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9 October 2019
11434-R2

Mr Jason & Ms Janine Crawford
c/o Turnbull Planning International P/L
2301/4 Daydream Street
Warriewood NSW 2102

Dear Jason and Janine,

Subject: 39 Cabbage Tree Road, Bayview - Flood Risk Assessment

1. Introduction

This assessment has been undertaken as part of the requirements for a Development Application for the proposed indoor recreation facility at 39 Cabbage Tree Road, Bayview.

2. Description of existing site and flood regime

The flood information for the site summarised in Table 1 was provided by Northern Beaches Council on 26 March 2018. The majority of the site has been classified flood storage, with minor sections of flood fringe along the northern boundary and floodway adjacent to the north-west and southern corners, as shown in the accompanying *Flood Information Request* (Northern Beaches Council, 26 March 2018).

***Table 1**: Flood Characteristics – 39 Cabbage Tree Road, Bayview*

Flood Risk Precinct	Low risk
1% AEP Hydraulic categorisation	Flood fringe, storage and floodway
Flood Life Hazard Category	H3 – H5 (varies over property)
1 in 100 year flood level	1.93 m AHD
Max depth of flooding on property	0.62 m
Flood Planning Level	2.45 m AHD
Probable Maximum Flood (PMF) level	3.18 m AHD

The 980m^2 site is located on the southern side of Cabbage Tree Road, adjacent to Bayview Golf Course and west of the intersection with Annam Road. It is triangular in shape with a gentle fall towards a natural watercourse which is a tributary of Cahill Creek and located largely within the golf course along the south-eastern boundary of the site.

The survey indicates that natural ground levels over the site vary from approximately RL 2.0m AHD at the north-western boundary along Cabbage Tree Road, to RL 1.34m along the top of the bank of the watercourse in the southern corner of the site. The site would be inundated during both the 1% AEP flood and the PMF by overbank flooding from the adjacent watercourse.

The site is currently undeveloped, with well-established tree lines along the northern and south-western boundaries and a stand of casuarinas located near the centre of the block which is otherwise vegetated by various grasses and groundcovers.

3. Description of proposed development and impact on local flood behaviour

The proposal is for the development of a two-storey indoor recreation facility comprising exercise rooms, amenities, a reception lounge and terrace, car parking and landscaping, as detailed on the architectural plans by Blue Sky Building Designs, prepared in support of the Development Application (DA). The works would be categorised as *Business and Industrial* land-use for the purposes of a flood risk to life assessment under Council's Development Control Plan (Pittwater 21 DCP 2015).

The proposed development would largely be constructed with an elevated subfloor, with the exception of a stair and lift access well and rainwater tank at ground level. This would allow for the unimpeded passage of floodwaters during both the 1% AEP and PMF flood events, with the impact of the ground level structures and minor fill to enable suitable grading for foot access on the available flood storage volume during the 1% AEP event mitigated by levelling of the proposed carpark area as indicated in Figure 1 and detailed in Table 1. All proposed works would be located within the 1% AEP flood storage area, with a portion of the driveway and pedestrian access path within the flood fringe along the northern boundary.

Overall, the subfloor area would be approximately 90% open with no more than 30% impedance in any direction. The proposed structures could be expected to present a similar level of impedance to flows and potential for blockage as the existing boundary vegetation. It is expected therefore that the proposed works would not have a significant impact on the available flood storage or flow characteristics during the 1% AEP flood event.

Table 1 *Impact of proposed works within 1% AEP extent on flood volume*

Construction element	Approx flood volume
Removal of existing vegetation	0.3 m^3
Total demolition and removal	**0.3 m^3**
Construction of proposed facility:	
Supporting columns and piers	1.5 m^3
Lift and stairwell	11.1 m^3
Rainwater tank	2.7 m^3
Fill to grade entry footpath	4.6 m^3
Total new works	**- 15.3 m^3**
Reduced ground levels to subfloor carpark	24.5 m^3
Total mitigation works	**24.5 m^3**
Net impact on 1% AEP flood storage	**+ 9.5 m^3 (increase)**

4. Compliance with Flood Planning Level and Floor Area Controls

The proposed ground floor level of RL 4.3m AHD would provide 2.37 metres freeboard to the 1% AEP flood level and would be located over one metre above the PMF level. It would satisfy the required minimum habitable floor level by exceeding the FPL of RL 2.45m AHD by 1.85m which is over three times the current 1% AEP flood depth. This provides a significant allowance for the impacts of climate change with respect to current predictions for both sea level rise and increased rainfall volume. The proposed floor levels are compared to the predicted flood levels in Table 2.

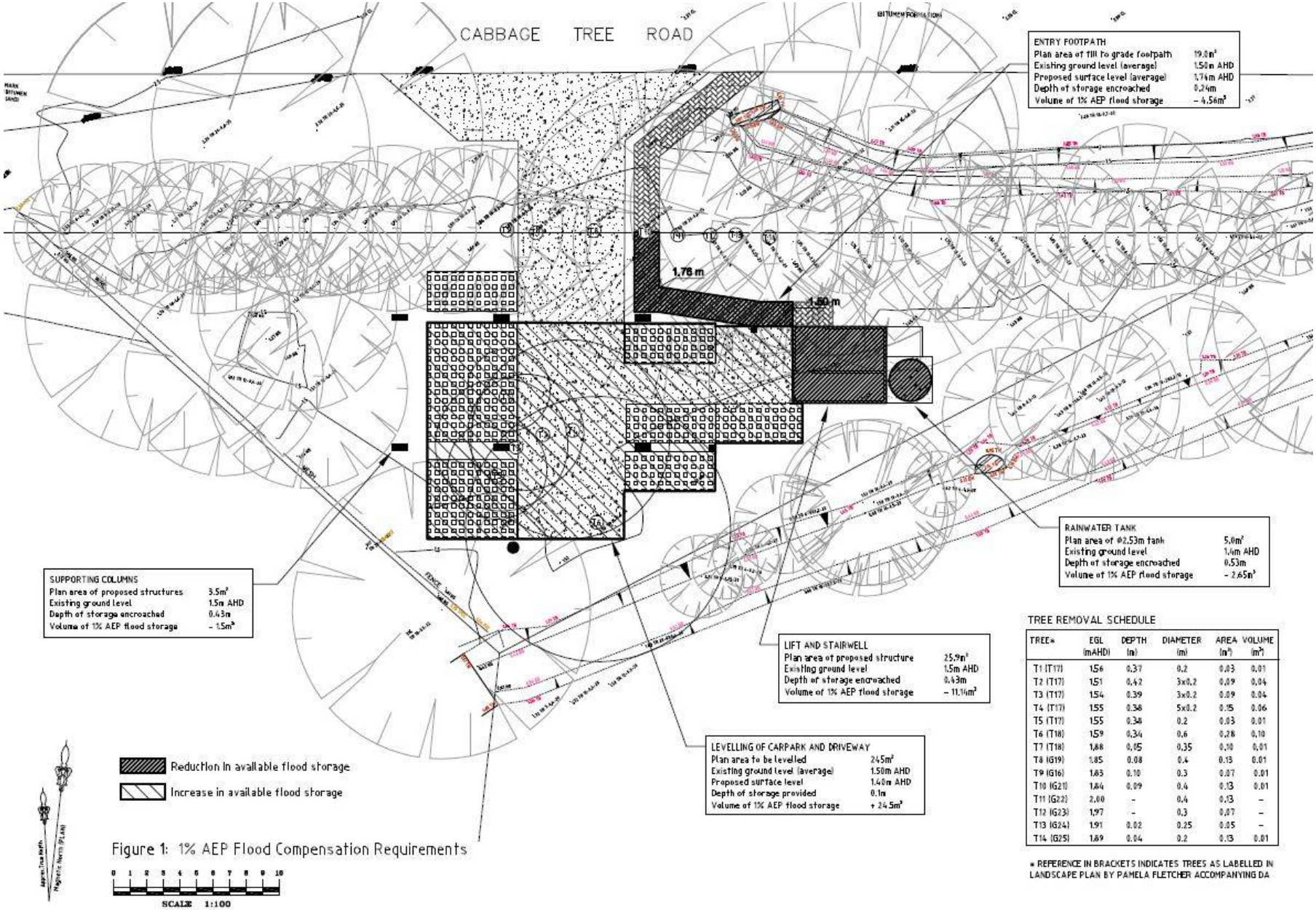

Figure 1: 1% AEP Flood Compensation Requirements

TREE REMOVAL SCHEDULE

TREE*	EGL (mAHD)	DEPTH (m)	DIAMETER (m)	AREA (m²)	VOLUME (m³)
T1 (T17)	1.56	0.37	0.2	0.03	0.01
T2 (T17)	1.51	0.42	3x0.2	0.09	0.04
T3 (T17)	1.54	0.39	3x0.2	0.09	0.04
T4 (T17)	1.55	0.38	5x0.2	0.15	0.06
T5 (T17)	1.55	0.38	0.2	0.03	0.01
T6 (T18)	1.59	0.34	0.6	0.28	0.10
T7 (T18)	1.88	0.05	0.35	0.10	0.01
T8 (G19)	1.85	0.08	0.4	0.13	0.01
T9 (G16)	1.83	0.10	0.3	0.07	0.01
T10 (G21)	1.84	0.09	0.4	0.13	0.01
T11 (G22)	2.00	–	0.4	0.13	–
T12 (G23)	1.97	–	0.3	0.07	–
T13 (G24)	1.91	0.02	0.25	0.05	–
T14 (G25)	1.89	0.04	0.2	0.13	0.01

* REFERENCE IN BRACKETS INDICATES TREES AS LABELLED IN LANDSCAPE PLAN BY PAMELA FLETCHER ACCOMPANYING DA

Table 2 *Freeboard of proposed floor levels to predicted flood levels*

Development	Ground Floor	First Floor
Floor level (m AHD)	4.30	7.10
Freeboard to 1% AEP flood level, RL 1.93m AHD (m)	2.37	5.17
Freeboard to PMF, RL 3.18m AHD (m)	1.12	3.92

5. Evacuation Response and Shelter-In-Place Development Controls

The site is located within the Cahill Creek catchment and is affected by floodwaters overflowing the watercourse located adjacent to the south-eastern boundary with Bayview Golf Course. The total Cahill Creek catchment is relatively small, at 3.4km^2. The critical storm duration for 1% AEP event over the immediate subcatchment would be 2 hours, increasing to 9 hours for the larger Cahill Creek catchment just downstream of the site. During the PMF, the critical storm durations through the catchment would range from 15 minutes to two hours. The site would therefore be regarded as being prone to flash flooding. While there will be very limited notice that can be provided to prepare for a significant flood event, it would be of short duration.

While the proposed driveway would provide flood free access from the site to Cabbage Tree Road during the 1% AEP event, the road would be blocked in all directions by floodwaters, limiting opportunities for evacuation from the site. All levels of the proposed two-storey development would, however, be constructed above the PMF level, providing a suitable option for staff and patrons to "shelter in place" during significant flood events.

The Plan of Management for the proposed facility states that the expected patronage would be 20 to 30 persons at any one time. It is anticipated that there would usually be two, but up to ten staff, bringing the maximum number of persons on site at any one time to approximately 40.

The prescriptive controls required to satisfy Council's shelter in place requirements are summarised in Table 3. The controls have been assessed against the highest hazard category, H5, affecting the site as advised by Council in the *Prelodgement Report*, dated 4 August 2016. This category was identified around the perimeter of the site, with the majority of the central portion of the site and the road access to the west of the site rated being in the lesser hazard category H3-H4.

Table 3 *Shelter-in-Place Requirements*

Flood Life Hazard Category	H5
Land Use Group	Business and Industrial
Control 1b – Flood Risk Emergency Assessment	Accompanying report prepared
Control 2 – Minimum Floor Level	The proposed ground floor level would provide in excess of one metre freeboard to the PMF level and an extensive shelter-in-place refuge.
Control 3 – Floor Space Requirement	The total floor area at completion of the proposed works would exceed 300m^2, providing in excess of 7.5m^2 floor space per occupant as a shelter-in-place refuge area suitable for either long or short duration flood events.
Control 4 – Accessibility	All shelter-in-place refuge areas would be accessed via the stairway/lift well.

Table 3 (cont'd)

Control 5b – Building Stability	As a designated flood refuge, the building would be designed to withstand the flood effects of the PMF design flood depths and velocities.
Control 6a – Serviceability	The shelter-in-place refuge (the proposed facility) would be fitted with the following emergency items: • sufficient clean water for all occupants; and • portable radio with spare batteries; and • torch with spare batteries; and • first aid kit.

6. Summary of Compliance with DCP

The requirements of the DCP as they relate to the proposed development are summarised in Table 4 and detailed in Appendix A. The works are compliant with the DCP, with the exception that the lowest floor level of the proposed open carpark be constructed no lower than the natural ground levels. It is proposed to use the carpark area for the required flood storage mitigation by levelling the area to RL 1.40m AHD, which is approximately 10cm below the existing natural ground level. Consideration is requested in this regard as the proposed compensatory works would ensure minimal impact on the surrounding native vegetation and adjacent watercourse. The proposed carpark would be subjected to 530mm depth of flooding during the 1% AEP flood level, necessitating the incorporation of nominally 600mm high bollards at 1.5 metre centres around the perimeter of the carpark area. The bollards would also prevent vehicular access to the remnant vegetation and riparian areas.

Table 4 *Assessment of flood impacts of proposed development*

DCP Planning Consideration	*Compliance*
A Flood effects caused by development	Yes
B Drainage infrastructure and creek works	Yes
C Building components and structural design	Yes
D Storage of goods	Yes
E Flood Emergency Response	Yes
F Floor levels	Yes, with entry foyer at ground level.
G Car parking	Yes, other than G2 as the proposed open carparking area would be typically 10cm below the existing ground level as part of the flood mitigation works.
H Fencing	Not Applicable
I Pools	Not Applicable

5. Conclusion

The proposed works are not expected to have a significant impact on upstream or downstream flood levels, flow velocities or distribution, flood response or hazards, or upon the safe evacuation of the property or neighbourhood. All prescriptive controls of Northern Beaches (Pittwater) Council's shelter in place requirements can be satisfied by the proposal, designating the development a tolerable flood risk for flood emergency response planning in accordance with Pittwater 21 DCP.

Consideration is requested for the carpark area to be used as compensatory works. While this would require it to be constructed at typically 10cm below the existing natural ground level, vehicle barriers (bollards) would be provided to the perimeter of the carpark area to manage the risk of vehicle flotation, with the advantage of minimising disturbance to the remainder of the site, including remnant vegetation and riparian areas.

Please do not hesitate to contact me if you have any queries regarding the above assessment.

Yours sincerely,

Kate Waddington
BE(Hons) MEngSci (Water Resources)
MEAust CPEng NER

References

Pittwater 21 Development Control Plan. 2014.
McCarrs Creek, Mona Vale and Bayview Flood Study Review. Prepared by Royal HaskoningDHV for Pittwater Council, 2016.

Appendix A High Flood Risk Planning Precinct Requirements – Business and Industrial Land Use

Planning Consideration		*Assessment*
A Flood effects caused by development		
1	Development (including earthworks and subdivision) shall not be approved unless it can be demonstrated in a Flood Management Report that it complies with the Flood Prone Land Design Standard found on Council's webpage.	The proposed development has been designed and can be constructed such that there are no significant changes to the 1% AEP flood characteristics.
3	The applicant shall include in their submission, calculations to illustrate that any fill or other structures that reduce the total flood storage are replaced by Compensatory Works.	Refer to Table 1.
B Drainage infrastructure and creek works		
1	Flood mitigation works or stormwater devices that modify a major drainage system, stormwater system, natural water course, floodway or flood behaviour within or outside the development site may be permitted subject to demonstration through a Flood Management Report that they comply with the Flood Prone Land Design Standard found on Council's webpage.	No modifications to drainage infrastructure or natural watercourses proposed.
2	A Section 88B notation under the Conveyancing Act 1919 may be required to be placed on the title describing the location and type of flood mitigation works with a requirement for their retention and maintenance.	Levelling of carparking area proposed to satisfy flood compensatory requirements.
C Building components and structural		
1	All buildings shall be designed and constructed as flood compatible buildings in accordance with Reducing Vulnerability of Buildings to Flood Damage: Guidance on Building in Flood Prone Areas, Hawkesbury-Nepean Floodplain Management Steering Committee (2006).	Requirement to be incorporated into structural design of appropriate elements for Construction Certificate.
2	All structures must be designed and constructed to ensure structural integrity up to the Flood Planning Level, taking into account the forces of floodwater, wave action, flowing water with debris, buoyancy and immersion. Structural certification shall be provided confirming the above. Where shelter-in-place refuge is to be provided the structural integrity is to be to the Probable Maximum Flood level.	All structures to be designed and constructed to ensure structural integrity up to the Probable Maximum Flood level.
3	All new electrical equipment, power points, wiring, fuel lines, sewerage systems or any other service pipes and connections must be waterproofed and/or located above the Flood Planning Level. All existing electrical equipment and power points located below the Flood Planning Level must have residual current devices installed that turn off all electricity supply to the property when flood waters are detected.	Requirement to be incorporated into detailed design of appropriate elements for Construction Certificate.

Table 4 (cont'd)

Planning Consideration		*Assessment*
D Storage of Goods		
1	Hazardous or potentially polluting materials shall not be stored below the Flood Planning Level unless adequately protected from floodwaters in accordance with industry standards.	No storage facilities for hazardous or potentially polluting materials are proposed below the FPL. Storage shall be provided above the FPL.
2	Goods, materials or other products which may be highly susceptible to water damage are to be located/stored above the Flood Planning Level.	No storage areas are proposed below the FPL.
E Flood Emergency Response		
1	Development shall comply with Council's Flood Emergency Response Planning for Development in Pittwater Policy and the outcomes of any Flood Risk Emergency Assessment Report where it applies to the land.	Refer to Section 5 of this report.
2	New development must provide an appropriately sized area to safely shelter in place above the Probable Maximum Flood level and appropriate access to this area should be available from all areas within the development.	Occupants would be able to safely shelter in place on the ground and first floors of the facility for events up to and including the PMF. Over 250m^2 floor space would be available for flood refuge, which comfortably exceeds the 1m^2 requirement per person for a short duration event.
3	Adequate Warning Systems, Signage and Exits shall be installed to allow safe and orderly evacuation without reliance upon the SES or other authorised emergency services personnel.	To be incorporated in detailed design of facility.
F Floor Levels		
2	All development structures must be designed and constructed so as not to impede the floodway or flood conveyance on the site, as well as ensuring no loss of flood storage in a 1% AEP Event. Where the dwelling is located over a flow path it must be elevated on suspended pier/pile footings such that the level of the underside of all floors including balconies and decks within the flood affected area are at or above, or raised to the Flood Planning Level to allow clear passage of the floodwaters under the building. The development must comply with the Flood Prone Land Design Standard.	With the exception of the entry foyer, the proposed facility would be constructed with suspended flooring over an open subfloor with piered columns such that the level of the underside of all floors would be above the 1% AEP flood level to allow clear passage of the floodwaters under the building and provide compliance with the *Flood Prone Land Design Standard.*
3	Where the lowest floor has been elevated to allow the passage of flood waters, a restriction shall be imposed on the title of the land, pursuant to S88B of the Conveyancing Act confirming that the undercroft area is not to be enclosed.	Restriction to be imposed to ensure undercroft area is not enclosed.
6	Any existing floor level may be retained below the Flood Planning Level when undertaking a first floor addition provided that: (a) it is not located within a floodway; (b) there is no increase to the building footprint below the Flood Planning Level; (c) it is flood proofed to the Flood Planning Level.	No existing structure present on the site.

Table 4 (cont'd)

Planning Consideration		*Assessment*
F Floor Levels		
8	The minimum floor level of any first floor additions shall be at or above the Probable Maximum Flood Level.	Not applicable. No existing structure present on the site.
10	Consideration may be given to a minimum floor level for the first 5 metres from the street front of new development in business zonings below the Flood Planning Level provided it can be demonstrated that it complies with the Flood Prone Land Design Standard.	The entry foyer will be below the FPL to gain access to the premises, but all business and recreational facilities will be located above the FPL. All structures will comply with the Flood Prone Land Design Standard.
G Car parking		
1	Open carpark areas and carports shall not be located within a floodway.	The proposed carpark would be located in a flood storage area.
2	The lowest floor level of open carparks and carports (unroofed or with open sides) shall be constructed no lower than the natural ground levels.	The proposed open carparking area would be typically 10cm below the existing ground level as part of the flood mitigation works.
3	All enclosed car parks must be protected from inundation up to the relevant flood planning level. For example, basement carparks must be provided with a crest at the entrance, the crest of which is at the relevant Flood Planning Level. All access, ventilation and any other potential water entry points to any enclosed car parking shall be above the relevant Flood Planning Level. Council will not accept any options that rely on electrical, mechanical or manual exclusion of the floodwaters from entering the enclosed carpark.	No enclosed parking proposed
4	Vehicle barriers or restraints are to be provided to prevent floating vehicles leaving the site where there is more than 300mm depth of flooding in a 1% AEP flood event. The minimum height of the vehicle barriers or restraints must be at or above the FPL. Vehicle barriers or restraints must comply with the Flood Prone Land Design Standard.	The proposed carpark would be subjected to 530mm depth of flooding during the 1% AEP flood level. Vehicle barriers (bollards) would be provided to the perimeter of the carpark area.
5	Enclosed Garages must be located at or above the 1% AEP level.	No enclosed parking proposed.
6	Carports must comply with the Flood Prone Land Design Standard.	Carpark area would be open, no solid walls proposed.
7	Where a driveway is required to be raised it must be demonstrated that there is no loss to flood storage in the 1% AEP flood event and no impact on flood conveyance through the site.	No raised driveway proposed.

Table 4 (cont'd)

Planning Consideration	*Assessment*
H Fencing	
1 Fencing, including pool fencing, shall be designed so as not to impede the flow of flood waters and not to increase flood affectation on surrounding land. Appropriate fencing must comply with the Flood Prone Land Design Standard in addition to other regulatory requirements of pool fencing.	Not applicable – no fencing proposed.
I Pools	
1 Pools located within the 1% AEP flood extent are to be in-ground, with coping flush with natural ground level. Where it is not possible to have pool coping flush with natural ground level, it must be demonstrated that the development will result in no net loss of flood storage and no impact on flood conveyance on or from the site. All electrical equipment associated with the pool (including pool pumps) is to be waterproofed and/or located at or above the Flood Planning Level. All chemicals associated with the pool are to be stored at or above the flood planning level.	Not Applicable

CABBAGE TREE ROAD

(BITUMEN FORMATION)

MARK BITUMEN (AHD)

WIRE

MESH

FENCE

1.76 m

1.50 m

ENTRY FOOTPATH

Plan area of fill to grade footpath	19.0m²
Existing ground level (average)	1.50m AHD
Proposed surface level (average)	1.74m AHD
Depth of storage encroached	0.24m
Volume of 1% AEP flood storage	- 4.56m³

RAINWATER TANK

Plan area of Ø2.53m tank	5.0m²
Existing ground level	1.4m AHD
Depth of storage encroached	0.53m
Volume of 1% AEP flood storage	- 2.65m³

SUPPORTING COLUMNS

Plan area of proposed structures	3.5m²
Existing ground level	1.5m AHD
Depth of storage encroached	0.43m
Volume of 1% AEP flood storage	- 1.5m³

LIFT AND STAIRWELL

Plan area of proposed structure	25.9m²
Existing ground level	1.5m AHD
Depth of storage encroached	0.43m
Volume of 1% AEP flood storage	- 11.14m³

LEVELLING OF CARPARK AND DRIVEWAY

Plan area to be levelled	245m²
Existing ground level (average)	1.50m AHD
Proposed surface level	1.40m AHD
Depth of storage provided	0.1m
Volume of 1% AEP flood storage	+ 24.5m³

Reduction in available flood storage

Increase in available flood storage

Approx.True North

Magnetic North (PLAN)

Figure 1: 1% AEP Flood Compensation Requirements

0 1 2 3 4 5 6 7 8 9 10

SCALE 1:100

TREE REMOVAL SCHEDULE

TREE*	EGL (mAHD)	DEPTH (m)	DIAMETER (m)	AREA (m²)	VOLUME (m³)
T1 (T17)	1.56	0.37	0.2	0.03	0.01
T2 (T17)	1.51	0.42	3x0.2	0.09	0.04
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T5 (T17)	1.55	0.38	0.2	0.03	0.01
T6 (T18)	1.59	0.34	0.6	0.28	0.10
T7 (T18)	1.88	0.05	0.35	0.10	0.01
T8 (G19)	1.85	0.08	0.4	0.13	0.01
T9 (G16)	1.83	0.10	0.3	0.07	0.01
T10 (G21)	1.84	0.09	0.4	0.13	0.01
T11 (G22)	2.00	-	0.4	0.13	-
T12 (G23)	1.97	-	0.3	0.07	-
T13 (G24)	1.91	0.02	0.25	0.05	-
T14 (G25)	1.89	0.04	0.2	0.13	0.01

* REFERENCE IN BRACKETS INDICATES TREES AS LABELLED IN LANDSCAPE PLAN BY PAMELA FLETCHER ACCOMPANYING DA