Attachment A13

Preliminary Floor and WSUD Study

55 Pitt Street, Sydney

Flood Study and Options Review

Prepared for Mirvac / 17 December 2019

161751 CAAF

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1.0 Introduction

This Flood Study report has been prepared by TTW for Mirvac to address the flooding issues at 55 Pitt Street. The proposed development site is located between Pitt, Underwood, and Dalley Streets, and Queens Court at Circular Quay, Sydney. The report provides information to support a planning proposal and inform future detail design.

The report reviews options presented by FJMT for the basement entry.

1.1 The Site

The site comprises 6-8 Underwood Street, 37 Pitt Street, 57 Pitt Street, and 6 & 14 Dalley Street. The proposed development will consist of a Commercial Tower and a public through site link.

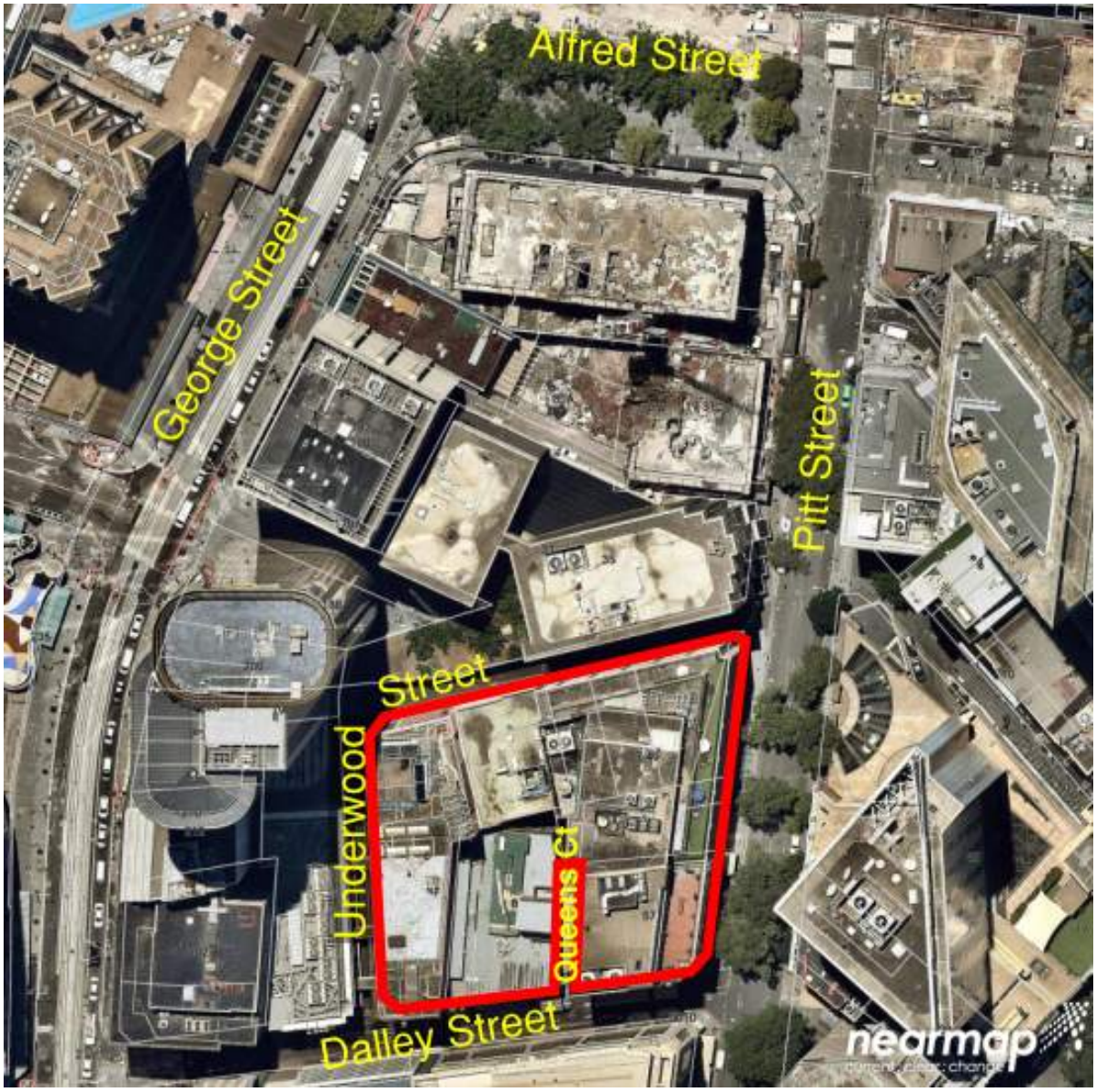

Figure 1 **Existing Site**

Figure 2 Development Site 5

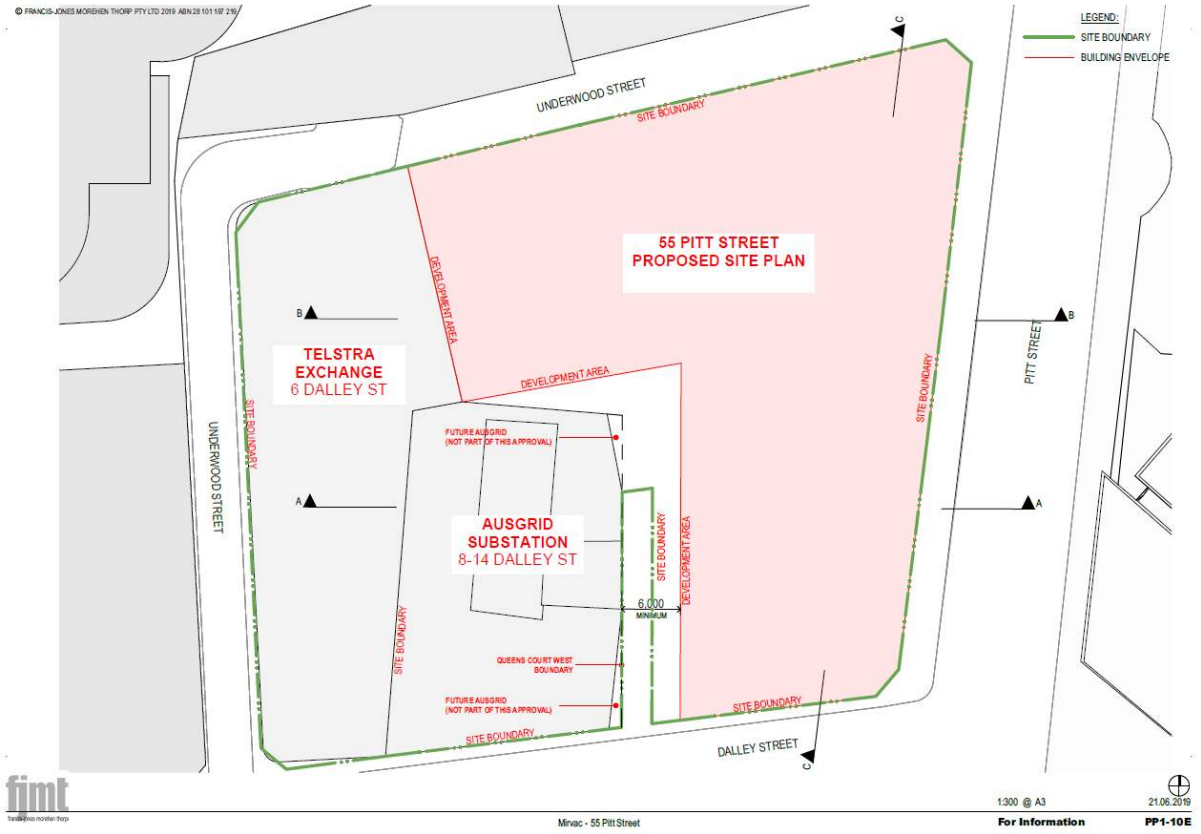

Figure 2 **Proposed ground floor scheme (FJMT)**

1.2 Relevant Documents

The following documents were reviewed as part of this Flood Study:

- City of Sydney Interim Floodplain Management Policy (approved May 2014)
- City Area Catchment Flood Study (BMT WBM, October 2014)
- NSW Floodplain Development Manual 2005
- Sydney Local Environment Plan 2012
- Sydney Development Control Plan 2012
- Central Sydney Planning Committee SSD Assessment Report: Mixed Use Hotel Development, 1 Alfred Street, Sydney, D/2016/1529 (SSD 8111), May 2017.

2.0 Flood Study

TTW have been engaged by Mirvac to advise on flooding and prepare a preliminary study report for the purpose of supporting a planning proposal and future detail design regarding flooding hazards and to make recommendations relating to:

- Suitable risk adjusted public retail levels and grades
- Possible drainage solutions
- Possible flood mitigation measures including the use of flood gates (where relevant)

2.1 Background

The current Interim Floodplain Management Policy (approved May 2014) provides the key flood planning levels for the site. These Flood Planning Levels are set out in Table 1.

Table 1 Flood Planning Levels

Area	Flood Planning Level
Retail Floor Levels	Merits approach presented by the applicant with a minimum of the 1% AEP flood. The proposal must demonstrate a reasonable balance between flood protection and urban design outcomes for street level activation
Below-ground car parks	1% AEP flood level + 0.5 m or the PMF (whichever is the higher)

It is proposed that new retail areas typically fronting Pitt, Dalley and Underwood Streets and Queens Court to have threshold and tenancy at grade access with footpath. These street frontages are flood affected. In order to utilise retail street frontages, self raising barriers may be considered. Alternatively, these tenancies could accept flood affectation and use flood compatible materials in the fit-out.

Below ground car parks will have all access points (driveways, stairs, lift wells) protected from the PMF through a combination of passive measures and active flood gates.

Lift and stair access to the basement will be from the mezzanine level to provide flood protection to the basement.

2.2 Yuhu and Lendlease

In December 2015, The City approved Yuhu's redevelopment plans for sites it controls at 1 Alfred Street, 19 Pitt Street and Rugby Place.

A development application for Lendlease's site at 174-176A George Street and 33-35 Pitt Street (LLCQ) was approved in October 2018 and is now under construction (DA number D/2017/1620).

TTW has included the proposed grading of the laneways (subject to detail design) in the Yuhu and Lendlease sites as part of the flood modelling process. 210-220 George Street is assessed as per the current development.

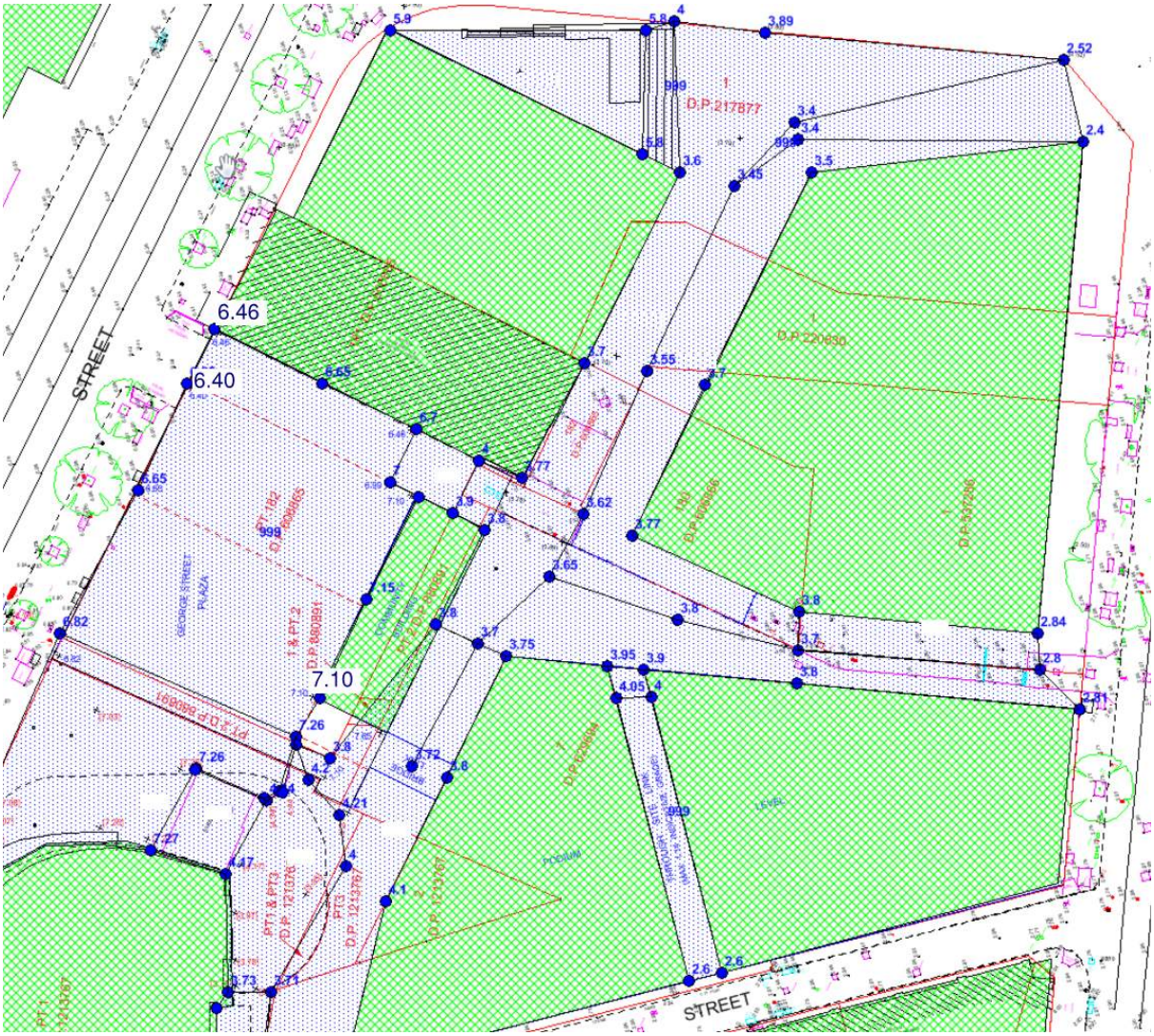

Figure 3 APDG Indicative Terrain for downstream overland flow path to North from Underwood Street

3.0 Flood Modelling

To support the proposed development, TTW has undertaken a flood modelling exercise for the site. The model was based on Council's flood model prepared for the City Area Catchment Flood Study (BMT WBM, October 2014). The model was provided by Council for this flood study.

Council's model is a catchment wide model. Additional APDG site specific terrain details and surface levels were updated for the site by TTW for the purpose of this report. This includes adjustments for the updated terrain relating to 200 George Street, and the proposed works by Yuhu and Lendlease on the northern sections of the block shown in Figure 3.

Figure 4 200 George Street and Crane Lane

Figure 5 Queens Court facing north

The 210-220 George Street development does not affect our site as it doesn't direct additional flow to Underwood Street based on the flow information we have as per the following WMA flood report on 210-220 George Street.

2.2 FLOOD EXTENTS

The extent of the 100 year ARI flood event surrounding the site is shown in Figure 1.

Figure 1: 100year ARI Flood Extents

Source: Flood Certificate - 210-220 George Street, Sydney, WMA Water, 2017

2.4.2 IMPACTS ON EXISTING FLOODING SCENARIO

It is expected that the proposed works will not increase flood affectation elsewhere in the floodplain as:

- Existing public domain and driveway alignment levels on the Underwood Street boundary and existing access way are being maintained; and
- Boundary levels on the George Street and Dalley Street frontages are being raised minimally to provide a consistent grade of travel in the Public Domain and will assist in containing overland flow to the road reserve. Refer Section 2.3 for further discussion on levels.

Flood levels on George Street are RL 9 – RL 8 following the road profile. The diversion of the George Street flow occurs at Darley Street.

The 210-220 George Street development doesn't worsen the flood condition based on the WMA Flood Report.

The model was modified for two flood assessment scenarios:

- The existing conditions including the Mirvac development at 200 George Street plus the proposed conditions with the LLCQ and Yuhu developments based on the APDG Indicative Terrain.
- The proposed conditions with the LLCQ, Yuhu and 55 Pitt Street developments, extending Queen's Court through to Underwood Street

Note that the grading for the through site link on 55 Pitt Street has been prepared by FJMT based on TTW's advice that the 100-year ARI flood must be restricted from flowing between Dalley Street and Underwood Street via the link.

Figure 6 Site layout plan (FJMT)

3.1 Results

Appendix A contains flood mapping outputs arising from the analysis:

Figure A.1: LLCQ + Yuhu conditions flood maps

Figure A.2: LLCQ + Yuhu with the addition of 55 Pitt Street development, restricting floodwater from moving from Queens Court to Underwood Street in a 100-year ARI event.

Figure A.3: Flood Impact - LLCQ + Yuhu with the addition of 55 Pitt Street development, restricting floodwater from moving from Queens Court to Underwood Street in a 100-year ARI event.

Figure A.4: PMF - LLCQ + Yuhu with the addition of 55 Pitt Street development, restricting floodwater from moving from Queens Court to Underwood Street in a 100-year ARI event.

Figure A.5: Provisional flood hazard categories based on NSW Floodplain Development Manual, under the developed scenario.

Figure A.6: Velocity depth product plot with velocity vectors, under the developed mitigated scenario.

Figure A.7: 20-year ARI: LLCQ + Yuhu with the addition of 55 Pitt Street development, restricting floodwater from moving from Queens Court to Underwood Street in a 100-year ARI event.

A summary of results is presented in the figures below.

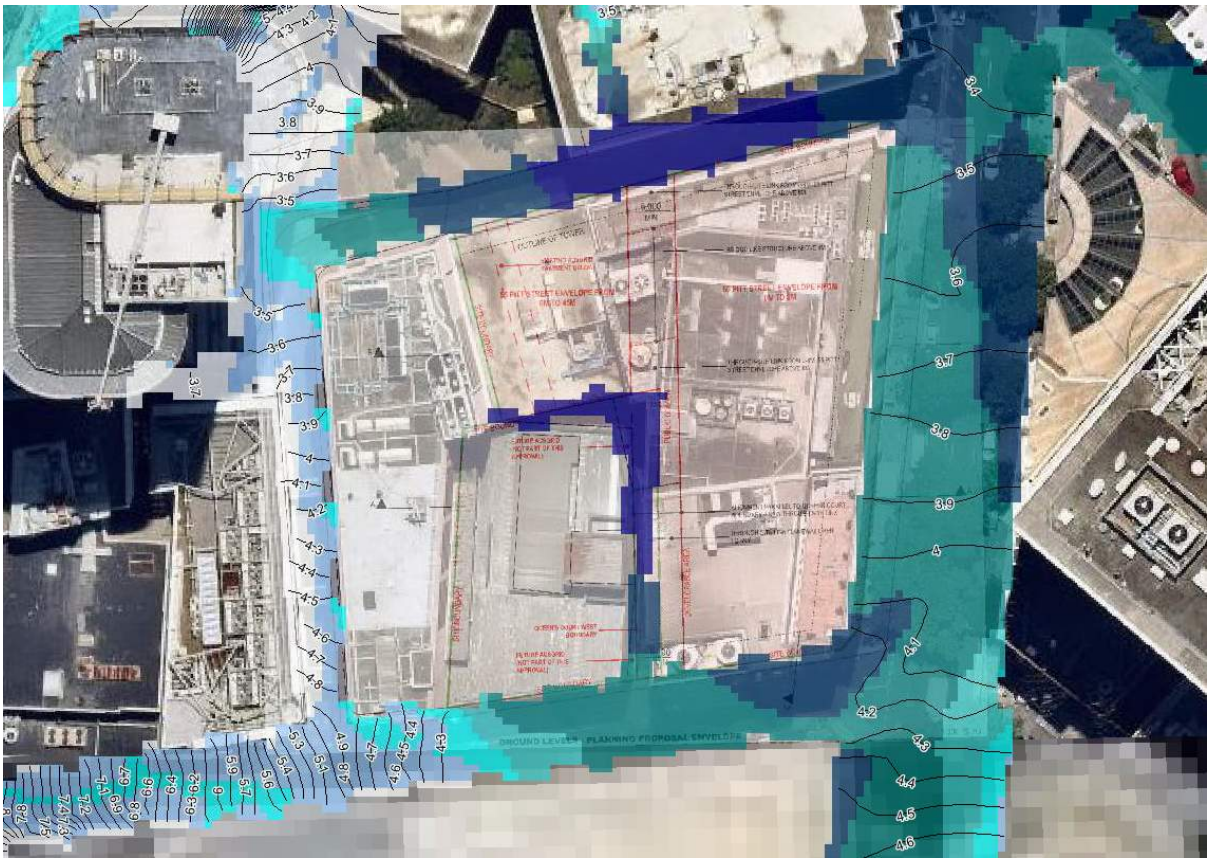

Figure 7 **Flood Depth: LLCQ + Yuhu completed 100-year condition**

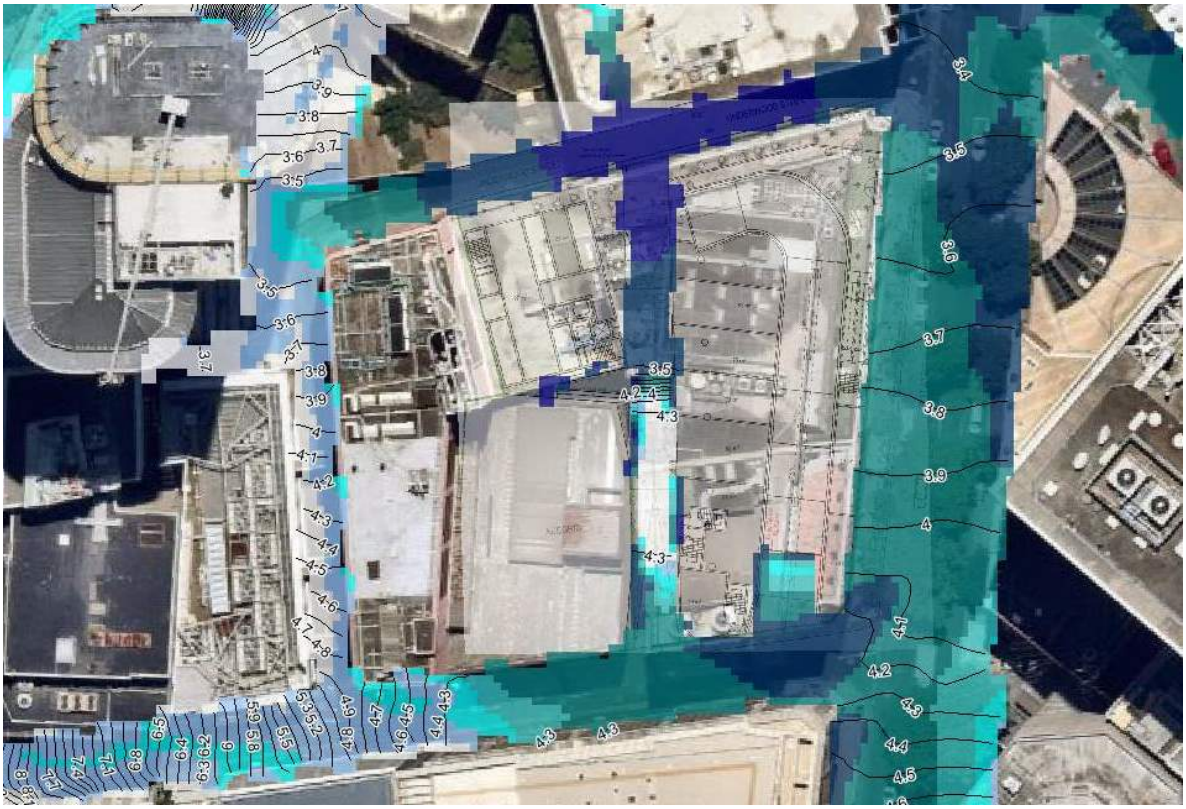

Figure 8 Flood Depth: LLCQ + Yuhu complete with 55 Pitt Street development 100-year condition

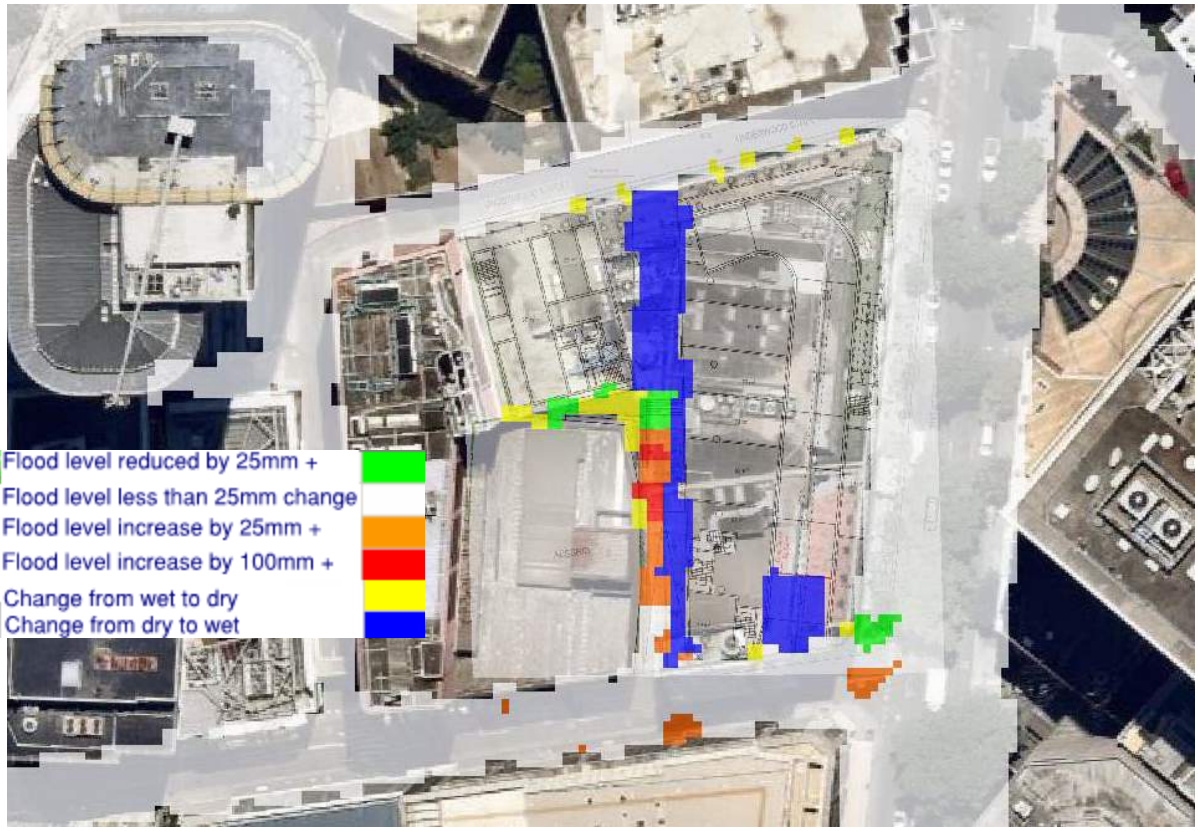

Figure 9 Flood Impact: LLCQ + Yuhu complete with proposed scheme at 55 Pitt Street 100-year condition

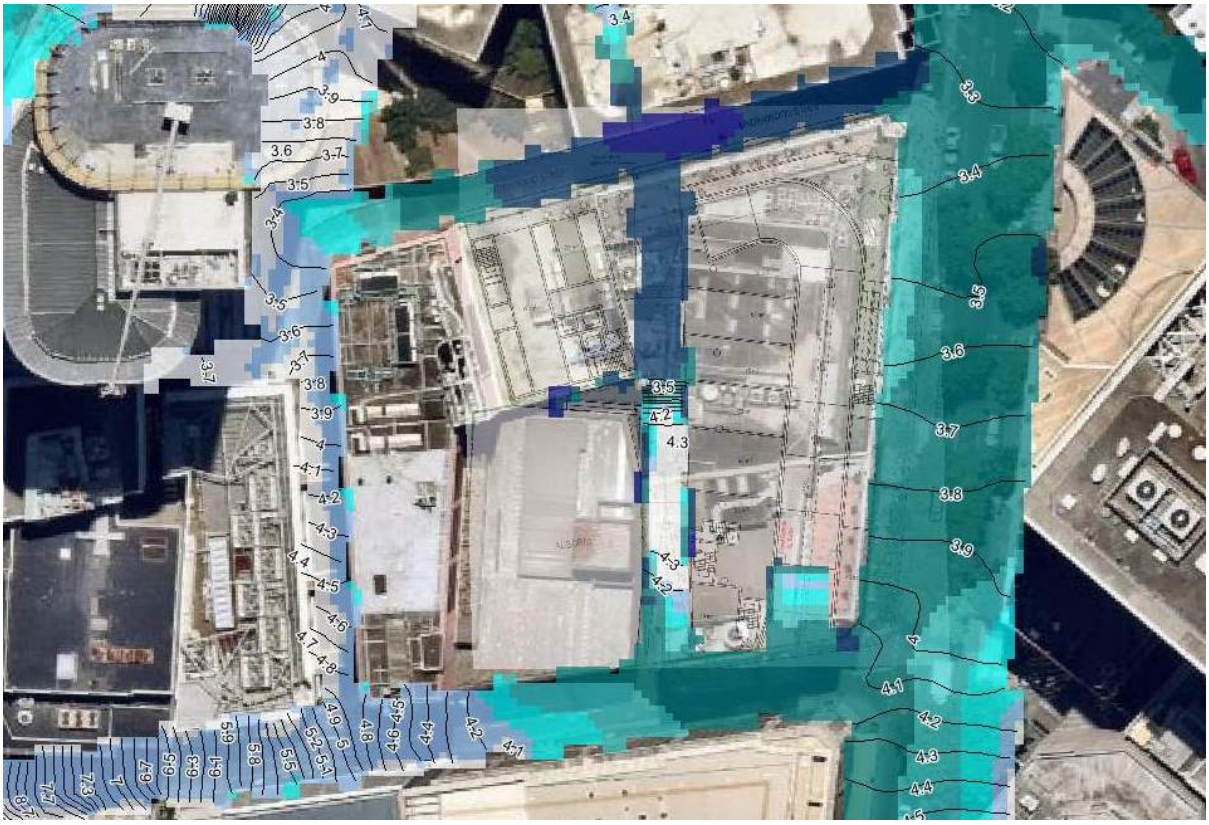

Figure 10 20-year ARI Flood (developed conditions). Note that the 20-year ARI flood level on Dalley Street near the proposed basement entry is 4.15mAHD.

In order to avoid a negative impact on Underwood Street, floodwater has been prevented from entering Underwood street via the through site link (similar to the existing conditions). This has been achieved through regrading of Queens Court to prevent the flow of water through the link for all events up to and including the 100-year ARI flood.

3.2 Flood Modelling Results Discussion

This report demonstrates that the impact on surrounding flood behaviour is minimal. This has been achieved through regrading of Queens Court to prevent the flow of water through the link for all events up to and including the 100-year ARI flood, mimicking existing conditions at the site.

Existing flooding in the surrounding streets remains.

3.3 Flood Management

With regard to the Interim Floodplain Management Policy, flood risk to the development can be managed using a combination of:

- Site grading to minimise flood impacts. Regrading of Council's Underwood Street is possible to reduce nuisance flooding and overall flood risk but will affect the ground levels along the property boundaries at 55 Pitt Street and the Lendlease site. Queens Court is proposed to be regraded.
- Where existing flood conditions on Pitt Street, Dalley Street and Underwood Street dictate, alternate engineered solutions or risk/merits based approaches including active flood gates are proposed to mitigate flooding. Refer to Appendix B for an example system.

3.4 Flood Planning Requirements

3.4.1 General

Flood Planning Levels (FPLs) are generally to comply with the City of Sydney's Interim Floodplain Management Policy (Policy):

Area	Flood Planning Level
Retail Floor Levels	Merits approach presented by the applicant with a minimum of the 1% AEP flood. The proposal must demonstrate a reasonable balance between flood protection and urban design outcomes for street level activation
Below-ground car parks	1% AEP flood level + 0.5 m or the PMF (whichever is the higher)

3.4.2 Commercial, retail and business uses

Commercial/Business/Retail uses to be provided with:

Internal to retail space, FPL's are proposed to comply with the Policy (1 in 100 year ARI flood level) where possible or an alternate ARI coupled with alternate engineered solution and/or risk/merits based approach acceptable to Mirvac and Council. All mechanical, electrical and plumbing fixtures need to be located at or above the FPL where practicable. Where not practicable, it is recommended that such elements be protected by alternate engineered solutions and/or risk/merits based approaches.

3.4.3 Basement Entry

Due to existing flood conditions within the surrounding road reserves, TTW recommends to afford protection of the building up to the PMF level of 5.2mAHD at the basement entry in line with the City of Sydney's Interim Floodplain Management Policy. Where this cannot be achieved through grading, an alternate solution such as self raising flood gates is required.

Fire stairs and all other ingress points to the basement such as ventilation ducts, windows, light wells, lift shaft openings, risers, to be designed to flood planning levels to comply with the Policy where practicable. Where not practicable, TTW recommend that such elements be protected by alternate engineered solutions and/or risk/merits based approaches.

An initial assessment in basement entries showed that to meet the PMF level, the design of the basement car park ramp would require a significant length that would extend beyond the site boundary and impact the design of the building and adjoining public domain. Therefore, giving protection in a PMF event without the use of flood gates would reduce the active street usage and ground floor usability to include almost all the site footprint.

We note the approach taken at 1 Alfred Street (D/2016/1529) is to provide passive protection up to the 20-year ARI event for the basement car park entry, with flood gates giving protection above this level.

The Central Sydney Planning Committee's Assessment Report on the site notes:

> *While flood gates are generally discouraged City staff recommended consideration be given to granting development consent to the automated flood gates for the following reasons:*

- *The site is situated in a natural flood basin, situated where the historical Tank Stream met Sydney Harbour, resulting in particularly onerous flooding conditions along Pitt Street and adjacent to this site in particular.*
- *To meet the FPL the design of the basement car park would be cumbersome and inefficient, requiring a significant ramp at the entry which would have a significant knock-on effect for the design of the tower and public domain.*
- *The Pitt Street hotel lobby entrance and Alfred Street entrance for Tower B are sufficiently high enough to achieve flood resilience in all flood events up to and including the 100 year ARI flood event.*
- *The Pitt Street basement car park entry is sufficiently high to achieve resilience in flood events up to and including the 20 year ARI event.*

While the use of flood gates is rightly unsupportable on the majority of sites, it is considered that the circumstances outlined above are exceptional, and their use is warranted in this instance.

55 Pitt Street faces the same issues – located in the natural flood basin where meeting the FPL would be cumbersome and inefficient.

Several solutions have been investigated and are presented in the following section.

4.0 Site Layout Options Assessment

Options for the site layout prepared by FJMT are presented in Appendix C. Discussion on each option is presented below.

Table 2 Key flood levels at proposed basement entry

Flood Event	Flood level at proposed basement entry
20-year ARI	4.15 mAHD
100-year ARI	4.30 mAHD
PMF	5.20 mAHD

4.1 Option 1 - Ramp up to PMF level

Figure 11 below presents Option 1 which proposes the driveway crest RL of 5.20m to meet the PMF level. However, to transition down towards the basement car park level of RL -2.10m and comply with AS 2890.2, the access ramp would need to be extended an additional 20m further across the site boundary, across Underwood Street and 33-35 Pitt Street, Sydney. Therefore, this option is not achievable due to the encroachment on neighbouring properties. Mirvac explored the option of a shared basement option with LLCQT, but was formally advised by LLCQT that this was not an option

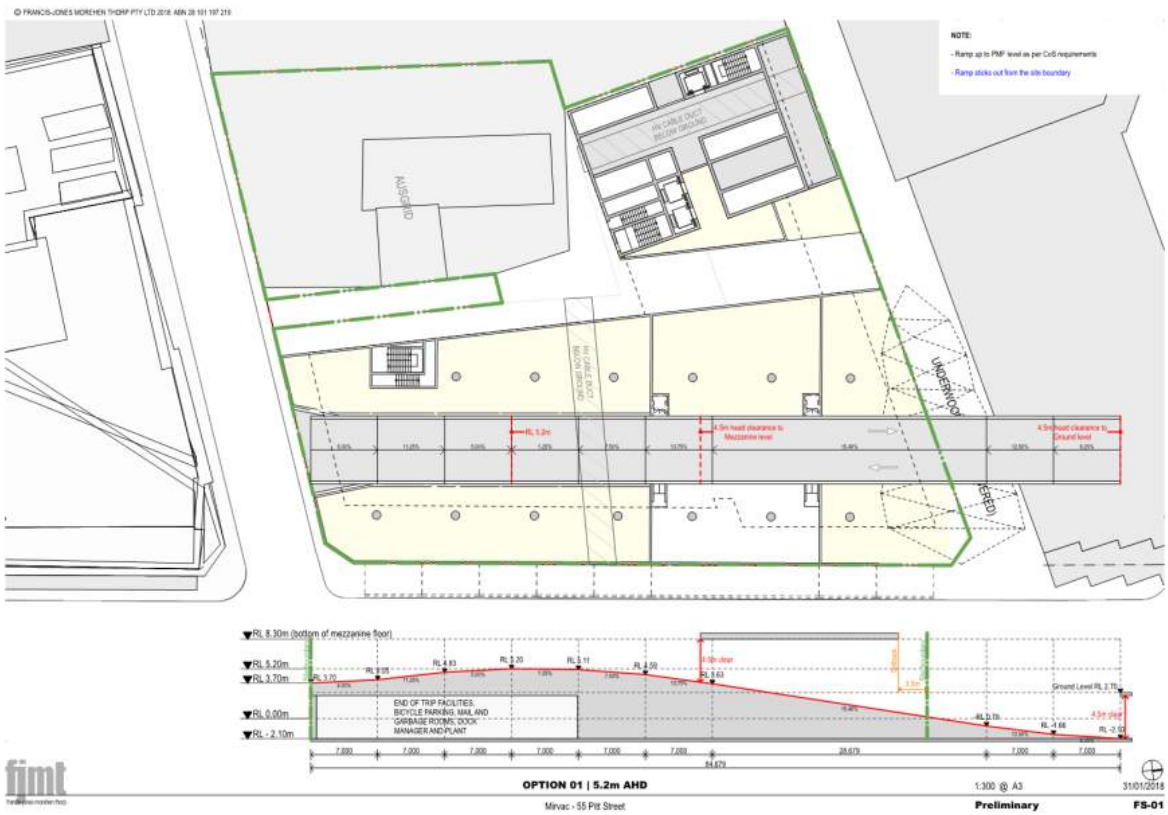

Figure 11 Option 1

4.2 Option 2 – Ramp to 20-year ARI (4.2m AHD) with flood gate at the crest

Figure 12 below presents Option 2, which proposes a driveway crest RL of 4.20m and a flood gate which rises to RL 5.20, to meet the 20-year ARI event and PMF event flood levels, respectively.

However, like Option 1, to transition down towards the basement car park level of RL -2.10m and comply with AS 2890.2, the access ramp would need to be extended approximately 3 metres across the site boundary. Therefore, this option is not achievable due to encroachment over the boundary.

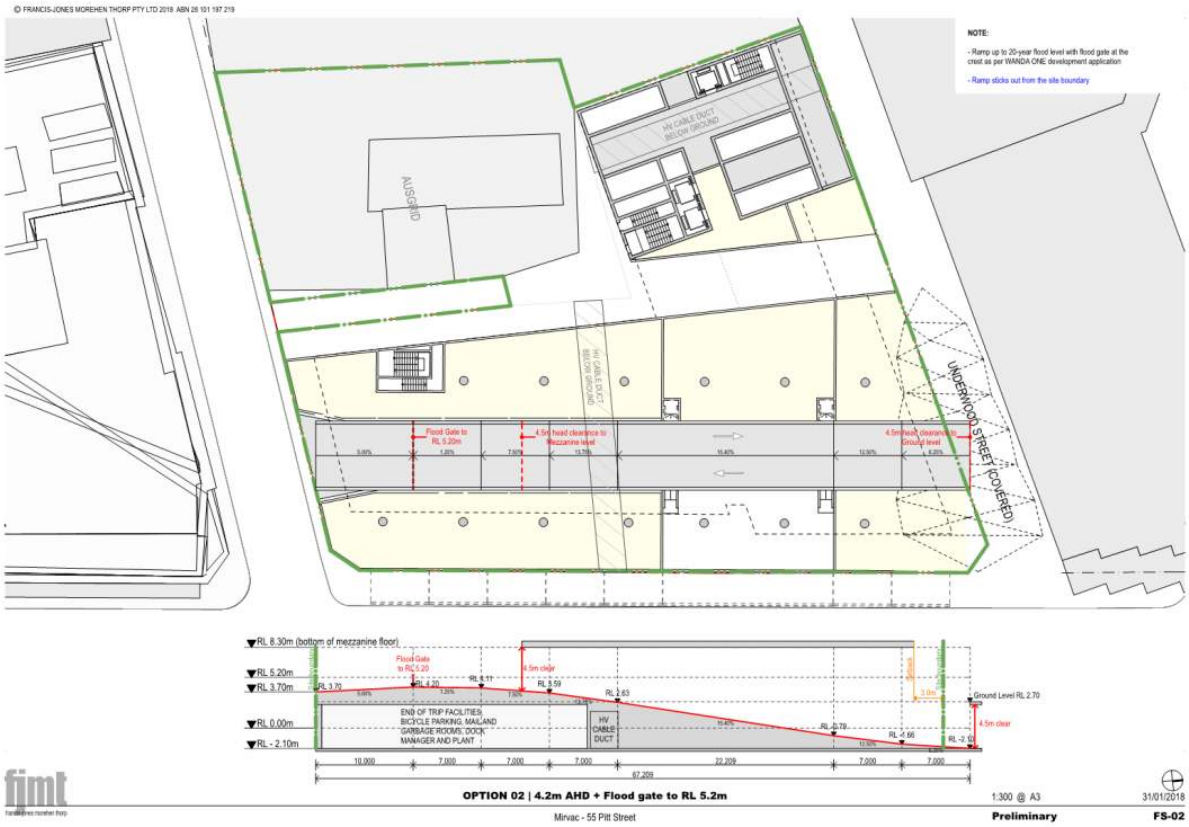

Figure 12 Option 2

4.3 Option 3 – Ramp up to 20-year ARI with flood gate at the crest (preferred)

Figure 13 below presents Option 3 which proposes a ramp crest RL of 4.15m and a flood gate which rises to RL 5.20m. The flood gate when in operation would meet the PMF flood level. This option would allow for the driveway to ramp to the basement level RL of -2.10m, be compliant with AS2890.2 and be contained within the property boundary.

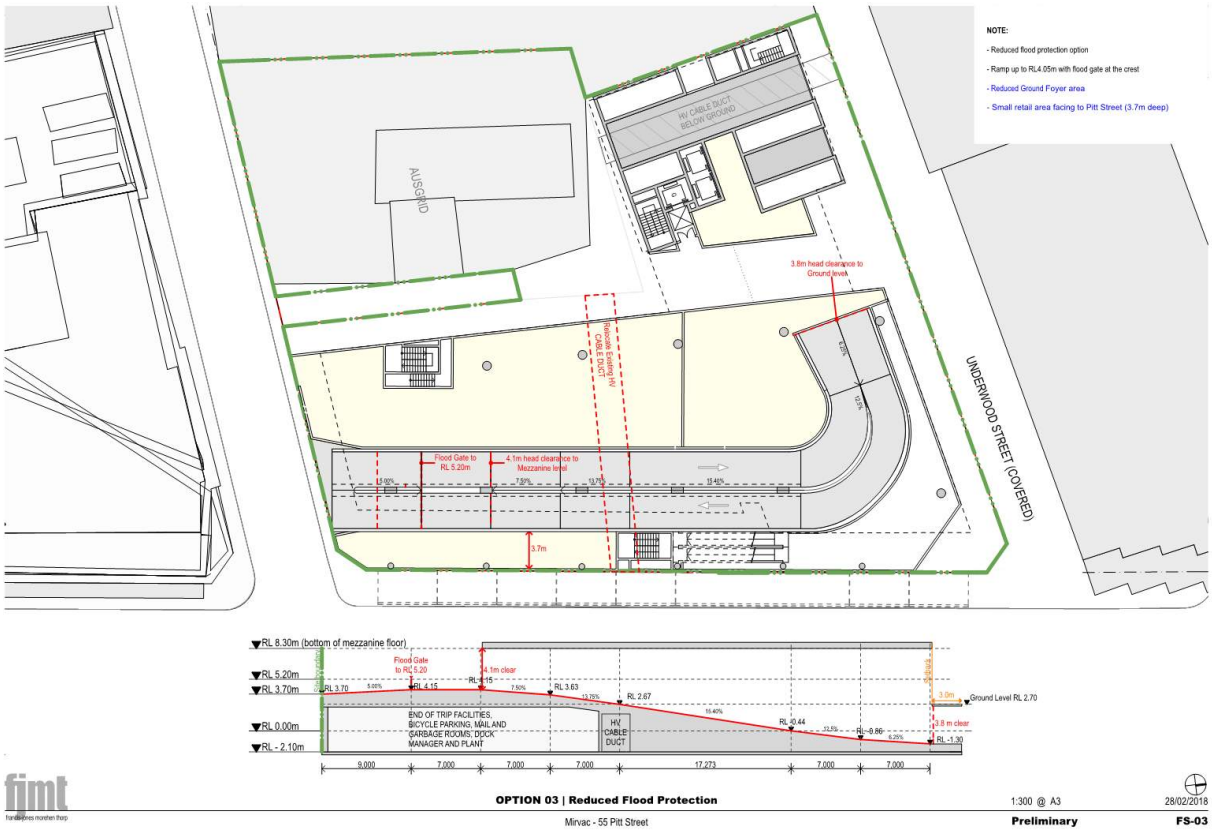

Figure 13 Option 3

4.4 Option 4 – Ramp up to 20-year ARI flood level with flood gate at the crest

Figure 14 below presents Option 4 which proposes combining the general vehicle entry point with the service vehicle manoeuvring area and a circular vehicle ramp which transitions down to the basement. Similarly, to Option 2, the proposed crest level of the driveway is RL 4.20 and a flood gate which rises to RL 5.20 to meet both the 20-year ARI and PMF flood level, respectively. Unlike Options 1 and 2, Option 4 confines the access ramp within the site boundaries, however option 4 is not recommended as the general cars would pass through the service vehicle manoeuvring area and the commercial lobby area is affected by the vehicle ramp. In addition to this, all Pitt Street retail activation is adversely affected.

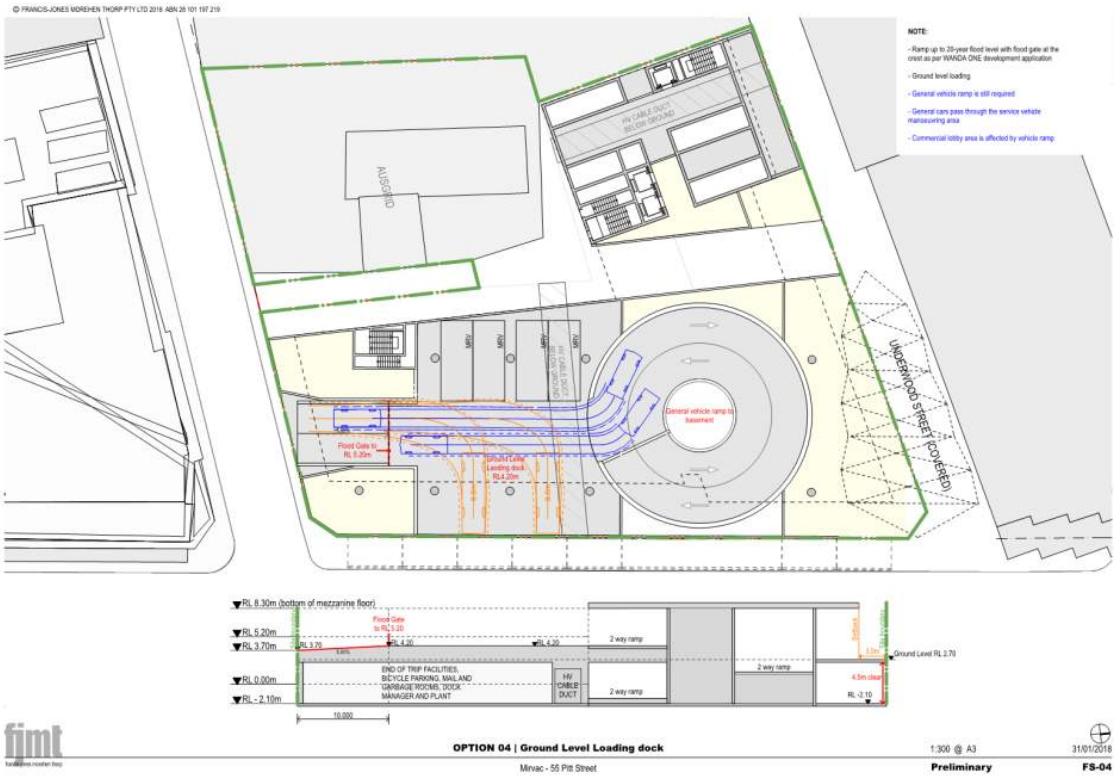

Figure 14 Option 4

4.5 Option 5 – Ramp up to flood planning level

Figure 15 below presents Option 5 which proposes for a driveway up to RL 5.20m, to meet the PMF flood level and a vehicle lift system to lower vehicles from the ground level of the carpark to the basement level (RL -2.10). This option is not recommended as it requires the introduction of truck and car lifts. This is not a suitable solution for a premium grade building in the Sydney CBD area.

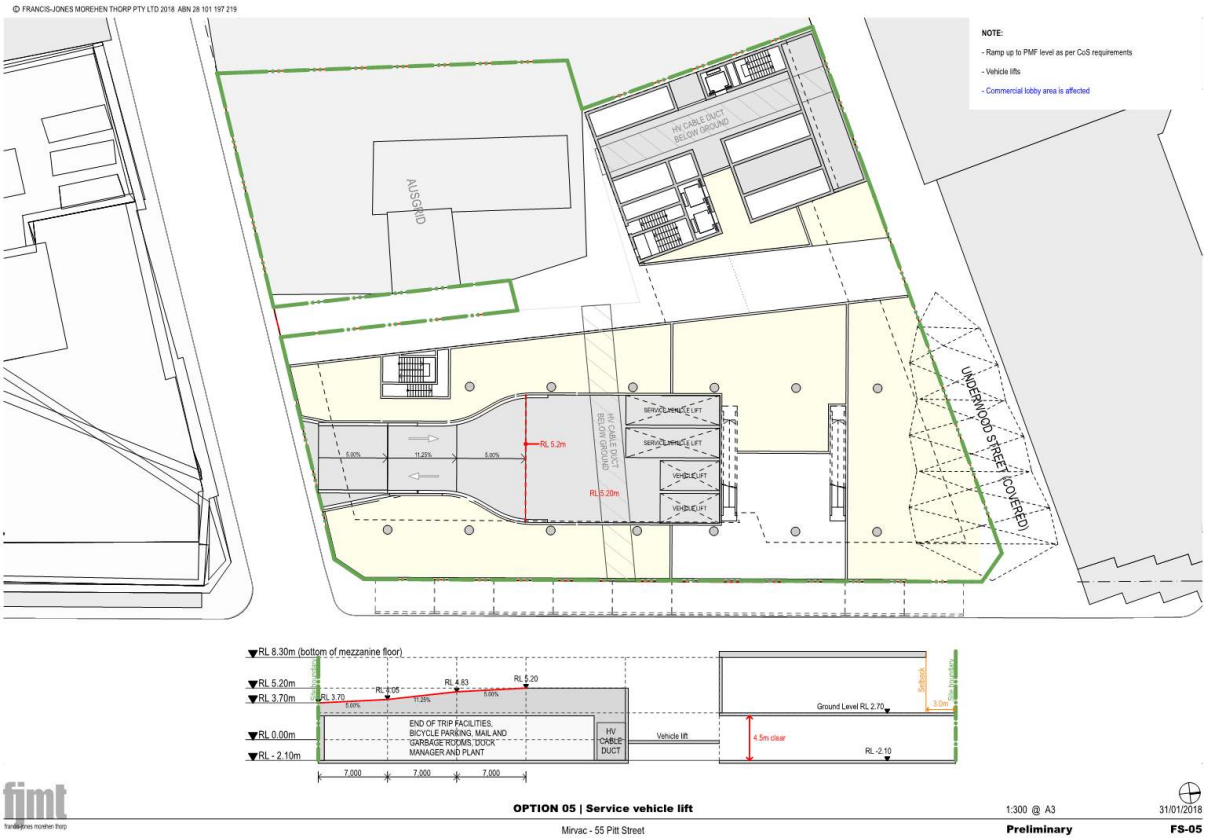

Figure 15 Option 5

4.6 Option 6 – Ramp up to 20-year ARI flood level with flood gate at the crest

Figure 16 below presents Option 6 which proposes for a driveway crest RL of 4.20m to meet the 20-year ARI flood, a flood gate which rises to RL 5.20m, to meet the PMF flood level and a vehicle lift system to lower vehicles from the ground level of the carpark to the basement level (RL -2.10). This option is not recommended as it requires the introduction of truck and car lifts. This is not a suitable solution for a premium grade building in the Sydney CBD area.

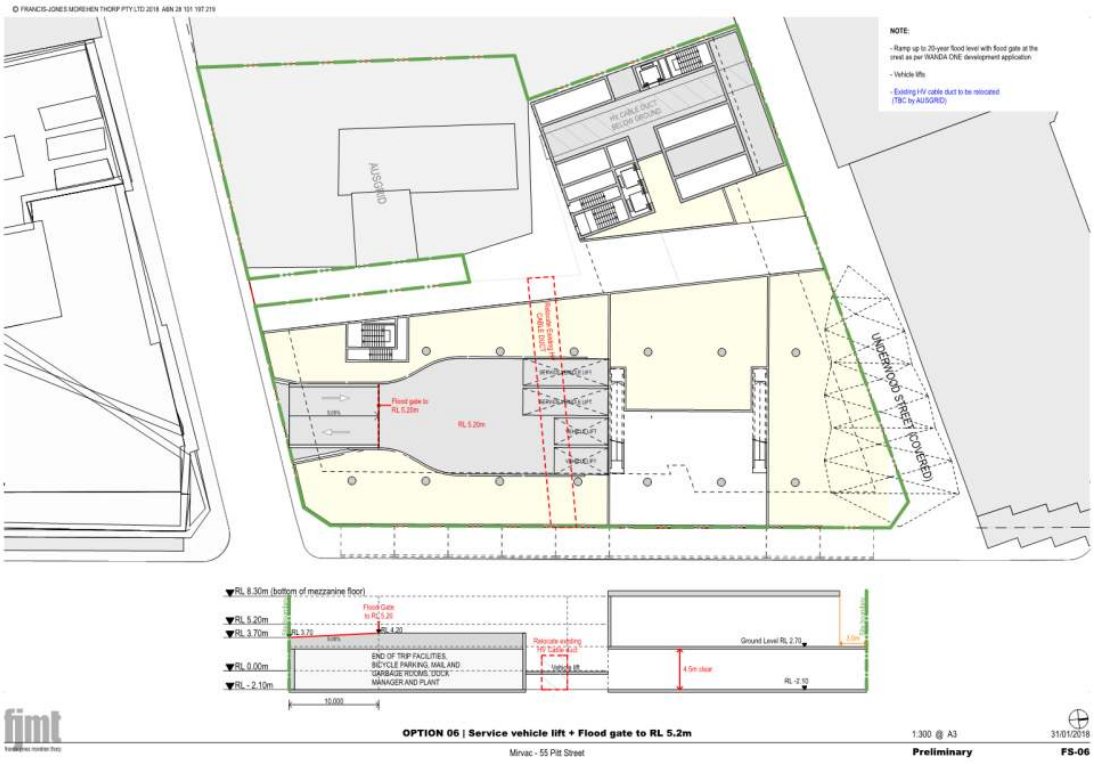

Figure 16 Option 6

5.0 6 Dalley Street

This section of the report outlines flood advice for the Telstra Exchange building at 6 Dalley Street. Council has advised Mirvac that they will be required to complete the following works to the Telstra Exchange:

- Relocation of car park entry and ramp from Underwood street (east – west) to Underwood street (north – south);
- Activation of retail space on Underwood Street (east – west);
- Public Domain upgrades to the colonnade; and
- Façade and roof upgrades.

5.1 Proposed Works

As per the Council requirements above, the proposed works involves relocating the vehicle entry ramp from the northern to the western face of the building. Refer to Figure 18.

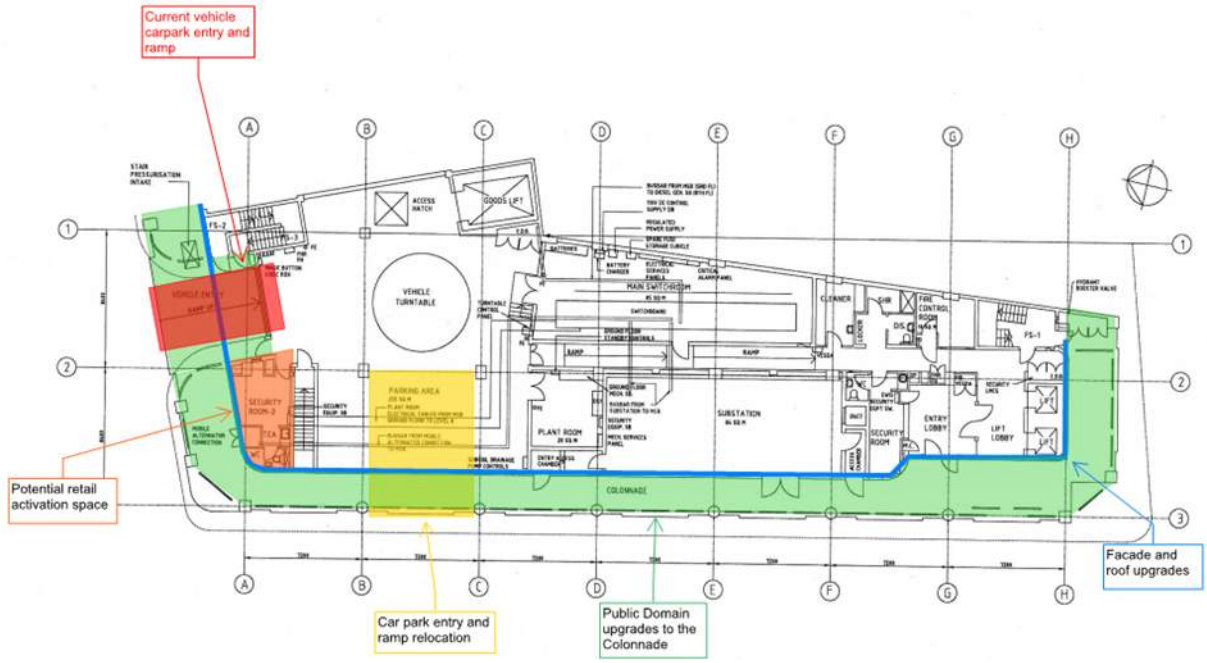

Figure 17 Proposed Telstra Exchange Building Works Concept

5.2 Flood Conditions

Key levels are given in the following table, and are represented schematically on Figure 19.

Table 3 Key Levels

	Existing vehicle entry	Proposed vehicle entry
1% AEP (100-year) flood level	3.47 mAHD	3.80 mAHD
Road level	2.98 mAHD	3.76 mAHD
1% AEP flood depth	300-500mm	Less than 100mm

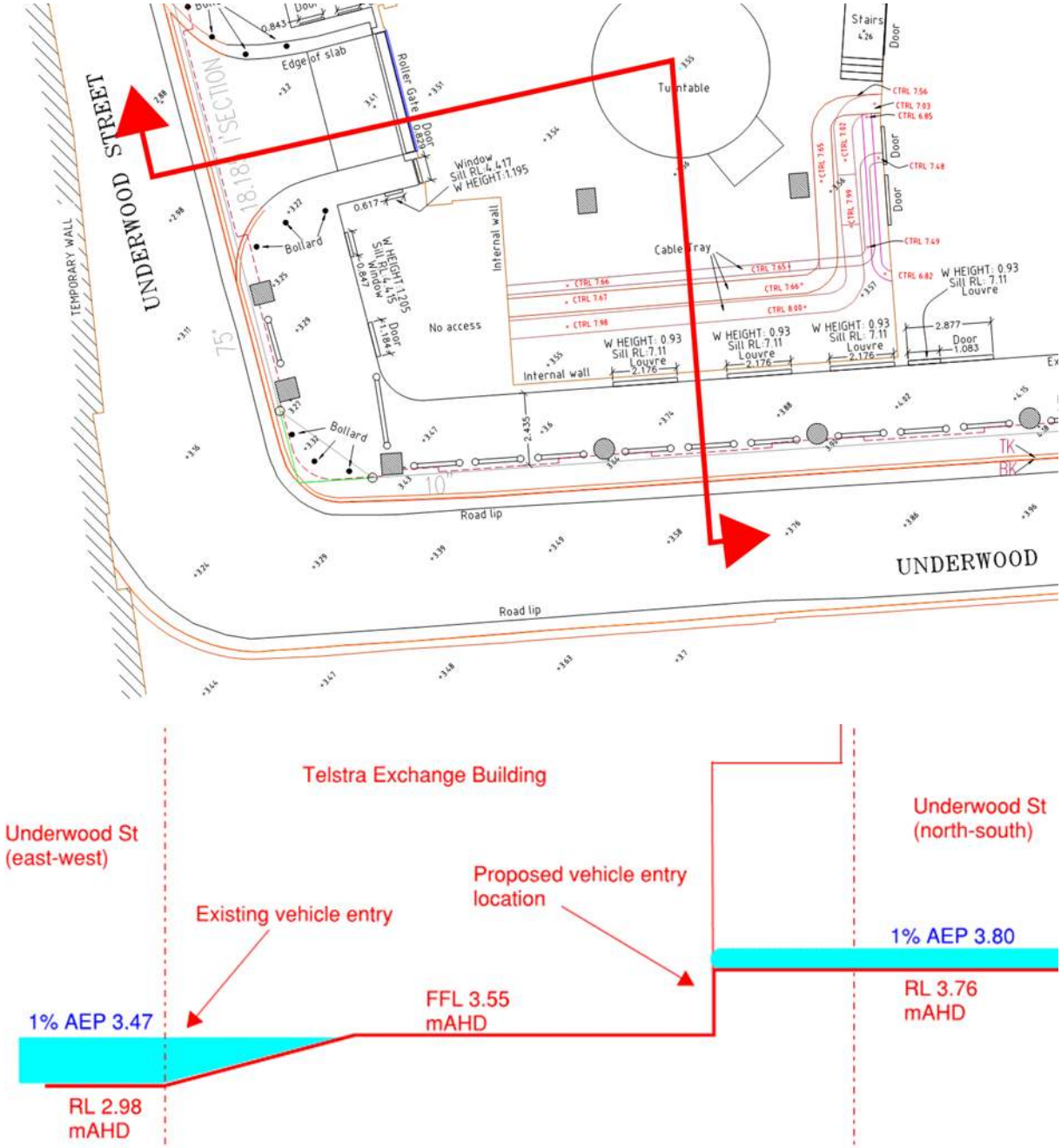

Figure 18 Schematic section through the Telstra Exchange Building

Council's Interim Floodplain Management Policy outlines the requirements for car parks with respect to flooding. The following extract gives requirements for the existing condition of the car park.

Above ground car park	Enclosed car parks	Mainstream or local drainage flooding	1% AEP flood level
	Open car parks	Mainstream or local drainage	5% AEP flood level

At present, the car park complies with Council's interim Floodplain Management Policy. The car park is defined as an above ground and enclosed car park. The floor level of the car park is above the 1% AEP flood level.

Under the proposed conditions, the car park is re-defined as a below ground car park in the policy:

Term	Meaning
Basement Car Parking or Below-Ground Car Parking	The car parking area generally below ground level where inundation of the surrounding areas may raise water levels above the entry level to the basement, resulting in inundation. Basement car parks are areas where the means of drainage of accumulated water in the car park has an outflow discharge capacity significantly less than the potential inflow capacity.

The flood planning level requirement for below ground car parks is more strict in the policy:

Below-ground garage/ car park	Single property owner with not more than 2 car spaces.	Mainstream or local drainage flooding	1% AEP flood level + 0.5 m

Under this requirement, the entry to the car park needs to rise up to 4.30mAHD to achieve 500mm freeboard. This is approximately 750mm above the existing car park which would not be feasible. Raising the internal level by 750mm to remove the below ground classification is not feasible, as the impact on headroom clearance, the existing turntable, and good lift servicing would have operational implications for Telstra. If the entrance has to be relocated then a food gate would be required to meet the requirements of City of Sydney Interim Floodplain Management Policy.

6.0 8-14 Dalley Street, Ausgrid

The Ausgrid substation at 8-14 Dalley Street has an existing vehicular entry off Dalley Street. This is above ground and does not form part of the proposed works. It will be retained in it's current configuration.

Figure 19 - Existing Ausgrid vehicular entry

7.0 WSUD

In accordance with the Sydney DCP 2012, the development will require water sensitive urban design (WSUD) measures as part of the site stormwater management scheme.

7.1 Stormwater Retention and Re-use

The DCP requires a reduction in the runoff volume of 30% in an average year. For the subject site, this equates to approximately 900 kl/year to be used on site. Rainwater could be used for toilet flushing, in a car-wash bay, landscape irrigation, or other situations where non-potable water is suitable.

A 20 kl stormwater retention tank will provide one week's supply based on a re-use demand of 900 kl/year. Details of rainwater re-use demand and retention tank sizes are to be completed by a hydraulic engineer as the design progresses.

7.2 Stormwater Quality

The DCP sets out stormwater pollutant reduction targets:

- Litter and vegetation: 90%
- Total suspended solids: 85%
- Total phosphorus: 65%
- Total nitrogen:45%

The stormwater quality targets can be achieved through the use of a propriety stormwater treatment device such as a Humes Jellyfish JF1200-2-1 or a Spel Hydrosystem HS1500.

8.0 Conclusions

55 Pitt Street is located in the natural flood basin where meeting the FPL would be cumbersome and inefficient. The approach taken to overcome this, is to provide passive protection up the 20-year ARI flood, with a self raising flood gate giving protection to the basement in larger events.

The site has been designed to have no impact on flooding on surrounding properties during a 100-year ARI event. This has been demonstrated with flood modelling.

Relocating the car park entry for 6 Dalley Street from the east-west section of Underwood Street to the north-south section of the street has a significant impact from a flood compliance perspective. A flood gate would be required to ensure the relocated entry is compliant with the Interim Floodplain Management Policy..

Authorised by
TAYLOR THOMSON WHITTING (NSW) PTY LTD

STEPHEN BRAIN
Technical Director

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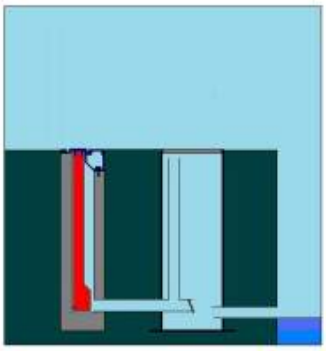
Appendix A

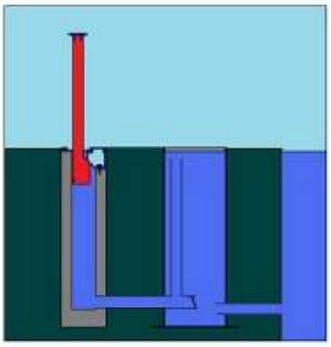
Flood Maps

Appendix B

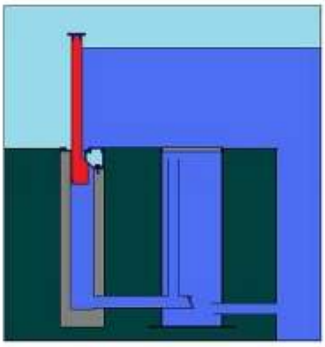
Flood Gates Information



Following installation and in non-flood conditions, alL operational parts of the barrier are invisibly concealed in the ground inside its basin.



When floodwater rises to within 10cm below flood level, the enclosed basin, which houses the floating wall, starts to fill up through an inlet pipe from the adjacent service pit. The flood wall floats and rises. When the basin is totally filled, the angled support block will ' lock the barrier into position making it watertight.



The floodwater can now continue to rise without flooding the protected area.

As the water subsides , the flood water in the basin is drained by drain pipes with one way check valves.
As the water continues to drain from the basin, the flood wall returns to its resting position within the basin and the lid seals the barrier to prevent the barrier of waste and debris.

Appendix C

FJMT Design Options

Appendix D

Mirvac Response To CoS Flooding Due Diligence Meeting Dated 6th April 2018

1.0 Introduction

Mirvac and TTW met with the City of Sydney on 6th April 2018 to discuss flooding and flood management at 55 Pitt Street, Sydney. Key out-takes from the meeting listed below:

- The design of the basement ramp should consider passive flood protection up to the 100-year ARI flood level of 4.30mAHD, which is 150mm higher than the submitted ramp up the to the 20-year ARI flood level of 4.15mAHD.
- TTW to investigate the impact of raising ground levels in Underwood Street. This should take into account smaller flood events (5-year ARI) where the greatest benefit is expected.
- Investigate and consider alternate flood controls in the public domain, (not in the immediate vicinity of the site) that may alleviate flood risk for 55 Pitt Street.

2.0 Basement Ramp

The preferred basement ramp Option 3 proposes a ramp crest RL of 4.15m and a flood gate which rises to RL 5.20m. The flood gate when in operation would meet the PMF flood level. This option would allow for the driveway to ramp to the basement level RL of -2.10m, be compliant with AS2890.2 and be contained within the property boundary.

Following the meeting, FJMT prepared ramp Option 7, where the ramp crest is at the 100-year ARI level of RL 4.30m (Figure 20)

When compared to Option 3, the ramp is required to be longer to make up for the increased height. This change has a negative impact on the public domain as an alternate alignment of the through site link is required to achieve adequate clearance height (3800mm) for vehicles entering the ramp and driving under the through site link.

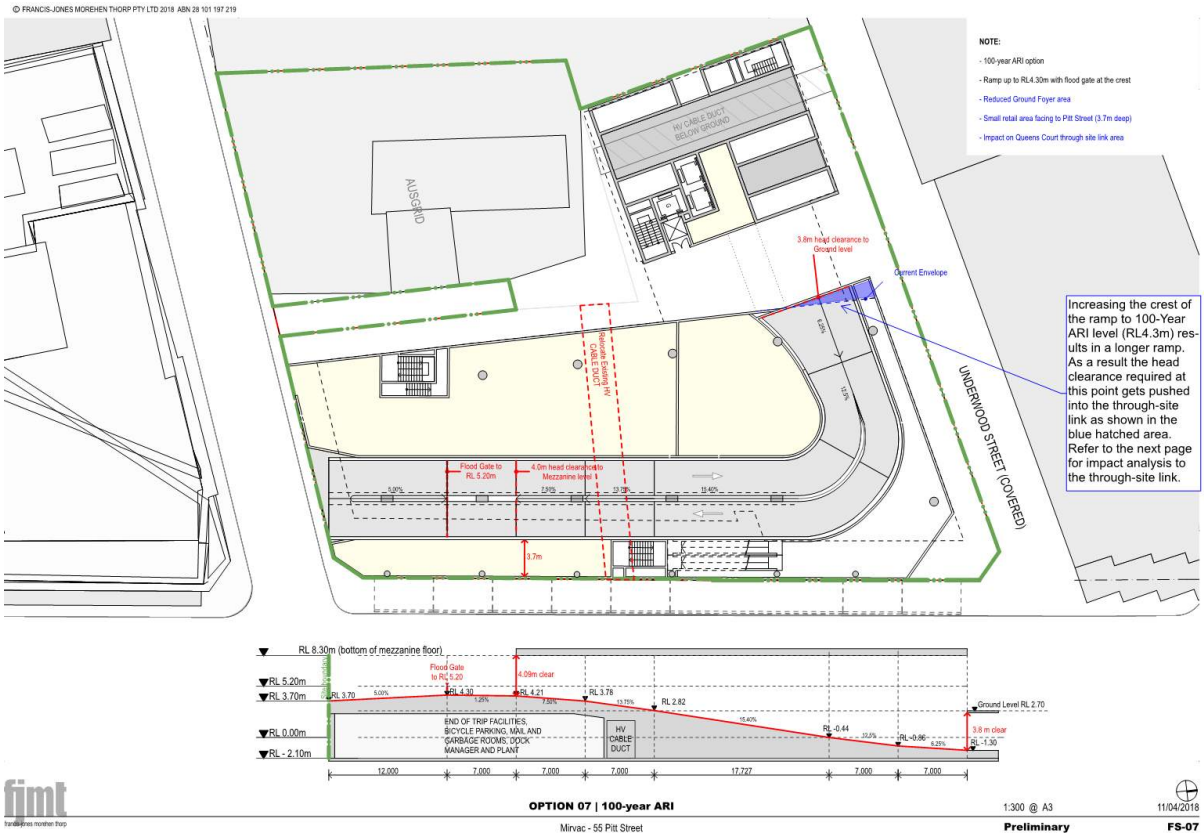


Figure 20 Option 7

3.0 Underwood Street

TTW has prepared a conceptual grading analysis of Underwood Street with the aim of reducing flood depth in rare flood events such as the 100-year ARI event, and minimising flooding in frequent events such as the 2-year and 5-year ARI flood events.

3.1 Concept Grading

The regrading is constrained by the existing levels on Pitt Street, and the driveway entry to 2 Dalley Street.

Any proposed regrading of the street would need to be coordinated with the Lendlease Circular Quay development, and the various utility services located in Underwood Street.

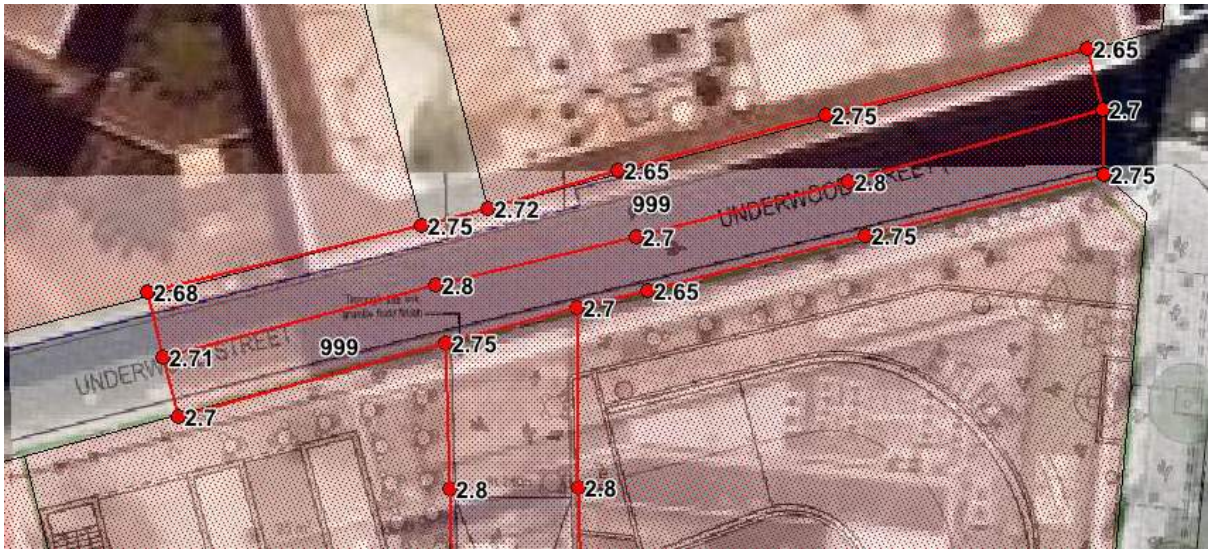


Figure 21 **Proposed concept grading of Underwood Street (model extract)**

The concept regrading shown in Figure 21 was added to the flood model. Refer to Section 3 of the main report for details of the model. The modelled pit and pipe network in the street was adjusted to suit the proposed grading.

3.2 Underwood Street Regrading Results

The proposed regrading of Underwood Street does not have any effect on flood levels in Underwood Street or the surrounding area. With the ground level of Underwood Street raised and the flood level unchanged, the flood depth is reduced. Refer to Table 4.

Table 4 Impact of Underwood Street grading on flood results

	5-year ARI	100-year ARI
Flood level with existing grading	3.15 mAHD	3.47 mAHD
Flood level with proposed grading	3.15 mAHD	3.47 mAHD
Maximum flood depth with existing grading	0.61 m	0.93 m
Maximum flood depth with proposed grading	0.46 m	0.78 m

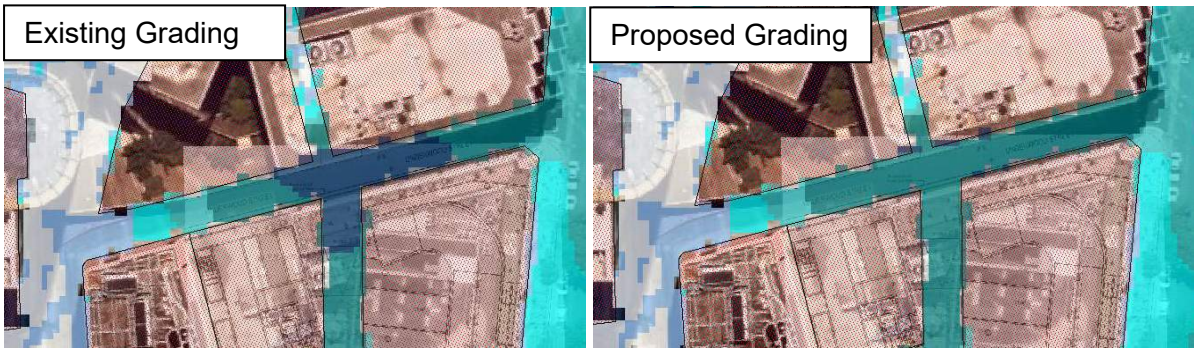


Figure 22 **5-year ARI Flood depth plot: intersection of Underwood St and the through-site link.**

Larger flood maps are presented at the end of this Appendix.

4.0 Other Flood Management Controls in the Public Domain

TTW investigated flood management controls in the public domain. These would typically take the form of a raised threshold at an intersection. This provides an on-grade crossing for pedestrians. An example of such an arrangement can be seen at the intersection of Liverpool Street and Nithsdale Street, in the Southern CBD area (Figure 23)

Figure 23 **Raised threshold example - cnr Nithsdale and Liverpool Streets**

4.1 Dalley and Pitt Streets

Figure 24 Pitt and Dalley Streets (Google Maps)

A review of flood levels at the intersection of Pitt and Dalley shows that the flood depth at this intersection is up to 600mm in a 100-year event, and 350mm in a 5-year event. Providing a 150mm high threshold here will not provide any benefit in terms of flood behaviour and could create additional ponding on Dalley Street.

A review of the intersection of Pitt and Underwood Streets gives a similar outcome.

4.2 Dalley and Underwood Streets

Figure 25 Intersection of Underwood and Dalley Streets (Google Maps)

Flood modelling shows there is minimal stormwater flowing from Dalley Street to Underwood Street. Furthermore, there is limited space to install a threshold in this location. The width from

the building to the kerb on Dalley Street is approximately 1.2m. The site geometry dictates that this is not an appropriate position for a threshold.

4.3 Dalley and George Streets

Figure 26 **Intersection of George and Dalley Streets (Google Maps)**

Previous modelling shows that a significant amount of stormwater can flow from George Street down Dalley Street in a flood event. There is a flow depth of between 50mm and 180mm at the intersection in a 100-year event. This appears to be an appropriate location for a threshold to both reduce flooding in Dalley Street and improve pedestrian access on the George Street footpath.

In order to model proposed threshold and show the impact on flooding, the levels across the entry to Dalley Street were increased by 150mm in the model.

4.4 Results

Flood levels with and without the threshold have been compared to show the impact for both the 5-year and 100-year flood events.

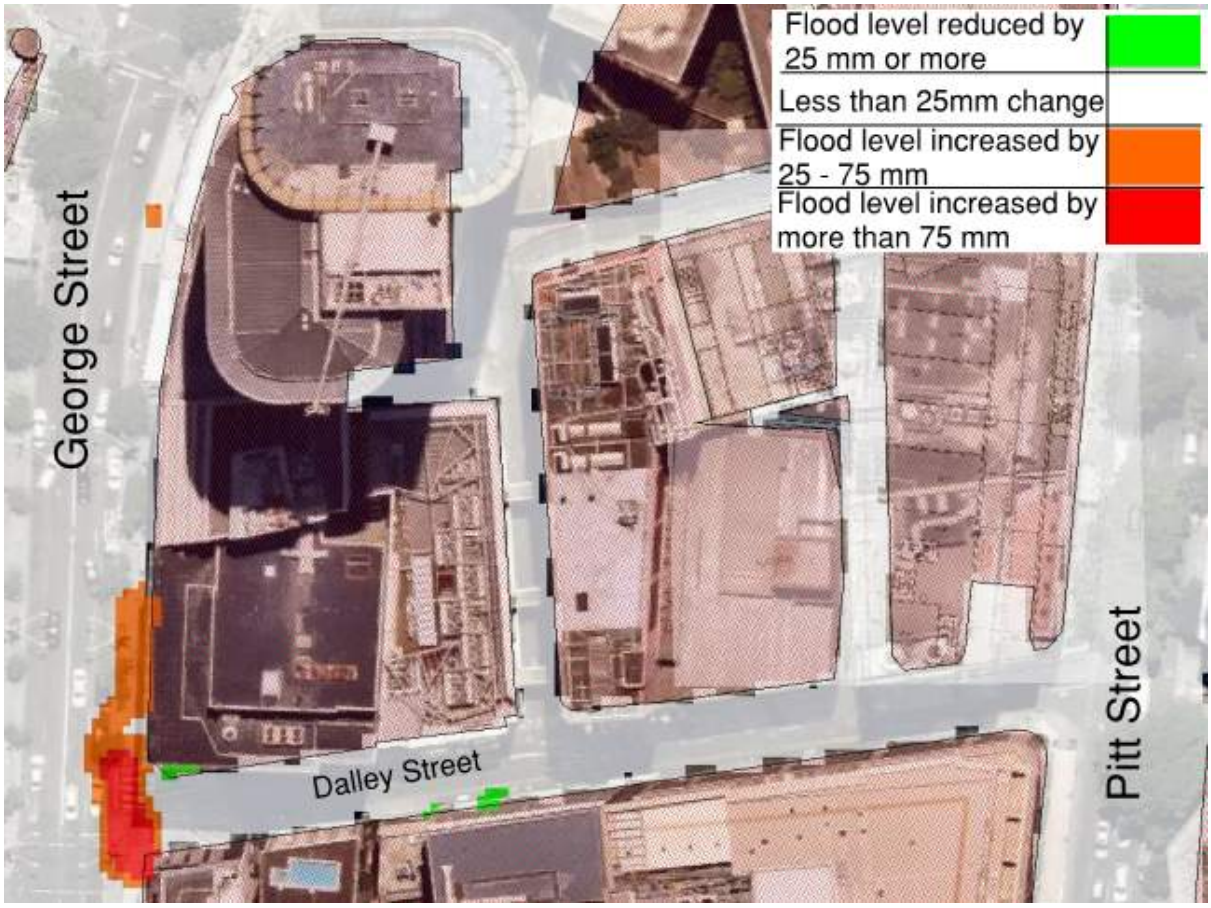


Figure 27 **Impact of proposed threshold on flood levels: 5-year ARI**

The 5-year ARI flood shows some increase in flood levels on George Street in the vicinity of the intersection. Any improvement in flood levels on Dalley Street is generally less than 25mm.

Figure 28 **Impact of proposed threshold on flood levels: 100-year ARI**

The impact on 100-year flood levels gives an increase in flood levels on George Street that extends to 200 George Street, however this increase is mostly in the vicinity of the proposed threshold.

There is some improvement in flood levels in the upper end of Dalley Street. This improvement is less pronounced downstream of Queens Court at the subject site as Pitt Street flooding dominates the flood regime. The improvement at the proposed basement entry is less than 25mm.

Appendix E

Site plan and survey