

## **Attachment A18**

**Preliminary Flooding Advice - 133-145  
Castlereagh Street, Sydney**

Stockland

**Stockland Piccadilly Complex**

**Preliminary Flooding Advice for  
Planning Proposal**

Report

Issue 3 | 10 August 2020

This report takes into account the particular instructions and requirements of our client.

It is not intended for and should not be relied upon by any third party and no responsibility is undertaken to any third party.

Job number 249470-00

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## Glossary

\*Many terms in this Glossary have been derived from *Interim Floodplain Management Policy* (City of Sydney, May 2014).

Team	Meaning
Annual Exceedance Probability (AEP)	The chance of a flood of a given or larger size occurring in any one year, usually expressed as a percentage. 1% AEP flood is approximately equal to 1 in 100 year Average Recurrence Interval (ARI) flood event (or simply 100 year flood). It has 1% chance to occur in a given year.
Australian Height Datum (AHD)	A common national plan of level corresponding approximately to mean sea level.
Average Recurrence Interval (ARI)	The long-term average number of years between the occurrence of a flood as big as or larger than, the selected event. For example, floods with a discharge as great as, or greater than, the 100 year ARI flood event may occur on average once every 100 years
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.
Extreme Flood	An estimate of the probable maximum flood (PMF), which is the largest flood that could conceivably occur at a particular location, generally estimated from the probable maximum precipitation (PMP). Generally it is not physically or economically possible to provide complete protection against this event.
Flood Planning Level (FPL)	The combinations of flood levels and freeboards selected for floodplain risk management purposes, as determined in flood studies and floodplain risk management studies and plans.
Probable Maximum Flood (PMF)	The largest flood that could conceivably occur at a particular location, usually estimated from probable maximum precipitation.
Probable Maximum Precipitation (PMP)	The greatest depth of precipitation for a given duration meteorologically possible over a given size storm area at a particular location at a particular time of the year, with no allowance made for long-term climatic trends (World Meteorological Organisation, 1986). It is the primary input to the estimation of the probable maximum flood.

# 1 Introduction

This Preliminary Flooding Advice Report has been prepared by Arup on behalf of Stockland. It accompanies a planning proposal seeking to initiate the preparation of a Local Environmental Plan amendment for the land known as ‘Stockland Piccadilly Complex’ located at 133-145 Castlereagh Street, Sydney (the site) legally described as Lot 10 in DP828419, and shown in Figure 1:.

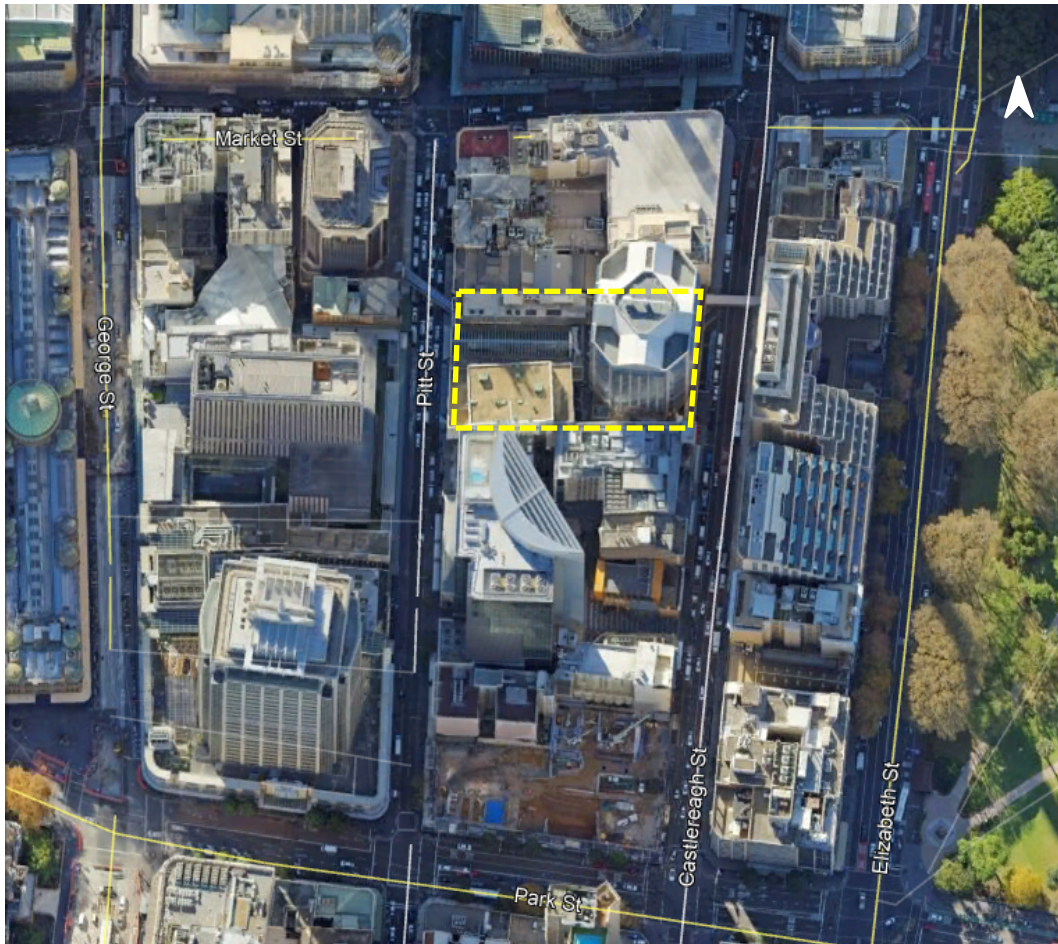


Figure 1: 133-145 Castlereagh Street, Sydney – Stockland Piccadilly Complex

The planning proposal seeks to amend the floor space ratio development standard applicable to the site, under the *Sydney Local Environmental Plan 2012* (the LEP), in accordance with Section 3.33 of the *Environmental Planning and Assessment Act 1979* (EP&A Act).

In accordance with Clause 7.20 of the LEP, this planning proposal also seeks amendments to the *Sydney Development Control Plan 2012* (the DCP) to establish site specific provisions to guide the future development, including establishing a building envelope for the site as well as other key assessment criteria.

The intended outcome of the proposed amendments to the LEP and DCP is to facilitate the redevelopment of the site for a mixed-use commercial development together with basement car parking and associated facilities. Such a proposal



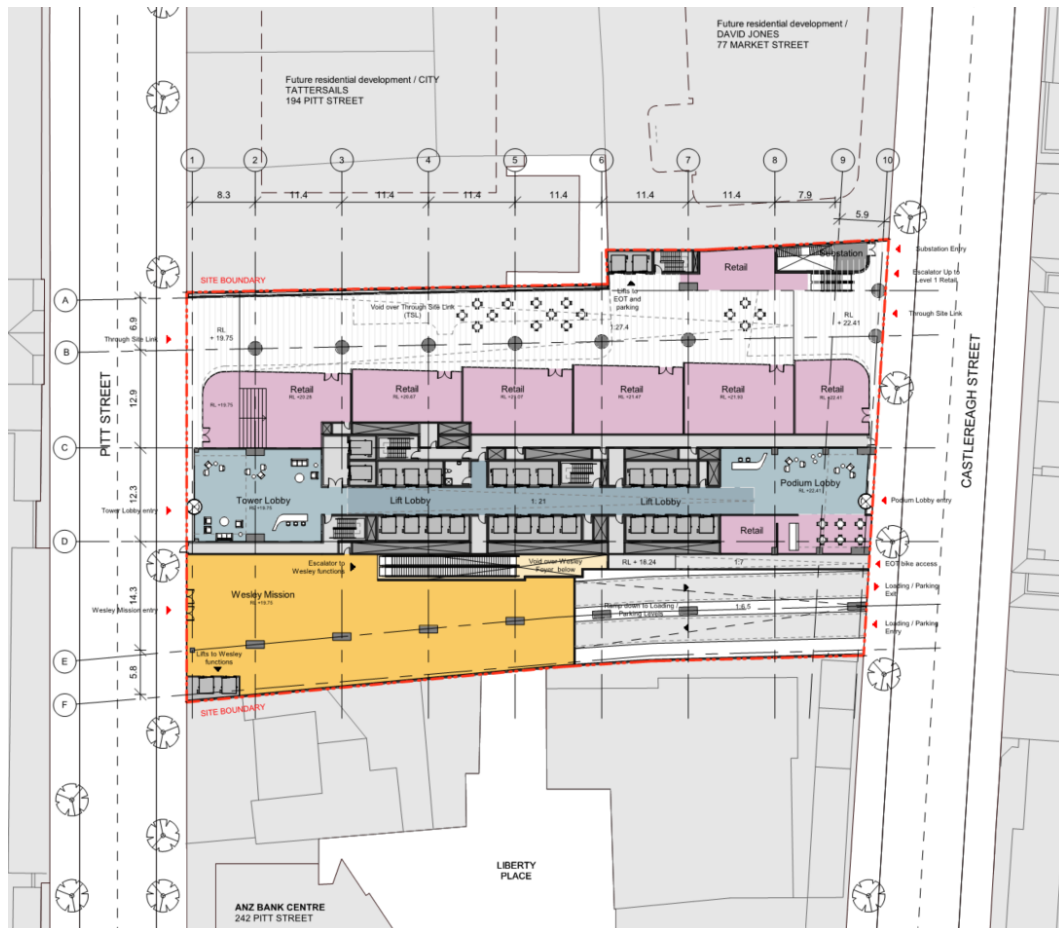


Figure 2 Stockland Piccadilly Complex – Concept Reference Design - Ground plan (3XN, 55001\_200805)

The Concept Reference Design includes the following elements:

- Basement car parking and mechanical plant (B05-B03);
- Wesley Mission facilities including the Church, Theatre and Lyceum, as well as supporting offices (B2-B1);
- End of trip, back of house area and plant (B1);
- A northerly aligned east-west pedestrian through-site link connecting Pitt Street and Castlereagh Street (L00);
- Podium levels (L00-L09) comprising lobby (L00), retail (L00-L01), commercial (L02-L09) and plant (L09); and
- Tower levels (L10-L34) comprising commercial and plant (L19, L35-L36).

### 1.3 Purpose of report

The purpose of this Preliminary Flood Advice Report is to provide a review of relevant aspects of the proposed planning amendments and the Concept Reference Design, to evaluate their likely suitability, and requirements for future assessment and detailed design. As the planning submission does not seek consent for the

specific development, a detailed quantitative assessment of the Concept Reference Design is not considered to be warranted at this stage.

A high-level review of flooding risk has been undertaken to identify the flooding constraints and likely flood planning implications for the proposed development. The flood advice is based on a desktop review of:

- *City Area Catchment Flood Study, Final Report, October 2014, BMT WBM*
- *City Area Catchment Floodplain Risk Management Study, Final Report, September 2016, WMAwater*
- *Interim Floodplain Management Policy, May 2014, City of Sydney Council*
- *Sydney Development Control Plan 2012.*

To undertake an initial flood assessment for the proposed development, six sample reference locations have been identified as follows and as indicated in Figure 3. These reference locations have been interpreted from the provided Concept Reference Design *Level 0 Ground, DA-01-L00, Issue A (5/8/2020)*.

- P1: entrance to the loading/ parking
- P2: exit from the loading/ parking
- P3: podium lobby entry on Castlereagh Street
- P4: entrance to the pedestrian through-site link on Castlereagh Street
- P5: tower lobby entry on Pitt Street
- P6: entrance to the pedestrian through-site link on Pitt Street

Additional building egress locations not identified above are currently proposed to the development. As the design evolves during design development, all points of egress to the development site will require an individual flood assessment.

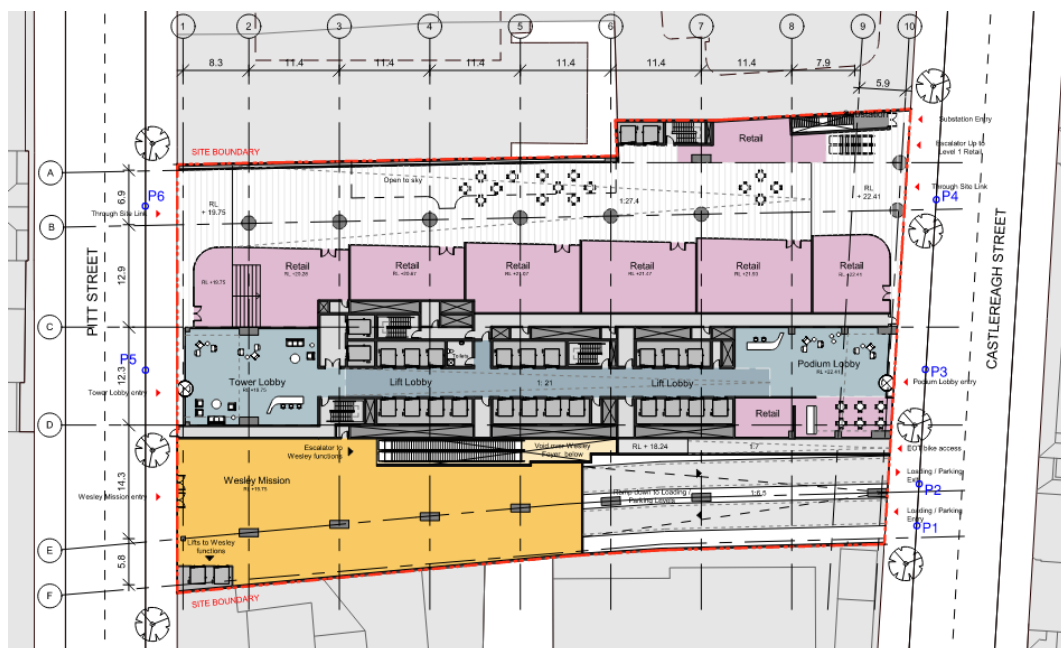


Figure 3: Concept Reference Design Ground Plan and the Reference Locations

## 1.4 Objectives

The key objectives of this preliminary flood assessment are to:

- Review the relevant flood studies and the model results around the proposed development;
- Review the relevant Council flood risk management policies that may apply to the site; and
- Provide flood advice for the proposed redevelopment, including identifying specific flood design requirements for specific areas of the development.

## 2 Review of existing flood study

### 2.1 Previous studies

The City Area Catchment Flood Study was completed by BMT WBM in October 2014 on behalf of the City of Sydney. A dynamic 1d/2d TUFLOW model was utilised using ‘the direct rainfall’ approach (also referred to as ‘rainfall-on-grid’ approach) in this study. This study defined the flood behaviour within the City Area catchment under the existing conditions in terms of the flood depths, flood levels, velocities and provisional hazard for a range of design events.

The City Area Catchment Floodplain Risk Management Plan was undertaken by WMAwater for the City of Sydney (WMAwater, September 2016). The existing model adopted in this study was based on the WBM’s model but incorporated minor refinements. It is referred to this report for flood information. The purpose of this study was to investigate the performance of a range of flood mitigation measures.

### 2.2 Review of the flood model results

This preliminary flood assessment was based on the existing model results in the City Area Catchment Floodplain Risk Management Study (WMAwater, September 2016). It is noted that the permission to use this WMAwater model for the current study has been granted by the City of Sydney.

The flood maps for the 100 year average recurrence interval (ARI) and the probable maximum flood (PMF) events are listed in Table 1. The peak flood depths and flood levels at the reference locations are shown in Table 2. These locations are approximate only and have relied upon a manual overlay of the ground floor layout with the flood mapping.

Table 1: Flood information extracted from WMAwater Model

Figure Reference	Flood Map Title
Figure 4	Critical Durations – 100 Year ARI
Figure 5	Critical Durations – PMF
Figure 6	Peak Flood Depths and Flood Levels – 100 Year ARI
Figure 7	Peak Flood Depths and Flood Levels – PMF
Figure 8	Provisional Hazard – 100 Year ARI
Figure 9	Provisional Hazard – PMF

Table 2: Peak Flood Depths and Flood Levels at the Reference Locations

Reference ID	Location Description	Flood Depth (m)**		Flood Level (mAHD)*	
		100yr	PMF	100yr	PMF
P1	Loading/ Parking Entry	0.10	0.21	22.57	22.68
P2	Loading/ Parking Exit	0.07	0.18	22.49	22.61
P3	Podium lobby entry on Castlereagh Street	0.09	0.21	22.27	22.38
P4	Entrance to the pedestrian through-site link on Castlereagh Street	0.10	0.22	22.01	22.13
P5	Tower lobby on Pitt Street	0.10	0.31	19.85	20.05
P6	Entrance to the pedestrian through-site link on Pitt Street	0.13	0.28	19.56	19.70

\* Flood depths and levels have been provided at the kerb alignment located perpendicular to each entrance location.

# Due to the coarse nature of the flood model (2m grid size) the flood depth should conservatively be measured from top of kerb level. The 2m grid size will not define the local depression of the gutter invert.

A review of the flood maps included within the study indicates that:

- The site is positioned near the top of the City North stormwater catchment. The critical duration is 25 minutes and 15 minutes for the 100 year ARI and the PMF events respectively in the vicinity of the site (as shown in Figure 4 and Figure 5).
- For the 100 year ARI event shown in Figure 6, the peak flood depths are up to 0.10m at the entrance/exit of the basement (P1 and P2) and the front door of lobby at Castlereagh Street (P3) and Pitt Street (P5). The peak flood depth is 0.13 m at the entrance of the pedestrian through-site link at Pitt Street (P6).
- For the PMF event shown in Figure 7, the peak flood depths are in a range of 0.2 to 0.3 m along Castlereagh Street and Pitt Street adjacent to the proposed development in general.
- Provisional flood hazard is determined through a relationship between the depth and velocity of floodwaters. It is referred to Figure L2 in *Floodplain Development Manual* (NSW Government, 2005) for details. The provisional hazard classifications consist of high hazard, transition, and low hazard.

The model results indicate that the proposed site is located at the low hazard in the 100 year ARI event (shown in Figure 8). For the PMF event, Castlereagh Street is located at the low hazard, and Pitt Street is located at the transition zone (shown in Figure 9).

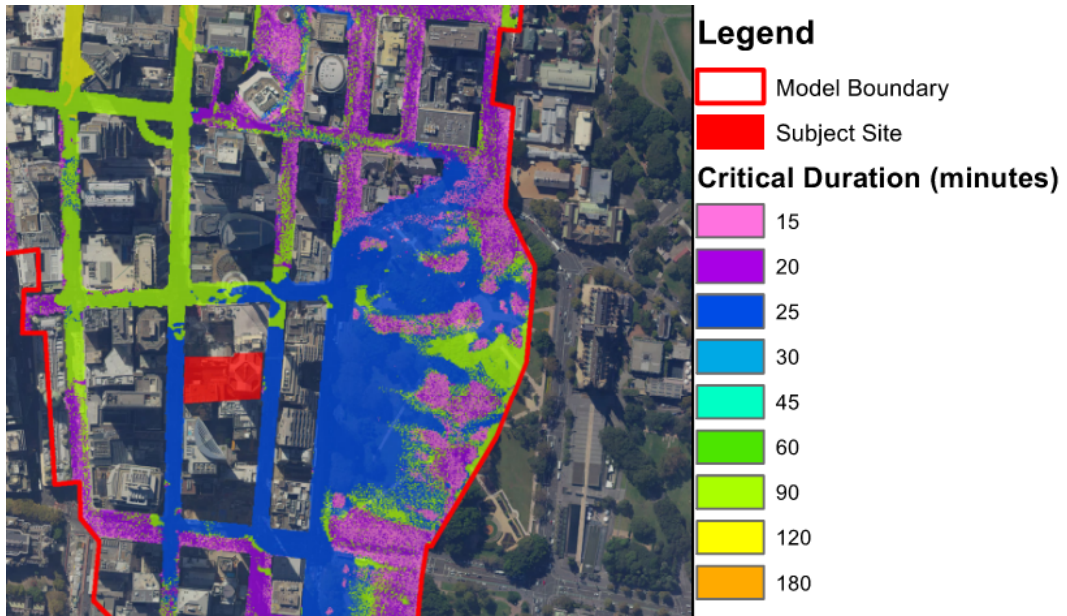


Figure 4: Critical Durations – 100 Year ARI

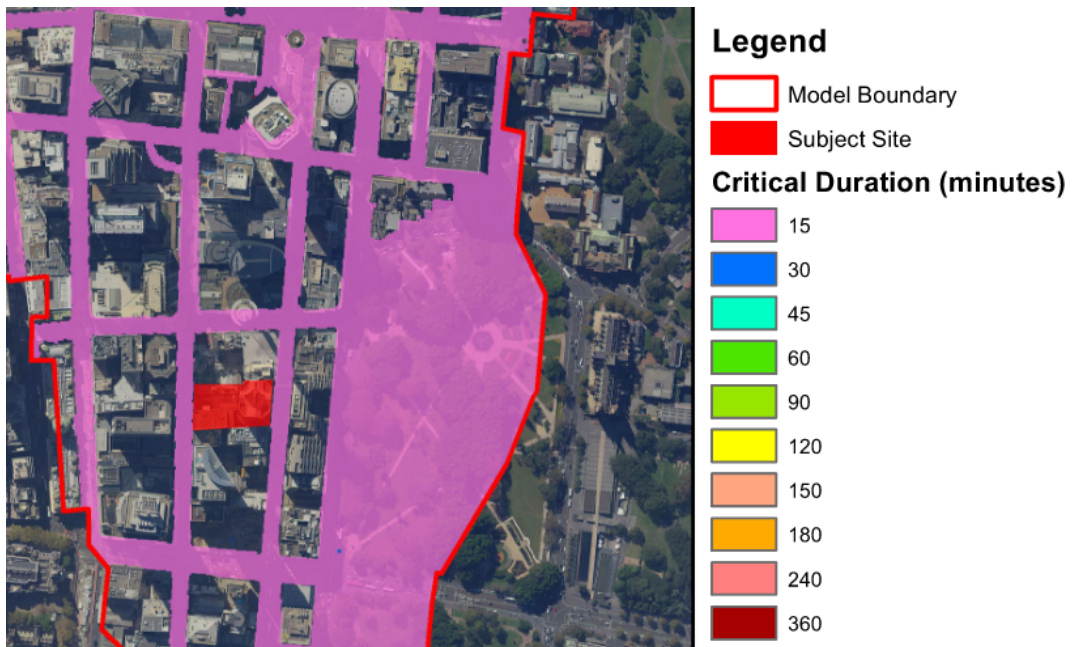


Figure 5: Critical Durations – PMF

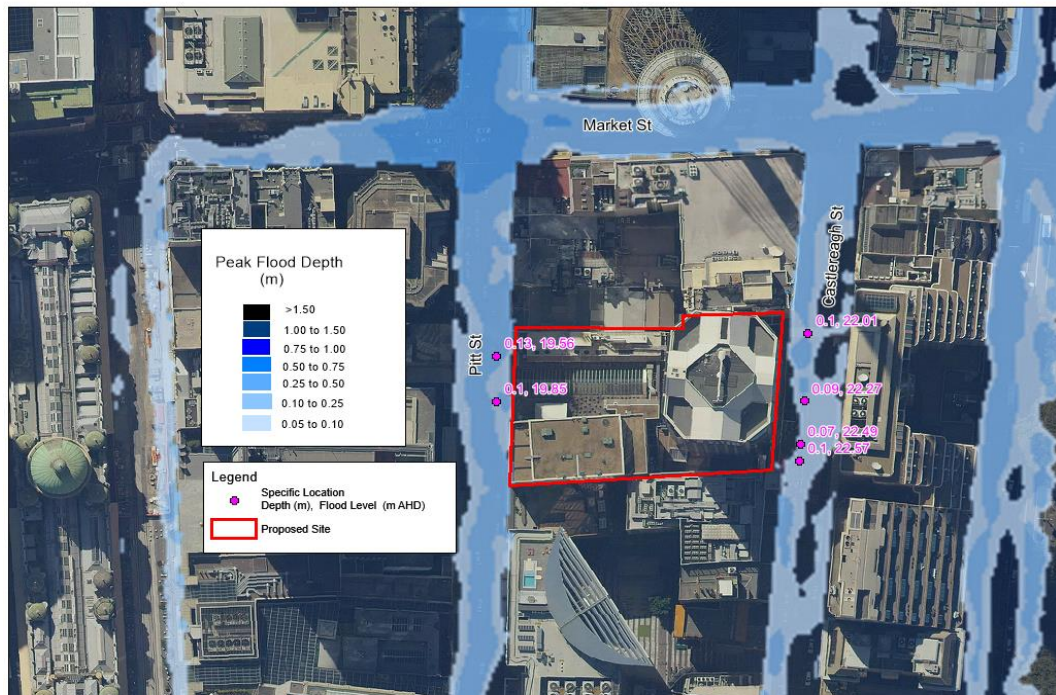


Figure 6: Peak Flood Depths and Flood Levels – 100 Year ARI

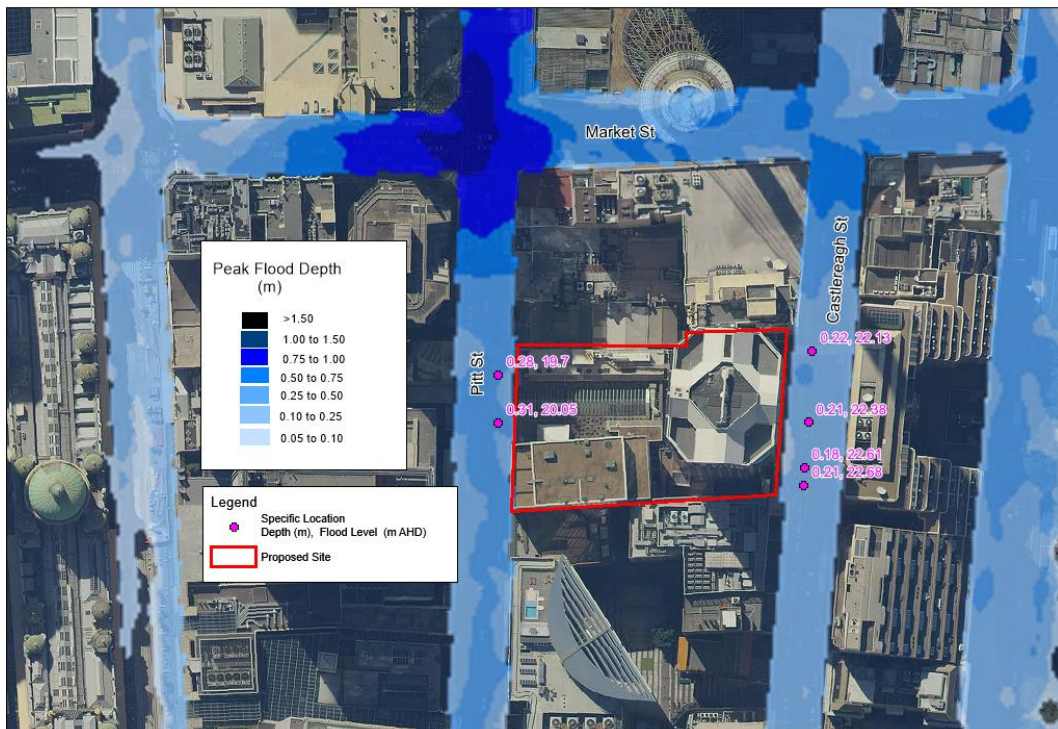


Figure 7: Peak Flood Depths and Flood Levels – PMF

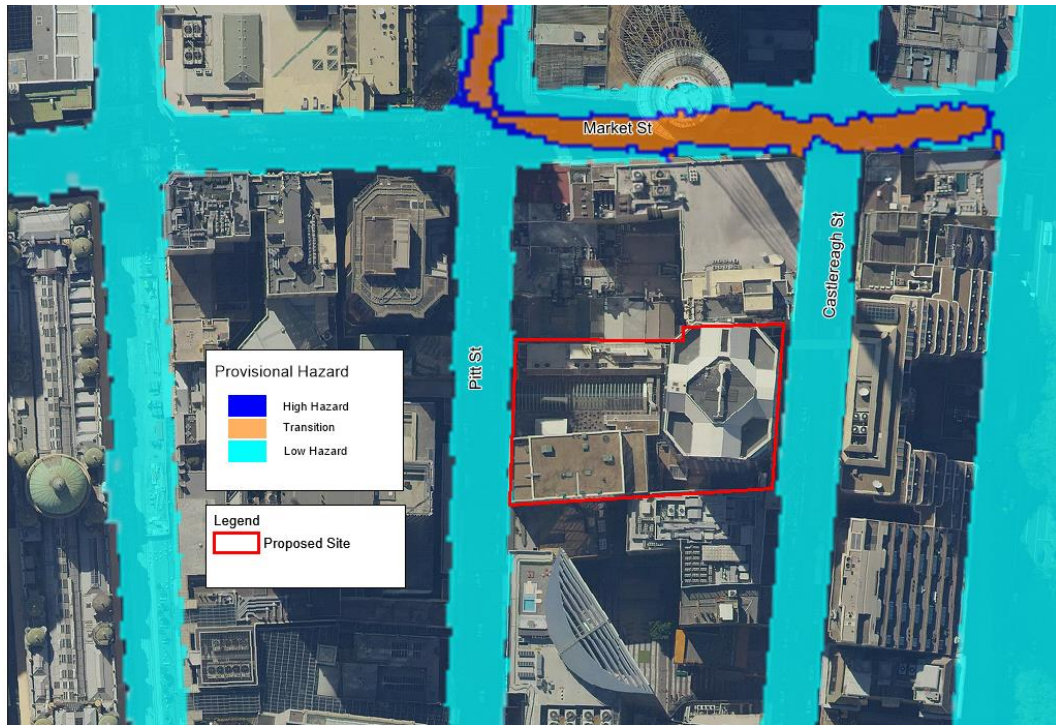


Figure 8: Provisional Hazard – 100 Year ARI

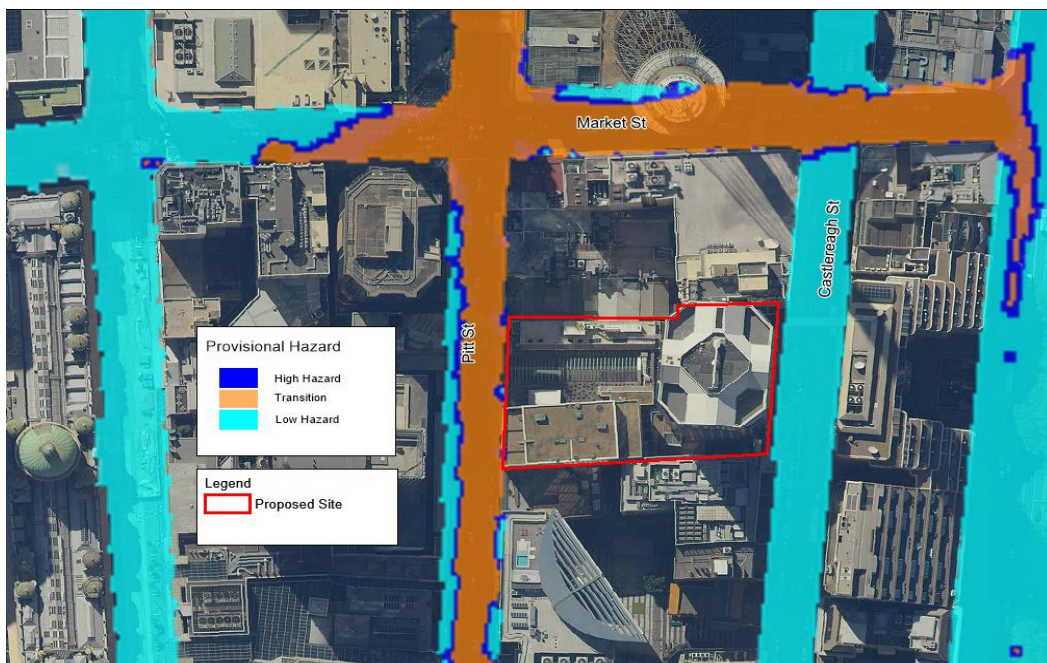


Figure 9: Provisional Hazard – PMF

### 3 Flooding design criteria

According to the City of Sydney *Interim Floodplain Management Policy*, Flood Planning Level (FPL) is defined as

*“The combinations of flood levels and freeboards selected for floodplain risk management purposes, as determined in flood studies and floodplain risk management studies and plans.”*

The FPL refers to the permissible minimum building floor levels. For below-ground parking, the FPL refers to the minimum level at each access point, including ventilation ducts, windows, light wells, lift shaft openings, risers, services pits and stairwells. Details of these levels as extracted from the *Interim Floodplain Management Policy* are included in Table 3.

Table 3: Flood Planning Level Requirements (Extracted from the City of Sydney *Interim Floodplain Management Policy*)

Development	Flood Planning Level (FPL)
Industrial or commercial - business subject to mainstream or local drainage flooding	Merits approach with a minimum of the 1% AEP flood level
Industrial or commercial - retail floor levels subject to mainstream or local drainage flooding	Merits approach with a minimum of the 1% AEP flood level. The development must demonstrate a reasonable balance between flood protection and urban design outcomes for street level activation.
Industrial or commercial - schools and childcare facilities subject to mainstream or local drainage flooding	Merits approach with a minimum of the 1% AEP flood level + 0.5 m.
Below-ground car park outside floodplain*	0.3 m above the surrounding surface
Below-ground car park subject to mainstream or local drainage flooding*	1% AEP flood level + 0.5 m or the PMF (whichever is the higher)

\* The criteria for below ground car parks includes any intended use for spaces located below the surrounding surface levels e.g. car parking, retail, commercial uses, plant etc.

Sydney Development Control Plan 2012 requires that the development should manage and mitigate flood risk and does not exacerbate the potential for flood damage or hazard to existing development and to the public domain.

The City of Sydney’s *Interim Floodplain Management Policy* performance criteria includes a requirement that a development “will not significantly adversely affect flood behaviour resulting in detrimental increases in the potential flood affectation of other developments or properties”.

## 4 Development requirements

### 4.1 Flood planning level requirements

The City of Sydney's *Interim Floodplain Management Policy* (May 2014) defines a floodplain as "the area of land which is subject to inundation by floods up to and including the probable maximum flood (PMF) event". The WMAwater model results indicate that the peak flood depths for the PMF event are in a range of 0.2 to 0.3 m at Castlereagh Street and Pitt Street adjacent to the development, which would overtop the standard 150mm kerb height. Therefore, the proposed site should be considered as being subject to local drainage flooding, and the following flood requirements would apply in accordance with the required design criteria listed in Table 3.

The WMAwater flood model results indicate that the peak flood depths are up to 0.3 m for the PMF event on Castlereagh Street and Pitt Street adjacent to the development. Therefore the development types requiring a flood planning level criteria of "a minimum 1% AEP flood level + 0.5 m or the PMF (whichever is the higher)", the governing flood planning level will be the 1% AEP flood level +0.5 m. This applies to developments including schools and childcare facilities and below-ground car parks and other basement infrastructure.

The following identifies key considerations for the current Planning Proposal (*Level 0 Ground, DA-01-L00, Issue A*). Similar principles would apply to design development made to this proposal.

#### **Loading/ Parking Entry and Exit**

The 1% AEP flood level + 0.5 m will likely be the governing the crest level of the driveway to the basement loading/ parking. The WMAwater flood model indicates 1% AEP flood depths ranging 70-100 mm across the Castlereagh loading/ parking entry/ exit frontage. These depths are conservatively measured from top of kerb due to the coarse nature of the flood model. As such, the loading/ parking entry and exit will require grading within the public domain and internally to the site to achieve the FPL requirements which is in the order of 570-600 mm above adjacent top of kerb level. Based on similar commercial developments in the Sydney CBD, it can be a challenge to achieve this threshold level with a driveway crest while balancing urban design outcomes for street level activation and vehicle clearance requirements. FPL criteria and mitigation can be addressed through further consultation with Council during detailed DA stage. Options to address the FPL requirements include extended ramping to achieve flood protection through grading, a flood barrier (subject to Council approval) or a combination of both.

#### **Ground Plane Development**

Ground plane development areas identified in the current Planning Proposal (*Level 0 Ground, DA-01-L00, Issue A*) include:

- Retail
- Tower Lobby

- Podium Lobby
- Wesley Mission

The ground plane development areas have a FPL based upon a merits approach with a minimum of the 1% AEP flood level. The WMAwater flood model indicates 1% AEP flood depths ranging 90-130 mm across the Castlereagh and Pitt Street frontages. These depths are conservatively measured from top of kerb due to the coarse nature of the flood model. As such, the ground plane development areas will require grading within the public domain and internally to the site to achieve the FPL requirements.

### Basement Access and Penetrations

Basement access and penetrations identified in the current Planning Proposal (*Level 0 Ground, DA-01-L00, Issue A*) include:

- Substation entry from Castlereagh Street
- Escalator up to Level 1 retail (on the basis that the escalator pit base will typically require a drainage pit connected to sewer in the basement)
- Lifts with connections to lower levels
- Stairs with connections to lower levels
- Escalators with connections to lower levels (eg escalator to Wesley functions)
- Services connections to lower levels, including ventilation ducts, light wells, services risers, voids over lower levels etc.

The basement access and penetrations have a FPL of the greater of the 1% AEP + 0.5 m or the PMF flood level. Based upon the WMAwater flood model results, the governing FPL is the 1% AEP + 0.5 m. The WMAwater flood model indicates 1% AEP flood depths ranging 70-130 mm across the Castlereagh and Pitt Street frontages. These depths are conservatively measured from top of kerb due to the coarse nature of the flood model. As such, the basement access and penetrations will require grading within the public domain and internally to the site to achieve the FPL requirements which is in the order of 570-630 mm above adjacent top of kerb level. This may be achieved through grading/ ramping in both the public and private domain and steps at thresholds. However, it is recognised that achieving the FPL requirements whilst maintaining urban design outcomes for street level activation and accessible entry is likely to be a challenge. Flood barriers may be an option to achieve compliance, however this is subject to Council approval.

## 4.2 Flood affectation

It is anticipated that public domain works will be undertaken to the Castlereagh and Pitt Street site frontages. This may include adjustment to footpath alignment levels and grading. Any adjustment to existing levels would need to consider the performance requirement for the development which is:

*the development should manage and mitigate flood risk and does not exacerbate the potential for flood damage or hazard to existing development and to the public domain; and*

*a development “will not significantly adversely affect flood behaviour resulting in detrimental increases in the potential flood affectation of other developments or properties”.*

During design development it will be necessary to coordinate the public domain design with the existing flooding to confirm that this requirement is met. This will also include incorporating detailed survey into the existing flood model to better define the existing site conditions.

## 5 Conclusion

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This preliminary flood assessment was based on the flood model results in the City Area Catchment Floodplain Risk Management Study. The model results are subject to assumptions and limitations associated with this model. Further hydraulic modelling is required to refine the existing flood levels, in particular incorporating detailed existing ground survey information for the site and surrounds and inclusion of more accurate representation of existing kerb lines within the model. Once the proposed design for the site has been developed, modelling will be undertaken to review flood performance, flood impact and to more accurately define the flood planning level requirements for the site.

The preliminary flood planning levels for the site have been identified based upon the existing WMAwater flood model. This information would be used to inform the future design development for the site. The requirements for the loading/ parking entry and exit and the basement access and penetrations (1% AEP flood level + 0.5 m) are particularly challenging within the constraints of maintaining urban design outcomes for street level activation and accessible site entry. This will require further consideration in design development to achieve compliance.

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8 February 2021

Dear

## 133 Castlereagh St Masterplan

Arup is currently providing preliminary flooding advice in support of the planning proposal for 133 Castlereagh Street Masterplan, hereafter referred to as “The Project”. Arup has previously prepared a report, “*Preliminary Flooding Advice for Planning Proposal*”, Issue 3, 10 August 2020 in which the following flood aspects were identified and summarised:

- A review of existing flood study relevant to The Project site;
- Identification of flooding design criteria; and
- Identification of development requirements to achieve the flood design criteria.

The report identified that that The Project is located within the floodplain based on being inundated up to the probable maximum flood (PMF) event. The flood planning level (FPL) requirements as defined by the City of Sydney’s “*Interim Floodplain Management Policy*”, May 2014 were defined for each of the proposed development uses and risks. These uses and risks included ground floor retail, below ground car park/ penetration etc.

CoS has previously provided comment that

*“Flood gates or barriers are not supported. Prior to giving consideration to the use of flood gates or barriers all other alternatives to meet the requirements of the City’s Policy need to be adequately investigated.”*

A review of design implications for compliance with the FPL requirements has been undertaken by the architect, 3XN. This review has identified that FPL compliance in areas with penetrations/ access to basement levels, would compromise the conflicting interests of:

1. Street level activation;
2. Disability Discrimination Act (DDA) compliance; and
3. Vehicle clearance requirements to basement level carpark ramp.

Compliance according to the CoS's "*Interim Floodplain Management Policy*" for penetrations/ access to basement levels requires a minimum FPL of the greater of 1% AEP + 0.5m or PMF. This letter has been prepared to discuss a proposal for an alternate FPL criterion which is considerate of the flood risk to the site whilst balancing the requirements of the above-mentioned design aspects.

The alternate options presented include FFLs/ threshold levels set at a minimum of:

1. PMF level
2. 300mm above gutter invert (complies with the CoS's "*Interim Floodplain Management Policy*" for below-ground car parks outside the floodplain.)

Achieving these alternate levels would provide flood immunity to the maximum possible flooding without the use of flood gates or flood barriers. The results of this review are contained in Table 1.

Preliminary architectural grading has been undertaken by 3XN and are referenced in this flood review. Relevant documents include:

- 550001\_210205\_Flood\_Plan\_Castlereagh Ground Floor Plan\_3XN.pdf
- 550001\_210205\_Flood\_Section Cuts\_Basement Parking\_3XN.pdf
- 550001\_210205\_Flood\_Section Cuts\_Section B\_3XN.pdf
- 550001\_210205\_Flood\_Section Cuts\_Section C\_3XN.pdf
- 550001\_210205\_Flood\_Section Cuts\_Section G\_3XN.pdf
- 550001\_210205\_Flood\_Section Cuts\_Section H\_3XN.pdf

Table 1: FPL Compliance Table

Location Reference	Description	FPL Criteria <sup>#</sup>	Proposed FFL/ Threshold Level (mAHD)	1% AEP (mAHD)	1% AEP + 0.5m (mAHD)	PMF (mAHD)	300mm Above Gutter Invert Level (mAHD)	Compliance with FPL Criteria? *	FPL Compliance comments
B	Tower lobby	Ground level – 1% AEP	19.91	19.913	20.413	20.072	19.99	Y	NA
		Basement penetrations – greater of 1% AEP + 0.5 or PMF	20.07					N	Achieves PMF flood immunity and minimum 300mm above gutter invert
C	Wesley Mission entry	Ground level – 1% AEP	20.14	20.140	20.64	20.337	20.27	Y	NA
		Basement penetrations – greater of 1% AEP + 0.5 or PMF	20.33					N	Achieves PMF flood immunity and minimum 300mm above gutter invert
G	Podium Lobby	Ground level – 1% AEP	22.55	22.368	22.868	22.481	22.56	Y	NA
		Basement penetrations – greater of 1% AEP + 0.5 or PMF	22.56					N	Achieves PMF flood immunity and minimum 300mm above gutter invert
H	Basement parking access ramp	Basement penetration – greater of 1% AEP + 0.5 or PMF	22.71	22.599	23.099	22.711	22.67	N	Achieves PMF flood immunity and minimum 300mm above gutter invert

<sup>#</sup> Source: CoS's "Interim Floodplain Management Policy", May 2014

\* Proposed FFLs have been rounded to 2 DPs and flood levels provided to 3 DPs. FFLs to achieve 3 DP FPL compliance in detailed design.

Compliance with FPLs (both CoS standard requirement or alternate agreed criteria) would be achieved by one or a combination of the following:

- CoS kerb and gutter profile;
- CoS footpath crossfall;
- Threshold ramps
- Landscape elements (within property boundary); and
- Ramping (internal to site boundary).
- Steps (internal to site boundary where acceptable eg egress stairs and substation)

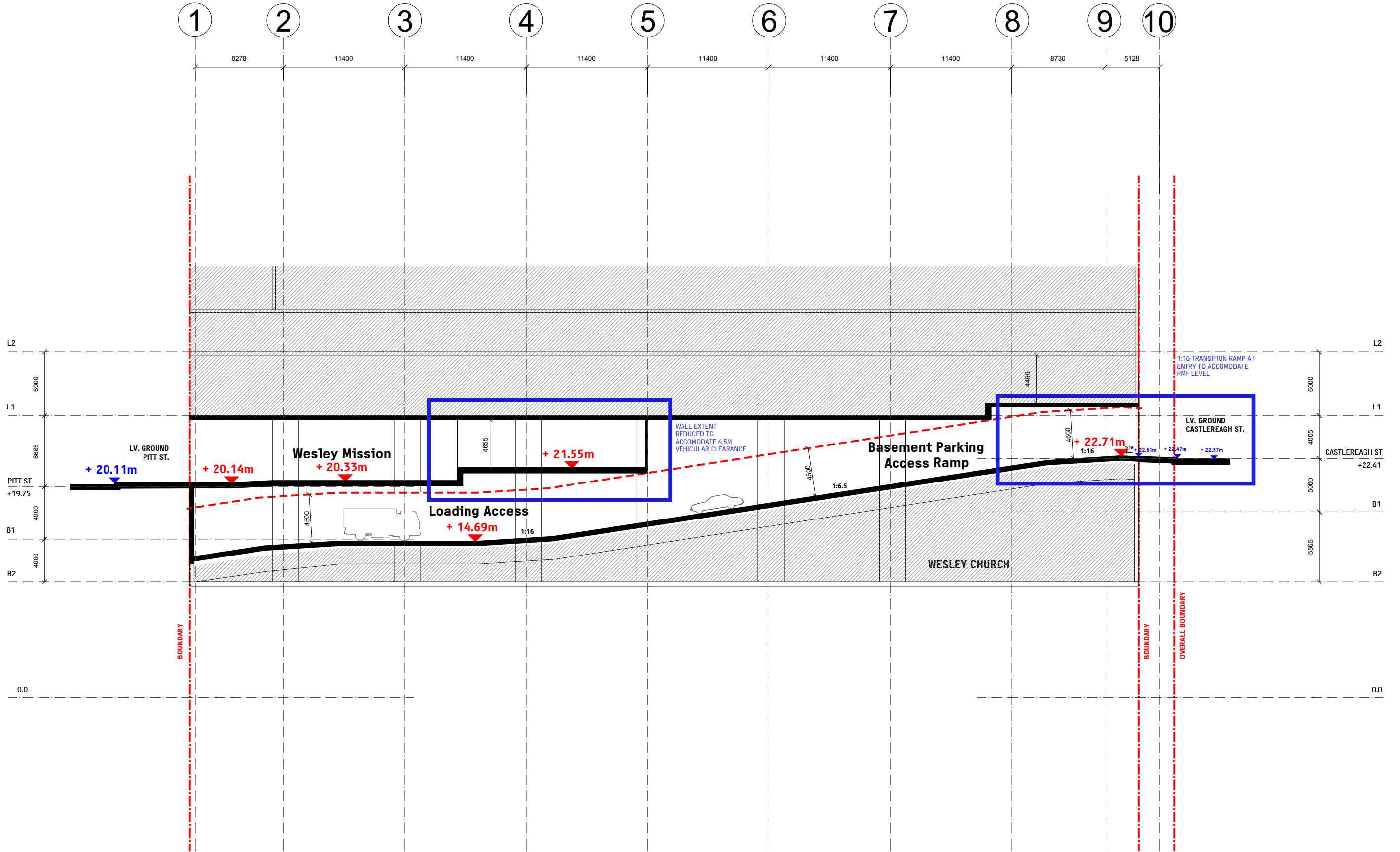
Once the appropriate FPL criteria are agreed with the CoS, the design would be developed in subsequent to design stages to achieve the required compliance. Acknowledging that the existing flood model is based upon LIDAR survey and a 2m grid, future design stages also present the opportunity to further refine the flood model and the resulting flood levels. This may include opportunities to incorporate detailed survey, reduce the grid size or assess the overland flow as a 1D channel.

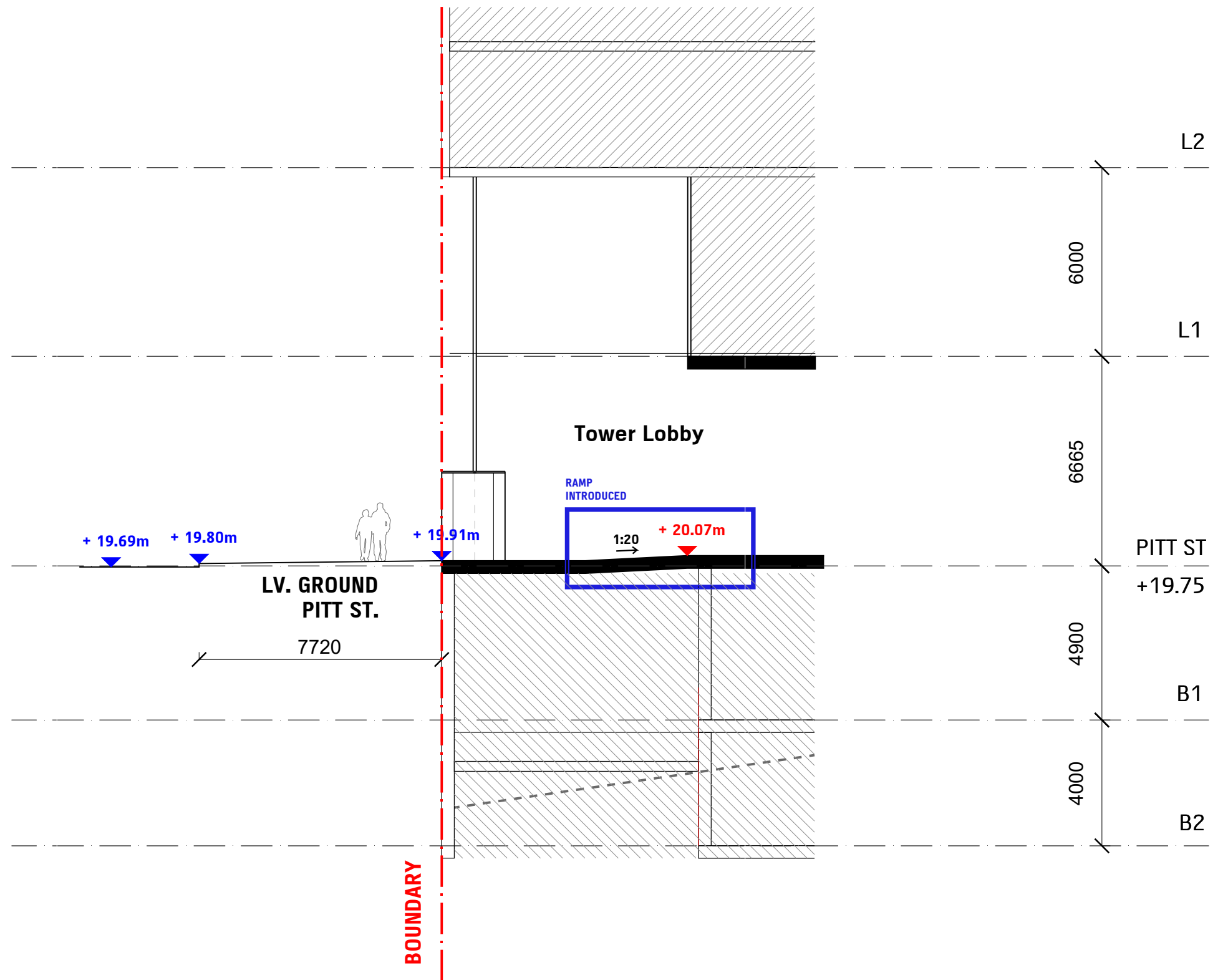
Yours sincerely



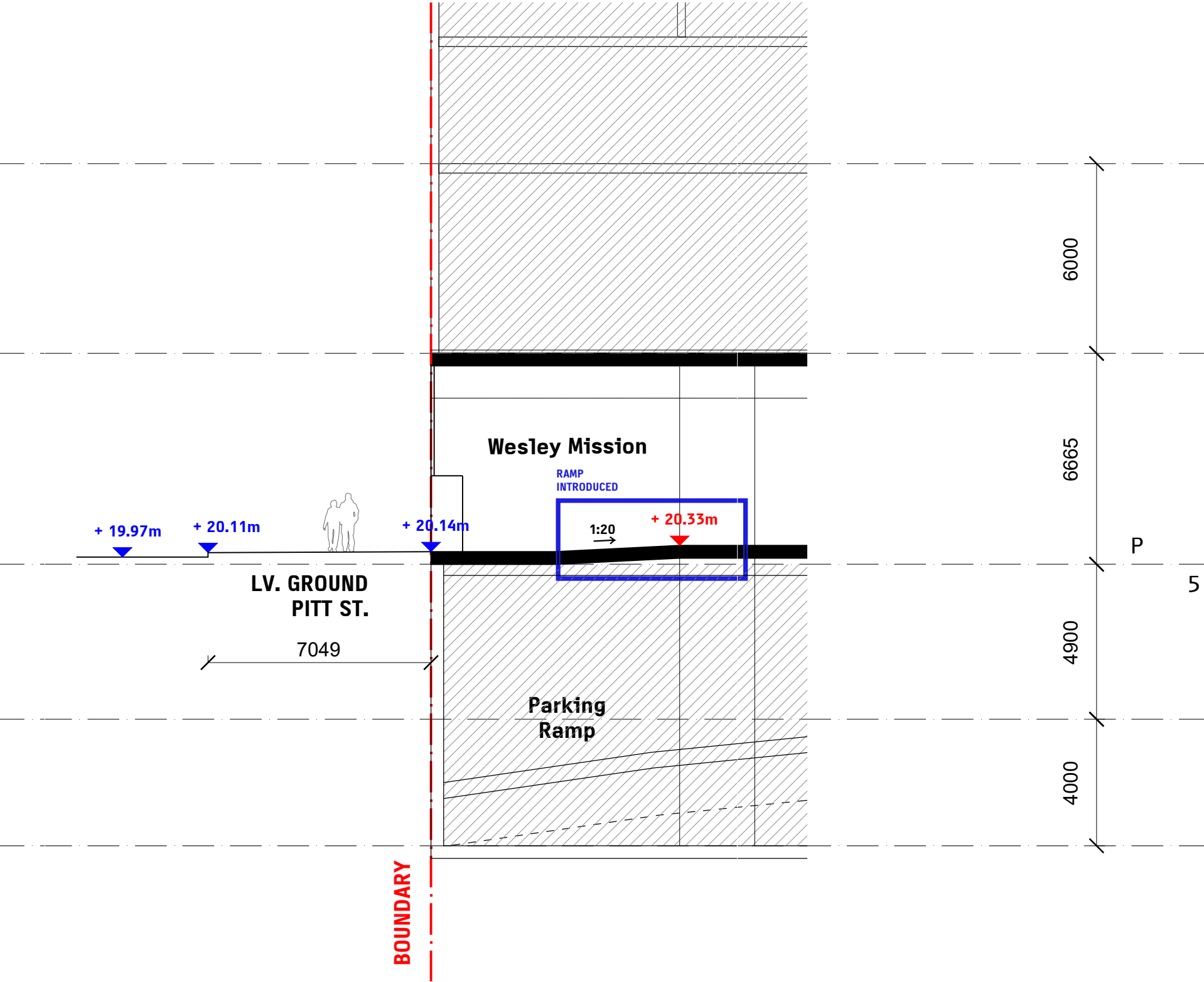
Karen Seeto  
Associate

cc      Iain Bell (Stockland)  
         Rob Saidman (Arup)  
         Cameron Dymond (Arup)  
         Sebastian Grøgaard (3XN)  
         Fred Holt (3XN)  
         Cristina Suarez (3XN)  
         Tim Blythe (Urbis)

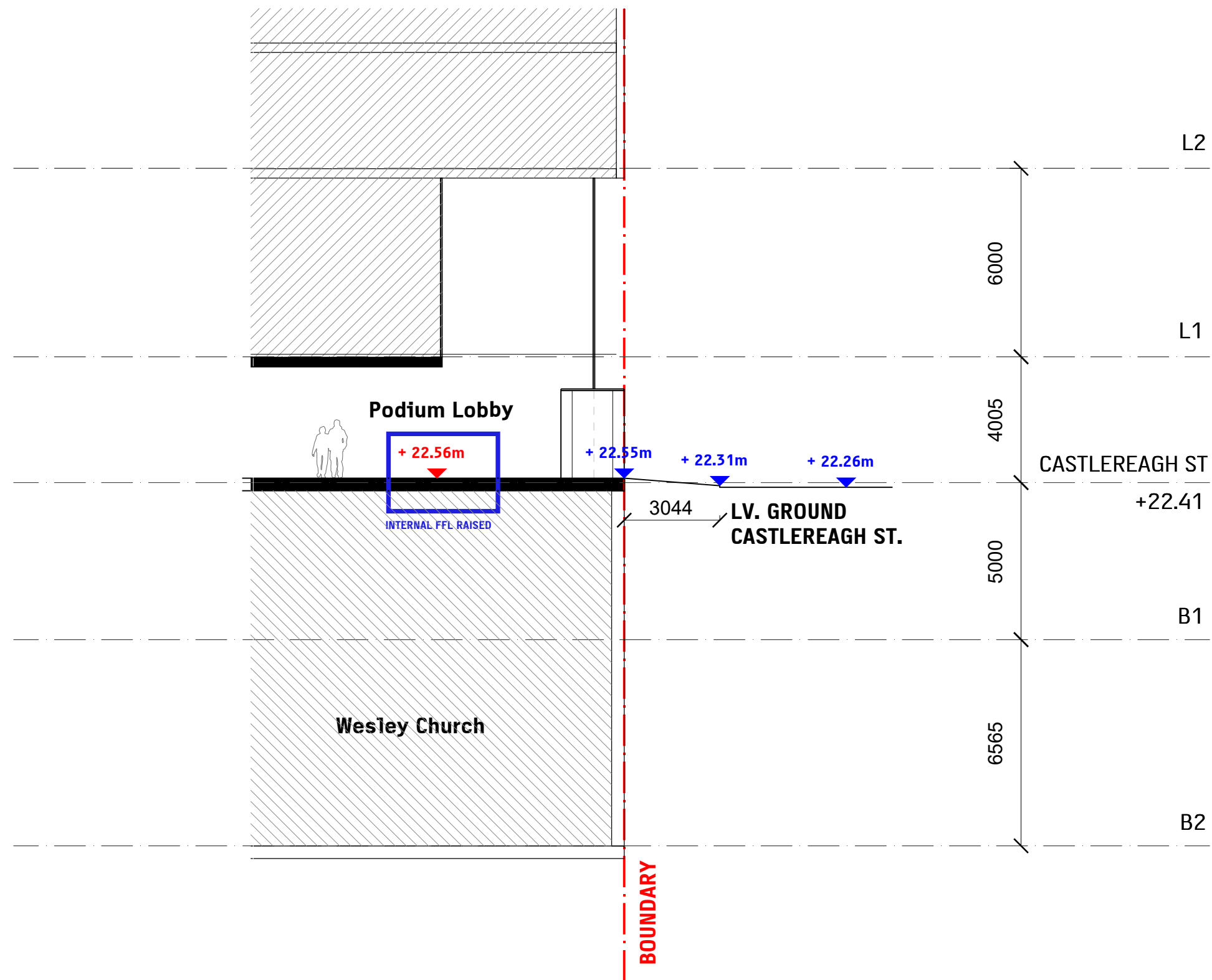




SECTION B



**SECTION C**



SECTION G

## SECTION H