Appendix F

Flood Assessment and Flood Emergency Plan

This page has been left intentionally blank

Level 2, 160 Clarence Street
Sydney, NSW, 2000

Tel: 9299 2855
Fax: 9262 6208
Email: wma@wmawater.com.au
Web: www.wmawater.com.au

SOUTH WEST ROCKS RIVERSIDE CABINS FLOOD STUDY

MARCH 2010

Project SOUTH WEST ROCKS RIVERSIDE CABINS FLOOD STUDY	**Project Number** 29047
Client GeoLINK	**Client's Representative** Simon Waterworth
Authors Rhys Hardwick-Jones Mark Babister	**Prepared by**
Date 17 March 2010	**Verified by**

Revision	Description	Date
1	Final	Mar 2010

SOUTH WEST ROCKS RIVERSIDE CABINS FLOOD STUDY

TABLE OF CONTENTS

PAGE

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

1. INTRODUCTION

1.1. BACKGROUND

GeoLINK have prepared a Preliminary Environmental Assessment Report (PEA) on behalf of Shannon Pacific Pty Ltd, relating to a proposed development of tourist cabins adjacent to the existing Riverside Tavern in South West Rocks. The subject site on Lot 4 DP 1022342 is located on the bank of the Macleay River approximately 3km upstream of the ocean entrance, with frontages to New Entrance Road and Marlin Drive.

The response by the Department of Planning to the PEA (letter of 6 March 2009) disclosed a set of Director-General's Environmental Assessment Requirements (DGRs) to be addressed. WMAwater have undertaken a flood assessment of the site. The methodology and outcomes of the study are detailed below. The flood assessment has been undertaken specifically in relation to flood-related aspects identified in the DGRs, as outlined in items 6.7 and 6.8.

1.2. SCOPE OF ASSESSMENT

This report addresses the following flood-related issues:

- design flood levels and flood hazard at the site;
- flood impacts of the proposed development;
- potential implications of sea level rise and/or increases in rainfall intensity;
- flood evacuation considerations; and
- the determination of appropriate fill levels for the site based on consideration of flood risk and impacts.

.

2. BACKGROUND

2.1. AVAILABLE DATA

A comprehensive hydrographic survey of the Macleay River was undertaken in 2003. This dataset was combined with detailed survey of the site and surrounding area collected in 2006. The combined survey data were used to develop a Digital Elevation Model (DEM) of the site and surrounding area. The DEM is illustrated on Figure 1.

Hydrologic data including rainfall intensities, peak design flows in the Macleay River and ocean water levels were available from Reference 2. These are summarised in Table 1:

Table 1: Design Flood Flows and Ocean Levels

Event	Peak Macleay River Flow at Macleay Arm (m^3/s)	Peak Ocean Level (m AHD)
Extreme (PMF)	29,500	2.6
1% AEP	6,850	2.3
2% AEP	5,700	2.2
5% AEP	4,300	2.05
HHWSS	1,300	1.12
MHWS	960	0.74

2.2. FLOOD BEHAVIOUR

Flooding at the site is governed by two primary flow mechanisms. The site is susceptible to inundation from the Macleay River when catchment runoff exceeds the capacity of the main river channel, and also from elevated ocean water levels due to storms and tidal variation, due to the proximity of the site to the river mouth and South West Rocks Creek. After flooding occurs, some floodwaters generally remain trapped in the wetland areas to the east and north of the site, partially draining through a small culvert into the Macleay River, and eventually receding completely through infiltration and evapotranspiration.

Flooding from elevated ocean water levels will occur from the north, and will be generally characterised by a relatively slow rate of rise and slow floodwater velocities. Flooding of the site from the Macleay will occur from the south-west, with generally higher velocities and potentially faster rate of rise.

The probability of flooding from either mechanism is roughly equal, with ocean surge being a slightly more dominant flooding mechanism for the site for events more frequent than the 1% AEP, and flood levels at the site are dictated primarily by the ocean level for such events. For larger less frequent events, mainstream (Macleay River) flooding (in conjunction with backwatering due to ocean water levels) is the more dominant mechanism.

To adequately assess flood risk it is necessary to consider both flood levels and velocities. At the site, flooding from ocean surge is more likely to cause higher flood levels than Macleay River floods, but Macleay River floods will cause higher velocities and thus be potentially more hazardous. For the purposes of this assessment, the reported flood levels and velocities for a given event (eg the 1% AEP flood) are the estimated worst case of either ocean surge or Macleay River flood mechanisms for that probability of occurrence.

2.3. PROPOSED DEVELOPMENT

GeoLINK provided WMA with a sketched site plan illustrating the proposed site extent and layout (Figure 2). Based on the site plan, WMA determined appropriate fill levels for the site with consideration of several factors, including:

- surrounding ground levels;
- evacuation requirements;
- existing flood risk;
- changes to flood risk arising from climate change; and
- likely flood impacts.

The existing ground level at the proposed cabin locations is generally between 0.5 mAHD and 1.0 mAHD. The floor level of the existing tavern is approximately 3.0 mAHD. For the purposes of flood evacuation it is desirable to have a clear unambiguous egress route to high ground, and the route should grade upwards continuously without lowpoints in between, as this should reduce the likelihood of occupants being cut-off by floodwaters as they rise.

It is also desirable that the site should have sufficient elevation to avoid nuisance flooding. Sea level rise associated with climate change (see Section 4) will present a real risk of nuisance flooding due to spring tides, with a high spring tide water level (approximately once a year) of around 2.0 mAHD projected by 2100.

The recommended site levels determined by WMA, based on the above factors, consultation with the developer and the outcomes of the flood modelling, is a minimum of 1.9 mAHD, with a minimum uninterrupted rising grade of 0.3% to high ground to the south, to facilitate evacuation.

3. DESIGN FLOOD MODELLING

3.1. METHODOLOGY

WMAwater established a localised 2D hydraulic model of existing conditions covering the subject site and surrounding areas, including the Macleay River and nearby wetlands. The model used boundary conditions derived from an existing 1D RUBICON model of the complete Macleay River and Estuary, which was developed for the *Lower Macleay Floodplain Management Study* (Reference 2).

The model of existing conditions was adjusted to reflect changes arising from the proposed development, and the results compared to assess the hydraulic impacts. A range of design flood events was modelled, including the 5%, 2% and 1% Annual Exceedance Probability (AEP) events. The Probable Maximum Flood (PMF) could not be modelled for this assessment, due to insufficient topographic data to describe the multiple extra break-outs, however an estimate was made of the likely peak flood level. Flood hazard was assessed in accordance with the *NSW Floodplain Development Manual 2005* (Reference 6).

Potential impacts of climate change resulting due to increases in sea level rise and/or rainfall intensity were assessed by sensitivity testing of the modelling to such changes, in accordance with NSW Government policy (refer Section 4).

3.2. JOINT PROBABILITY

As there are two flood mechanisms at the site (catchment runoff and/or elevated ocean levels), the joint probability of the two mechanisms acting in unison must be considered. It is not appropriate to assess the 1% AEP Macleay flow in combination with the 1% AEP ocean water level, as the combined probability of these events occurring in unison will be rarer than 1% AEP. However, it is likely that the atmospheric conditions that lead to significant storm surge will also generate rainfall over the Macleay catchment.

Therefore for the purposes of this assessment, the 1% AEP design flood event was considered to be the worst case of the following scenarios, as suggested in Reference 4:

- the 5% AEP ocean level in conjunction with the 1% AEP flood flow in the Macleay River; and
- the 1% AEP ocean level in conjunction with the 5% AEP flood flow in the Macleay River.

The peak ocean tide was assumed to occur prior to the arrival of the peak Macleay River flow, based on an estimate of the travel time for Macleay River runoff to arrive at the site. This approach is consistent with the modelling undertaken for the Macleay River Flood Study (Reference 7).

Using the above approach, the scenario with a 1% AEP ocean level was found to be the critical event for flood levels, while the 1% AEP Macleay River flow was found to be the worst case for

velocities and hazard levels through the site.

3.3. MODEL SCHEMATISATION

A 2D hydraulic model was established using the TUFLOW modelling package to estimate design flows and water depths in the vicinity of the site. The DEM created from the available survey datasets was sampled at a 10m resolution to define the model topography and bathymetry, which was considered adequate to characterise the flood behaviour in the areas of interest.

Boundary conditions for the model (both up and downstream) were derived from the 1D RUBICON model of the Lower Macleay River and its tributaries. A flow hydrograph was used for the boundary condition at the upstream modelled extent of the Macleay River, and a water level boundary was used for the downstream limits in the Macleay River and at South West Rocks Creek. The model extent and layout is shown on Figure 3.

The Mannings ‘n’ roughness coefficient for the model was selected based on observations of vegetation at the site. A value of 0.02 was applied within the banks of the Macleay River, and a value of 0.04 was used for overbank areas. These values are consistent with those generally adopted for similar land types, and those used for the RUBICON modelling.

4. CLIMATE CHANGE CONSIDERATIONS

Climate change impacts have the potential to impact flood planning levels at the site in two ways (Reference 3), these being through elevated ocean water levels or via increased rainfall intensities. This section discusses how the potential impacts of climate change should be estimated at the site, with reference to pertinent NSW Government guidelines.

4.1. SEA LEVEL RISE

4.1.1. Introduction

In October of 2009 the NSW State Government released a policy statement (Reference 3) which sought to address how sea level rise should be dealt with in studies seeking to define flood risk in those areas likely to be impacted by sea level rise. This document superseded the NSW Governments "Practical considerations of climate change" which was released in 2007 (Reference 5). From this policy statement document (Reference 3) ensued further draft guideline documents one of which entitled "Draft Flood Risk Management Guide" (Reference 4) addresses how sea level rise associated with climate change should be incorporated into flood risk assessments.

The document (Reference 4) makes a number of points which are particularly salient to the study area discussed herein and these are as follows:

- As part of the State Government's policy sea level rise benchmarks have been adopted and these are as follows:
    - A sea level rise of 0.4 m by 2050; and
    - A sea level rise of 0.9 m by 2100.
- Based on the simple criteria that the study site is, in some part, at a height of less than 4 mAHD, the study site is "likely" to be impacted by sea level rise impacted flood levels;
- Any flood study for a site likely to be impacted by sea level rise (see above point) should utilise the 2100 sea level rise benchmark of 0.9 m;
- Any sea level rise must not be accounted for in the 0.5 m freeboard (as prescribed in Reference 5);
- Where a study site is below 4 mAHD a conservative and quick estimate of the sea level rise impacted 1% AEP flood level is to add the sea level rise benchmark (see point 1 above) to the "existing" 1% AEP flood level.

Interim advice on the consideration of the joint probability issues of rainfall induced flooding occurring in conjunction with elevated ocean water levels are made in the appendix to Reference 4 (entitled "Ocean boundary conditions for hydraulic flood modelling"). These are::

- Use an envelope approach in order to determine design flood heights. The following specific scenarios are suggested:
    - A 1% AEP flood in conjunction with a 5% ocean level; and
    - A 5% AEP flood in conjunction with a 1% ocean level.

Further sections of Reference 4 address downstream ocean related boundary conditions and

this issue is of direct relevance to the study site. Essentially the interim advice is that in lieu of a site specific study which uses modelling in order to calculate the actual downstream ocean water level for design purposes, a value of 2.6 mAHD for the 1% AEP ocean water level may be used. The document states that the use of 2.6 mAHD is likely to be conservative. Furthermore, it includes components of wave setup that are not appropriate on a large deep trained river entrance such as the Macleay. For the present study a detailed analysis is available (Reference 2) which estimates the 1% AEP ocean water level as 2.3 mAHD. The document then states that the sea level rise benchmark (the applicable value in this case being 0.9m) should be added to the value of 2.3 mAHD.

4.1.2. Summary

- Given that is lower than 4 m it can be stated that the study site is subject to impact due to sea level rise. This means that sea level rise must be taken into account when determining design flood levels at the site;
- The ocean boundary condition used in modelling was altered by adding the 2100 sea level rise estimate to it (0.9m) and then re-running the model. To comprehensively address the joint probability issue two scenarios were assessed:
    - the 5% AEP ocean level plus sea level rise of 0.9m, in conjunction with the 1% AEP flood flow in the Macleay River; and
    - the 5% AEP flood event in conjunction with a 1% AEP ocean water level plus sea level rise of 0.9 m.
- A further 0.5m must still be added to the estimated flood level for freeboard as per Reference 5.

4.2. RAINFALL INTENSITY

Besides producing sea level rise it is anticipated that one of the impacts of climate change will be relatively more intense rainfall for events of a specific probability of occurrence. This issue is addressed in the Reference 5 which was issued in 2007. Table 1 from Reference 5 indicates that the intensity of a daily rainfall event may increase by 5% to 10% within the Northern Rivers region.

With the projected sea level rise scenario of 0.9m, ocean level flooding will become the dominant flood mechanism at the site for all but the most extreme Macleay River flood events. Nevertheless some inclusion of the climate change impact on rainfall intensity was considered appropriate, even if for sensitivity modelling only. As such the 1% AEP event was re-run with peak flood flow in the Macleay increased by 10%. This is in accordance with other studies undertaken by WMAwater where the percentage increase in rainfall intensities has roughly translated to the increase in peak discharge. Given the size of the Macleay catchment, which has an area of approximately 11,400 km^2 and the projected increases in evapotranspiration (which will generally make the catchment dryer and reduce runoff volumes), this approach is likely to be conservative.

5. FLOOD EVACUATION CONSIDERATIONS

5.1. INTRODUCTION

Appendix N7 of the Floodplain Development Manual (Reference 6) provides specific discussion concerning private (site specific) flood emergency plans. While the preparation of a plan is encouraged, it is recognised that "implementation of a plan depends explicitly on a thorough understanding of the risk and of the roles and responsibilities of participants." As such, private flood plans will generally be more prone to failure than those prepared and enacted by State Emergency Services (SES) personnel.

Appendix N7.2 of Reference 6 discourages the use of private flood emergency plans as a development consent condition. While "the SES supports the idea of owners and occupiers of premises in areas of flood risk having a plan for what they should do to prepare for and respond to flooding," it must be recognised that the responsibility for maintenance and carrying out of the plan lies with the owner/occupier, in this case the proprietor of the proposed development.

A detailed Flood Emergency Plan has been developed for the site and is provided in Appendix A. The limitations of such a plan are acknowledged, however it is considered that aspects of the site layout and flood behaviour at the site are such that a robust flood emergency plan can be implemented, with due diligence on the part of the proprietor and the implementation of an "any doubt, get out" policy. The plan provides physical constraints to minimise the risk of occupants being trapped by floodwaters, and provides a firm basis for the owner/operator to further refine the plan.

This section of the report briefly discusses some of the principal flood evacuation issues for the site, namely:

- flood warning times;
- evacuation routes; and
- rate of rise of floodwaters.

5.2. FLOOD WARNING

The available flood warning time will depend on the flood mechanism. The Bureau of Meteorology (BOM) provides severe weather warning services, which cover both of the major flood risk mechanisms for the site – catchment runoff or elevated ocean levels from storm surge.

For flooding resulting from Macleay catchment runoff, when heavy rainfall is observed on the catchment the BOM will generally declare a Flood Warning for the Lower Macleay River, along with a predicted peak flood height at Kempsey Traffic Bridge. The peak flow of Macleay River floods at the site will generally occur at least 24 hours after the peak flood level at the Kempsey Traffic Bridge, and the observed height at Kempsey will give a reasonable indication of the magnitude of flooding that can be expected at the site.

For storm surge, the BOM will generally issue a tropical cyclone watch if a cyclone is expected to affect a coastal community within 48 hours, but not within the next 24 hours. The tropical cyclone watch will be upgraded to a tropical cyclone warning if a cyclone is expected to affect a coastal community within 24 hours. Severe storm warnings will also provide an indication of potentially dangerous weather conditions. Additionally, for extreme elevated ocean levels to occur, the storm surge must coincide with an astronomic high tide event, the timing of which is readily available.

Therefore, for both types of major flood mechanism at the proposed development site, a warning period of 24 hours or more will generally available, which should provide sufficient time for the Flood Emergency Plan to be enacted.

5.3. EVACUATION ROUTE

It is a fundamental aspect of the Flood Emergency plan that the primary evacuation route from the site should rise in a consistent and uninterrupted manner to high ground, such that the evacuation route is not liable to be cut at any stage during the flood ("Rising Road Access" – Diagram 1). It is a key recommendation of this report that an obstacle-free evacuation route with a minimum upward grade of 0.3% be supplied to the entrance of each proposed dwelling within the site.

Diagram 1: RISING ROAD ACCESS (RRA)
Access uninterrupted and via all-weather rising road (usual route or alternative); site below predicted flood level

5.4. RATE OF RISE

The Flood Emergency Plan (Appendix A) recommends that the site be evacuated and closed when flooding of the site is probable, and outlines criteria for triggering evacuation. When flooding of the site does occur, if for any reason evacuation has not yet occurred, the rate of rise of floodwaters is an important factor in the ability of the site occupants to evacuate.

For flooding from elevated ocean levels, and Macleay River floods up to the 1% AEP, the peak rate of rise of floodwaters once overtopping has occurred is estimated to be up to 0.3 m per hour. For the PMF the rate of rise is estimated to be up to 0.5m per hour. In conjunction with the modelled velocity results (less than 0.5 m/s across the proposed site) the evacuation route can be classified as low hydraulic hazard. With an assumed rising grade of 0.3% along the evacuation route, occupants would need to travel approximately 100m per hour to remain clear of the flood extent after flooding of the site begins.

6. OUTCOMES

6.1. DESIGN FLOOD RESULTS

The critical 1% AEP design flood scenario for the site was found to be the 1% AEP ocean level occurring jointly with a 5% AEP Macleay River flood. Peak flood levels under existing conditions for a range of design flood events are given in Table 2. Peak flood velocities and flood hazard at the site are shown on Figure 4 to Figure 7 inclusive.

Table 2: Design Peak Flood Levels

Event Probability	Design Peak Flood Level (mAHD)	2050 Projected Peak Flood Level (mAHD)	2100 Projected Peak Flood Level (mAHD)
10% AEP	1.9	2.3	2.8
5% AEP	2.1	2.5	3.0
2% AEP	2.25	2.65	3.15
1% AEP	2.35	2.75	3.25
PMF	4.0 *	**	**

* The PMF level is an estimate only, based on the approximate level of surrounding dune systems which would be overtopped and provide additional flowpaths during the PMF event

** PMF levels under climate change scenarios are not estimated, since it is unknown how the dune system will respond to the projected changes.

Assuming an expected design life for the cabins of 50 years, the habitable floor levels of the raised cabins should be placed at the 1% AEP level under the 2050 climate change scenario, plus 0.5 m freeboard, which is a total minimum level of 3.25 mAHD. The cabins should be raised to the projected 2100 1% AEP flood level plus 0.5 m freeboard (to 3.75 mAHD) by 2050 as part of an adaptive management strategy

6.2. SITE FILL LEVELS

The appropriate fill level for the site is governed by several factors, as outlined in Section 2.3. Of those factors identified, flood evacuation considerations and the existing level of flood risk are of primary importance.

It is highly desirable that the filled level of the evacuation route should grade up gradually from north to south, such that a rising evacuation route to high ground at Marlin Drive is provided. The level of the lowest point of the site should be based on an acceptable level of flood risk. For example, a filled level of 1.9 mAHD will give protection from the estimated existing 10% AEP flood level, rising to 2.8 mAHD by 2100 under current climate change projections. Based on these considerations, it is recommended that the access/evacuation routes through the site be initially filled to a minimum level of 1.9 mAHD, with a consistent rising grade of at least 0.3% from north to south to provide evacuation to the high ground.

If the climate change predictions for sea level rise are realised, the proposed fill level will not

provide sufficient flood immunity for the site. It is likely that adaptive management though intervention will be required approximately every 15 to 20 years, to increase the level of access/evacuation routes by a level commensurate with observed rates of sea level rise. These measures will enable the level of the site to be maintained at or around the 10% AEP level.

6.3. FLOOD IMPACTS OF PROPOSED DEVELOPMENT

The hydraulic impacts of the proposed development were assessed by comparing modelling results for existing conditions and the proposed development conditions. The primary aspect of the development to be considered in regard to hydraulic impact is the filling of portions of the site, which generally can exacerbate flooding through the blockage of flowpaths and/or removal of temporary floodplain storage.

The impacts vary depending on the nature of flooding at the site. For flooding from elevated ocean levels (which is the dominant mechanism for events up to and including the 1% AEP), flow velocities are relatively slow and the tidal prism (flow volume) is large, so filling at the proposed location is unlikely to have a significant impact on flow distributions and flood levels.

For flooding from the Macleay River, the filled sections of the proposed development are likely to cause a slight reduction in flood velocity in the wetland area east of the site (Figure 7). This will result in a slight net increase in net accretion of sediment over the long term, as silts and sands will tend to settle out of floodwaters in areas of lower velocity. It is noted that the present trend in this area will be for net accretion of sediment, and increased ocean water levels from climate change are likely to have a similar effect of accelerating sediment deposition in the wetland and entrance of the Macleay River.

Results from the hydraulic modelling undertaken indicate that the proposed development is unlikely to have a significant impact on peak flood levels (less than 0.01m for the range of events modelled). The position of the site adjacent to the high ground to the south is such that the fill does not significantly impede the existing flood flow paths. The removal of temporary floodplain storage is not considered to be significant, since the flood volumes associated with both ocean and river flooding are orders of magnitude larger than the fill volume.

6.4. CLIMATE CHANGE

The potential implications of sea level rise and/or increases in rainfall intensity for the site have been assessed. Refer to Section 4 for discussion.

6.5. FLOOD EMERGENCY PLANNING

A detailed Flood Emergency Plan for the site has been prepared, and is provided in Appendix A. Refer to Section 5 for discussion. In accordance with Appendix N of Reference 6, it should be recognised that the preparation of the plan alone, while important for the site, is unreliable as a long term risk mitigation measure. However, the design of the evacuation route and the nature of the flood behaviour are such that the risk to life resulting from a flood at the site are minimised.

It is emphasised that the responsibility for the maintenance and operation of the Flood Emergency Plan are the responsibility of the site owner/operator.

7. REFERENCES

1. Pilgrim H (Editor in Chief)

Australian Rainfall and Runoff – A Guide to Flood Estimation
Institution of Engineers, Australia, 1987.

2. WMAwater

Macleay River Estuary Processes Study
Kempsey Shire Council, January 2009.

3. **NSW Sea Level Rise Policy Statement**
NSW State Government, Australia, October 2009

4. **Draft Flood Risk Management Guide: Incorporating sea level rise benchmarks in flood risk assessments**
NSW State Government, Australia, October 2009

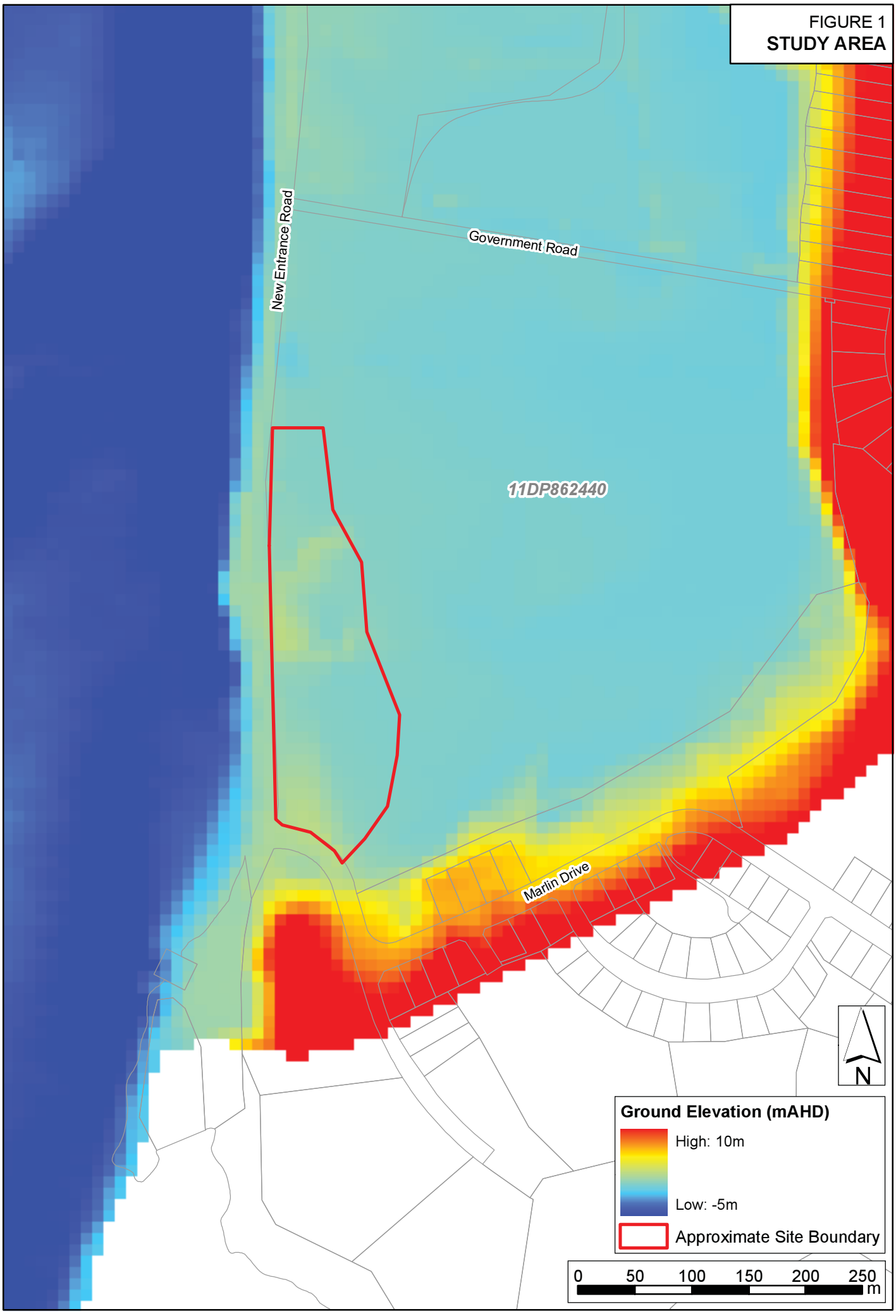
5. **Practical Considerations of Climate Change**
NSW State Government, Australia, 2007

6. **Floodplain Development Manual**
NSW State Government, Australia, April 2005

7. Webb McKeown & Associates

Macleay River Flood Study
Department of Public Works, 1989

Figures

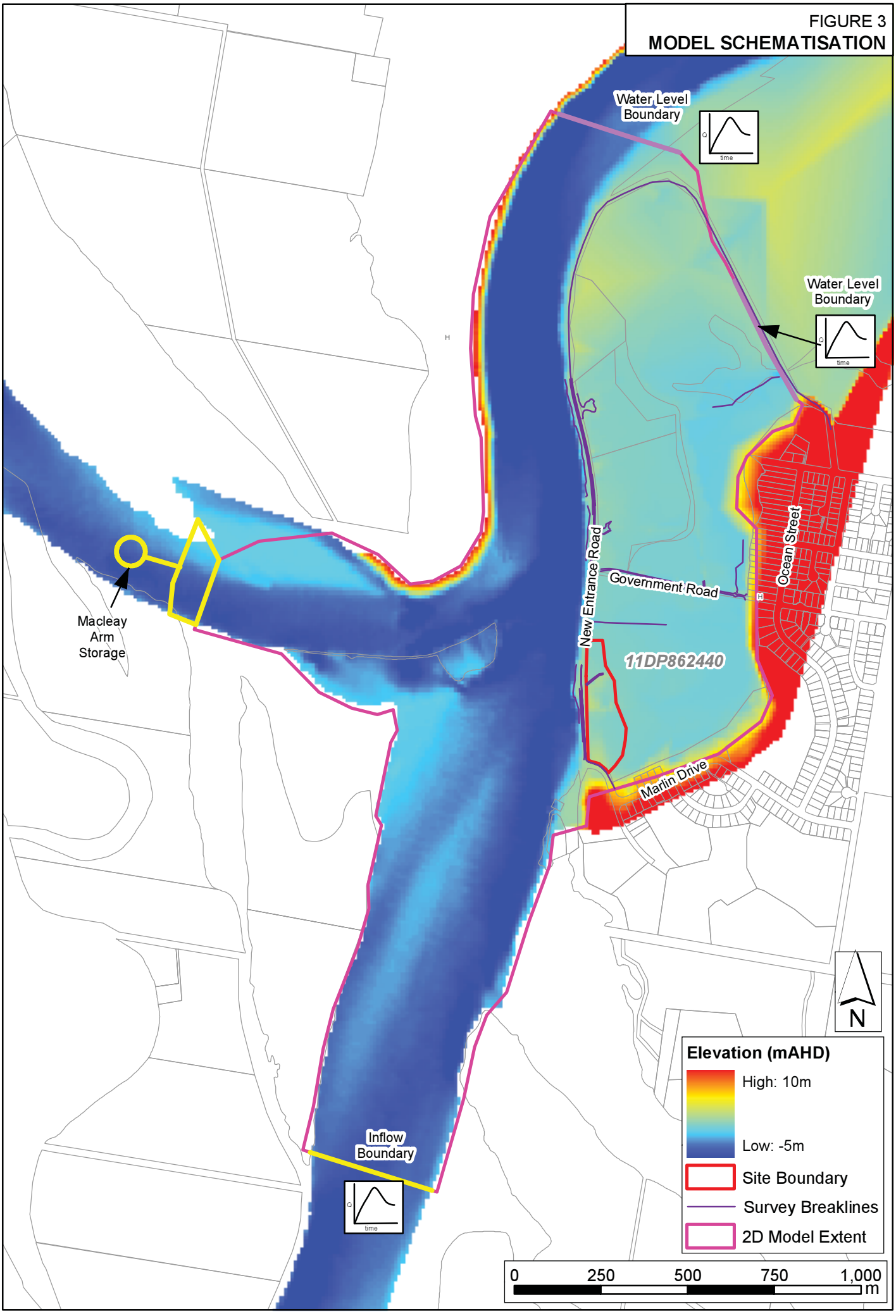

J:\Jobs\29047\ArcView\ArcMaps\Figure01_StudyArea.mxd
FIGURE 1
STUDY AREA
New Entrance Road
Government Road
11DP862440
Martin Drive
N
Ground Elevation (mAHD)
High: 10m
Low: -5m
Approximate Site Boundary
0
50
100
150
200
250
m

J:\Jobs\29047\ArcView\ArcMaps\Figure02_ProposedSitePlan.mxd

FIGURE 2
PROPOSED SITE PLAN

J:\Jobs\29047\ArcView\ArcMaps\Figure03_ModelSchematisation.mxd

FIGURE 3
MODEL SCHEMATISATION



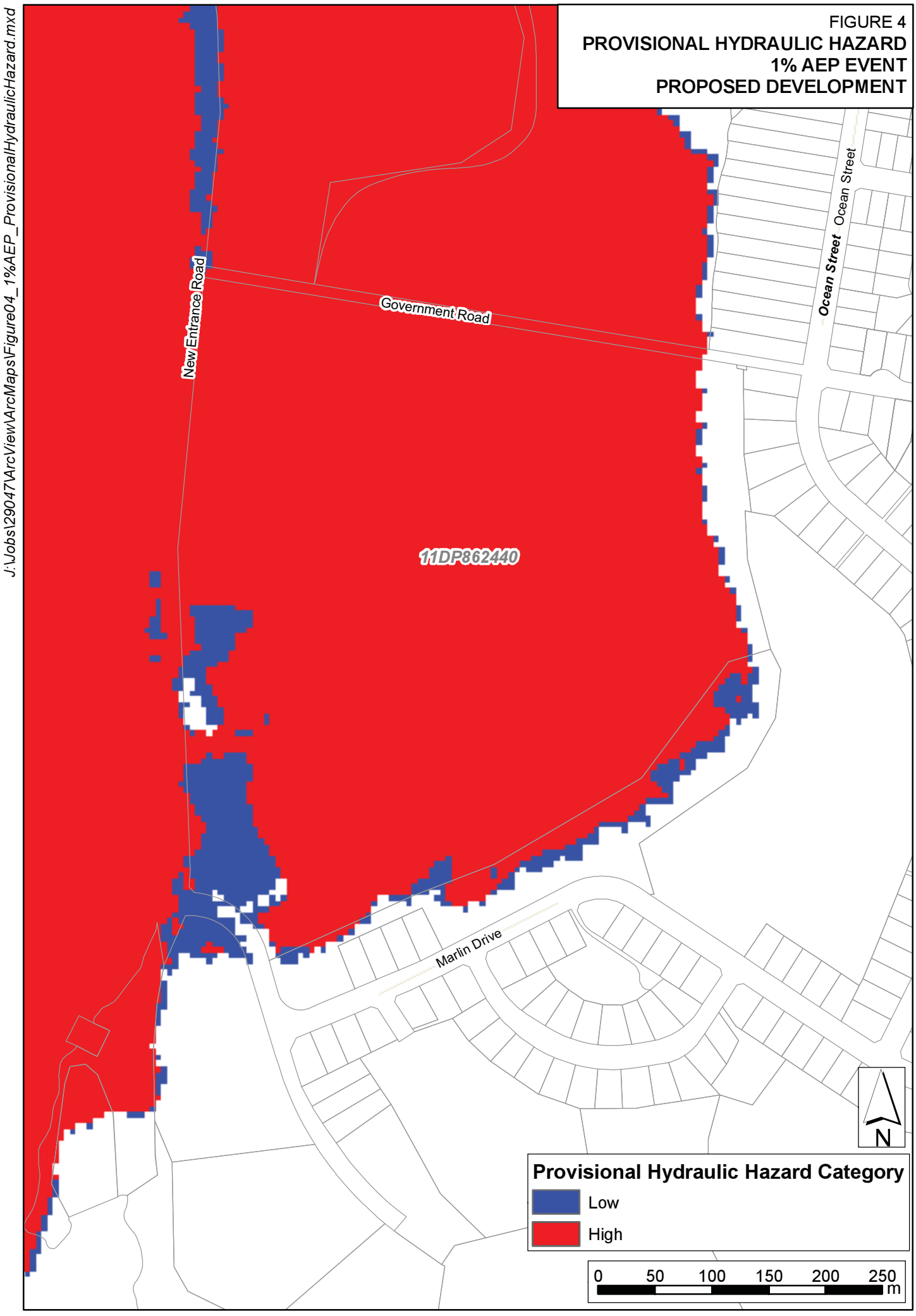
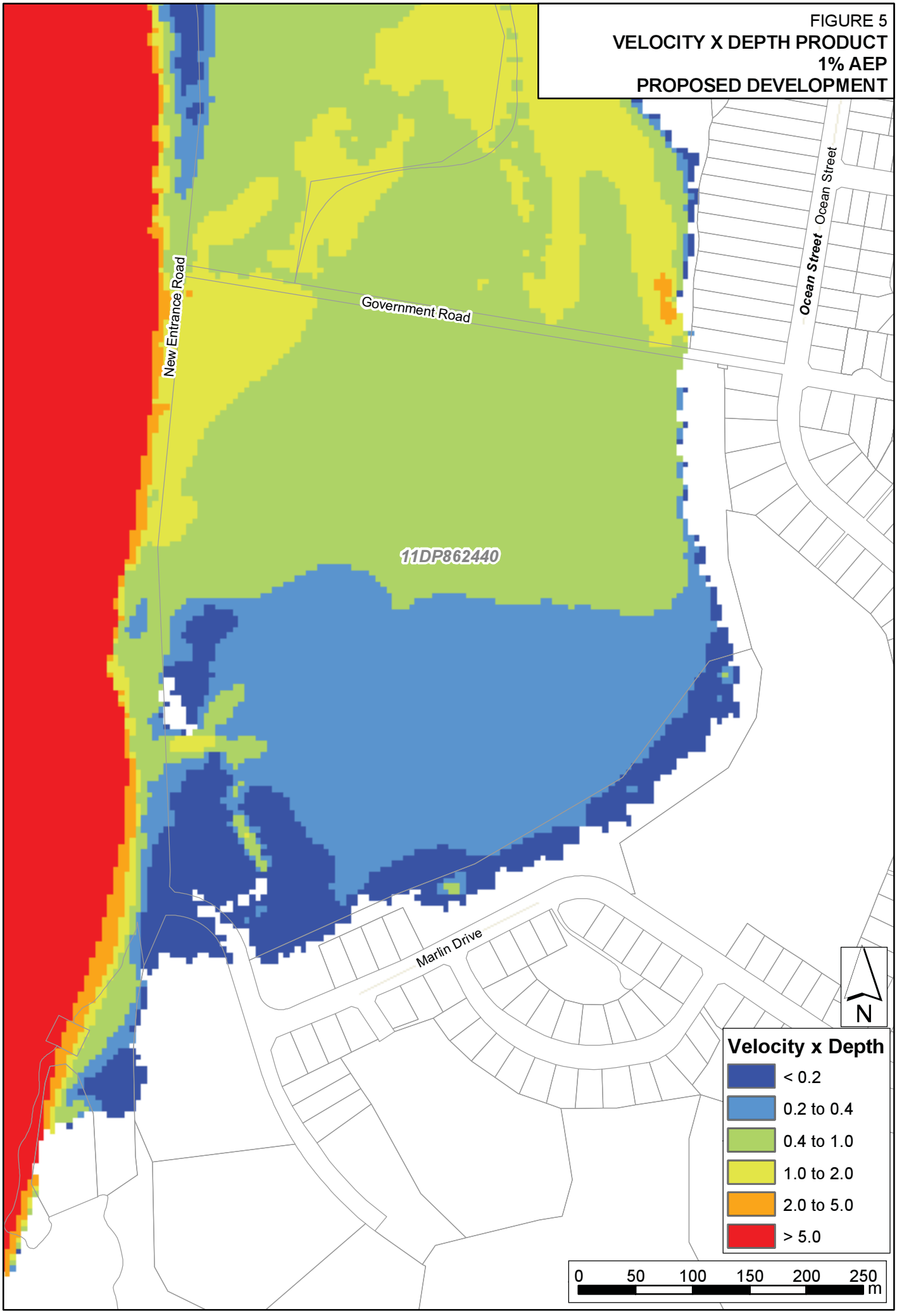
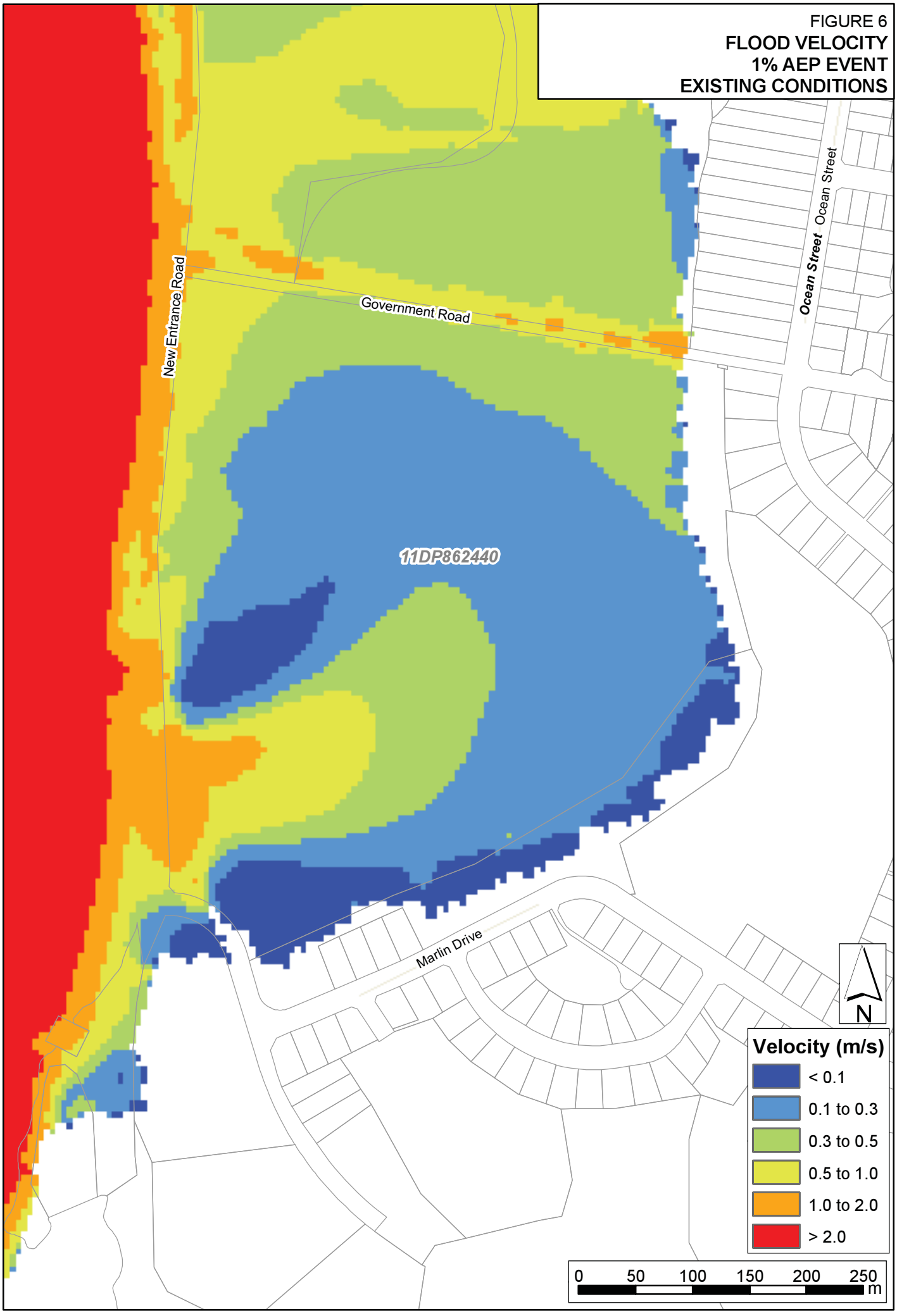


FIGURE 4
PROVISIONAL HYDRAULIC HAZARD
1% AEP EVENT
PROPOSED DEVELOPMENT
J:\Jobs\29047\ArcView\ArcMaps\Figure04_1%AEP_ProvisionalHydraulicHazard.mxd
New Entrance Road
Government Road
Ocean Street
Ocean Street
11DP862440
Marlin Drive
N
Provisional Hydraulic Hazard Category
Low
High
0
50
100
150
200
250
m


J:\Jobs\29047\ArcView\ArcMaps\Figure05_1%AEP_VelocityDepth.mxd
FIGURE 5
VELOCITY X DEPTH PRODUCT
1% AEP
PROPOSED DEVELOPMENT
New Entrance Road
Government Road
Ocean Street
Ocean Street
11DP862440
Marlin Drive
N
Velocity x Depth
< 0.2
0.2 to 0.4
0.4 to 1.0
1.0 to 2.0
2.0 to 5.0
> 5.0
0
50
100
150
200
250
m


J:\Jobs\29047\ArcView\ArcMaps\Figure06_1%AEP_Velocity_Existing.mxd
FIGURE 6
FLOOD VELOCITY
1% AEP EVENT
EXISTING CONDITIONS
New Entrance Road
Government Road
Ocean Street
Ocean Street
11DP862440
Marlin Drive
N
Velocity (m/s)
< 0.1
0.1 to 0.3
0.3 to 0.5
0.5 to 1.0
1.0 to 2.0
> 2.0
0
50
100
150
200
250
m

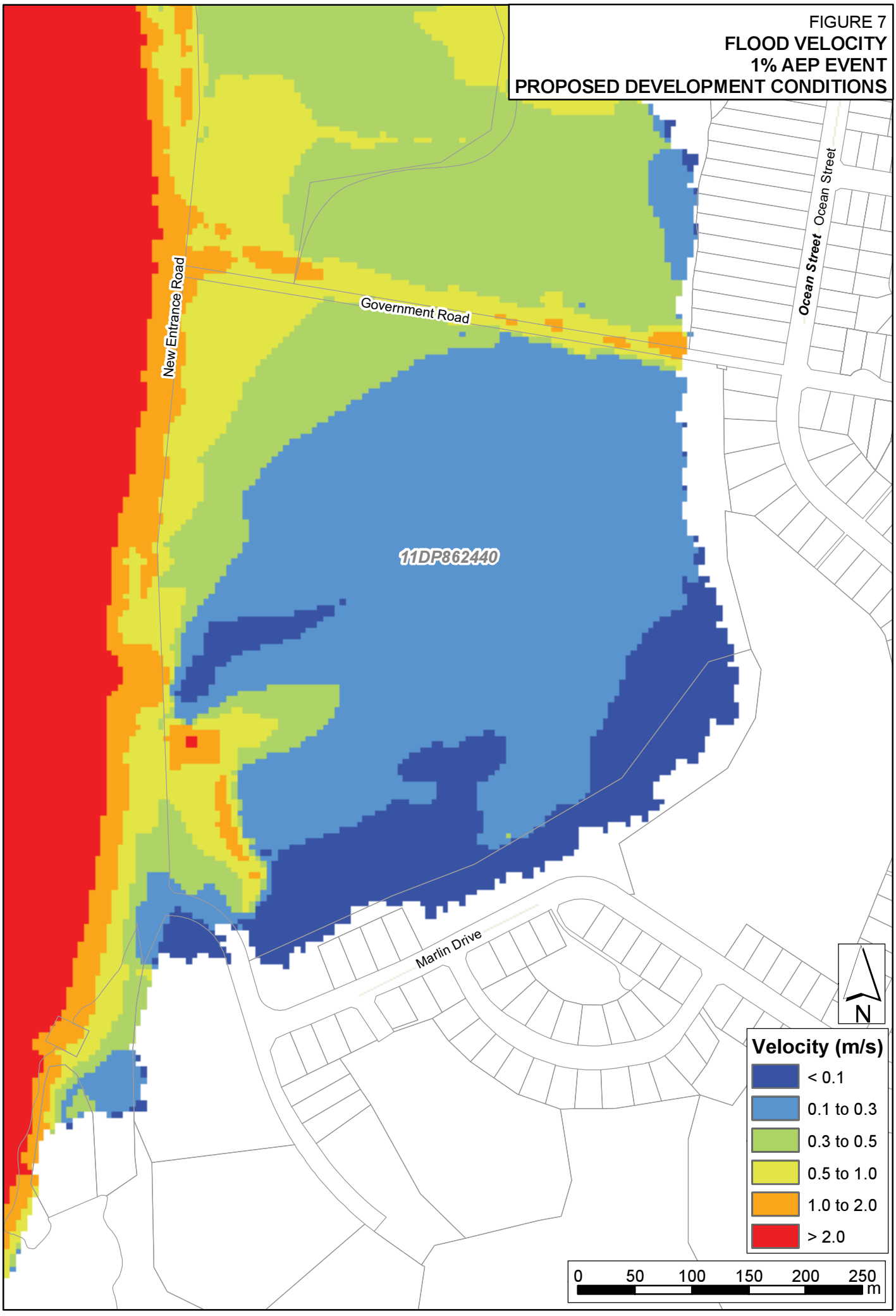


FIGURE 7
FLOOD VELOCITY
1% AEP EVENT
PROPOSED DEVELOPMENT CONDITIONS
J:\Jobs\29047\ArcView\ArcMaps\Figure07_1%AEP_Velocity_Proposed.mxd
New Entrance Road
Government Road
Ocean Street
Ocean Street
11DP862440
Marlin Drive
N
Velocity (m/s)
< 0.1
0.1 to 0.3
0.3 to 0.5
0.5 to 1.0
1.0 to 2.0
> 2.0
0
50
100
150
200
250
m

APPENDIX A: FLOOD EMERGENCY PLAN

SOUTH WEST ROCKS RIVERSIDE CABINS

FLOOD EMERGENCY PLAN

LAST UPDATED 15/03/2010

PART A – BACKGROUND INFORMATION

Table 1

To be updated as necessary by the resort owner/operator.

Resort name	South West Rocks Riverside Cabins
Street address	
Postal address	
Phone number	
Land tenure (e.g. Crown, freehold, leasehold)	
Source(s) of potential flooding	Macleay River Ocean Tide / Storm Surge

BACKGROUND

This Flood Emergency Plan has been prepared for South West Rocks Riverside Cabins, situated at New Entrance Road, South West Rocks. The site is located on the bank of the Macleay River approximately 3km upstream of the ocean entrance, with frontages to New Entrance Road and Marlin Drive.

There are two primary flow mechanisms governing severe flooding at this site:

1. inundation from the Macleay River when the catchment runoff is greater than the capacity of the river channel; and
2. inundation from elevated ocean water levels resulting from storms and tidal variations.

Flood inundation from the above causes can damage property and in some cases, threaten lives. This plan has produced to inform the Proprietor about appropriate action in the event of a flood and to reduce the risk of life. "The Proprietor" as referred to in this plan is _____, the owner of the property, who can be contacted on telephone _____.

OBJECTIVES

The primary objectives of this Flood Emergency Plan are to:

- provide framework for the tourist site to be prepared in the event of the site or the surrounding area being subjected to flooding;
- minimising the risk to life during flood events; and
- detail recovery measures required after flood occurrence.

The underlying principle is that any action undertaken during a Flood Emergency must not place any person at risk of injury and/or death. This Flood Emergency Plan provides a mechanism for identifying and managing such an emergency.

MEANS OF IMPLEMENTING THIS STRATEGY

- A hard copy of this strategy must be located at the South West Rocks Riverside Cabins Head Office, and provided in a prominent location within each individual cabin;
- This strategy is to be reviewed every two years or immediately following a flood.

RESONSIBILITIES

It is the responsibility of The Proprietor of South West Rocks Riverside Cabins to:

- Monitor flood warnings and advice issued by the Bureau of Meteorology and the local SES Controller;
- Activate procedural aspects of the Flood Emergency Plan immediately if requested by the SES or Police to do so, or if in the Proprietor's opinion a flood risk exists;
- Maintain a record of all current guests and visitors to the Cabins to facilitate orderly evacuation;
- Establish an effective warning system within the site to alert guests, visitors and employees of any flood-related information;
- If inundation appears likely, activate evacuation procedures for part or the entire Park and request the assistance of the SES.
- Provide a copy of the evacuation procedure to all guests and visitors.
- Make certain that structures that are required to be moved in the event of flooding are maintained in a movable condition such that:
    - Services can be readily disconnected and/ or detached and secured to ensure public safety.
    - Loose equipment is stowed within the moveable structure for safe evacuation.
- Ensure structures that are not required to be moved in the event of flooding are maintained so that:
    - Adequate tie-downs are enforced to prevent floatation
    - Service connections are safe and secure
    - Associated structures and private property are properly secured to prevent floatation
- Be capable of alerting all guests, visitors and employees within 20 minutes of a flood warning being received, or decision being made that flooding is imminent.
- On receiving flood evacuation advice, or a decision that inundation is likely to occur, notify all guests and visitors to leave for high ground (Marlin Drive) immediately.

PART B – EMERGENCY CONTACTS

Table 2

To be updated as necessary by the resort owner/operator. Additional staff should also be listed.

	PHONE(S)
Park owner (INSERT NAME)	INSERT NUMBER(S)
Park operator (manager) (INSERT NAME)	INSERT NUMBER(S)
Staff (INSERT NAME)	INSERT NUMBER(S)
NSW State Emergency Service (SES)	FLOOD STORM EMERGENCY SES 132 500 www.ses.nsw.gov.au
Bureau of Meteorology *(automated land weather and flood warning information)*	**1300 659 217** www.bom.gov.au/hydro/flood/nsw/
Rural Fire Service	FOR EMERGENCIES DIAL '000' www.rfs.nsw.gov.au
Police South West Rocks Police Station	**000** (emergency) (02) 6566 6244
Medical South West Rocks Medical Clinic	**000** (emergency) (02)
NSW Poisons Information Centre	**13 11 26 www.poisonsinfo.nsw.gov.au**
Local Council Kempsey Shire Council	02 6566 3200
Roads and Traffic Authority *(traffic hazard reporting and advisory service)*	**13 27 01** http://www.rta.nsw.gov.au/
Northern Rivers Catchment Management Authority (CMA)	02 6561 4960 (Kempsey Office)
Water Authority (INSERT NAME)	INSERT NUMBER
Electricity Authority (INSERT NAME)	INSERT NUMBER
Gas Authority (INSERT NAME)	INSERT NUMBER

PART C – FLOOD RISK ASSESSMENT

Flood Levels and Extents

Table 3

EVENT WITH APROX. FREQUENCY ARI – Average Recurrence Interval	FLOOD LEVEL AT SITE (m AHD)	PROPORTION OF SITE AFFECTED (%)	LOCAL CONSEQUENCES
1 in 20 year	2.1	50	New Entrance Road cut. Inundation of significant portion of site
1 in 50 year	2.25	80	Lower portion of site access road inundated.
1 in 100 year	2.35	90	Lower portion of site access road inundated.
Probable Maximum Flood	4.0 *	100	Site completely inundated. Significant damage to structures and services likely.

Sources/date of flood data:	South West Rocks Riverside Cabins Flood Study – WMAwater 2010

Ground Levels, Floor Levels and Flood Depths *Table 4*

To be updated as necessary by the resort owner/operator.

FEATURE	GROUND LEVEL (m AHD)	AVERAGE FLOOD DEPTH OVER GROUND (M)			FLOOR LEVEL (m AHD)	AVERAGE FLOOD DEPTH OVER FLOOR (M)		
		20 YEAR ARI	100 YEAR ARI	PMF		20 YEAR ARI	100 YEAR ARI	PMF
Office								
Amenities (A) block(s) (B)								
Lowest site in park (INSERT SITE NUMBER)								
Highest site in park (INSERT SITE NUMBER)								
Park entrance								
Low-point on **access road**								

Source/date of ground/floor level survey:	

Elements at Risk

Table 5

To be updated as necessary by the resort owner/operator.

TYPE OF SITE	NUMBER OF SITES	NUMBER OF SITES WITHIN 100Y ARI FLOOD EXTENT	NUMBER OF SITES WITH READILY MOVED STRUCTURES	APPROX. NUMBER OF PEOPLE (PEAK SEASON)	APPROX. NUMBER OF PEOPLE (NON-PEAK SEASON)
Long-term sites for residents ('permanents')	0	-	-		
Long-term holiday sites ('annuals')	0	-	-		
Prefabs (cabins) owned by park for tourist hire		All	-	??	??
On-site vans owned by park for tourist hire	0	-	-		
Powered sites (for tourist hire)	0	-	-		
Unpowered sites (for tourist hire)	0	-	-		
TOTAL					

Other assets within 100 year ARI flood extent (e.g. manager's house, office, kiosk/shop, pool, amenities block(s), sewage treatment plant, BBQ/camp kitchen, boats, storage vans, fuel, gas)	

Flood Warning Arrangements and Constraints

Flood warning arrangements *Table 6*

	NAME (NUMBER)	ARE HEIGHT/TIME PREDICTIONS ISSUED? (Y/N)	AGENCY
Reference gauge	Kempsey Traffic Bridge *	Y	BOM

NOTE: Kempsey is only applicable as a reference for Macleay River floods, not Ocean Storm Surge

Flood warning time and duration *Table 7*

	TIME (DAYS/HOURS)
Available flood warning time (when warnings are typically available)	24-48 hours
Effective flood warning time (time after official warning released before inundation of evacuation routes commences)	Approximately 24 hours
Duration of the 100 year ARI flood	10 hours (Ocean Tide / Storm Surge) 30 hours (Macleay River flood)

The available flood warning time will depend on the flood mechanism. The Bureau of Meteorology (BOM) provides severe weather warning services, which cover both of the major flood risk mechanisms for the site – Macleay River floods or elevated ocean levels from storm surge.

For flooding resulting from Macleay catchment runoff, when heavy rainfall is observed on the catchment the BOM will generally declare a Flood Warning for the Lower Macleay River, along with a predicted peak flood height at Kempsey Traffic Bridge. The peak flow of Macleay River floods at the site will generally occur approximately 24 hours after the peak flood level at the Kempsey Traffic Bridge, and the observed height at Kempsey will give a reasonable indication of the magnitude of flooding that can be expected at the site.

For storm surge, the BOM will generally issue a tropical cyclone watch if a cyclone is expected to affect a coastal community within 48 hours, but not within the next 24 hours. The tropical cyclone watch will be upgraded to a tropical cyclone warning if a cyclone is expected to affect a coastal community within 24 hours. Additionally, for extreme elevated ocean levels to occur, the storm surge must coincide with an astronomic high tide event, the timing of which is readily available.
Therefore, for both types of major flood mechanism at the proposed development site, a warning period of 24 hours or more will generally available, which should provide sufficient time for the Flood Emergency Plan to be enacted.

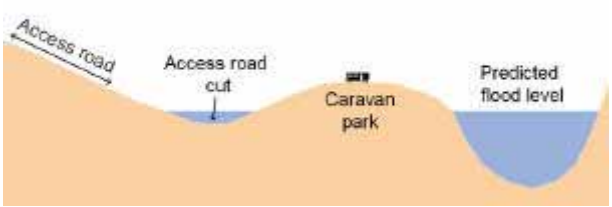
Evacuation Arrangements and Constraints

Evacuation setting *Table 8*

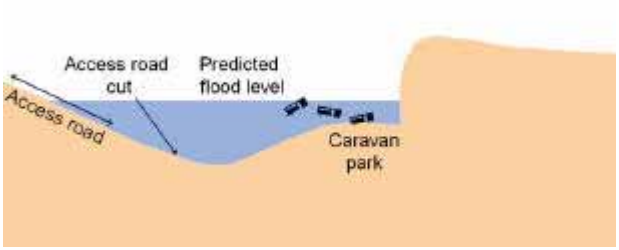
20 YEAR ARI EVACUATION SETTING	100 YEAR ARI EVACUATION SETTING	PMF EVACUATION SETTING
Rising Road Access (RRA)	Rising Road Access (RRA)	Rising Road Access (RRA)

LOW FLOOD ISLAND (LFI)
Access road cut and no overland or alternative road access possible; island below predicted flood level

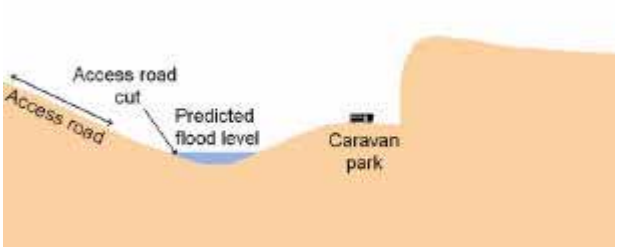
HIGH FLOOD ISLAND (HFI)
Access road cut and no overland or alternative road access possible; island above predicted flood level



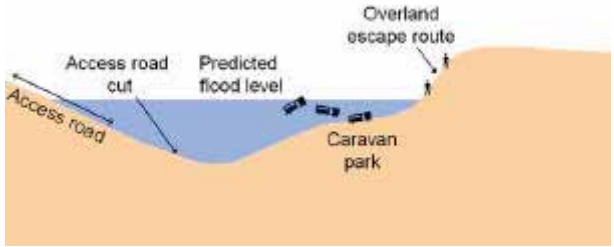
LOW TRAPPED PERIMETER (LTP)
Access road cut and no overland or alternative road access possible; site below predicted flood level



HIGH TRAPPED PERIMETER (HTP)
Access road cut and no overland or alternative road access possible; site above predicted flood level

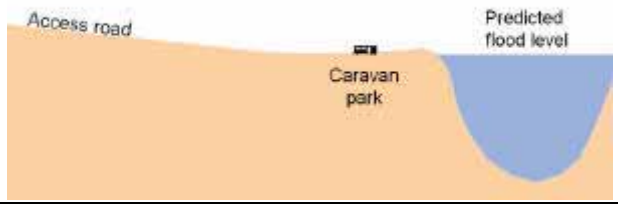


OVERLAND ESCAPE ROUTE (OER)
Access road cut but overland escape/rescue possible (on foot or AWD vehicle); site below predicted flood level



RISING ROAD ACCESS (RRA)
Access uninterrupted and via all-weather rising road (usual route or alternative); site below predicted flood level

INDIRECTLY AFFECTED AREA (IAA)
Access uninterrupted and via all-weather rising road (usual route or alternative); site above predicted flood level; one or more services failed



Key evacuation information *Table 9*

To be updated as necessary by the resort owner/operator.

Note that an evacuation assembly area for floods should be located on higher ground, and may need to be distinguished from an evacuation assembly area for fire.

	DESCRIPTION
Evacuation assembly area(s)	Cnr Marlin Drive & Salmon Circuit
Evacuation route(s)	Primary: SWR Riverside Cabins Driveway, Secondary: New Entrance Drive
Mobile caravan/vehicle/ boat storage area(s)	
Hazardous substances storage area	

Summary of flood risk

South West Rocks Riverside Cabins is subject to flooding from the Macleay River and the Pacific Ocean. Partial inundation of the site is expected for 10 year ARI floods or greater, with complete inundation of the site for the 100yr ARI flood. Velocities from Macleay River floods are expected to be between 1.0 m/s and 2.0 m/s through the site, but velocities from ocean flooding are generally expected to be low (< 0.5 m/s).

Flood Warnings for Macleay River floods at Kempsey are provided by the Bureau of Meteorology, which provide a good indication of the possibility of a flood at the site. Tropical Cyclone Warnings from the Bureau of Meteorology may provide an indication that ocean flooding is likely. Preparation for evacuation should commence whenever a Flood or Cyclone Watch is issued for the area. Immediate evacuation of the cabins should occur as soon as flood waters rise within 0.3m (1 foot) of New Entrance Road.

The cabins are 0.5 m above the estimated 100 year ARI flood level for 2050. Evacuation must occur before the cabins are isolated from the evacuation route by floodwaters.

Long-term options to reduce flood risk

This section should be completed by the park owner/operator

PART D – KEY PRIORITIES AND TRIGGERS

Key triggers initiating main responses *Table 10*

TRIGGER	KEY ACTION	RESOURCES	TIME NEEDED
Flood Watch Issued by BoM	Table 11 – "RESPOND: FLOOD POSSIBLE"	Manager and Staff	12 hours
Cyclone Watch Issued by BoM	Table 11 – "RESPOND: FLOOD POSSIBLE"	Manager and Staff	12 hours
Flood Warning Issued by BoM ("Moderate" or greater at Kempsey)	Table 11 – "RESPOND: FLOOD VERY LIKELY"	Manager and Staff	12 hours
Cyclone Warning Issued (BoM)	Table 11 – "RESPOND: FLOOD VERY LIKELY"	Manager and Staff	12 hours
Flood waters rise within 0.3 m (1 foot) of New Entrance Road	Evacuate cabin occupants immediately.	Manager and Staff	2 hours

PART E – FLOOD ACTION

Table 11

*This section should be adhered to and updated where required by the park owner/operator. The key priorities in any flood emergency are **ENSURING SAFETY** and **REDUCING PROPERTY DAMAGE**. Park occupants should evacuate before the flood arrives, if safe to do so. Actions should be linked to the triggers identified in Table 10.*

PREPARE – BEFORE THE FLOOD				
ACTION	WHEN	WHO	HOW (e.g. Resources)	COMPLETED
Maintain a flood emergency kit (e.g. first aid kit, portable radio, torch, waterproof bags, etc)	Always	Manager		✍
Back up records, accounts and computer files and store off site and out of floodplain	Monthly	Manager		✍
Document OH&S procedures for a flood (see NSW SES Business FloodSafe toolkit for ideas)	Annually	Manager		✍
Display evacuation procedures in office, amenities block(s), park-owned dwellings	Always	Manager		✍
Anchor any fuel tanks located below the 100 year ARI flood level	Always	Manager		✍
Investigate possibility of obtaining flood insurance for park-owned dwellings	Annually	Owner		✍

RESPOND – FLOOD POSSIBLE				
ACTION	WHEN *(see Table 12)*	WHO	HOW (e.g. Resources)	COMPLETED
Obtain information about flooding via www.bom.gov.au, SES, local radio stations	e.g. Flood Watch / Tropical Cyclone Watch issued / Severe Storms	Manager		✍
Check availability of staff and others to assist in emergency		Manager		✍
Check availability of equipment (e.g. trucks) to assist with evacuating people and relocating property		Manager		✍
Advise park occupants of possible flood, assembly areas, evacuation routes, relief centres		Manager/staff	Door-knock, loud-speaker, notice board	✍
Notify any advance bookings or prospective visitors of situation		Staff	Phone	✍

RESPOND – FLOOD VERY LIKELY, BEFORE INUNDATION OF NEW ENTRANCE ROAD OCCURS				
ACTION	WHEN *(see Table 12)*	WHO	HOW (e.g. Resources)	COMPLETED
Obtain information about flooding via www.bom.gov.au, SES, local radio stations	e.g. Flood Warning issued / local conditions	Manager		✍
Warn park occupants of flood and request they vacate park via evacuation route		Manager/staff		✍
Arrange transport to relief centre for any people without private transport		Staff (possibly with SES assistance)		✍
Make available a list of registered caravan park occupants to Police or SES upon request		Manager/staff		✍
Notify any advance bookings or prospective visitors of situation		Staff	Phone	✍
Use safe manual handling procedures (for moving assets and equipment); wear protective clothing (including non-slip footwear and puncture-resistant gloves)		Staff		✍
Relocate any mobile vans and vehicles to storage area(s) (if prior approval given, for privately-owned vans)		Staff (possibly with SES assistance)		✍
Relocate or tie down any unattended boats (if prior approval given, for privately-owned boats)		Staff (possibly with SES assistance)		✍
Lift items from annexes to vans for absentee 'annuals' (if prior approval given)		Staff (possibly with SES assistance)		✍
Secure objects that are likely to float or cause damage (including gas bottles)		Staff (possibly with SES assistance)		✍
Block toilets, sinks and floor wastes with sand bags		Staff (possibly with SES assistance)		✍
Relocate chemicals/poisons above potential flood level		Staff (possibly with SES assistance)		✍
Turn off electricity, gas and water at sites and to park when required		Manager/staff		✍

RESPOND – DURING THE FLOOD				
ACTION	WHEN *(see Table 12)*	WHO	HOW (e.g. Resources)	COMPLETED
Obtain information about flooding via www.bom.gov.au, SES, local radio stations	Park flooding	Manager		✍
Use safe manual handling procedures (for moving assets and equipment); wear protective clothing (including non-slip footwear and puncture-resistant gloves)		Manager/staff		✍
Beware of sharp debris, snakes and spiders, and wading in contaminated water		Manager/staff		✍
Stay away from fallen powerlines		Manager/staff		✍
AVOID DRIVING, RIDING OR WALKING THROUGH FLOODWATERS – THESE ARE THE MAIN CAUSES OF DEATH DURING FLOODS		Manager/staff		✍

RECOVER – AFTER THE FLOOD				
ACTION	WHEN	WHO	HOW (e.g. Resources)	COMPLETED
Check with SES and Police before allowing people back into flooded area	Flood receded and warning lifted	Manager		✍
Have electric and gas fixtures checked by qualified personnel		Manager		✍
Never use matches, cigarette lights or any other naked flame since flammable gas may be trapped inside		Manager/staff/occupants		✍
Beware of sharp debris, snakes and spiders, and wading in contaminated water; wear protective clothing (including non-slip footwear and puncture-resistant gloves)		Manager/staff/occupants		✍
Boil all water supplies until declared fit to drink		Manager/staff/occupants		✍
Dispose of any food or medication contacted by floodwater		Manager/staff/occupants		✍
Remove debris and clean, repair and disinfect premises		Manager/staff/occupants		✍
Salvage, clean and dry as much as possible		Manager/staff/occupants		✍
Replace any lost furniture, fittings and floor coverings with more flood resistant products		Owner, owners of 'permanents' and 'annuals'		✍
Return any vans/vehicles/boats that were moved off site		Staff (possibly with SES assistance)		✍
Implement strategies for winning back customers		Regional tourism body, owner/manager		✍
				✍