

Ref: 06265

16 April 2009

BBK Coastal Development Group
P O Box 79
COFFS HARBOUR N.S.W. 2450

Att: Barry France



**de Groot &
Benson Pty Ltd**

**Consulting
Engineers &
Planners**

Dear Sir

Flooding assessment for Lot 21 Hearnese Lake Road Woolgoolga

We have been asked provide advice on the flood impacts on the proposed development.

The applicable flood study for the area is:

"Flood Impact Assessment – Sandy Beach North – Residential Development" – Issue No 5
– February 2009 prepared by Patterson Britton & Partners for WorleyParsons Pty Ltd

The Hearnese Lake and associated Double Crossing Creek are an ICOL – Intermittently Closed and Open Lagoon system. Peak water levels in the system are controlled by the berm at the outlet to the ocean. The above referenced has studied the flood behaviour of the site, including the operation of the ocean berm, in detail. Attached is Figure 3 from the above report which shows the location of the cross sections used in the modelling process. Lot 21 Hearnese lake Road is highlighted. This figure shows that the flood levels at the location of Cross Section 5 (XS-5) is applicable to the site.

The report concluded that the applicable 1 in 100 year flood level for the site is RL 2.6m AHD. (See attached page 14 from the above report).

Further the report examined the effects of climate change and concluded that after allowing for climate change the applicable 1 in 100 year for the site was RL2.95m AHD. (refer attached pages 19-21 of the report).

Proposed Development

The proposed development is a residential subdivision located generally on the southern side of a small ridge line. Examination of the site survey and proposed earthworks plan for the site shows that the residential lots vary in elevation from RL 5.5m AHD to approximately RL20.0m AHD

These levels are more than 2m higher than the estimated flood levels of the Hearnese Lake and Double Crossing Creek system.



As such, it is our opinion that the site is sufficiently elevated above the estimated 1 in 100 flood level such that flooding is not an issue in the assessment of the development for planning approval. This opinion also applies when climate change considerations are taken into account.

Should you have any further queries, please contact Rob de Groot on 02 6652 1700, or mobile 04 1883 1700 or by email at rob@dgb.com.au.

Yours faithfully

A handwritten signature in blue ink that reads "Rob de Groot". The signature is written in a cursive, flowing style with a prominent initial 'R'.

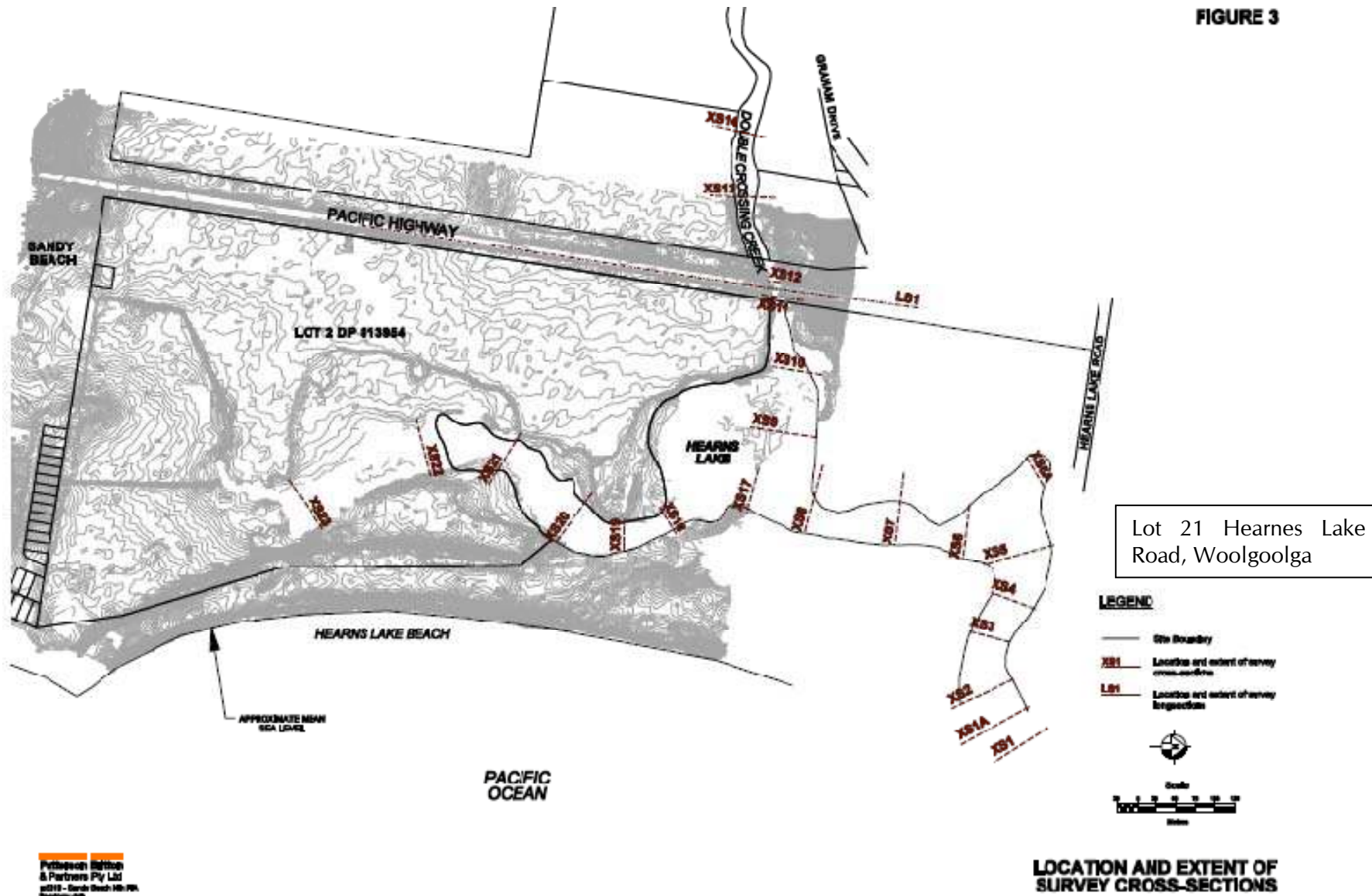
R J de Groot



EXTRACTS FROM:

"Flood Impact Assessment – Sandy Beach North – Residential Development" – Issue No 5 – February 2009 prepared by Patterson Britton & Partners for WorleyParsons Pty Ltd

- Figure 3
- Page 14
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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 Hearn's 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 |

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 Hearn's 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 Hearn's 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.

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 Hearn's 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 Hearn's 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 Hearn's 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 Hearn's 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**.