



FLOOD EMERGENCY RESPONSE REPORT

Northern Beaches Council (Pittwater)

New Dwelling

at

47 Elaine Avenue, AVALON BEACH

Job No. 160708

Issue B (13/11/2019)

Prepared for: James Campbell

Prepared by: Cameron Haack

Contents

1.0 INTRODUCTION	3
1.1 - Catchment Summary:	5
2.0 SITE EVACUATION CONSIDERATIONS.....	7
2.1 Site Occupants	7
2.2 Refuge Location	7
2.3 Evacuation Route	8
2.4 Evacuation Timeline.....	8
2.4.1 – T =0 – Commencement of PMF Rainfall Event.....	9
2.4.2 – T=7.5 - Evacuation Commences.....	9
2.4.3 – T=12.5 – Pit 227 Exceeds H2 Hazard Threshold.....	9
2.4.4 – T = 25 – Pit 537 Exceeds H2 Hazard Threshold.....	10
2.4.5 – Evacuation Timeline Summary	12
2.5 - Individual Alert Thresholds	15
3.0 FLOOD EMERGENCY RESPONSE STRATEGY	20
4.0 RECOMMENDATIONS / CONCLUSION.....	21

1.0 INTRODUCTION:

NB Consulting Engineers (NBCE) previously completed the Flood Risk Management Report for the Proposed New Dwelling at 47 Elaine Avenue, Avalon Beach, dated 5th September 2017.

The report recommends either shelter-in-place or evacuation to an appropriate high-level refuge as the primary flood emergency response mechanism.

NBCE have also reviewed council's email request dated 10/9/2019 received from Duncan Howley (Team Leader Floodplain Planning and Response).

We note that due to the level of inundation and high velocity of floodwaters in the PMF event it has been considered impractical to provide a shelter-in-place refuge on the site and therefore evacuation will be required as the primary flood emergency response mechanism.

This assessment has been based on the following flood studies: *The Careel Creek Catchment Flood Study (WMA Water 2013)* and *the Avalon to Palm Beach Flood Study (MHL 2017)*.

We note that the structural engineer has confirmed that the main dwelling constructed on the site has been designed and constructed to withstand flood loads, including debris impact up to the FPL, in the 1% AEP event. It is unlikely that the dwelling is able to withstand substantially higher flood levels than that predicted in the 1% AEP event due to the timber framed floor and building structure.



Figure 1.01 – Careel Creek Study (WMA Water 2013)

1.1 - Catchment Summary:

The Careel Creek catchment (refer figure 1.01) flood mechanism can be caused by a number of events, however severe storms and floods pose a major and high likelihood threat to flooding within the catchment.

The 4.3 km² catchment drains to Careel creek, which discharges directly into Careel Bay. The catchment is subject to both overland flow and mainstream creek flooding. A rapid rate of rise of floodwaters is typical of the catchment which makes providing effective response and warning times difficult.

The site is located on Elaine Avenue and the Eastern (rear) boundary backs onto Careel creek. The northern boundary of the site backs onto a council designated floodway, which directs overland flows from the upstream catchment down into Careel Creek. The *Avalon to Palm Beach Flood Study (2017)* identifies the site (and those fronting Elaine avenue to the south of the site) as a 'Low Flood Island', due to the area becoming trapped by floodwaters in a flood event. Section 7.2 of 'The Avalon to Palm Beach Flood Study (2017)' notes that the critical storm for the PMF is the 60 minute duration and the critical storm for the 0.2%, 0.5%, 1%, 5% and 20% AEP is the 120 minute duration.

In the PMF event, the 'Avalon to Palm Beach Flood Study (2017)' predicts that the flood level in Elaine avenue, adjacent the site will reach the peak flood level of RL5.67m AHD (2.67m depth) within 45mins (approximately) for the critical duration. The corresponding velocity is anticipated to be 1.12 m/s, which equates to a H5 hazard and would be considered unsafe for people and vehicles.

It should be noted that the flood information previously received from council about the PMF for the site (issued November 2015) addressed the peak flood characteristics of the Careel Creek channel only and not the proposed evacuation route.

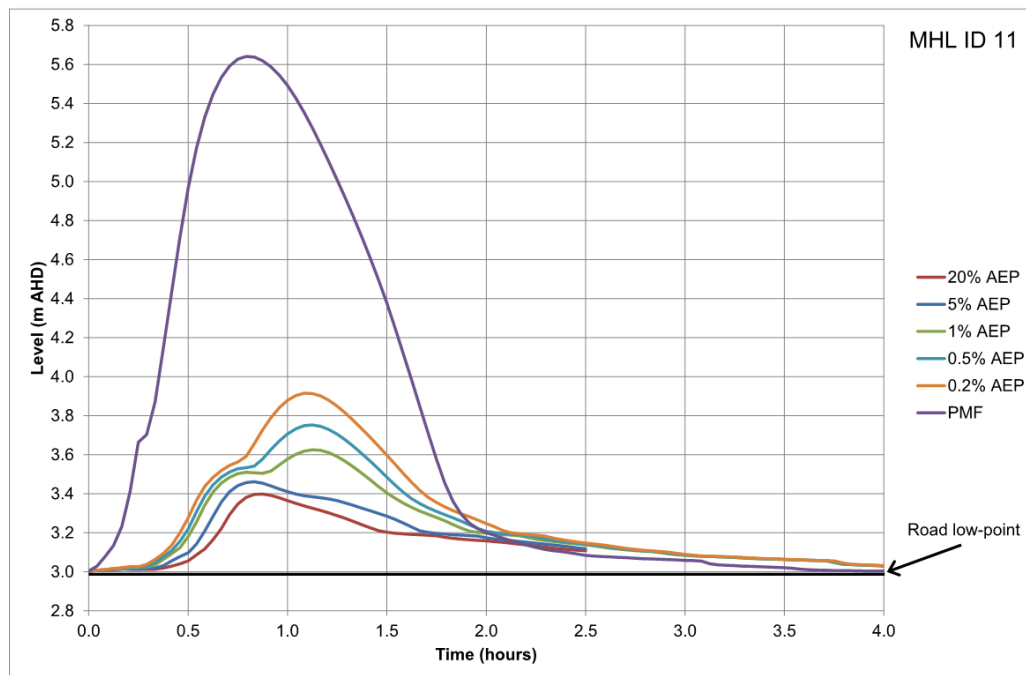


Figure 8.10 – Stage hydrographs, Elaine Avenue

Figure 1.02 – Stage Hydrographs, Elaine Avenue - Avalon to Palm Beach Flood Study (MHL 2017)

NBCE have assessed the TUFLOW output data file for 'The Avalon To Palm Beach Flood Study' for the critical (60 minute duration) PMF event, the critical (120 minute duration) 1%, 5%, 20% AEP events and QGIS information of the pit and pipe location including surface levels and inverts within the catchment. The output data file provides the water surface level and velocity at each point from time (T) = 0. The information is provided over 3 hours in 2.5-minute intervals.

2.0 SITE EVACUATION CONSIDERATIONS

This report has considered the following in determining an adequate flood emergency evacuation plan:

1. The number of residents on site during a flood event
2. Refuge location
3. Evacuation Route
4. Evacuation Timeline
5. Individual Alert Thresholds and triggers

2.1 Site occupants

The site contains a single residential dwelling with 4 bedrooms and one study, as a conservative estimate we have anticipated there to be a maximum of 10 occupants on the site at any one time.

2.2 Refuge Location

NBCE have reviewed and identified several potential evacuation refuge locations including:

- Fire and Rescue NSW Avalon Fire Station located south-west of the site on Barrenjoey road
- Avalon Ambulance Station located south-west of the site on the corner of Barrenjoey road and Central road
- The Avalon Baptist Church located north-west of the site on George street.

NBCE are of the opinion that any evacuation to the south-west will not be feasible because it would require the evacuation route to rely on access through several downstream neighbors' properties to access Barrenjoey road or traverse along public footpath located adjacent to Careel Creek.

Evacuation to a refuge to the north-west of the site will allow occupants to proceed along public footpaths and roadways and ensures evacuees are required to enter floodwaters of high hazard provided an acceptable evacuation timeline can be achieved. We have therefore determined that the preferable flood refuge is The Avalon Baptist Church located at 2 George Street, Avalon Beach.

2.3 Evacuation Route

Once the threshold is reached and evacuation triggered (refer section 2.4 below) evacuees are to:

1. Proceed North on foot along Elaine Avenue to the intersection of Eastbourne Avenue,
2. Then proceed West along Eastbourne Avenue to the intersection of Barrenjoey road, and
3. Proceed North along Barrenjoey road and cross the road at George street, and
4. Proceed North along George street and seek refuge at the Avalon Baptist Church

2.4 Evacuation Timeline:

We note that evacuation in a vehicle (any vehicle larger than a small car) may be feasible before evacuation cutoff and would reduce the evacuation timeline. However, for the purpose of this report we have only considered evacuation on foot due to possible road closures and traffic delays.

All evacuation routes will require patrons to pass through flood affected areas, therefore we recommend that all evacuees reach a point that is beyond the PMF extent before the flood hazard exceeds H2 at the lowest point along the evacuation route.

The evacuation route will be outside the PMF at a point that is beyond the corner of Eastbourne Avenue and Barrenjoey road (approximately 270m distance from the start of the evacuation route).

NBCE has summarized the TUFLOW output data files for the PMF event at several pit locations along the proposed evacuation route in figures 2.42 and 2.43 below (note: refer figure 2.41 for corresponding pit locations along evacuation route). Since the lowest point along the evacuation route is adjacent to the site in Elaine Avenue, (refer Pit 227 in figure 2.41) an evacuation trigger is to be implemented to allow evacuees to reach pit no.233 before floodwaters become unsafe at pit no.227.

As noted in section 1.1, the evacuation timeline describes the timing thresholds from when the PMF storm commences at T=0. NBCE have identified several timesteps that are critical to ensure the safe evacuation of occupants from the dwelling in the PMF flood event, and are listed below:

1. T=0
2. T=7.5
3. T = 12.5
4. T = 25

Each critical timestep is described further below.

2.4.1 – T =0 – Commencement of PMF rainfall event

At time T = 0 minutes the rainfall event will commence. There will be not visible signs of flooding over the site or within the catchment.

2.4.2 – T=7.5 - Evacuation Commences

At T=7.5 minutes rainfall will cause widespread initial flooding within the catchment. In Elaine Avenue the water level will not have exceeded the grate level of pit no.227. Adjacent the rear of the site at Careel Creek the water level will not be overtopping the channel. Evacuation must commence at this time to allow enough time for safe evacuation.

2.4.3 – T=12.5 – Pit 227 exceeds H2 hazard threshold

At T = 12.5 minutes there will be significant flooding within the catchment. The rear of the site will experience approximately 0.3m depth of flooding, and Elaine avenue will have just under 0.5m of flooding at pit no.227. Evacuation from the

dwelling to a point beyond pit no.227 (ie: pit no.233) must be completed by $T=12.5$, to ensure evacuees are not exposed to floodwaters that exceed the H2 hazard threshold. Small cars parked in Elaine avenue are expected to be swept away by floodwaters at this time.

Therefore, we recommend an evacuation trigger is implemented at $T = 7.5$ minutes into the PMF event. This will provide 5 mins for evacuees to proceed to pit no.233, located approximately 55m North of 47 Elaine Avenue (less than 1-minute walk).

2.4.4 – $T = 25$ – Pit 537 exceeds H2 hazard threshold

At $T = 25$ minutes the catchment will be almost completely flooded. 47 Elaine avenue will be completely inundated. The flood depth across the site is expected to be approximately 2.0m deep, with high velocity.

Pit 537 located at the intersection of Elaine avenue and Eastbourne avenue will exceed the H2 hazard threshold shortly after this time, therefore it is critical that evacuation to a point beyond pit no.537 (ie: pit no.253) is completed before $T = 25$ minutes.

From Pit no.233 evacuees are to proceed along the designated evacuation route (refer figure 2.41) to the proposed refuge point. The evacuation route will be outside the PMF flood extent at the corner of Eastbourne Avenue and Barrenjoey road, (a further 230m away from pit no.233). Evacuees will have an additional 12.5 minutes ($T = 25$ mins) to proceed to this point before the H2 threshold is exceeded at Pit No. 537 (refer figure 2.41).

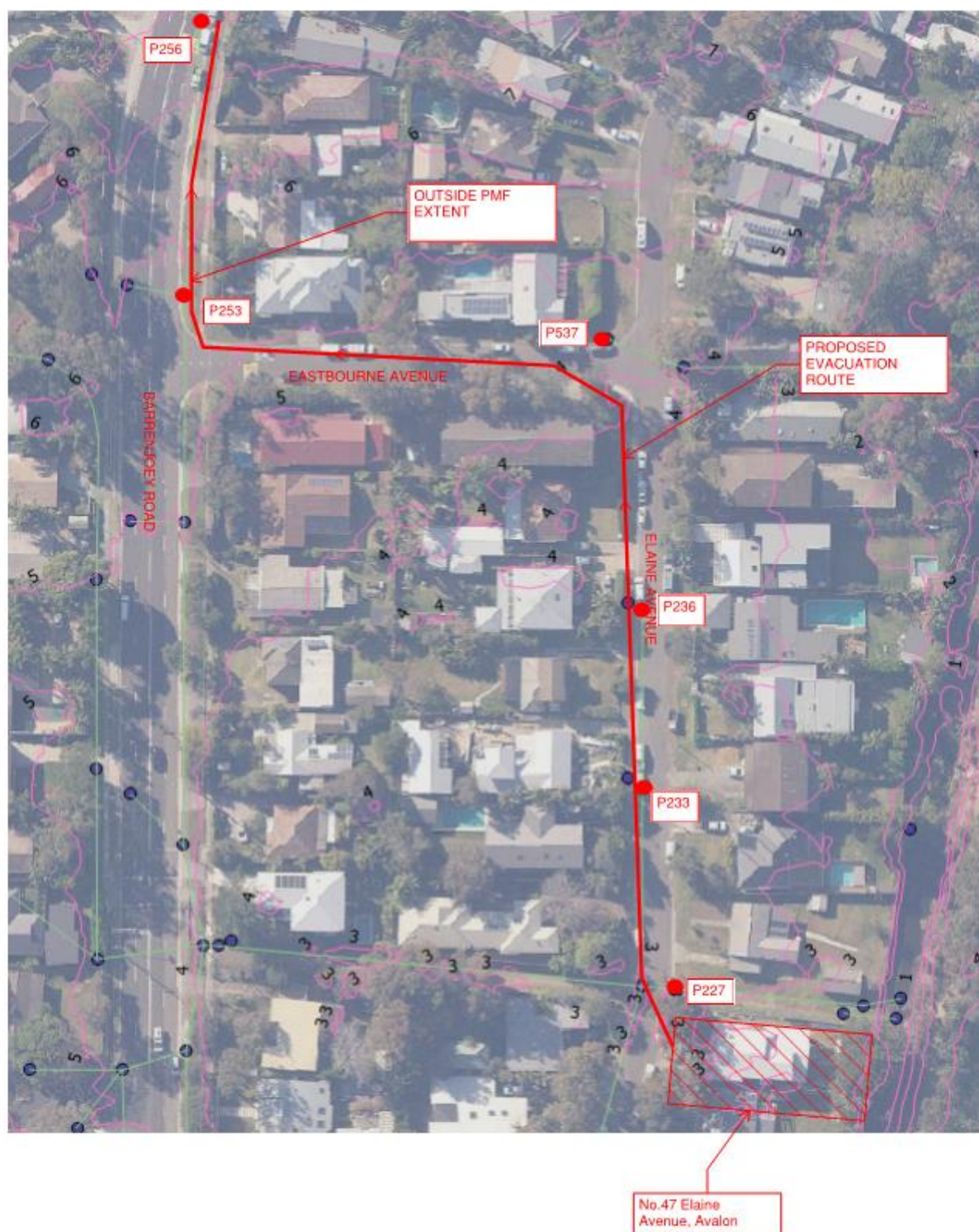


Figure 2.41 – Pit locations along proposed evacuation route

PMF CRITICAL DURATION (60 min) FLOOD DEPTHS ALONG PROPOSED EVACUATION ROUTE AT TIME (T) = 12.5 mins					
PIT ID	SURFACE LEVEL	WATER LEVEL	DEPTH	VELOCITY	VD
227	3.0894	3.3915	0.3021	1.415	0.4274
233	3.23944	3.4074	0.16796	0.461	0.07742
236	3.52572	3.7045	0.17878	0.321	0.11356
537	4.12843	4.3494	0.22097	0.655	0.14474
253	5.77395	5.8911	0.11715	0.123	0.01441
256	7.74571	7.8189	0.07319	0.046	0.098569

Figure 2.42 – Water Depth, Velocity and highest VD at pit locations for Time (T) = 12.5 mins.

PMF CRITICAL DURATION (60 min) FLOOD DEPTHS ALONG PROPOSED EVACUATION ROUTE AT TIME (T) = 25 mins					
PIT ID	SURFACE LEVEL	WATER LEVEL	DEPTH	VELOCITY	VD
236	3.52572	4.3756	0.84988	0.109	0.09263692
537	4.12843	4.3783	0.24987	0.738	0.18440406
253	5.77395	5.8951	0.12115	0.132	0.0159918
256	7.74571	7.8125	0.06679	0.059	0.00394061

Figure 2.43 – Water Depth, Velocity and highest VD at pit locations for Time (T) = 25 mins.

2.4.5 – Evacuation Timeline Summary

We have anticipated that there will be a maximum of 10 evacuees from the site in a flood event and it will take approximately 3 minutes for all evacuees to exit the dwelling and reach pit no.233 and an additional 3 minutes for the last evacuee to reach a point that is outside the PMF flood extent (total 8 minutes including 2 minute buffer to get to pit no.227).

Therefore, evacuation in accordance with the alert thresholds and triggers will ensure evacuees are outside the H3 hazard approximately 2 minutes before the H2 threshold is exceeded at pit no. 227 and approximately 14.5 minutes before the H2 threshold is exceed at pit no. 537.

It is the client's responsibility to ensure that residents and guests are aware of the risk of flooding, the evacuation alert thresholds and the evacuation route in a flood event in accordance with this report. The client is to be educated with the alarm system and is to review this report and understand the requirements.



The alarm system is to be maintained and checked regularly by a qualified contractor to ensure it is in working order at all times.

We recommend a covenant is placed over the land and flood warning alarm system so that any future owners of the property are aware of the provisions in place in relation to flooding and evacuation.

The Flood Refuge is to provide the following:

- Sufficient Clean water for all occupants

Further, the client is required to have a 'go bag', positioned in a readily accessible location in the dwelling, at all times and containing:

- Portable Radios with spare batteries
- Torches with spare batteries
- First aid kit
- Emergency supply of medication (if applicable)

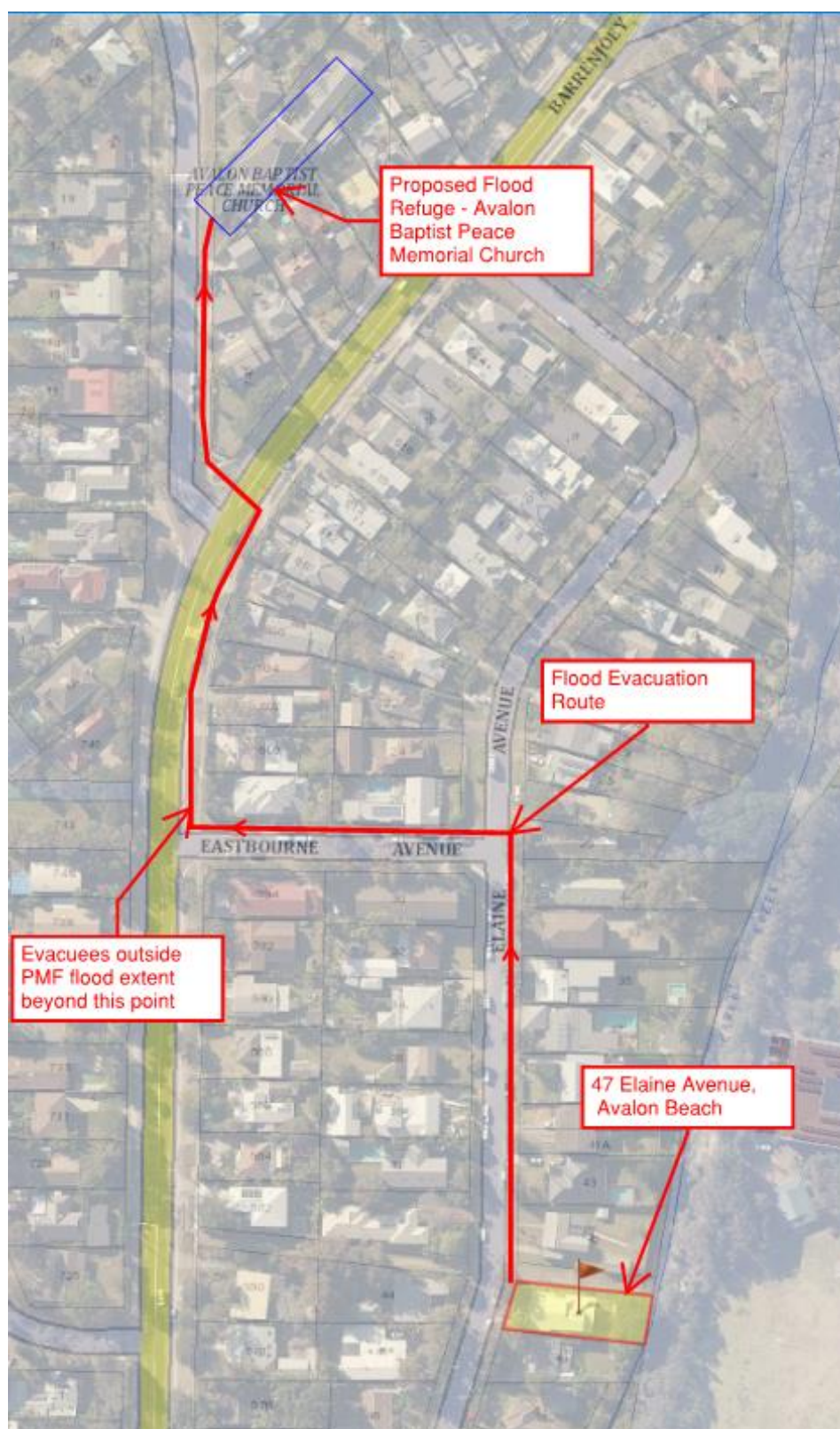


Figure 2.44 – Proposed Evacuation Route and Flood Refuge Location

2.5 - Individual Alert Thresholds

The evacuation timeline relies on the following key alert thresholds:

1. **Flood Watch** – Forecasts, Flood Warnings and Fallen Rain in accordance with Figure 2.54 below will trigger the ‘flood watch’ trigger.
2. **Flood Warning (T = 5 minutes)** – worst case (shortest response time) is triggered after a reading of 1.3126m or higher at the water level gauge in the front yard. This means ‘Flood Warning’ will trigger at approximately T = 5 minutes into the PMF event.
3. **Evacuation (T = 7.5 minutes)** – worst case (shortest response time) is triggered after a reading of 2.0946m or higher at the water level gauge in the front yard. This means ‘Evacuation’ will trigger approximately 2.5 minutes after the ‘Flood Warning’ threshold is reached (at T = 7.5 mins in the PMF event). At this point there will be approximately 5 minutes evacuation time (includes a 2-minute buffer). It will take approximately 3 minutes for all evacuees to exit the dwelling and proceed to pit no. 233 and a further 3 minutes to reach a point beyond the PMF (outside 598 Barrenjoey Road). The proposed flood refuge is approximately 3 minutes walk from 598 Barrenjoey road.
4. **Take Refuge** – Refuge will be triggered simultaneously with the ‘evacuation’ trigger and is the time allowed for evacuees to get from a point that is beyond the extent of the PMF flood extent to the flood refuge; that is, once the patrons are safely beyond the extent of flooding.

The corresponding triggers (actions) required to take place for each alert threshold are provided below:

1. **Flood Watch** –Begin to prepare for potential site evacuation.
2. **Flood Warning** – Flood Warning. Get ready to evacuate.
3. **Evacuation** – All residents evacuate along designated evacuation routes.
4. **Take Refuge** – All residents evacuate from the PMF flood extent, making their way (on foot) to the designated flood refuge located at 2 George street, Avalon Beach. Await further instructions from SES.

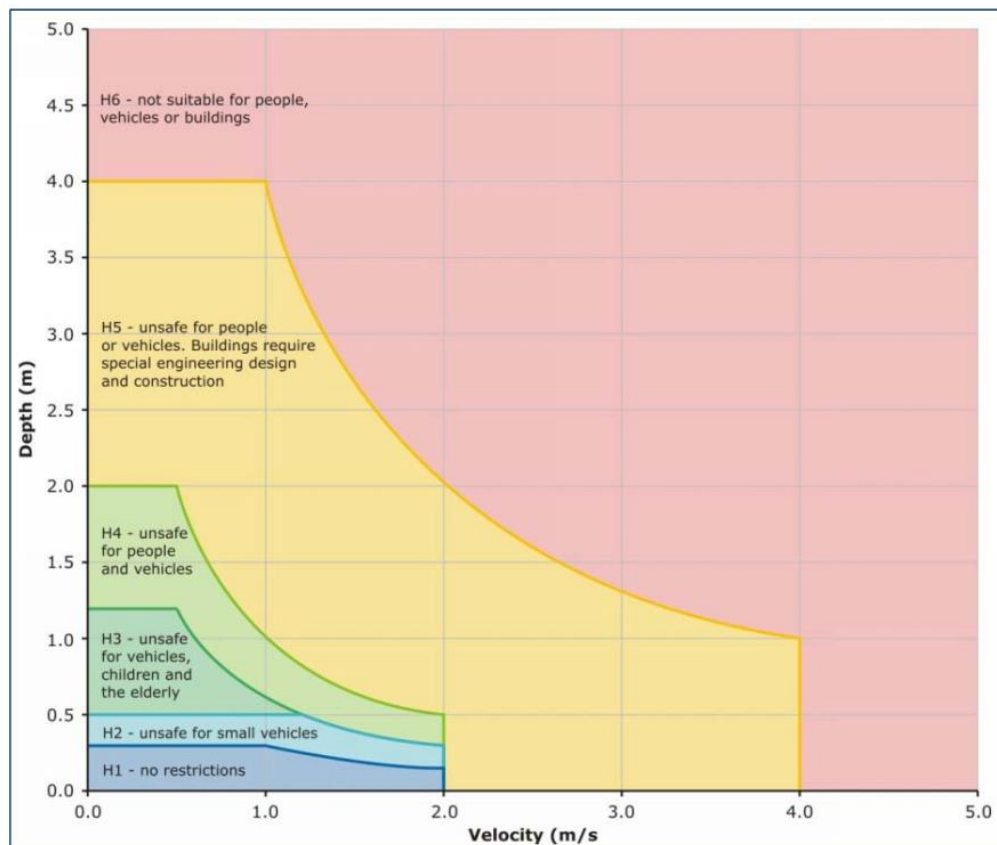


Figure 6-1 Combined Flood Hazard Curves

Figure 2.51 Flood Hazard Curves – (Pittwater Risk To Life Classification Study 2015)

The client is required to monitor the northern beaches flood warning website: <http://new.mhl.nsw.gov.au/users/NBFloodWarning/> constantly. In order to determine Individual alert thresholds, we recommend the following information on the website is monitored:

1. Rainfall Summary at:
 - a. Avalon Beach
2. Flood Warnings on Flood Watch (homepage)

We also recommend the BOM website is used: www.bom.gov.au. The following information should be monitored to determine individual alert thresholds:

1. 8 - day forecast
2. 4 - day forecast
3. 24 - hour forecast
4. 3 - hour forecast
5. Radar
6. Warnings

Furthermore, a water level gauge is recommended to be installed in the front yard and connected into the KIP at pit no.227 with a balance pipe. The system (located inside the front boundary) is required to have a switch (suspension electrode or equivalent, note: a float switch is not suitable) with an alert system that triggers an alarm inside the dwelling and calibrated to the following levels (refer to Figure 2.53 for switch requirements):

1. RL 1.3126m AHD – Flood Warning
2. RL 2.0946m AHD – Evacuation

Refer below for Water Level Gauge installation location.

We note that NBCE reviewed the QGIS information supplied by MHL, and the site survey to verify the trigger thresholds. There is an error of 0.2394m at the invert and 0.1894m at the grate. NBCE also performed a site inspection to verify the depth and note that the inlet and outlet pipes are at the base of the pit. To determine the trigger levels for flood warning and evacuation the site survey information was adopted, and we have therefore reduced the triggers by 0.2394m (error at invert). We recommend a surveyor be engaged to verify the levels when installing and setting the switch alarms.

Pit No.227 Inert and Surface Level		
	SURFACE LEVEL	INVERT
QGIS	3.0894m AHD	1.2894m AHD
SURVEY	2.9m AHD	1.05m AHD

Figure 2.52 – Levels at Pit No.227

NBCE have further reviewed the flood depths for the 1%, 20% and 5% AEP flood events to ensure that the alarms will not be triggered in more frequent rainfall events that do not result in flooding of the catchment (this will ensure there are no 'false positives' with the system, and that the alarm is not disregarded by occupants).

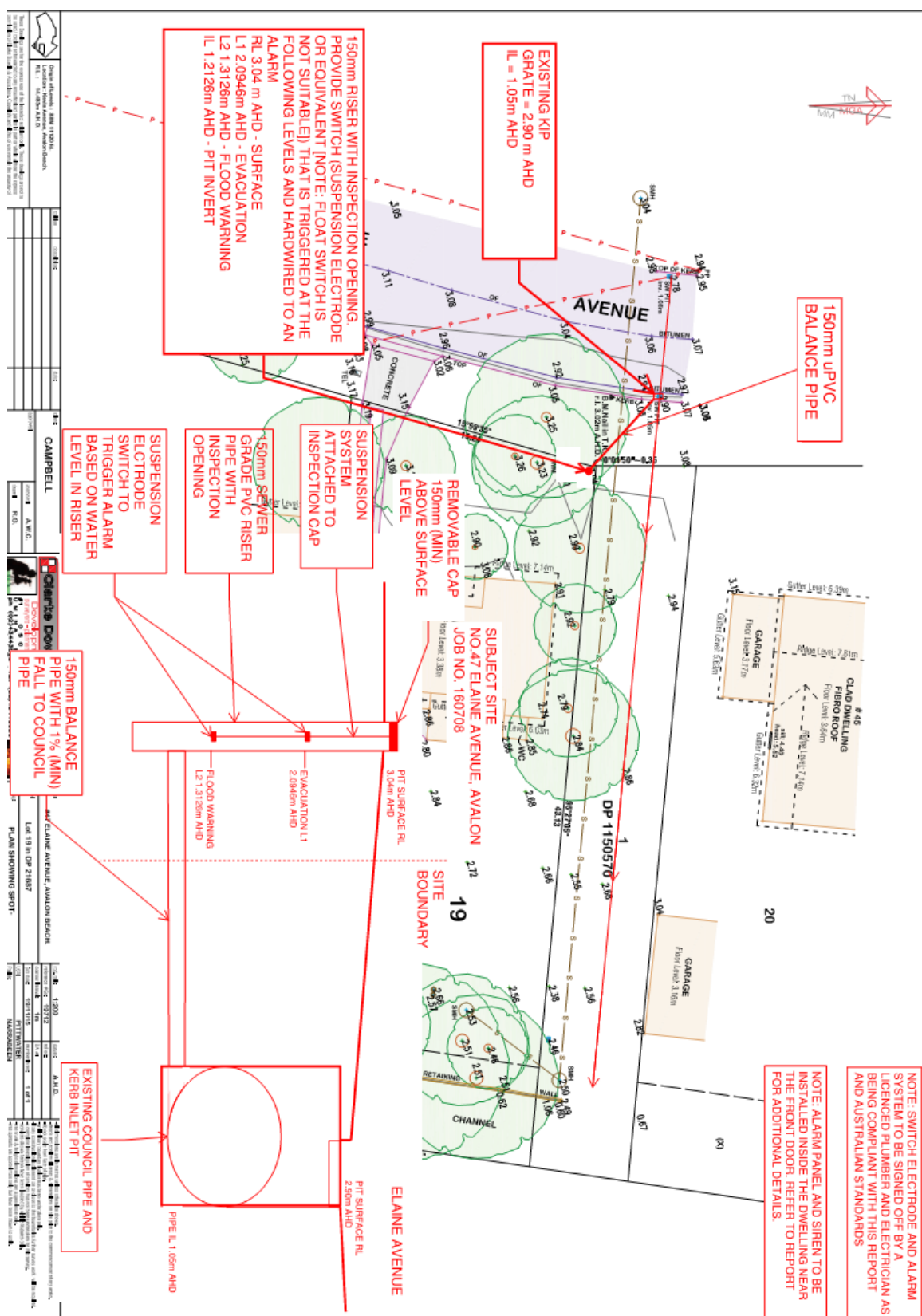


Figure 2.53 – Proposed Trigger Alarm System at 47 Elaine Avenue, Avalon Beach.

Figure 2.54, below provides the alert thresholds for the site.

Forecast / Observation	Individual Alert Thresholds For 74 Elaine Avenue, Avalon Beach			
	FLOOD WATCH	FLOOD WARNING	EVACUATION	TAKE REFUGE
8 day forecast	> 200 mm	NA	NA	NA
4 day forecast	> 100 mm	NA	NA	NA
24 hour forecast	> 50 mm	>55mm	>60mm	>60mm
3 hour forecast (10% chance of more than mm)	> 20 mm	> 25 mm	>30mm	>30mm
Flood Warnings	MHL Flood Watch Website	Directive From SES	Directive From SES	Directive From SES
Radar	Moderate/Heavy after > 50mm in 24 hours or Moderate/Heavy after 20mm in 3 hours	NA	NA	NA
Fallen Rain in 24 hours	>80mm	>100mm	>150mm	>150mm
Fallen Rain in 3 hours	>60mm	>70mm	>75mm	>75mm
Fallen Rain in 1 hour	>15mm	>20mm	>45mm	>45mm
Fallen Rain in 0.5 hour	NA	>10mm	>35mm	>35mm
Water Level gauge in front yard	NA	RL 1.3126m AHD	RL 2.0946m AHD	RL 2.0946m AHD

Figure 2.54 – Individual Alert Thresholds For 74 Elaine Avenue, Avalon Beach



3.0 FLOOD EMERGENCY RESPONSE STRATEGY:

- Risk Exposure Very High
- Level of evacuation destination Above the PMF event
- Triggers to action flood emergency response:

Refer Section 2.4 (Individual Alert Thresholds)

- A copy of this Flood Risk Report and the *Flood Emergency Response Plan* is to be kept on the premises at all times. The client is to be fully aware of these documents and requirements for the event in relation to flooding. If there is a change of ownership, a copy of this report is to be provided to the new owner upon purchase, to ensure they are aware of the evacuation strategy.

4.0 RECOMMENDATIONS / CONCLUSION:

- The proposed flood risk management plan reduces and mitigates risk effectively for the development. An acceptable level of hazard is achieved along the evacuation route for evacuees in the PMF flood event, provided that the recommendations of this report are adopted over the life of the development.
- Approval is to be sought from the proposed evacuation refuge at the Avalon Baptist Church
- Qualifications / experience

Rick Wray
Director NB Consulting Engineers
BE(Civil) MIEAust CPEng NER RPEQ
Over 30 years professional
experience

We trust that this report meets with your requirements. Please contact the author if further clarification is required.

NORTHERN BEACHES CONSULTING ENGINEERS P/L

Author:



Cameron Haack
BE Civil MIEAust

Reviewed By:



Rick Wray
BE CPEng NER RPEQ Director

\\NBADS\Company\Synergy\Projects\160708 47 ELAINE AVENUE, AVALON\ENG
Design\flood emergency response report.docx