SYDNEY CHILDREN'S HOSPITAL STAGE 1/CHILDREN'S COMPREHENSIVE CANCER CENTRE

SCH1/ CCCC

Flood Modelling Assessment

Civil

SSD No. 10831778

SCH-CIV-RPT-00001

Revision: 06

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Report Amendment Register

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01	For submission	E. Wu		George. K		12/02/2021
02	For Submission	G. Krzywda		George K.		27/04/2021
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Prepared by: Neal Foye

Date: 21/12/2020

Project No: 12221

Issued for: Response to SSD No. 10831778

Discipline: Civil

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1. Introduction

The purpose of this Report is to support the State Significant Development Application (SSDA) for the Sydney Children's Hospital Stage 1 (SCH1)/ Children's Comprehensive Cancer Centre (CCCC) (the project) at Randwick Campus Redevelopment area. This report responds to *item 17 Flooding* outlined in the Secretary's Environmental Assessment Requirements (SEARs) issued 2 December 2020 for State Significant Development Application (SSDA) 10831778:

- Identify any flood risk on-site in consultation with Council and having regard to the most recent flood studies for the project area and the potential effects of climate change, sea level rise and an increase in rainfall intensity;
- Assess the impacts of the development, including any changes to flood risk on- site or off-site, and detail design solutions to mitigate flood risk where required. This report is to be read conjunction with the flood maps in Appendix A.

The flood assessment results demonstrate that the proposed development complies with relevant requirements outlined in NSW Floodplain Development Manual (DIPNR, 2005) and Randwick Council DCP. Flooding related items in SEARs have been considered and addressed throughout this report.

This report has been updated in response to comments received from the Environmental, Energy and Science Group (EES) of the Department of Planning , Industry and Environment (DPIE) which were contained in the letter received from DPIE dated 24 June 2021. The following updates were made in this regard:

- SSDA site area (Figure 1) updated
- Randwick council DCP (Figure 5) added
- 1% EP levels and depth (BMT report extract – Figure 8) added
- Section 3.1 – Flooding – section amended
- Section 4.2 - Temporary & Permanent Flood Mitigation Requirements – section amended
- Appendix A, B and C added

2. Site Description

2.1. Location

The existing Randwick Hospital Campus is bound by High St to the north, Barker St to the south, Avoca St to the east and Hospital Rd to the west. The Sydney Children's Hospital Stage 1/Children's Comprehensive Cancer Centre (SCH1/CCCC) proposed development site was identified by the precinct master planning for future expansion of the Hospital Campus. The proposed development is located to the west of the existing campus and is bound by High St to the north, Magill to the south, Hospital Rd to the east and the University of New South Wales (UNSW) Kensington campus/Botany St to the west.

The SCH1/CCCC occupies the north east portion of the Randwick Campus Redevelopment (RCR) whilst the western portion is occupied by the UNSW Health Transition Hub (HTH) development. Refer to SSD-10822510 for further information on the HTH development.

The site lies immediately to the west of the existing SCH. Both of these developments lie to the north of the Integrated Acute Services Building (IASB) currently under construction. Refer to Figure 1 and 2 below. The site is located within the Randwick Local Government Area.

Figure 1 SSDA Site Area

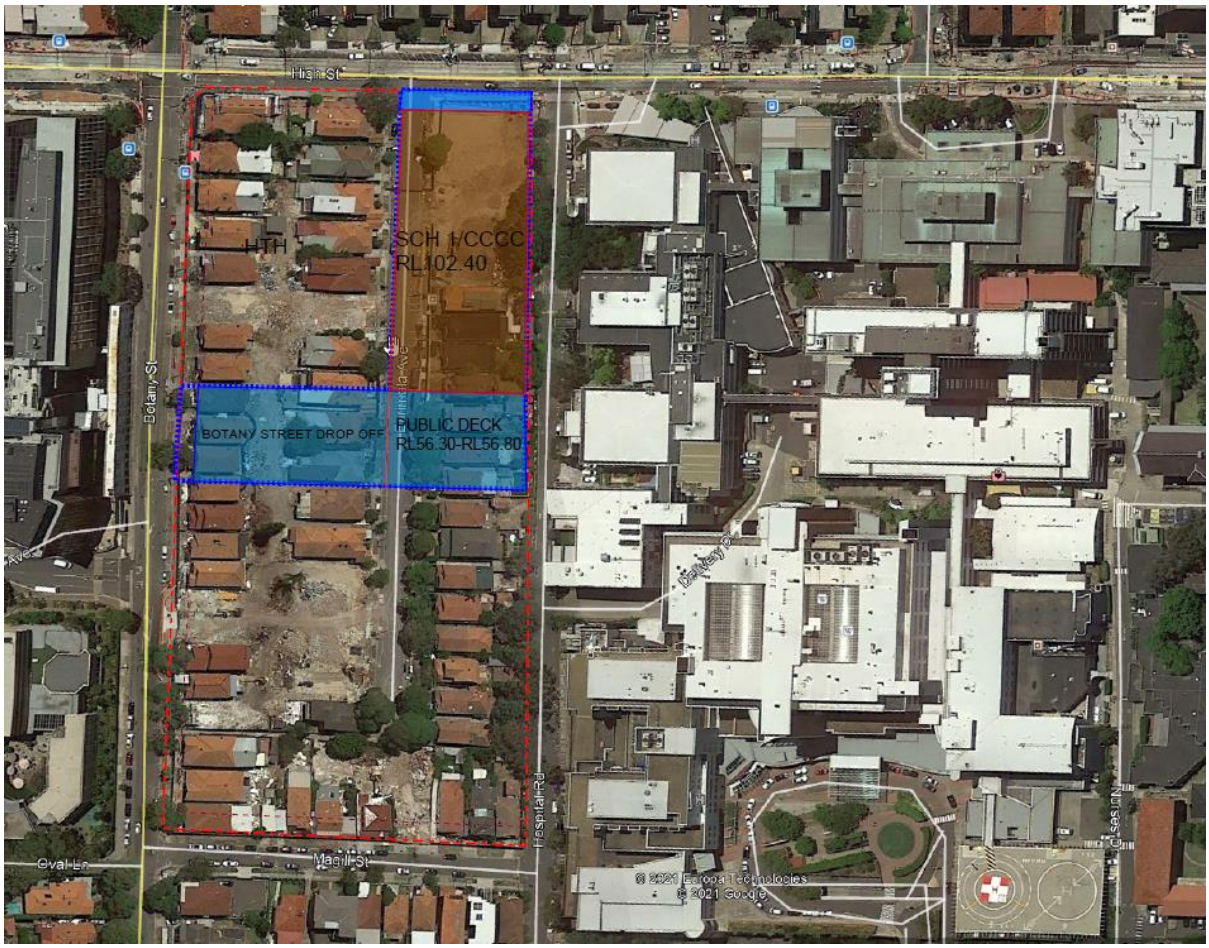


Figure 2 Aerial image of the site

2.2. Existing Flood Conditions

The RCR site bounded by High St, Botany Street, Hospital Rd and Magill St is affected by 1% Annual Exceedance Probability (AEP) and Probable Maximum Flood (PMF) flooding. A major overland flow path runs in a north-south direction through the centre of the site from the sag point on High St taking large upstream catchment from the north of the site.

Existing flooding conditions have been modelled and determined by BMT through Tuflow modelling. The results indicate that Hospital Road is not flood affected during the 1% AEP with the exception of localised ponding at existing trapped low point. Flooding occurs along High Street, Botany Street and the existing Eurimbla Avenue. Refer to Figure 3 and Figure 4 for the existing flood depth map for 1% AEP flooding and PMF event respectively by BMT.

Figure 3 1% AEP Flood depth - Existing Case (BMT 2018)

Figure 4 PMF Depth - Existing Case (BMT 2018)

3. Flooding

3.1. Design Criteria

Prior to the RCR, overland flooding ran southward from the sag point in High St, generally along Eurimbla St, towards Magill St. To protect the new IASB site from flooding in the PMF event a strategy for the was developed by Lendlease. This has been documented in the "*State Significant Development Application (SSDA) Civil Engineering Report for Randwick Campus Development Integrated Acute Services Building (IASB) Addition*" prepared by Acor Consultants on 05/08/2019 and Flood report prepared by BMT "*Randwick Campus Redevelopment IASB Project Summary Flood Report*" dated December 2018. Broadly this involves diverting stormwater from the sag point in High St to the west of the precinct and discharging into Botany St through large culverts. In line flood storage is also provided within these structures to ensure that the changed flood condition does not adversely affect any other properties.

This strategy dictates how the proposed sites are to be developed, as protection to the IASB relies on both developments blocking the flood waters across the full frontage of High St to a level which provides the required freeboard to the PMF (nominally 500mm). This imposes a significant constraint to both developments, specific requirements for each site is outlined below:

- SCH1/CCCC: as hospitals are critical infrastructure, Finished Floor Level (FFL) needs to achieve immunity to the PMF with adequate freeboard;
- Randwick City Council DCP outlines that the development is to ensure no increase in flood effects elsewhere for flood events up to and including the 1% AEP flooding;
- HTH site: as the protection to IASB site also relies on the development on HTH blocking flood waters from going south, flood protection is required north of the HTH site across the frontage of High Street. Refer to SSD-10822510 for further information;
- The staging of the works, including any delays in the construction of the HTH, will need to address the issue of the provision of flood protection to the IASB. This may include features such as temporary walls or bunds. Refer to SSD-10822510 for further information.

The flood protection requirements for the basements adjacent to the Botany St entry s (i.e. the underground carpark) is 1% AEP plus freeboard.

Further information is provided on this in the extracted tables below from the Water Management section of Randwick Council's draft Comprehensive DCP.

Table B - Floor Levels for Car Parking

Scenario	Floor Level
Above ground level open car parking, car ports and garages	
Open car parking spaces and car ports	5% AEP flood
Residential garages for up to two spaces	1% AEP but not less than 0.15m above surrounding ground level
Residential garages with more than two spaces	Applicable residential habitable floor level requirement (Table A)
Enclosed industrial/ Commercial parking spaces	Applicable industrial/commercial floor level requirement (Table A)
Underground car park (where floor level is more than 0.8m below surrounding ground level)	
Inundated by flooding or local overland flow path	All openings to be sealed up to 1% AEP + 0.5m freeboard with a minimum of 0.3m above the surrounding ground level
All emergency exits	All underground garages and car parks to have emergency exits protected from inundation up to the 1% AEP flood plus 0.7m freeboard with a minimum of 0.2m freeboard from vehicle entry point.

Table A - Floor Levels for Buildings

Scenario	Floor level
Habitable Floors - all development (excluding critical facilities)	
Inundated by flooding	1% AEP + 0.5m freeboard
Inundated by overland flow path	Two times the depth of flow in the 1% AEP flood with a minimum of 0.3m above the surrounding surface
Habitable floors - Critical facilities	
Inundated by flooding	PMF + 0.5m freeboard
Inundated by overland flow path	Two times the depth of flow in the PMF with a minimum of 0.3m above the surrounding surface
Non-habitable floors – residential (excluding garages)	
Gross floor area less than or equal to 10 square metres.	1% AEP but not less than 0.15m above surrounding ground level
Gross floor area greater than 10 square meters.	The applicable habitable floor level
Non-habitable floors – Industrial and commercial	
Located on flooding or overland flow path	1% AEP but not less than 0.15m above surrounding ground level
Material storage locations – all development	
Materials sensitive to flood damage, or which may cause pollution or be potentially hazardous during flooding	1% AEP + 0.5m freeboard

Figure 5 Extract of Randwick Council's draft Comprehensive DCP

3.2. Available Data

The BMT TUFLOW model for the development of IASB has been provided to Bonacci by the IASB project team. The key features of the design include:

- Flood storage adjacent to High Street and a portion of Botany Street to collect and divert upstream flood water from the Eurimbla Avenue to Botany Street;
- Stormtrap for water detention system;
- Site filling to provide flood immunity.

3.2.1. Ground Surface Assumptions

Interrogation of the model has been carried out and an extraction of the ground surface design/assumptions included in the model is shown in Figure 5. The Hospital site has been modelled as a podium at RL60.00 which is well above the PMF level plus freeboard (approximated at RL 56.23), which functions as a blockage to ensure no flood water will travel further south to the SCH1/CCCC and HTH site and also provide flood protection to the IASB site.

As discussed above, this modelling strategy dictates that any future development within the SCH1/CCCC site and HTH site will need to protect the building entrances and openings as well as providing flood immunity to IASB site.

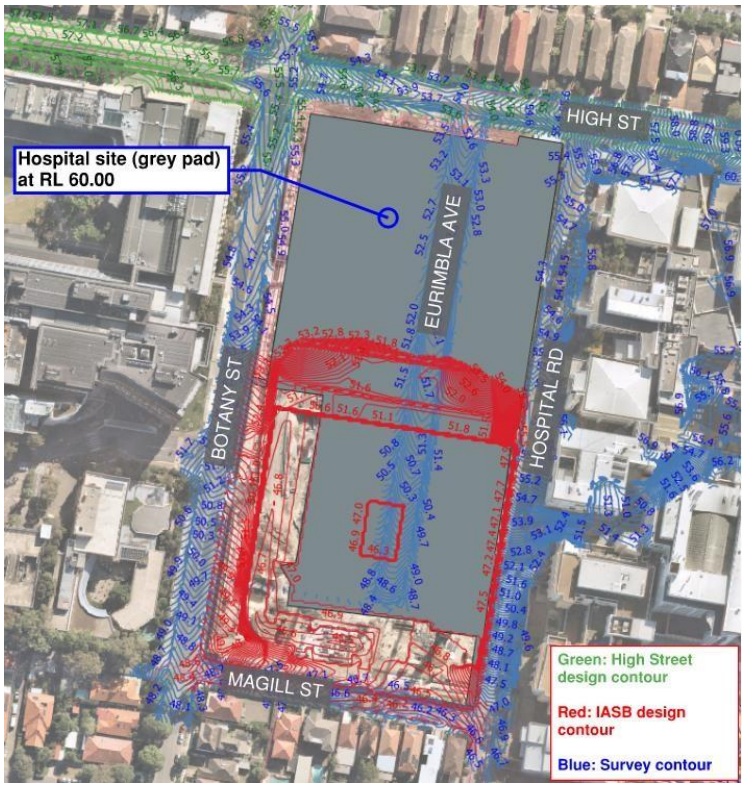


Figure 6 TUFLOW Model Ground Surface Design Extracted from BMT TUFLOW Model

3.2.2. Flood Modelling Results

Bonacci has been supplied with the TUFLOW model for the IASB development (model developed by BMT). A modelling run for the PMF flood event with the proposed flood strategy for IASB development has been carried out and the results are shown below.

3.2.3. Flood Levels and Depths

In a PMF event, a proportion of the stormwater is conveyed to Botany St via the buried culvert with the remainder overflowing into Botany St at the North West Corner of the site. In this scenario the water in High St ponds to a level of 55.75.

Randwick Council DCP require that a free board of 500mm be provided to the PMF for critical facilities. As a result, the minimum level to which the HTH and SCH1/CCCC sites need to be filled to provide protection for the precinct is RL 56.25.

The PMF and 1% AEP flood extents and depths as obtained from the BMT flood report for the precinct are provided below.

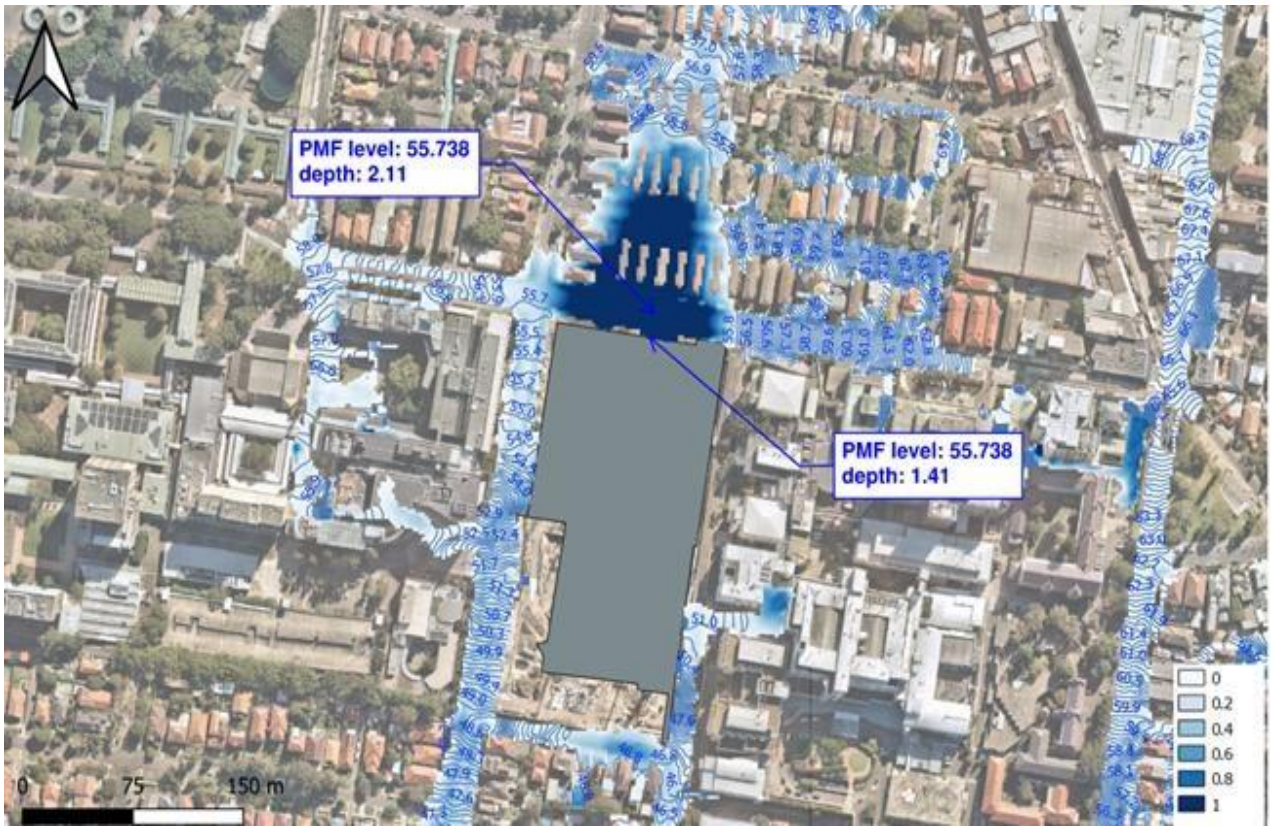


Figure 7 PMF Levels and Depth from BMT TUFLOW Model

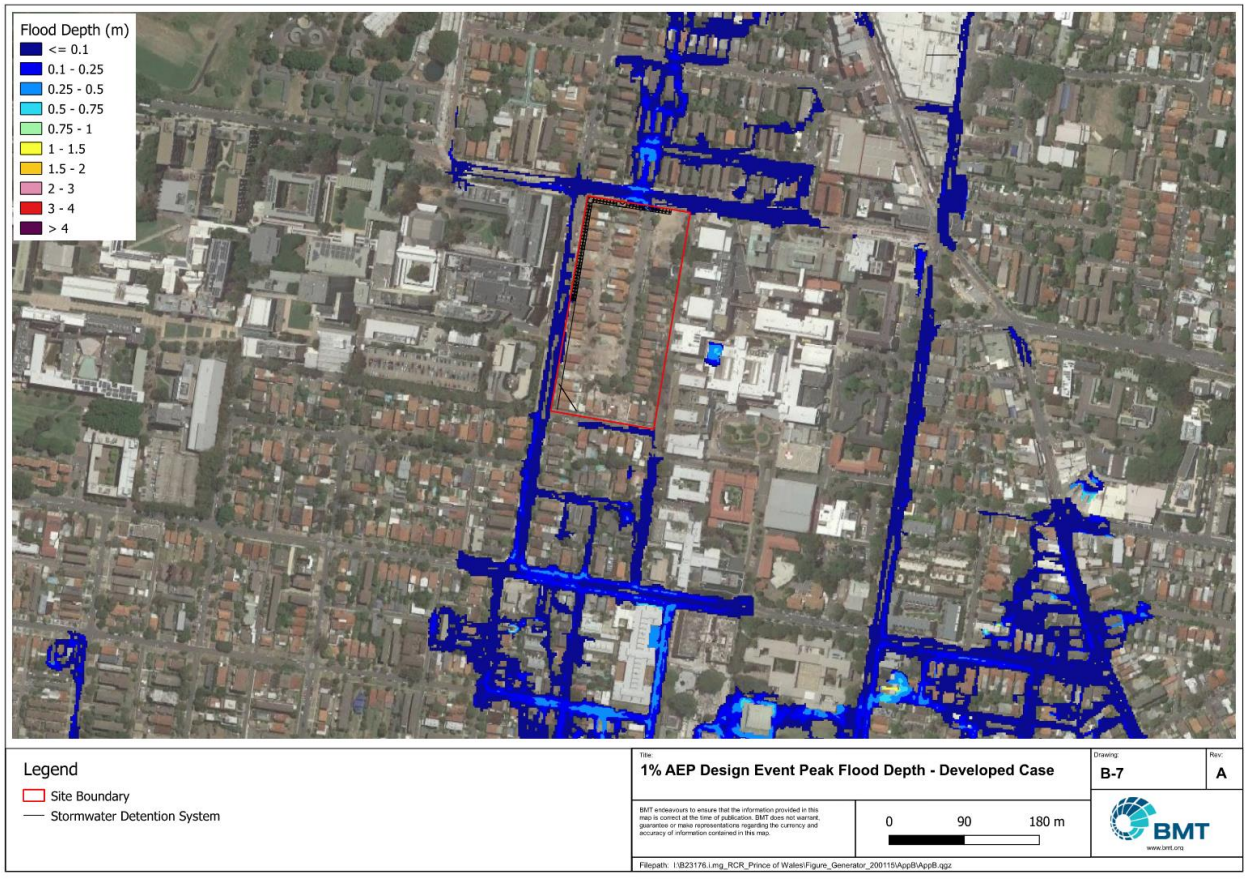


Figure 8- 1% AEP Levels and Depths (BMT Flood Report for IASB Development, 2020)

3.2.4. Flood Hazard

Flood hazard is high on the frontage of the site on High Street as expected given that the original overland flow path is blocked by the artificial podium on the SCH1/CCCC site and the HTH site.

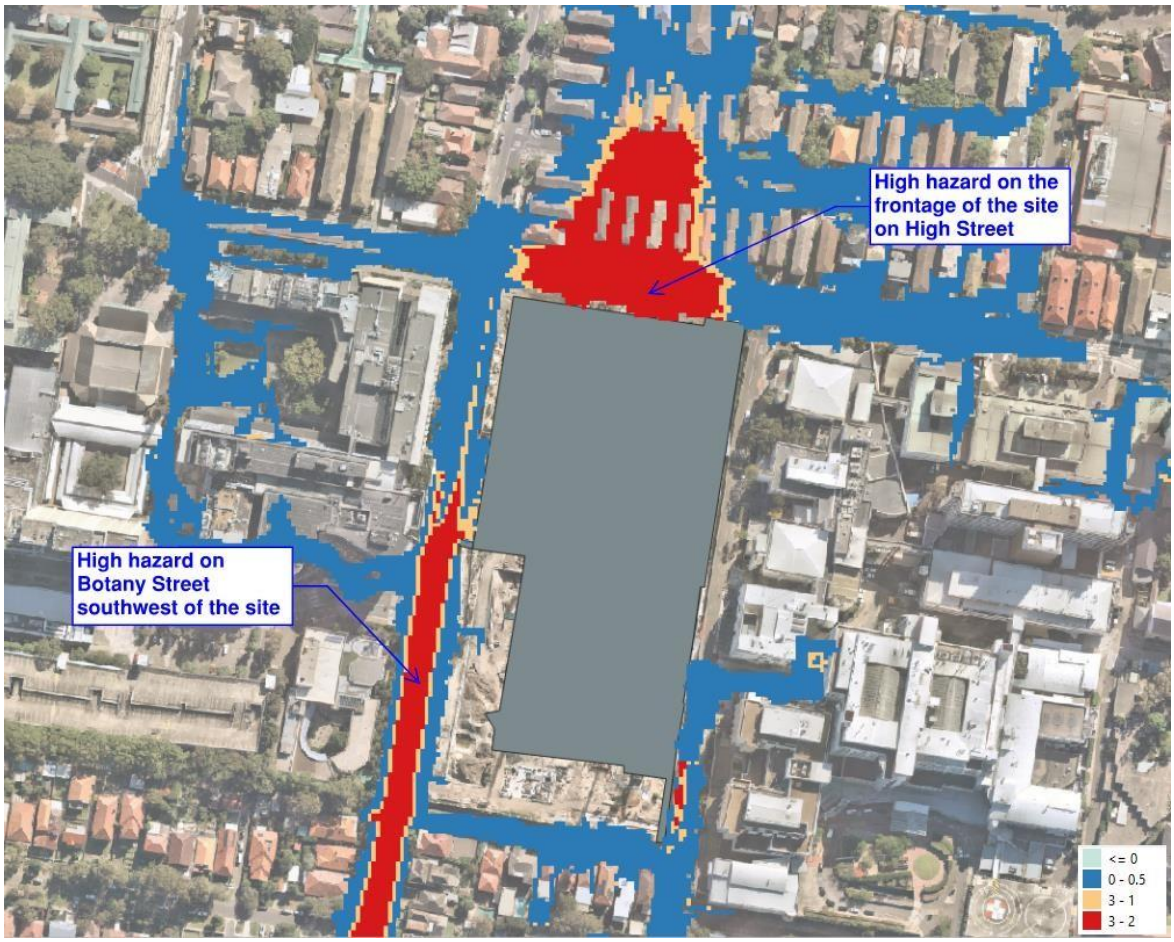


Figure 9 - PMF Hazard from BMT TUFLOW Model

3.2.5. Flood Afflux

BMT's 1% AEP flood impact map further demonstrates that the key design features including the filling of the hospital site, installation of stormtraps and the diversion of flood water need to be put in place to ensure no adverse impact on external properties during the 1% AEP storm event.

Figure 10 - 1% AEP Flood Afflux Map (BMT Flood Report for IASB Development, 2018)

The results above demonstrate that the development complies with all design criteria with appropriate mitigation strategies around the whole development area. The following section outlines the specific mitigation measures that SCH1/CCCC proposed to ensure compliance with relevant guidelines.

4. Mitigation Measures

4.1. Final Condition of the Precinct

The current planning for the SCH1/CCCC site requires the construction of floors and basements below RL56.25 and is not to be filled as assumed in the original model. In order to provide flood protection to the precinct, both developments will need to construct an impermeable barrier to RL56.25 along the full length of High St.

There would need to be no points where water could ingress such as doors, windows or vents. For example, steps or ramps which rise to a podium at RL56.25 would have the desired effect in place of filling the site.

4.2. Temporary & Permanent Flood Mitigation Requirements

To provide protection required we propose the following:

1. Prior to occupation of the IASB building, a sufficient barrier should be in place along the full frontage of High Street. This barrier needs to be at or above the PMF plus freeboard level.

   The staging of the SCH1/CCCC and HTH building construction works relative to the opening of the IASB building is not yet known. The flood barrier needs to be in place prior to the opening of the IASB and remain in place while the IASB is operational. The flood barrier in front of SCH1/CCCC and HTH may be a temporary or permanent wall design on the staging times of both projects.

   There may be a very short periods (a matter of weeks or a month) where no protection is provided during the transition of a construction period between the temporary and permanent solution.

   This barrier needs to be watertight and able to resist the hydrostatic pressures imposed by the flood water. Options could include a wall of suitable construction or a engineered soil berm. A flood barrier will also need to be constructed along the Botany St boundary to provide the required freeboard to the floodwaters flowing down the road reserve.

2. During construction of the SCH1/CCCC building a sufficient temporary or permanent flood barrier needs to be maintained along the High St frontage of both the HTH and SCH1/CCCC sites. This barrier needs to be at or above the PMF plus freeboard level.

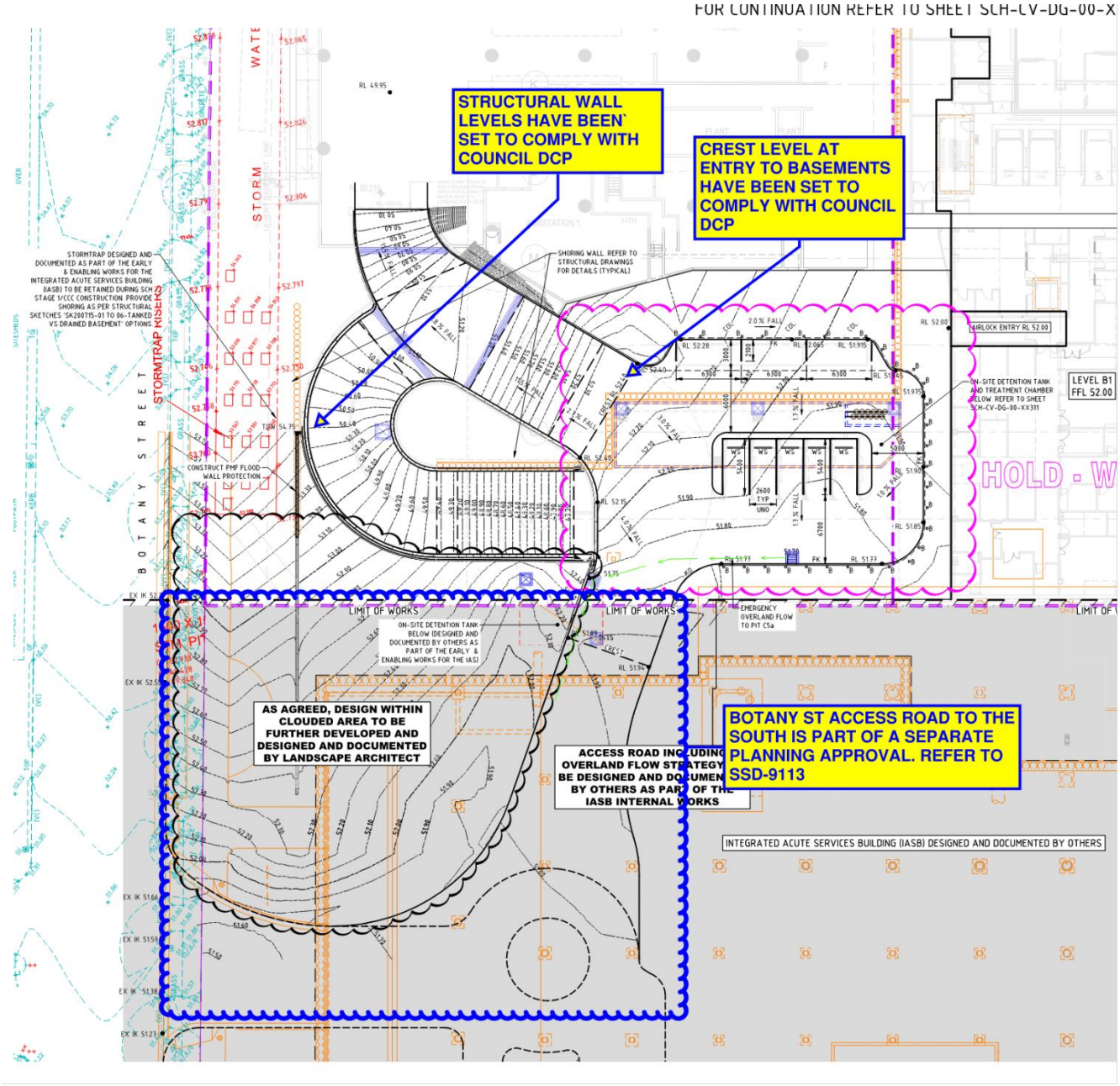
   The adopted construction methodology for the barrier will be developed by the SCH1/CCCC builder.

3. On completion of the SCH1/CCCC development, an interim flood protection will still need to be provided along the High Street and Botany Street boundaries of the HTH site until that building is completed.

   This is to be provided by a temporary flood protection barrier to the HTH frontage. This temporary barrier will coordinated and connected to the permanent SCH1/CCCC barrier to ensue the two work in conjunction with each to provide a complete barrier to the northern site boundary. Please refer to the diagram in Appendix C for details.

4. The basement entry off Botany Street is permanently protected by a crest entrance level in the forecourt set at the 1% AEP plus freeboard level. Additionally, the adjacent structural walls of the entry ramp to the basement are to be set at a height above the 1% AEP plus freeboard level to also provide a permanent solution to protect the HTH basement.

Appendix A – Civil Drawing of Botany St Entry


FOR CONTINUATION REFER TO SHEET SCH-CV-DG-00-X
STRUCTURAL WALL LEVELS HAVE BEEN SET TO COMPLY WITH COUNCIL DCP
CREST LEVEL AT ENTRY TO BASEMENTS HAVE BEEN SET TO COMPLY WITH COUNCIL DCP
BOTANY STREET
STORMTRAP KIS14
STORM WATE
AIRLOCK ENTRY RL 52.00
LEVEL B1 FFL 52.00
HOLD - W
LIMIT OF WORKS
AS AGREED, DESIGN WITHIN CLOUDED AREA TO BE FURTHER DEVELOPED AND DESIGNED AND DOCUMENTED BY LANDSCAPE ARCHITECT
BOTANY ST ACCESS ROAD TO THE SOUTH IS PART OF A SEPARATE PLANNING APPROVAL. REFER TO SSD-9113
INTEGRATED ACUTE SERVICES BUILDING (IASB) DESIGNED AND DOCUMENTED BY OTHERS

Appendix B – Responses to SSDA Comments

Comments have been received from the Environmental, Energy and Science Group (EES) of the Department of Planning, Industry and Environment which were contained in the letter from DPIE RTS to Health Infrastructure dated 24 June 2021.

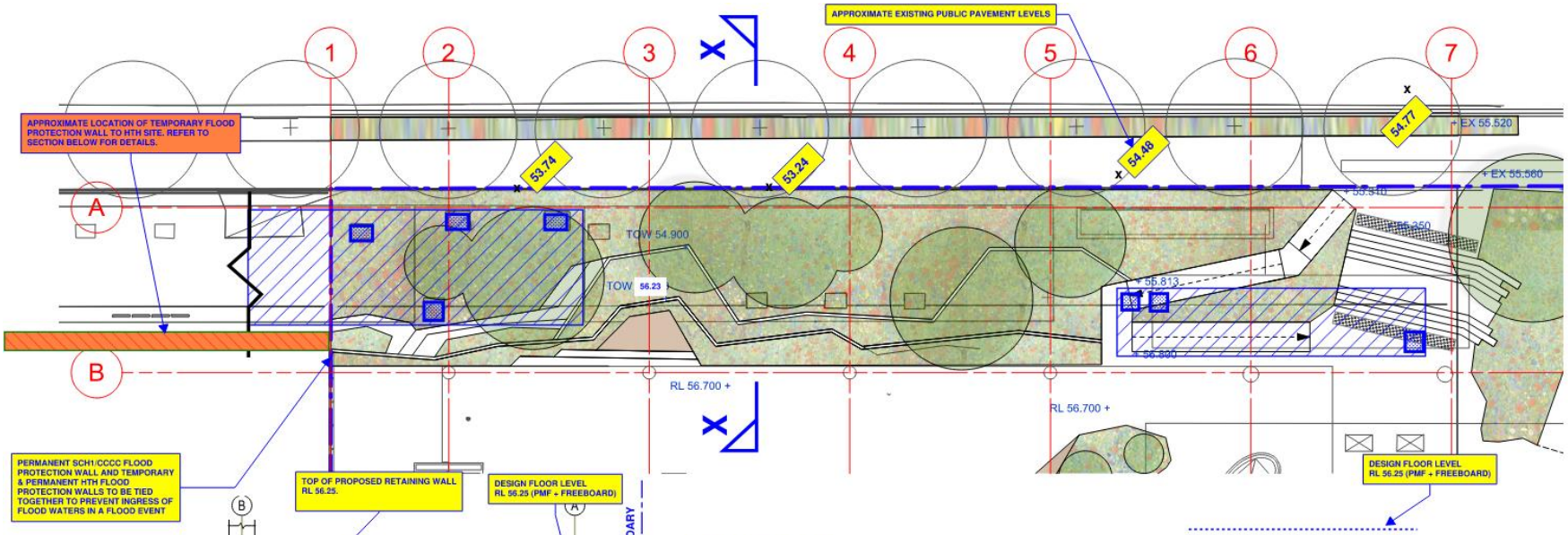
These comments relate to the flooding and flood protection on site and were received following the SSDA submission (SSDA NO SSD-10831778) for the project. These queries are listed in black italics below. Meinhardt Bonacci's responses to each query follows each in red.

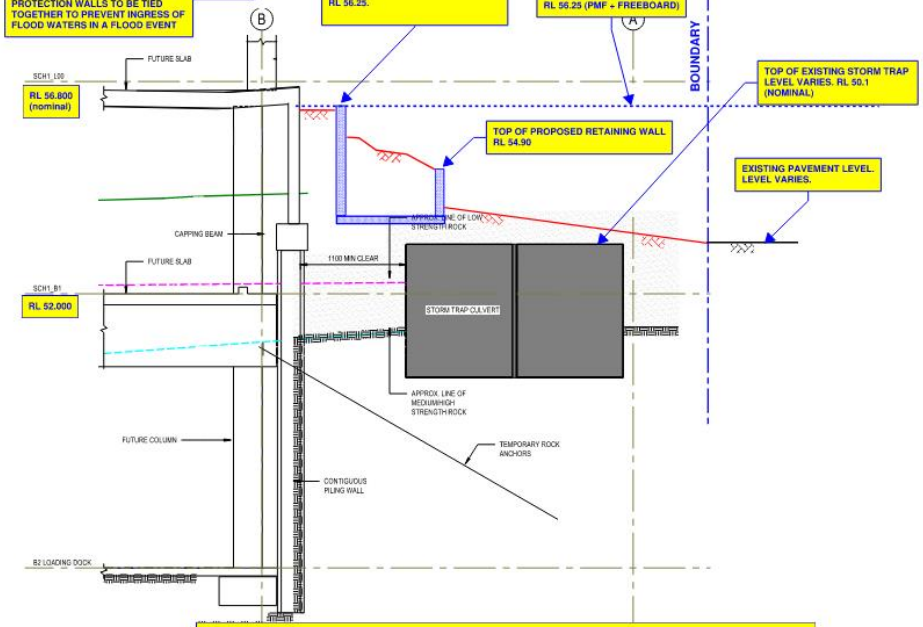
EES Comment	**Meinhard Bonacci Response**
Floodplain Risk Management The emergency department and car park for Sydney Children's Hospital Stage 1 and Children's Comprehensive Cancer Centre are proposed below ground level and below the relevant flood level. The Flood Modelling Assessment (Meinhardt Bonacci, 27 April 2021) notes correctly that a flood barrier 500mm above the probable maximum flood (PMF) of 1.4m in High Street will be required to protect the building from flooding. The subject development and the adjoining Health Transition Hub (SSD-10822510) buildings are proposed to be the flood barrier. EES does not support the use of new hospital buildings as a flood barrier – any required barrier should be separate and independent to any building wall. EES requests additional information be provided on the flooding issues, including revised reporting and drawings as follows.	Meinhardt Bonacci are of the opinion that the proposed perimeter walls to the main structure can be designed to withstand the required hydraulic forces which would be exerted in a maximum flood event. We do not believe that it is structurally or hydraulically required that a separate structure to the main building is required for this development. If it is deemed that the main building walls cannot be used for flood protection, an alternative solution can be implemented. Please refer to the attached drawing (SK 210725-01) provided in Appendix C which illustrates a proposed independent flood protection structure for the northern elevation. The proposed flood protection walls will be incorporated with the proposed landscaping design. The main entry steps to the building, which are also part of the landscaping scope, will also provide flood protection to the building. The attached drawing addresses the comments provided by EES and contained in the DPIE RTS letter dated 24 June 2021
1. A description of the flood barrier, including the following: - Material type	The proposed material type for the permanent flood protection wall is concrete with a reinforced concrete base. The permanent flood protection wall is proposed to be integrated with the landscape design to provide for a suitable urban outcome
- Finished surface levels at suitable intervals along the top of the barrier.	The top of retaining wall will be set at the flood design level (PMF + freeboard). Please refer to the attached drawing (SK 210725-01) provided in Appendix C.
- How the barrier would tie in to surrounding ground to prevent outflanking, i.e. floodwater making its way around the barrier, and	The SCH1/CCCC barrier and main entry steps will extend sufficiently to the east to marry in the proposed Hospital Road levels. The Hospital Road levels will also be at or above the design flood level in order to prevent outflanking of the flood waters from the east. The temporary HTH barrier designed by Meinhardt Bonacci will extend far enough to the west to prevent outflanking to the west. The permanent HTH flood barrier is to be designed by others. Please refer to SSD-10822510. The SCH1/CCCC permanent barrier will suitably tie into the temporary HTH barrier to prevent outflanking of the flood waters from the west of SCH1/CCCC. The tie in detail between the SCH1/CCCC permanent wall and the HTH temporary wall is to be confirmed once the HTH barrier design is developed. The junction will be suitably designed to hold back any flood waters.
- How the barrier would interface with the building, e.g. whether any footings are likely to be required and if these can feasibly be provided separately to the hospital building.	Refer to the attached sketch in Appendix C which shows the proposed flood protection wall structure, independent of the main building.

2. The Flood Modelling Assessment states that the flood barrier must be watertight and able to resist hydrostatic pressures. In addition, the flood barrier below the PMF level must be designed to achieve the following: - withstand the impact of likely debris, such as floating cars.	Please refer to the attached drawing (SK 210725-01) provided in Appendix C illustrating a proposed lower height wall in front of the taller main flood protection wall. The proposed lower wall can act as a protective barrier. This concrete retaining wall will be designed to withstand debris from the flood waters. The rate of flow of flood water (and therefore debris) in this urban (i.e not tidal or riverine) and relatively flat setting is not anticipated to be fast.
- accommodate predicted scour, and	The proposed flood protection wall will be designed to accommodate the predicted scour from the PMF design flood event.
- withstand buoyancy and drawdown forces, if applicable.	The flood protection barrier will be designed to withstand the required buoyancy and drawdown forces.
3. For all potential flood ingress points to below ground levels of the development, the level of the entry and relevant flood level must be stated (preferably tabulated to allow ease of comparison), and a description provided of how it will be protected against the ingress of floodwater. This will include, but is not limited to: - Basement carparks (the PMF event or 1% AEP event plus 500 mm freeboard would apply) - The driveway from Botany Street, and - Air vents/louvre openings along the north elevation, including specification of the minimum permissible level(s) for any such openings on architectural drawings.	Refer to table below.

Area	**Flood Design Level**	**How this area is to be protected against the ingress of floodwater**
Basement carparks	1 in 100 year ARI rainfall event plus 500mm freeboard. That is, RL 52.4 for the SCH1/CCCC car park entry near Botany St.	The entry level to the car park will be set at the flood design level in order to prevent flood ingress. This is compliant with Randwick Council's DCP.
The driveway from Botany Street	The SCH1/CCCC ED entrance connects into the driveway from Botany Street designed by others. Please refer to SSD-9113 for further details.	The SCH1/CCCC ED entrance connects into the driveway from Botany Street designed by others. Please refer to SSD-9113 for further details.
Air vents/louvre openings along the north elevation, including specification of the minimum permissible level(s) for any such openings on architectural drawings	PMF rainfall event plus 500mm freeboard. That is, RL 56.239 for the SCH1/CCCC Level 00 podium area.	The Level 00 podium level has been set at the flood design level of PMF plus 500mm freeboard level at typically RL 56.80 along the northern boundary. Building air vents/louvre openings will be designed to be above the design level noted to prevent flood water ingress.

Appendix C – Proposed Northern Boundary Independent Structure for Flood Protection





SECTION X-X
TYPICAL PROPOSED PERMANENT DETAIL IN FRONT OF SCH1/CCCC BUILDING

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Project Name: SYDNEY CHILDREN'S HOSPITALS STAGE 1 - CCCC BUILDING (SCH1/CCCC)		Drawn: NMF	Date: 25/07/2021
Drawing Title: NORTHERN BOUNDARY - PROPOSED FLOOD PROTECTION MEASURES	Project Ref: 12221	Drawing No: SK 210725-01	Rev: B

REV A - 28.7.21 - UPDATED FOLLOWING MEETING OF 28.7.21
REV B - 29.7.21 - HATCH TO PROPOSED WALLS UPDATED

MEINHARDT BONACCI