North Byron Parklands

Technical Paper

W2

Flood Evacuation Assessment

BMT WBM

North Byron Parklands Flood Evacuation Assessment

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North Byron Parklands Flood Evacuation Assessment

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1 INTRODUCTION

The North Byron Parklands site is intended to be used for a number of cultural events throughout the year, including concerts, festivals, demonstration field days and organisational gatherings. The assessment has been undertaken in consideration of a portion of the Director-General's Environmental Assessment Requirement 6.5, which requires '*adequate egress and safety in a flood event*' to be addressed. This report provides advice for evacuation during flood events. The size of the events will vary significantly. Broadly, the events can be categorised by the number of expected patrons. This report will refer to the following event size categories:

Table 1-1 Event Sizes

Event Category	Maximum Patrons
100% Capacity	50,000
70% Capacity	35,000
40% Capacity	20,000
30% Capacity	15,000
Moderate	10,000
Small	3,000
Minor	300

2 ANNUAL CONSTRAINTS CALENDAR

An annual constrains calendar has been developed for this site. The calendar highlights seasonal flooding trends. It is intended for the calendar to be consulted prior to scheduling major events on site in order to reduce the risk of a flood occurring during an event.

2.1 Methodology

Based on client advice, it was determined that flooding issues can constrain use of the site when either of the site catchments floods to a depth of 200mm. This depth was therefore used as a 'trigger' to gauge the frequency which the site might be flood affected at various times of the year.

The frequency was estimated using a multi-stage process:

(1) The time when 200mm or more of flooding first occurred on site was recorded for each modelled event. It is worth noting that depths greater than 200mm are predicted for both the northern and southern parts of the site during the smallest event modelled (5 year ARI).

(2) The modelled water height at the location of the Billinudgel stream gauge corresponding to (1) was recorded and tabulated in Table 2-1. Trigger levels at Billinudgel gauge of 700mm and 900mm were used.

(3) The historical record from Billinudgel stream gauge was analysed and a record made of each instance that the trigger level was exceeded.

(4) A sensitivity analysis was completed on the data inspection period. This variable was included to ensure that the method used to count the peaks didn't have a strong influence on the results. By way of example, if maximum peaks were recorded based on a daily inspection period, two consecutive days may be recorded which were the result of a single rainfall event. Therefore, each analysis was completed for 1-day, 2-day and 3-day inspection periods. Results of this analysis are provided in Table 2-2

2.2 Results

Using the existing case flood model, the water level at the location corresponding to the Billinudgel gauge was recorded at the time when the site first had at least 200mm of water. These water levels are provided in Table 2-1 below.

Table 2-1 Billinudgel Trigger Levels

Modelled Event	Modelled Gauge Height (m) at First Time of 200mm on Site
Q005 3hr	0.7
Q005 12hr	0.66
Q010 3hr	0.77
Q010 12 hr	0.75
Q050 3hr	0.8
Q050 12hr	0.8
Q100 3hr	0.88
Q100 12hr	0.9

The historical record from the Billinudgel gauge (approximately 24 years) was analysed to determine the frequency and temporal distribution of peaks above a defined threshold. Thresholds of 700mm and 900mm were used with a range of inspection periods. Results are provided in Table 2-2, below.

Table 2-2 Stream Gauge Analysis Results

Month	700 mm			900mm			Total
	1 day	2 days	3 days	1 day	2 days	3 days	
Jan	119	52	41	27	19	14	272
Feb	93	43	32	26	19	15	228
Mar	100	52	40	33	21	19	265
Apr	150	65	47	46	25	21	354
May	180	86	60	39	22	18	405
Jun	190	86	54	25	16	14	385
Jul	132	61	48	24	11	10	286
Aug	54	29	22	3	3	3	114
Sep	15	8	7	3	2	2	37
Oct	9	6	6	1	1	1	24
Nov	35	19	14	6	5	5	84
Dec	68	32	29	12	9	8	158
Total	1145	539	400	245	153	130	2612

Each of the variants (thresholds and inspection periods) produced a similar distribution of peaks throughout the year. The average of these analyses has been plotted in Figure 2-1. The error bars indicate the level of uncertainty associated with the inspection period and threshold in each of the values.

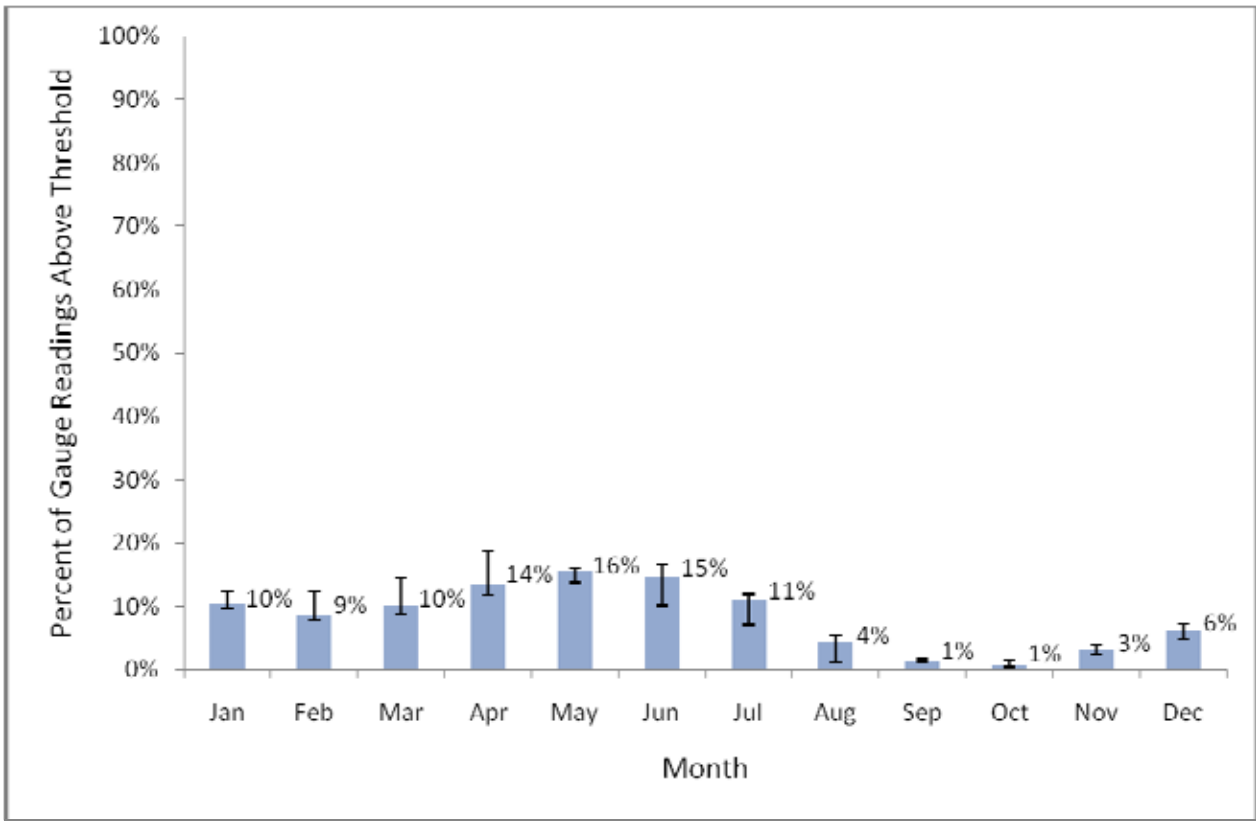


Figure 2-1 Annual Constraints Calendar

Note that a reading of '10%' means that 10% of the historical gauge readings above the threshold were recorded in January. These values do not correlate to a probability or likelihood that a rainfall event will occur in a particular month.

2.3 Recommendations

Based on the available historical data, the annual constraints calendar indicates that the months of September to November have had the fewest instances of flooding capable of producing 200mm of water on the development site. The constraints calendar provides a tool for consideration of scheduling of events and event evacuation planning.

Conversely, historical records show that the highest frequency of events occurs in April to June. It must be noted however, that the annual constraints calendar records all events above the threshold, and does not distinguish small flood events from large. Thus, although February and March recorded fewer instances of the gauge exceeding the threshold than April to June, local knowledge confirms that the largest and most intense rainfall events in this area are likely to occur during late summer.

3 EVACUATION CONSIDERATIONS

3.1 Evacuation Overview

Evacuation plans, outlining evacuation procedures and priorities, are essential for event sites, such as the proposed project. The following should be considered as part of the plan:

- Evacuation Routes;
- Ground levels of the evacuation routes;
- Depth and time of flooding along the evacuation routes;
- Method of evacuating the number of people and vehicles from the site;
- Critical rainfall events for cancellation or evacuation of the event; and
- Methods and location of flood monitoring.

As a preliminary step, the evacuation capacity of the site has been assessed. This assessment determines the timescales required to fully evacuate the site, irrespective of the timing of a particular flood event. Knowledge of these timescales assists the SES and the site manager to determine whether evacuation is a feasible option during a flood.

There are two evacuation scenarios, based on the feasibility of evacuation:

1) If there is insufficient time to evacuate, it is recommended that patrons be escorted to high ground within the event site.

2) If the flood warning is issued sufficiently early, cars from the southern car park should be evacuated south along Tweed Valley Way to the Yelgun interchange, with cars from the central and northern car parks evacuated via the Jones Road exit and Tweed Valley Way to the north.

Timeframes and detailed recommendations for both scenarios are outlined below.

3.2 Evacuation Requirements

An evacuation capacity assessment has been completed for each of the event categories to determine the minimum amount of time required to evacuate patrons from the site. Based on assumed public transport and car occupancy rates, the vehicle numbers in Table 3-1 have been assumed for each event. Note that cars have been proportionally distributed across the car parks.

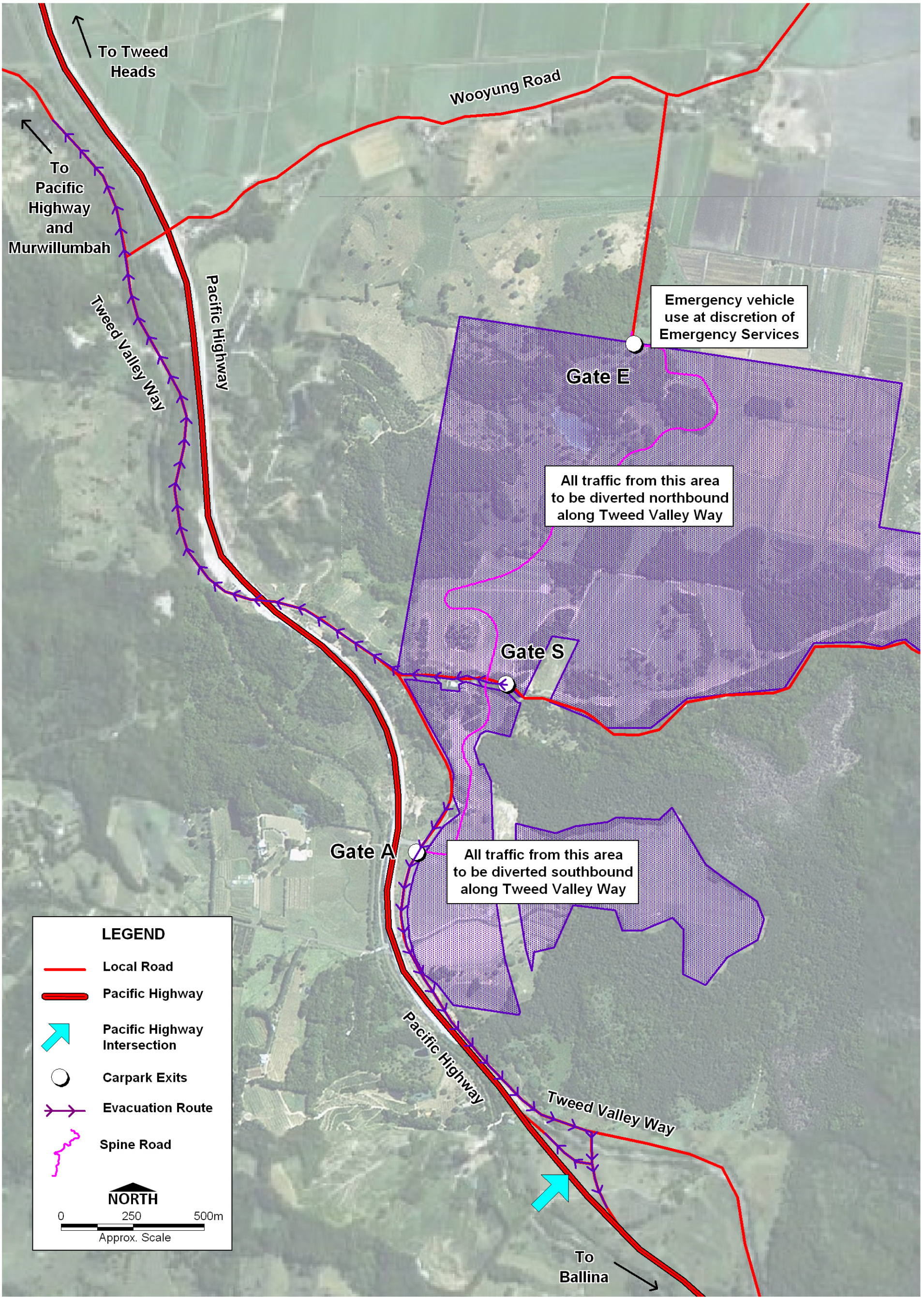
Table 3-1 Vehicle Numbers On-Site

Event Category	Northern Car Park	Central Car Park	Southern Car Park	Total Cars
100% Capacity	3708	1038	7155	11901
70% Capacity	3119	873	6017	10009
40% Capacity	2183	612	4213	7008
30% Capacity	1377	386	2657	4420
Moderate	1033	289	1992	3314
Small	878	246	1693	2817
Minor	310	87	597	994

It is recommended that cars parked in the southern car park are evacuated via the main gate to Tweed Valley way and directed south to the Yelgun interchange. This interchange provides access to the Pacific Highway.

Cars from the central and northern car park should be evacuated via the Jones Road exit to Tweed Valley Way and directed northward. These cars would be able to access the Pacific Highway at the Cudgera Creek Road intersection. Alternatively, there is an option to travel westward towards Murwillumbah or east to Pottsville and Kingscliff. Evacuation routes from the site are marked on Figure 3-1.

Should patrons require the use of an evacuation centre, the nearest centre is located approximately 6kms south of the site, at the Ocean Shores Country Club.



NORTH BYRON PARKLANDS
SITE EVACUATION ROUTES

Figure 3-1

3.3 Evacuation Timeframes

Evacuation timeframes have been calculated using a car flow rate of 600 cars/lane/hour as recommended in the Australian Standard for Traffic Management (AS2890.1:2004). This flow rate assumes a free flowing exit. Therefore, to achieve the timeframes provided in Table 3-2, sufficient traffic marshals must be assigned to each car park to direct traffic and minimise congestion. Note that times to evacuate have been rounded to half hour intervals, and do not account for the time taken to actuate an evacuation after receiving a flood warning.

Table 3-2 Vehicle Evacuation Timeframes

Event Category	Time to evacuate northern and central car parks (hrs)	Time to evacuate southern car park (hrs)	Total time to evacuate (hrs)
100% Capacity	7.0	10.0	8.5
70% Capacity	5.0	7.0	6.0
40% Capacity	3.0	4.5	4.0
30% Capacity	2.5	3.5	3.0
Moderate	2.0	3.0	2.5
Small	1.0	1.0	1.0
Minor	0.5	0.5	0.5

These calculations assume that both exits operate at capacity until all cars are evacuated. If the cars from the northern part of the site complete evacuation first, cars from the southern part of the site will be directed both north and south. This will double the flow rate of cars from the southern site and ensure the fastest overall evacuation.

After receiving a flood warning, there will be a period of time taken to acknowledge the warning, decide on the evacuation response and then implement the evacuation procedure. The length of this initial timeframe will depend on the onsite management conditions, and should be appended to the vehicle evacuation timeframes shown in Table 3-2 to estimate the total time taken to implement and action an evacuation.

3.4 Flood Warnings

During short duration rainfall events, flood waters begin to rise within an hour of the start of rainfall. Therefore, to enable complete evacuation, flood warnings must be issued by the Bureau of Meteorology (BoM) prior to the start of the rainfall event. For significant rainfall events, the BoM are able to issue flood alerts 12 to 24 in advance. The BoM continually monitor the weather pattern and issue revisions to the flood alert or warning as necessary.

Flood warnings are issued by the Bureau of Meteorology (BoM) via a range of media: low level flood alerts are issued via the BoM website, which includes localised flood warnings and rainfall radar imagery. More serious flood warnings may be issued via the BoM website as well as on local radio and television. The State Emergency Service (SES) will also be made aware of current flood warnings.

The relative timing of flood warnings and commencement of rain will vary for each weather system. It is not possible to generalise or 'assume' a standard lead up time for the purposes of evacuation planning. This evacuation plan therefore considers two scenarios of insufficient or sufficient warning time.

3.5 Scenario 1: Insufficient Time to Evacuate

Short thunderstorms or flash floods have a fast onset with no opportunity for flood warnings to be issued. During these events it will not be possible to evacuate patrons and their property from the site. For these fast onset events, it is recommended that patrons are directed to flood free land within the site and that no-one is permitted to return to their vehicles until flooding has subsided. This procedure has been discussed with the SES local controller, Noel McAviney, who confirms that this process is suitable for short duration flood events.

Due to the fast nature of these flood events, it is imperative that a plan be developed by site staff to quickly disseminate the flood warning and advise patrons where to shelter. Suitable areas to shelter include the raised land around Jones Road or the north-western area of the site where the conference centre is to be located.

The conference centre will provide shelter from rain and would be most suitable for smaller events. It is recommended that basic medical supplies and emergency equipment, such as battery powered torches and radios, be stored in the conference centre. The raised land around Jones Road does not provide shelter from the rain; however it is more easily accessed by emergency services, should an emergency evacuation be required.

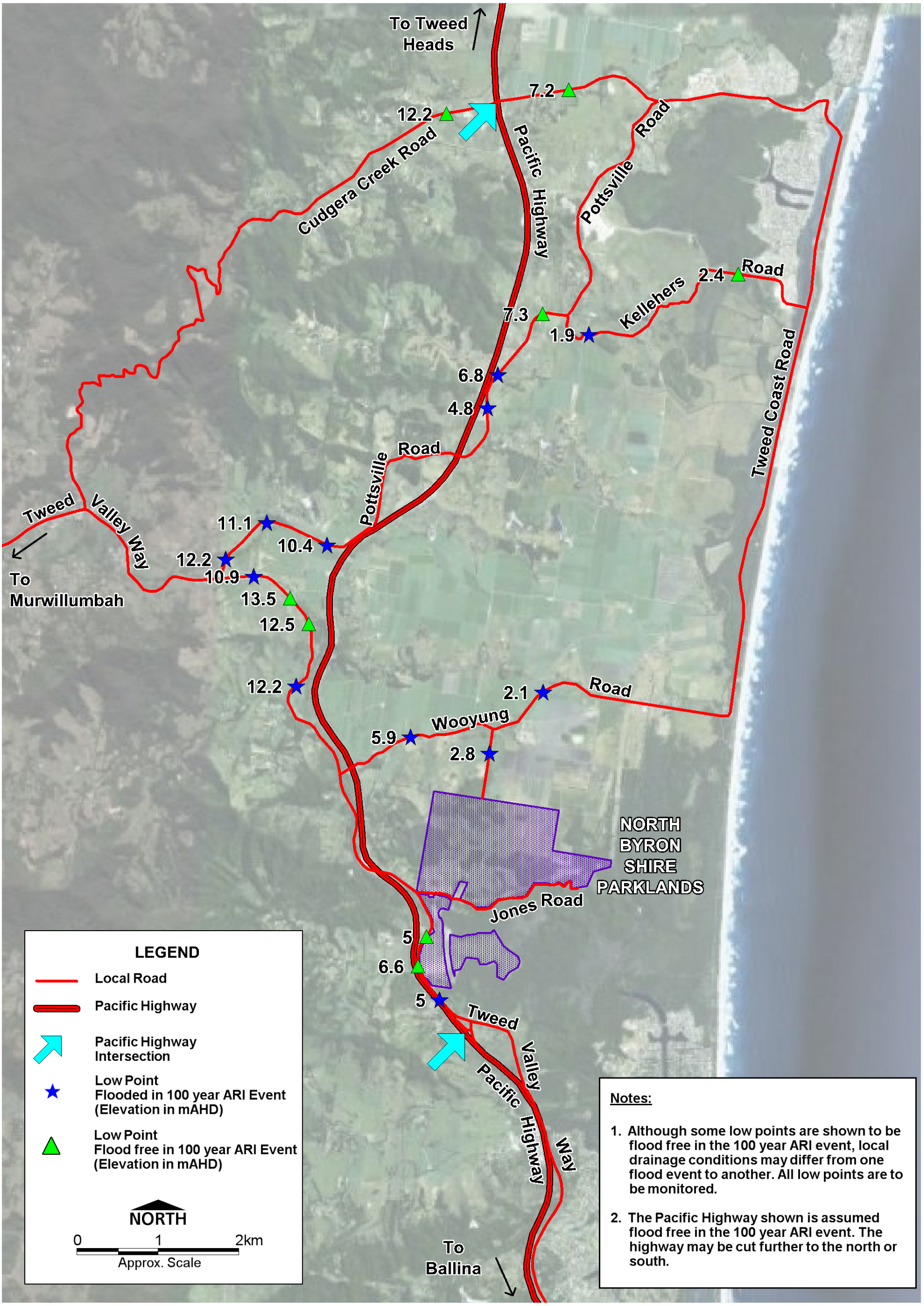
Flash floods tend to be of short duration, with floodwaters expected to recede fairly quickly. However, an efficient line of communication must be maintained between the site manager, the SES and the BoM to monitor flood risk and manage evacuation.

It is recommended that patrons are advised that car parks are located on flood prone land.

3.6 Scenario 2: Sufficient Time to Evacuate

Should sufficient warning time be provided to enable evacuation, it is recommended that evacuation commence as per the recommendations in section 3.2. However, as flooding events can change quickly, it is important that the evacuation is carefully monitored with continual reassessment to ensure safety at all times. In addition to maintaining a line of communication with BoM and SES, it is recommended that a number of low points on the evacuation routes are monitored. These low points are marked on Figure 3-2.

If evacuation routes become inundated, it is recommended that patrons cease driving and are directed to high ground on foot, as per scenario 1. Human safety must remain the highest priority under all circumstances.



NORTH BYRON PARKLANDS
EVACUATION ROUTE LOW POINTS

Figure 3-2

4 EXAMPLE FLOOD EVACUATION PLAN

An example flood evacuation plan has been developed which describes flood characteristics and suggested actions for flood preparation and evacuation. It is recommended that this evacuation plan be further developed by the site-manager to reflect on-site logistics. A flood evacuation plan should be prominently displayed in multiple locations around the site and all employees should be familiar with flood evacuation practices.

4.1 Flood Characteristics

Flooding can occur at any time of year and site staff should be prepared to assist flood evacuations at any time. In general, on-site flooding is more likely between January and July, with intense storms most often occurring in late summer.

On-site flooding is generally a combination of broader catchment flow, local catchment flow (from east of the Pacific highway) and on-site runoff. Flooding can be problematic and interfere with use of the site from depths of 200mm.

During a 100 year ARI event, it is anticipated that most of the southern part of the site and a large proportion of the northern part of the site will be flooded.

4.2 Flood Warnings

The SES should be given advance notice of large events, including the date, duration and anticipated size. This will assist the SES plan resources and ensure that the site manager is made aware of current flood warnings.

It is recommended that the BoM website is regularly checked in the days immediately prior to events and more frequently during events. Major flood warnings will be issued via local radio and television.

4.3 Preparations

It is recommended that a chain of command be developed on site to distribute flood warnings and coordinate flood evacuations. Key roles are outlined in Table 4-1 below:

Table 4-1 Key Evacuation Roles

Role	Key Duties
Site Manager	Point of contact with SES Oversee and coordinate evacuation Ensure all staff are aware of evacuation roles and procedures in advance of events
Event Coordinator	Determine whether an event should proceed based on current flood warnings
Area Coordinators	Manage evacuation in particular areas, e.g. camp grounds
Security Personnel	Assist distribution of evacuation warnings, including directing patrons to vehicles or emergency shelters, as appropriate
Car Park Attendants	Supervise vehicle evacuations to minimise congestion and confusion.
Road Monitors	Monitor evacuation routes out of the site Report to Site Manager when routes are closed

It is recommended that large events are registered with the SES local controller in advance of the event. Emergency supplies, such as first aid kits, bottled water and battery powered torches and radios are provided in a number of locations around the site.

4.4 Contacts

Table 4-2 Emergency Contacts

Contact	Location	Phone Number
State Emergency Service (SES) Noel McAviney (Local Controller)	7 Lancaster Drive, Goonnellebah	(02) 6625 7700
Police	2 Shirley Street, Byron Bay	(02) 6685 9499
Closest Emergency Shelter	Ocean Shores Country Club, 1 Orana Road, Ocean Shores	(02) 6680 1008
Alternative Emergency Shelter	Murwillumbah TAFE, Murwillumbah Street, Murwillumbah	(02) 6672 0800
Power Supplier	TBA	
Phone Supplier	TBA	
Local Radio Stations 1. ABC Local 2. ABC Radio National	 94.5 FM 96.9 FM	

4.5 Additional Detail

It is recommended that a flood warning matrix be developed (as per the example below) to assist decision making during the evacuation process. This matrix can be populated following discussions with the SES to determine suitable warning time-frames for each event category. For instance, the site manager may require 2 hours to decide on an appropriate evacuation plan and disseminate evacuation instructions to patrons during a '100% capacity'. Using the vehicle evacuation timeframes in Table 3-2, evacuation would take 8.5 hours plus 2 hours to disseminate the warning. Therefore, it would not be possible to fully evacuate the site if warnings were given less than 10.5 hours prior to the onset of flood waters.

Table 4-3 has been partially filled in using this example. 'Vehicles' indicates that there is sufficient time to evacuate patrons in their cars, 'people' recommends that patrons are evacuated on foot to the nearest high ground.

Table 4-3 Evacuation Decision Matrix

	Event Category						
Warning Time	100% Capacity	70% Capacity	40% Capacity	30% Capacity	Moderate	Small	Minor
1 hour	People						
2 hours	People						
5 hours	People						
10 hours	People						
24 hours	Vehicles						

5 CONCLUSIONS AND RECOMMENDATIONS

The site's evacuation capacity has been assessed for each of the specified event categories. A full evacuation should only be undertaken when there is sufficient flood warning time to evacuate the site. If there is insufficient time to evacuate, patrons should be directed to flood free land within the site as recommended in section 3.5.

The annual constraints calendar may be used to schedule events in less flood prone times of the year and can assist scheduling of events and event evacuation planning. It should be noted that the annual constraints calendar does not consider flood severity and flooding can still occur at any time. The SES should be contacted prior to the event to check that no flood warnings have been issued.

An example evacuation plan has been presented with recommendations. A full evacuation plan should be developed in conjunction with the SES and site manager which includes on-site evacuation logistics. The final evacuation plan should include an evacuation decision matrix based on the vehicle evacuation timeframes listed in this report and warning timeframes agreed with the SES.

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