that the philosophy for determining ICOLL setbacks as proposed by Haines (*2005*) be adopted for the Sandy Beach North Development, but that it be applied based on the recorded and analysed photogrammetric data contained in the Patterson Britton & Partners Report dated January 2007. On this basis, it is recommended that a setback consistent with the 2.55 mAHD contour should apply. This setback makes sufficient allowance for ICOLL expansion due to sea level rise predictions to the Year 2100.

4 REFERENCES

(1) Antony Tod & Partners (*Mid North Coast*) Pty Ltd, *'Hearns Lake / Double Crossing Creek Local Environment Study – Flood Investigation and Report on Water Supply, Sewerage and Water Pollution'*; prepared for McDonald Cox Corkill Pty Ltd.

(2) Coffs Harbour City Council (*2006, in draft*); *'Hearns Lake Estuary Processes Study'*; prepared by WBM Oceanics Pty Ltd.

(3) Department of Environment & Climate Change (*October 2007*); *'Floodplain Risk Management Guideline – Practical Consideration of Climate Change'*

(4) Department of Natural Resources [*DNR*] (*December 2005*); Results of Photogrammetric Analysis for Hearns Lake Beach; data supplied on 1st December 2006.

(5) Hanslow DJ, Davis GA, You BZ and Zastawny J (*2000*), *'Berm Height at Coastal Lagoons in NSW, Australia'*; proceedings from the 10th Annual NSW Coastal Conference, Yamba.

(6) Haines PE (*2005*), *'Determining Appropriate Setbacks for Future Development Around ICOLLs'*; presented at the 14th NSW Coastal Conference, Narooma, 8-11th November 2005.

(7) Intergovernmental Panel on Climate Change [IPCC] (*2001*), *'Climate Change 2001: Synthesis Report'*; edited by Robert T Watson and the Core Writing Team, Contribution of Working Groups I, II, and III to the Third Assessment Report of the Intergovernmental Panel on Climate Change, Cambridge University Press, ISBN 0 521 80770 0

(8) National Committee on Coastal and Ocean Engineering (*2004*), *'Guidelines for Responding to the Effects of Climate Change in Coastal Engineering Design'*

(9) Patterson Britton & Partners Pty Ltd (*2005a*), *'Sandy Beach North Residential Development – Water Management Strategy'*; Issue No 2, prepared for Sandy Shores Developments Pty Ltd.

(10) Patterson Britton & Partners Pty Ltd (*2005b*), *'Sandy Beach North Residential Development – Flood Impact Assessment'*; Issue No 3, prepared for Sandy Shores Developments Pty Ltd.

(11) Patterson Britton & Partners Pty Ltd (*2007*), *'Scientific Assessment of Entrance Berm Elevation for Hearns Lake, Sandy Beach North'*; Issue No 2, prepared for Sandy Shores Developments Pty Ltd.

(12) Sainty & Associates (*September 2006*), *'Environmental Constraints Analysis - Lot 22 DP 1070182, Pacific Highway, Sandy Beach North'*; prepared for the NSW Department of Planning.