IGS INTEGRATED GROUP SERVICES

Lot 1 DP 219742, Concord West

Flood Impact Assessment

Job Number: EN_N15 - 65
September 2016
Rev 0.6

VALUE | INNOVATION | TRUST

IGS INTEGRATED GROUP SERVICES

Level 4, 46a Macleay Street
Potts Point, NSW 2011
Phone: +61 2 8488 4600
Fax: +61 2 9475 4588
Email: admin@igs.com.au
Web: www.igs.com.au
linkedin.com/company/3213174
ABN: 68 163 019 029

Document Control

Version	Date	Author		Reviewer	
0.1	29 October 2015	Sam Haddad Andrew Barnett	SH AB	Mays Chalak	MC
0.2	04 December 2015	Sam Haddad Andrew Barnett	SH AB	Mays Chalak	MC
0.3	27 January 2016	Sam Haddad Andrew Barnett	SH AB	Mays Chalak	MC
0.4	27 January 2016	Sam Haddad Andrew Barnett	SH AB	Mays Chalak	MC
0.5	25 July 2016	Sam Haddad Andrew Barnett	SH AB	Mays Chalak	MC
0.6	09 Sept 2016	Sam Haddad Andrew Barnett	SH AB	Mays Chalak	MC

CONTENTS

1 INTRODUCTION

IGS was commissioned to undertake a flood assessment to support the proposed rezoning of Lot 1 in DP 219742 in Concord West.

This report outlines the approach taken for the flooding assessment for the proposed development on the site and the measures adopted to address the requirements of Council. The location of the site is shown in Figure 1-1.

Figure 1-1 – Locality Plan (Aerial Image Source: Nearmap)

The site has an existing industrial warehouse and associated office space of double storey construction. The site is currently used as a paintball facility.

The proposed re-development of the site comprises a new internal road and several multi-storey residential buildings with basement car parking. It is part of the Concord West Precinct development area bounded by Powells Creek and Homebush Bay Drive to the west, the Northern Railway line to the east, Pomeroy Street to the south, and the suburb of Liberty Grove to the north.

1.1 Previous Report

Jacobs have undertaken the Concord West Precinct Master Plan Flood Study (CWPMFS) (Jacobs 2015) which was commissioned by the City of Canada Bay. This flood study identifies the existing conditions for the Concord West Precinct adjacent to the Powells Creek channel to the west of the site. The development site was included as part of this flood study.

1.2 Jacobs Report Discussion

The report prepared by Jacobs includes a mitigation strategy that would allow the subject site to be developed.

The proposal as prepared by Jacobs includes providing flood free building pads for the proposed buildings and the internal roads within the development site. These flood free pads would detract from the available flood storage on the site. To mitigate the reduced flood storage from the flood free building pads, Jacobs proposed a floodway channel through the development site, as well as re-grading the areas of the site external to the proposed building and road footprints.

Figure 1-2 shows a screenshot of the flood mitigation works as proposed by Jacobs in the Concord West Precinct Master Plan Flood Study.

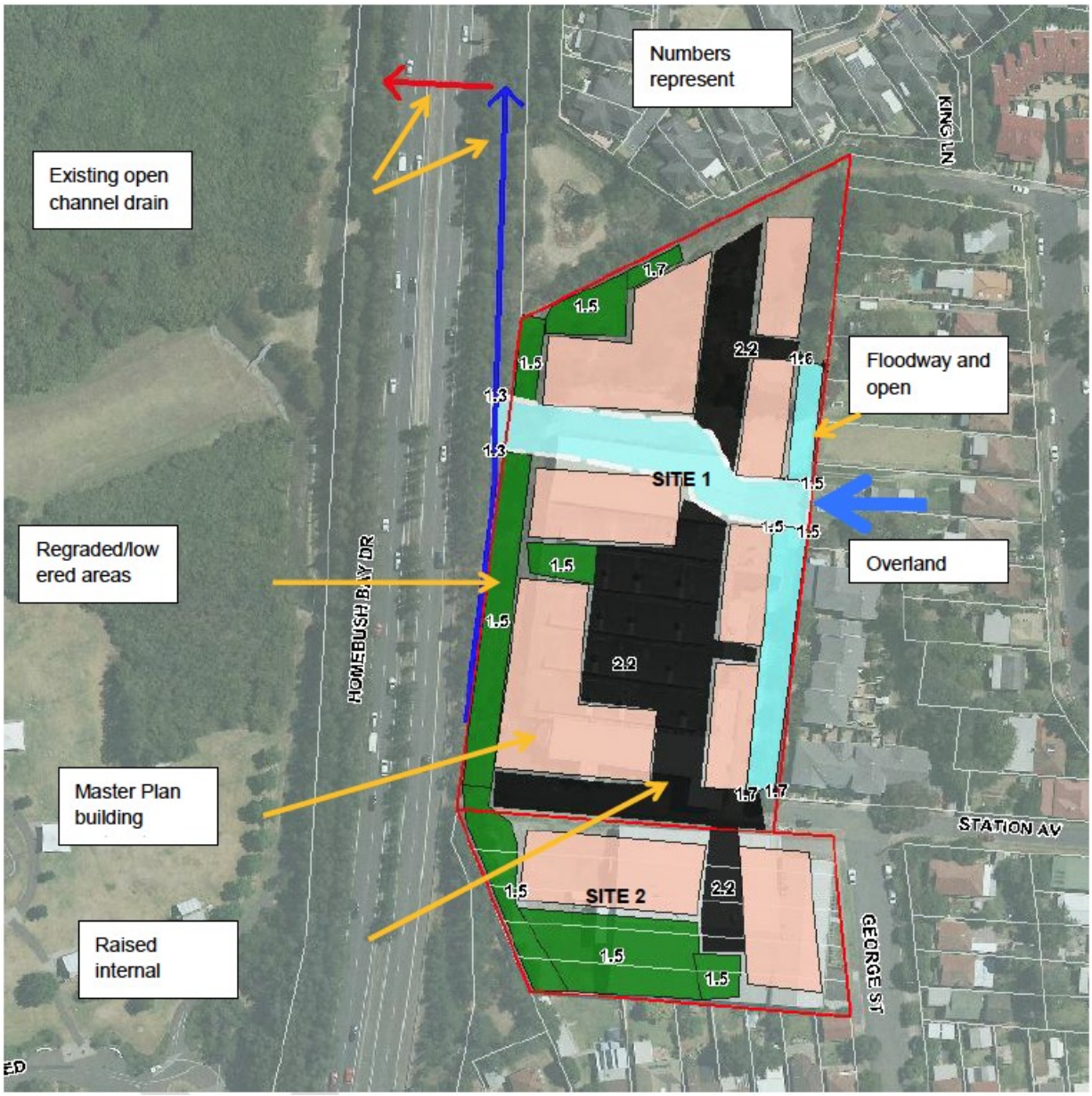


Figure 1-2 – Flood Mitigation works concept by Jacobs (source Jacobs 2015 – Exactly as per Jacobs Report)

The mitigation strategies were included in the modelling by Jacobs to show that development on Site 1 of the Concord West Precinct could be developed without causing impact on the upstream or downstream catchments. The Jacobs report states the following:

The adopted mitigation strategy for Site 1 and Site 2 are not considered sustainable in the long-term and the following recommendations are made for the proposed development in Site 1 and Site 2:

- *The mitigation option involving an overland flow path from Victoria Avenue sag point through Sydney Olympic Park land to Powells Creek is to be discussed with Sydney Olympic Park Authority;*
- *Additional investigations are to be undertaken to assess robustness of the mitigation strategy assessed in this study;*
- *The proposed development could be consolidated further to minimise flood impacts without requiring excavation of low laying lands; and*
- *Investigate alternative vehicular access to Site 1 and Site 2.*

In relation to the above points raised by Jacobs, the following is provided.

- The overland flow path from Victoria Avenue sag point is considered an external matter which the site does not rely upon to mitigate the flooding impacts. We have intentionally provided an assessment of the site to ensure that the proposed scenario 3 is sustainable independent of any other external measures that could potentially alleviate the flooding on site even further if implemented;
- This flooding assessment provides the additional investigations and modelling suggested by Jacobs. A solution is proposed under Scenario 3 which negates any impact on flooding including consideration of climate change, blockage of infrastructure downstream, etc…;
- No excavation is proposed under Scenario 3 which, by providing a flood void under the proposed building, promotes the consolidated approach suggested by Jacobs and reduces the impact of flooding elsewhere in the floodplain; and
- The access into the site is restricted to the western end of Station Avenue. No other access to the site is possible. There was no need to investigate any alternative access as the flood depth in the street is shallow in the street and access to the site is available as detailed further in this report.

1.3 Objective of this report

This report and flood modelling carried out to date are in line with the Jacob's recommendations. Whilst we understand that the recommendations made in the Jacobs report are to be used as a guide to achieve minimum standard, we have used this information as a basis to improve the situation and introduce further innovation to address and mitigate the flood situation associated with the proposed development site.

The objective of the assessment is to address the following considerations for planned development of the site which are based on contemporary planning requirements in other LGAs which consider the development of land with similar flood affectation as the subject site:

- Impact of planned development on flooding and vice versa;
- Sensitivity of design flood level to partial blockage of infrastructure downstream of the site (culverts under Homebush Bay Drive);
- Climate change impact on flooding;
- Cumulative development in the area;
- Flood emergency response in extreme flood events (PMF);
- Flood warning and evacuation.

2 AVAILABLE DATA

2.1 Concord West Precinct Master Plan Flood Study

Jacobs prepared the Concord West Precinct Masterplan Flood Study (CWPMFS) for the City of Canada Bay (Jacobs 2015). This study defines both mainstream and overland inundation through the entire catchment, which includes the subject site. The TUFLOW flood model developed for the CWPMFS has been used as the basis for the flood impact assessment of the proposed development of the subject site. This model was provided to IGS through an agreement with Council.

2.2 Ground Survey

A detailed survey of the ground levels on the site by Project Surveyors (dated 31/03/2010) is included as Appendix A.

2.3 Proposed Development

The proposed development of the subject includes multiple multi-storey residential flat buildings along the western side of the site, with townhouse style development along the eastern boundary. It is proposed to provide a single level of basement carparking with access from above the flood planning level for the site. Concept architectural plans are included as Appendix B.

2.4 Aerial Photography

All aerial photography within this report is used under licence from Nearmap.

3 FLOOD MODELLING

The 1D/2D hydraulic TUFLOW model developed as part of the Concord West Precinct Master Plan Flood Study (Jacobs 2015) was used as a base model for flood impact of the proposed development of the subject site.

In this 1D/2D TUFLOW model, the one-dimensional component was utilised to define the required pipes and culverts (new and existing) within the study area. The two-dimensional component was utilised to define the overland flows such as flows along the road reserves and through properties. Further details of the modelling, including the parameters and assumptions of the model are detailed in Jacobs report (2015).

A number of storm events were modelled both of short and long durations, as well as a range of ARI events. The following events were modelled for both the pre and post-development scenarios:

- 5 year ARI 25 minutes & 120 minutes;
- 20 year ARI 25 minutes & 120 minutes; and
- 100 year ARI 25 minutes & 120 minutes.

Additional scenarios were modelled include variations for increased rainfall and an increase in downstream water levels to allow for climate change. Downstream water levels of RL1.40 and RL1.90 have been adopted for sea level change for 2050 and 2100.

3.1 Pre-Development

Although the model developed for the 2015 CWPMPF study included the development site, it was established as a regional model for the entire catchment.

The pre-development model is representative of the existing site conditions and building layout. Buildings (except the one on our site) were modelled as inactive cells to represent obstructions to the flow. Figure 3-1 shows the ground topography from the Digital Terrain Model (DTM) used to model the existing conditions.

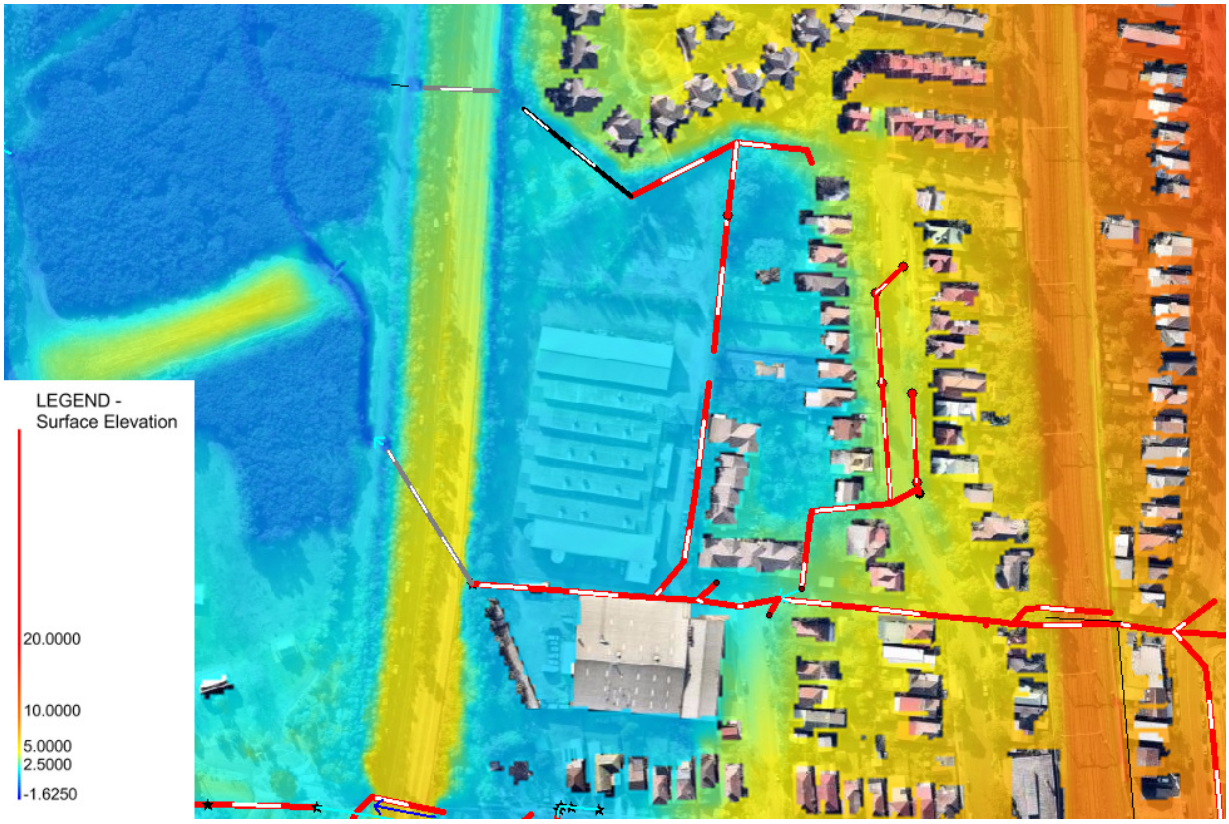


Figure 3-1 - Pre-Development DTM (Source Jacobs & IGS)

It should be noted that the Jacobs model did not consider the existing warehouse on site an assumption made by Jacobs that the warehouse will be inundated and would not cause any obstructions to the flows nor would it reduce the flood storage capacity.

3.2 Post-Development

The pre-development model prepared by Jacobs was amended to represent the development of the site as described in the following sections. The following sections of the report are shown in plan format in Appendix C.

Three (3) scenarios have been modelled by IGS for the development. Two scenarios are based around the concept prepared by Jacobs, while the third proposes a floodway void between the basement and the ground/podium level.

Scenario 1 allows for a 25m wide floodway void. This void is located between the basement and ground floor at the rear of 28A and 30 King Street at the low point of the catchment, to convey surface flows from the properties facing King Street to the proposed compensatory flood storage to the east of the site where additional inlet pits within the site setback adjacent to Homebush Bay Drive are proposed.

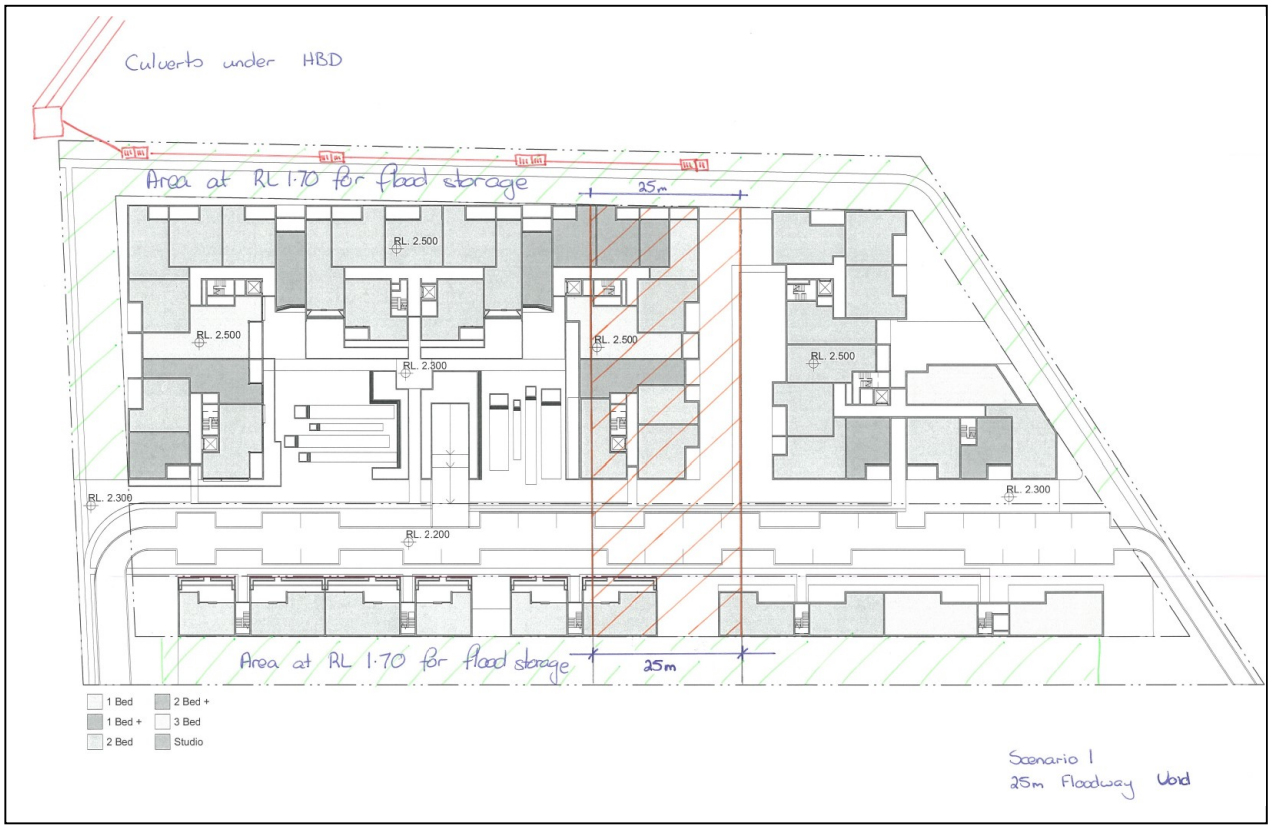


Figure 3-2.1 – Scenario 1 (25m Wide Floodway Void)

Scenario 2 allows for an open channel in a similar location as the floodway void under scenario 1, with similar compensatory flood storage and additional inlet capacity to the east. Scenario 2 is similar to that which was proposed by Jacobs in Section 8.2.1 and shown in Figure 8-1 the 2015 CWPMPF study.

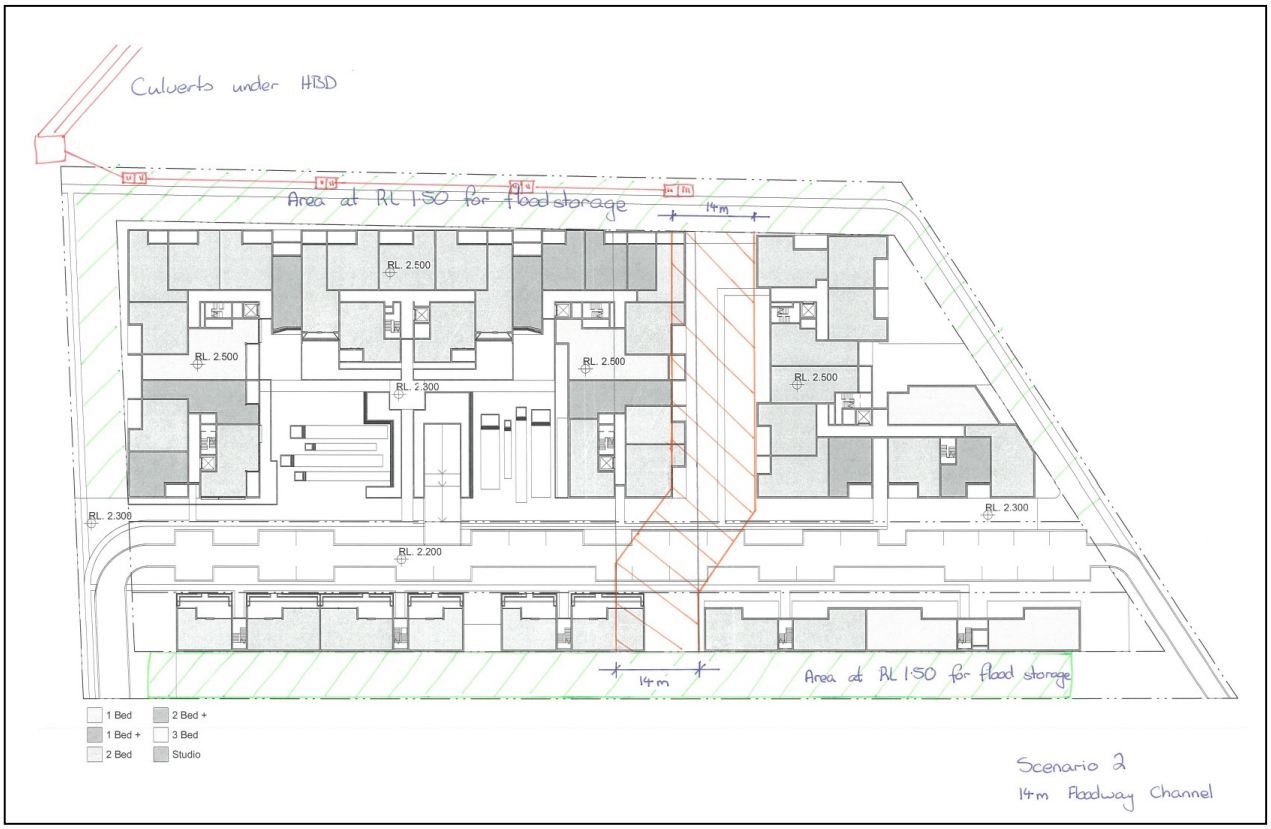


Figure 3-2.2 – Scenario 2 (14m Wide Overland Floodway Channel)

Scenario 3 provides a flood storage covering the entire development footprint. It is proposed to provide primary flow channels within the floodway void, while providing shallow areas to allow for additional flood storage to maintain the existing flood characteristics in the floodplain.

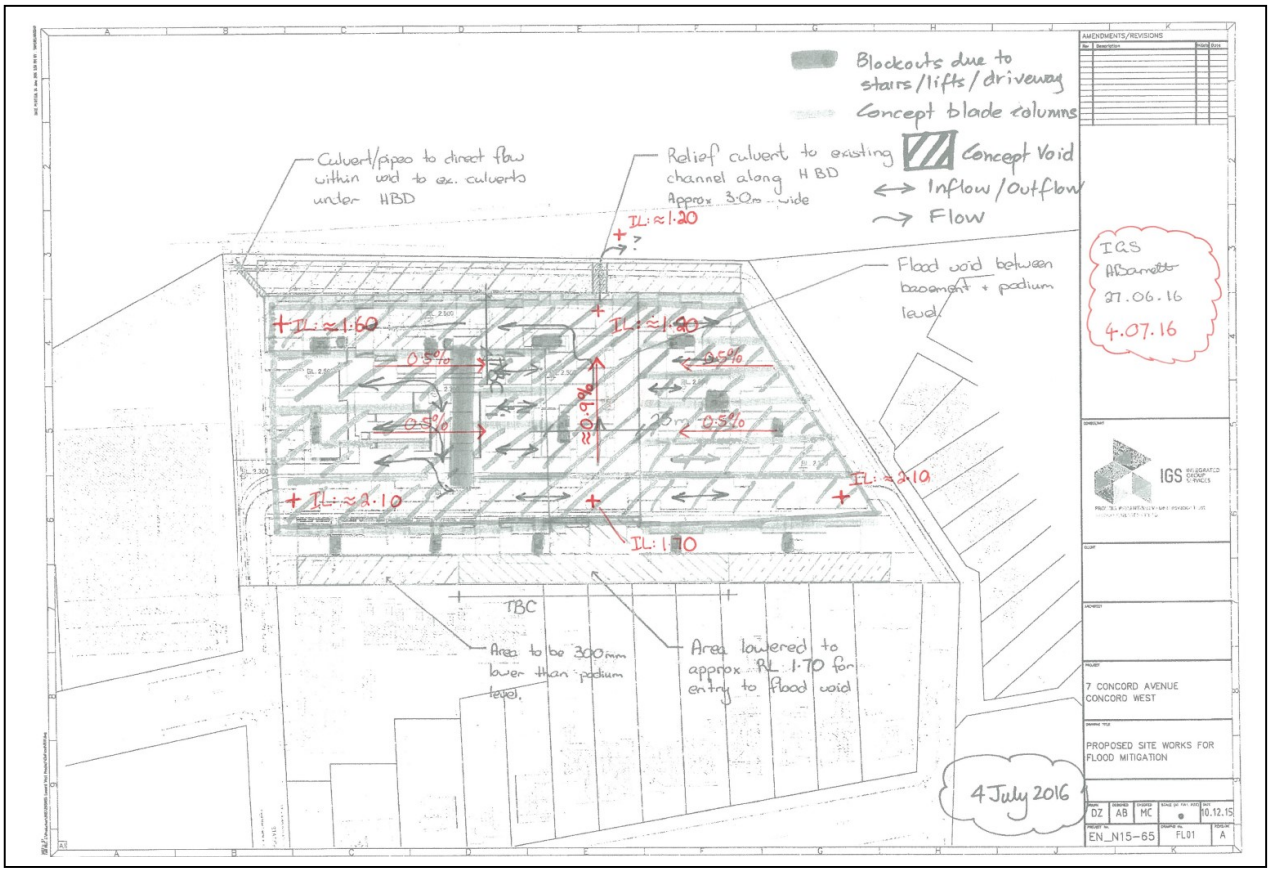


Figure 3-2.3 – Scenario 3 (Full Floodway / Storage Void Under Entire Building Footprint)

Scenario 3 relies on the full tanking of the basement level to provide a flood conveyance and storage area between the basement and the ground floor. Whilst the basement is protected from flooding for events up to the 100-yr, it is subject to inundation in extreme events that exceed the 100-yr. The driveway crest could potentially be overtopped by flood waters.

The access stairs from the basement will be used for evacuation from the basement and will discharge at least at level 1 which is elevated above the PMF flood level. This is to ensure that the evacuation from the basement is to a flood free area.

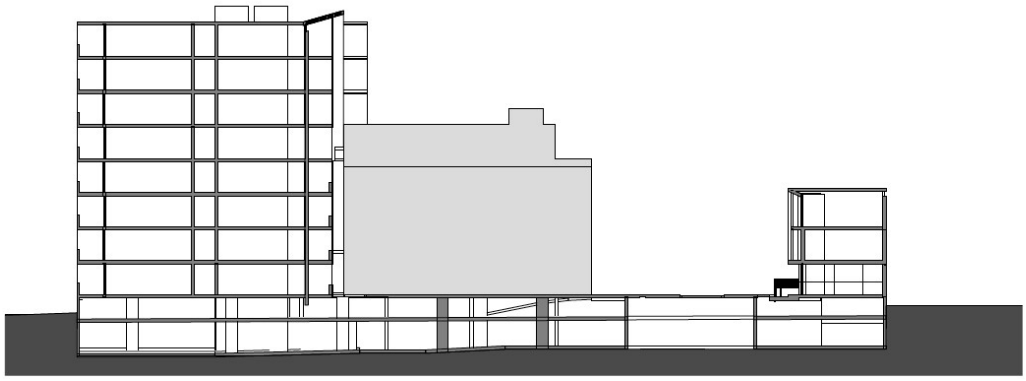


Figure 3-2.4 – Section Through Building (Scenario 3)

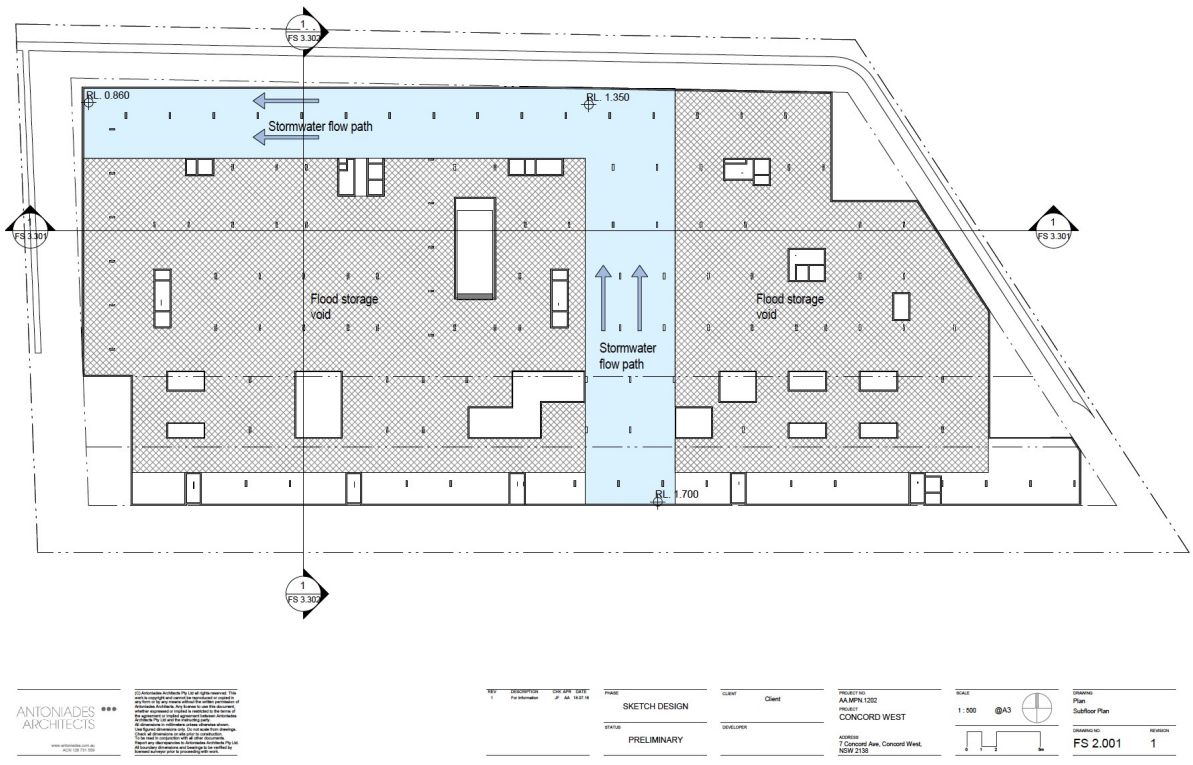


Figure 3-2.5 – Void Plan View (Scenario 3)

Scenario 3 was found to provide the innovation to the development that council were seeking whilst addressing all the planning requirements for the development. More specifically landscape and amenity was preserved by developing Scenario 3. Additionally, Scenario 3 provided further flooding benefits over Scenarios 1 and 2 (which were similar to the Jacobs outcome of their findings) further demonstrating the enhancement of the previous findings.

3.2.1 Modelling the Building

For scenarios 1 and 2, the building footprints and elevated roadways were modelled as complete obstructions (i.e. inactive cells). The Jacobs model represented buildings as obstructions by marking the cells as inactive within the building footprints. The method used by Jacobs was applied for the scenarios covered in this report to maintain consistency in the modelling approach.

For Scenario 1, the proposed building was modelled as obstructions with an opening of 25m to represent the flood void between the basement and podium levels.

Scenario 2 was modelled using a similar method, however the opening was limited to 15m to maximise the developable area, while maintaining the existing flood levels within the catchment.

While Scenario 3 proposed a flood void for the entire building footprint, areas external to the building would be raised to provide common open amenity areas. These raised areas were modelled as obstructions, while leaving an opening at the eastern boundary of the site to allow surface flows to enter the proposed flood void.

3.2.2 Modelling the Setback

The setbacks along the northern, western and southern boundaries were lowered manually within the TUFLOW model to RL1.75 to provide additional flood storage within the development site to compensate for the reduced flood storage. The reduced level of this area is higher than proposed by Jacobs in the 2015 CWPMPF of RL1.50.

These setback areas would be turf lined basins falling towards grated surface inlet pits to catch a larger portion of surface flows than are currently captured for the catchment. These turf areas could be underlain with slotted uPVC or alternate subsoil drainage pipes to reduce the likelihood of ponding water becoming a health hazard.

Scenario 3 does not propose to lower the setbacks. It is proposed to raise these setbacks to a level similar to the podium level to improve access to these areas for amenity. These areas have been modelled as obstructions as previously mentioned in section 3.2.1 of this report. This specifically addresses council concerns that the setback areas would not be suitable for attractive and appealing amenity areas.

3.2.3 Increasing the Inlet Capacity

In Scenarios 1 and 2 it is proposed to increase the inlet capacity to the existing twin culverts (2100x900mm) under Homebush Bay Drive. This additional inlet capacity would be provided with additional inlet pits within the side setbacks.

The Jacobs TUFLOW model showed that the twin culverts under Homebush Bay Drive had the same peak flow as the DN1200 along the southern boundary of the site, and that the capacity of the twin culverts exceeds the flow that was able to enter the existing underground drainage system. The additional inlet capacity in the post-development scenario indicates that there is additional capacity in the culverts under Homebush Bay Drive. These are shown in Figure 3-2.

It is not proposed to provide additional stormwater inlet capacity in Scenario 3.

Figures 3-3, 3-4 and 3-5 show the DTM adopted for Scenario 1, Scenario 2 and Scenario 3 respectively.

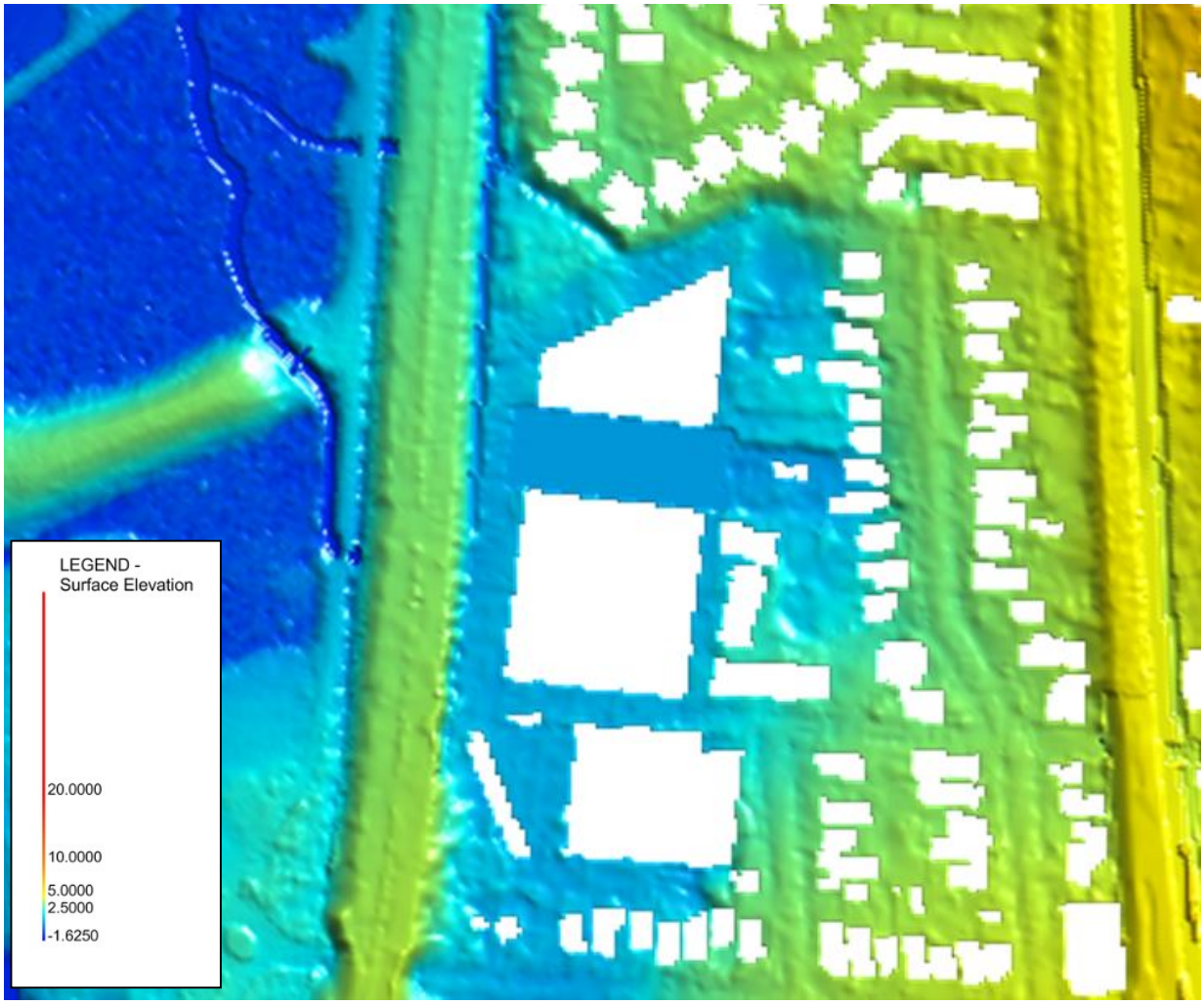


Figure 3-3 - Post-Development DTM for Scenario 1

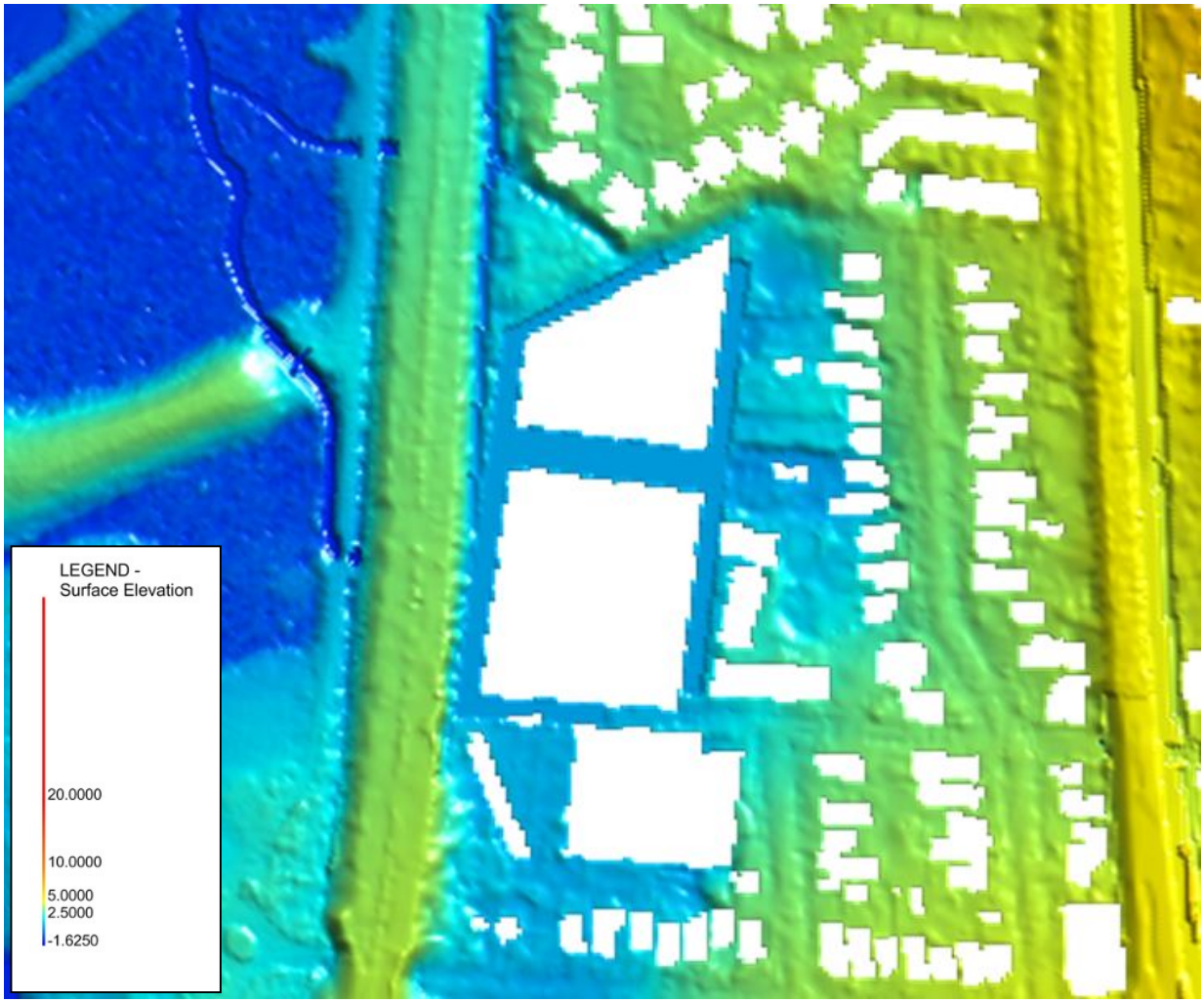


Figure 3-4 - Post-Development DTM for Scenario 2

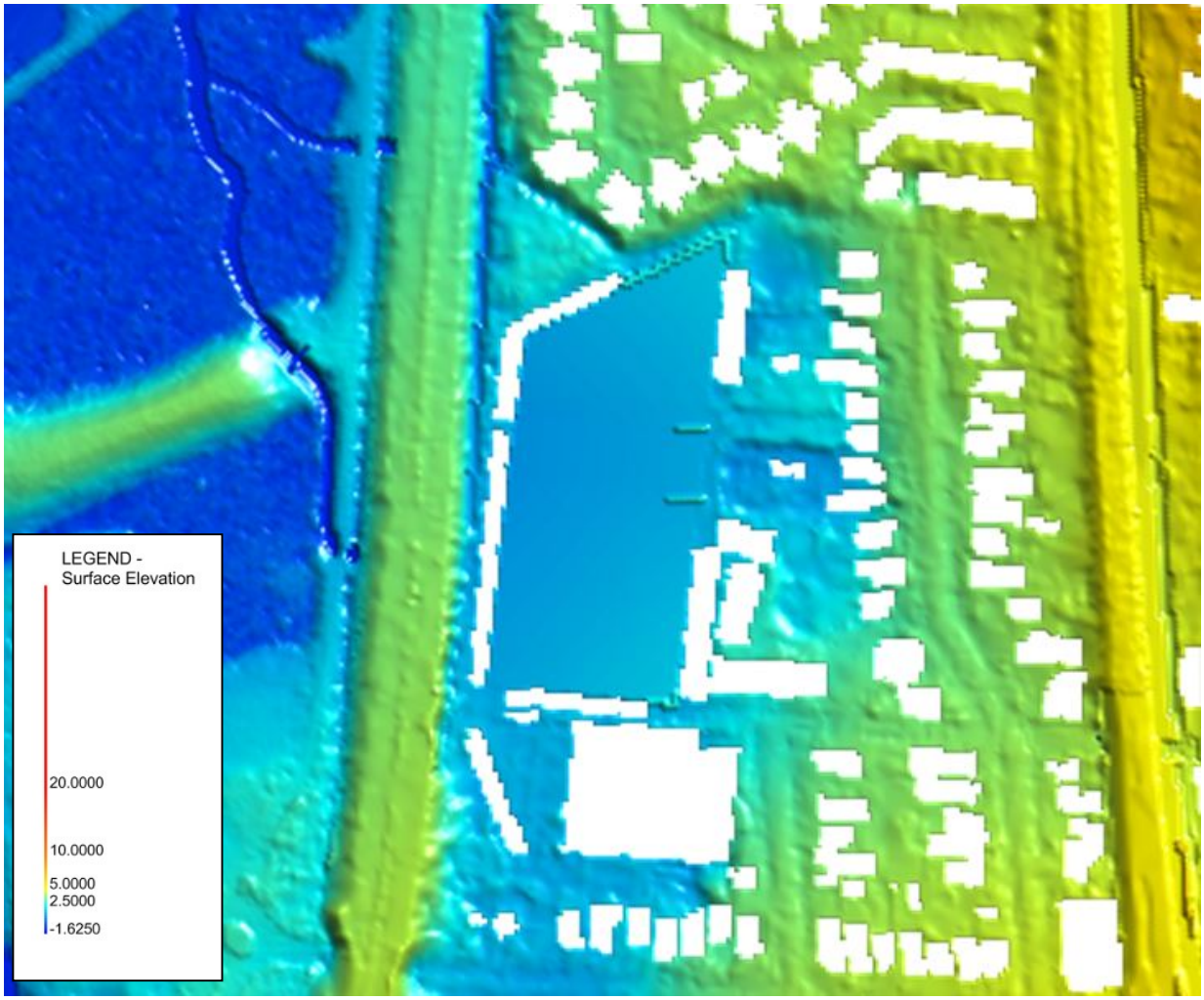


Figure 3-5 - Post-Development DTM for Scenario 3

In Scenario 3, no blockouts are indicated because the flooding is allowed to cover the entire area under the building footprint. There may be some small blockouts to indicate the proposed lifts and the staircases but these are considered minor compared with the flooding void under the building.

3.2.4 Recommendations from Jacobs

The CWPMPF (2015) prepared by Jacobs recommends that regrading of George Street be carried out to assist with flooding within the area (refer Figure 8-2 in Jacobs Report 2015).

Our flood assessment does not rely on any external modifications and/or improvements to stormwater systems or regrading to alleviate the flooding on the site. This assessment is intentionally reliant on modifications within the site itself.

4 FLOOD IMPACTS

Models were prepared for both the pre-development and post-development scenarios as described in Section 3. The critical storm duration for the catchment was determined to be 120 minutes for the 100 year ARI event in the CWPMPF (Jacobs 2015). This storm event was adopted for the pre- and post-development scenarios.

In addition for the critical storm event, Council has requested that addition storm events be modelled to determine whether the development has an impact across a range of storm events.

The pre-development model was used as the basis to determine the changes to the peak flood levels of the proposed development on the surrounding floodplain.

4.1 Flood Affectation of Neighbouring Properties

Changes to the peak water levels for the 1% AEP event for the post-development scenarios compared to the existing flood conditions near the subject site Post-Development is shown in Figures D15, D18, D21, D24, D27, D30, D33, D36, D39 and D42.

In Scenarios 1 and 2, maintaining and continuing the existing overland flow from the King Street properties, as well as the provision of flood compensatory storage around the perimeter of the development leads to the model showing a minor reduction in flood levels within the properties fronting King Street.

In these scenarios, the existing flow path that conveys overland flow from King Street would be affected by the proposed development. However the proposal to leave an opening through the development site, either as a flood void between the basement and podium level or an open channel through the development site, alleviates the potential increase in flood depth.

In addition to the opening through the development site for Scenarios 1 and 2, the additional inlet capacity within the site setbacks allows for additional surface flows to enter the twin culverts under Homebush Bay Drive at the south-western corner of the site further reducing the flood storage required on the development site.

These works show that the proposed development has minimal impact on the flood levels on the neighbouring properties

Under Scenario 3, the flood void covering the development footprint shows a reduction in flood levels up- and downstream of the development site. This is due to the additional flood storage provided on the site as part of the proposal from the existing site levels.

This scenario shows a minor reduction of up to 25mm upstream on the properties fronting King Street, as well as downstream within the mangroves of Bicentennial Park. There are minor increases, however these are located within the site boundary and do not have an impact on neighbouring properties. **Scenario 3 clearly demonstrates an improvement in flood conditions in the vicinity of the development**.

The following table shows the flood levels in 100-yr ARI flood event for the different scenarios and for the events modelled including the climate change.

ARI	**5-yr (Sc3)**	**100-yr (Sc3)**	**PMF (Sc3)**	**100-yr + 0.9m SL rise + 30% rainfall (Sc3)**	**100-yr + 0.9m SL rise + 30% rainfall + 50% blockage (Sc3)**
Concord Ave	2.34	2.34	3.77	2.34	2.34
Station Ave	2.34	2.34	3.76	2.41	2.41
George St Sag	4.21	4.28	4.80	4.33	4.32
NW Corner	1.83	1.83	1.83	1.83	1.83
SW Corner	1.89	2.04	3.76	2.31	2.31

ARI	5-yr (Sc3)	100-yr (Sc3)	PMF (Sc3)	100-yr + 0.9m SL rise + 30% rainfall (Sc3)	100-yr + 0.9m SL rise + 30% rainfall + 50% blockage (Sc3)
King St	1.96	2.04	3.77	2.31	2.31
SW Corner	2.34	2.34	3.76	2.41	2.41
NE Corner	2.32	2.31	3.77	2.32	2.32

The figure below shows the location of the points where the flood levels are tabulated.

Figure 4-1 – Key Locations of Flood Levels

4.2 Habitable Floor Levels

Mainstream overland flooding in the 1% AEP event occurs at the boundaries of the site. The flood extent and the peak flood levels in the 1% AEP event for the post-development scenario is shown in Figures D37 & D40. Minor flows of depth less than 50mm have been filtered from the results.

Habitable floor levels are proposed at RL 3.20m AHD, which is above the 1% AEP flood level plus 0.5m freeboard inclusive of Climate Change (30% increase in rainfall and 0.9m rise in sea level) which is over and above the requirements of Council's Specification for the Management of Stormwater. The current architectural plans reflect these levels.

In our opinion, this conservative approach provides protection from flooding now and in the future. It safeguards the development against projected sea level rise.

As previously stated, the basement will be subject to inundation in extreme flood events above the 100-yr

flood level. The PMF flood level (RL 3.80m AHD) will overtop the crest of the driveway and inundate the basement level. Two options are available as follows:

- Protect the basement from flooding up to and including the PMF flood level via a flood gate to be installed at the crest of the driveway. All access stairs to the basement will discharge at RL 3.80m AHD minimum prior to coming down to the podium level. All mechanical shafts and openings will have to be also raised to RL 3.80m AHD; or
- Allow the basement to flood in storm events exceeding the 100-yr ARI and provide a flood management and response plan to evacuate the persons at risk from the basement efficiently and in a timley manner to reduce the flooding risk to manageable levels.

Both options are deemed acceptable for this type of development because the number of persons in the basement level would be minimal at any given time. The residential nature of the development also suggests that the number of visitors would be also minimal.

4.3 Structural Soundness and Utilities

Any portion of the building that is lower than the nominated flood planning level (FPL) shall be constructed from flood compatible materials. Materials suitable for construction of flood affected walls may comprise of reinforced concrete, solid brickwork or blockwork construction.

All services associated with the development shall be flood proofed to the nominated FPL.

A suitably qualified engineer shall certify that the structure can withstand the forces of floodwater, debris and buoyancy in the PMF event.

4.4 Other Flood Events

Other storm events were considered and the impact for each of these events compared the pre-development flood levels to the post-development flood levels based on the design prepared for the 100 year ARI event. The storm event runs produced for comparison were the following:

- 5 year ARI 25 minutes & 120 minutes;
- 20 year ARI 25 minutes & 120 minutes;
- 100 year ARI 25 minutes & 120 minutes; and
- PMF 120 minutes.

For Scenario 1 and 2, all six (6) events (above) were run. All events generally show that the proposed development has negligible impacts on the flood levels elsewhere in the floodplain.

It is noted that the 20 year ARI 120 minute storm event causes a minor increase in flood levels (up to 25mm) adjacent to the proposed development. This is the only event modelled that has a small increase in the flood levels. As this only occurs on one (1) event and this event is a smaller event than the flood planning event, this small increase in this particular event is seen as negligible to the overall catchment.

For Scenario 3, the flood levels are generally lower for the post-development case than the existing flood levels. This reduction in levels is both up- and downstream of the development site.

The flood impact maps for each of the storm events modelled has been included in Appendix D.

4.5 Climate Change Consideration

A variety of conditions were modelled for climate change. While Jacobs looked at increasing the rainfall by 10%, 20% and 30%, they also looked at increasing the downstream boundary levels to reflect the adopted sea levels of RL 1.40m AHD and RL 1.90m AHD for 2050 and 2100 respectively. IGS did not look at the 10% and 20% increase in rainfall, however we did model the 30% increase (because it is considered the worst case scenario), as well as looking as the scenarios with increased downstream water levels.

The modelling also looked at the combined 30% increase in rainfall intensity and rise in flood level.

Flood maps for each of the storm events modelled have been included in Appendix D as Figures D43 to D48.

4.6 Flood Planning Level

An appropriate flood planning level (FPL) has been determined for the development to ensure that flooding of the site has manageable consequences in terms of danger to life, personal safety, and social, economic, environmental and cultural aspects.

The flood planning level (FPL) for the development site is based on but also exceeds the recommendations within the FDM 2005 and Council's policy of setting habitable floor levels and basement access to be at or above the 1% AEP flood level plus 500mm freeboard.

The proposed ground floor level is proposed at RL 3.20m AHD. This level provides 1.1m freeboard over the existing 1% AEP flood level and more than 0.5m freeboard over the projected 1% AEP flood level including 30% increase in rainfall and 0.9m sea level rise. This is to allow for wave actions within the floodwaters, variability due to climate change and effects on flood levels within the catchment due to unforeseen changes such as blockages and obstructions to the pit and pipe network.

5 RESPONSES TO COUNCIL COMMENTS RECEIVED TO DATE

The following section addresses comments that Council's planners and engineers have raised regarding the proposed development.

5.1 Rate of Rise and Effects on Safety

The warning times and associated response times during extreme flood events that affect the development site are dependent upon the expected rate of rise of flood waters. Under the proposed development conditions, the expected rate of rise of floodwaters is 0.53 metres per hour for the 1% AEP event and 1.1 metres per hour for the PMF event.

In the PMF event, the flood level is higher than the proposed ground floor level and higher than the crest level of the basement car parking. So it is concluded that the ground floor and the basement levels will be inundated in extreme events such as the PMF.

The warning time as well as the rate of rise of floodwaters within the catchment makes evacuation of the site during extreme events highly unlikely. The preferred method of evacuation would be vertical evacuation to a higher floor within the development. Note that this would also apply for other properties in the vicinity of the site and not just our development site.

As the proposed method of evacuation of the site is vertical, the lobbies of all levels above Level 1 of the proposed development will be made larger to accommodate the site occupants temporarily until floodwaters recede. The duration of flooding for the site is limited to a few hours due to relatively small upstream catchment.

During the 100-yr ARI flood event, it is more than likely that the site would not be isolated as the flood levels in the street are shallow (around 0.3-0.4m). Access by emergency vehicles to the site is available in shallow flood waters where the velocity x depth ratio is generally low, despite a small area showing a high velocity depth ratio. It can be confidently concluded that during 100-yr event, the site would be accessible if needed.

The duration of which the proposed development is isolated is limited to approximately 3-3.5 hours for the PMF event (i.e. flood depth more than 0.5m above the street level of RL 1.8m AHD).

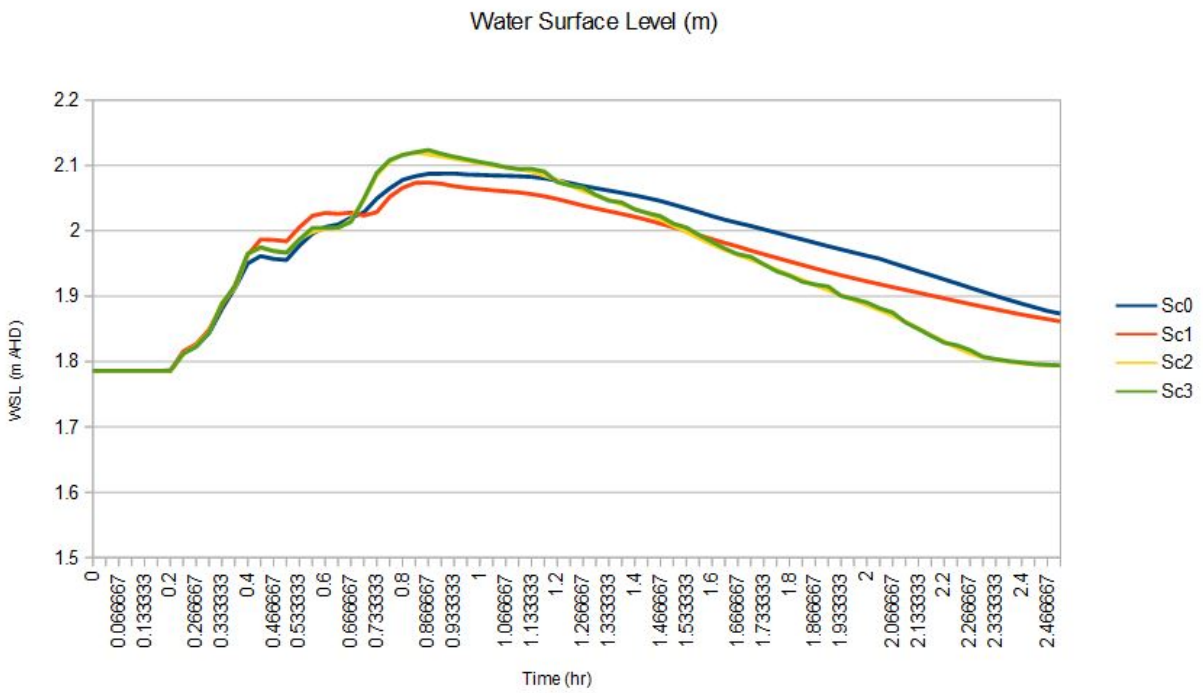


Figure 5-1 – Rate of rise – 100-yr ARI

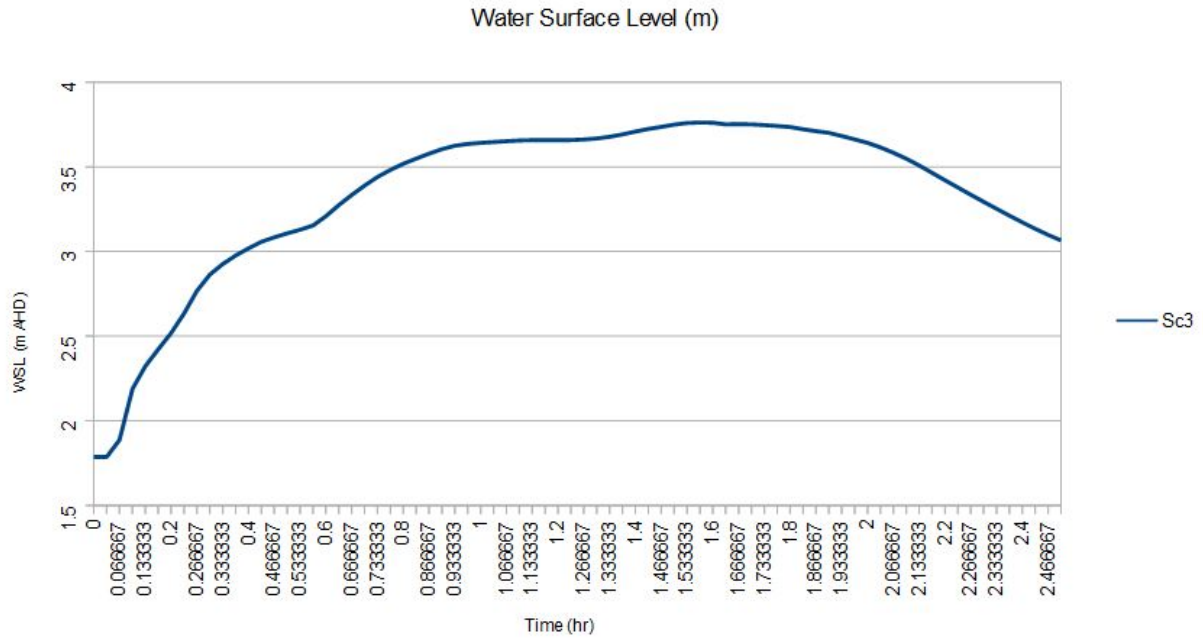


Figure 5-2 – Rate of rise – PMF

5.2 Rate of Rise & Its Effect on Hazard Category & Safety

5.2.1 Safety Management

The continuing flood risk for the proposed development is the inundation of the ground floor and the basement levels during the PMF event.

The direct Persons at Risk (PAR) during the PMF event are the occupiers of the ground floor level and the persons in the basement at the time of flooding.

A shelter in place strategy is proposed for the proposed development which will form part of a flood emergency and response plan that will identify the triggers for evacuation such as rising floodwaters, heavy rainfall, BOM issuing a flood warning.

The flood emergency and response plan will identify flood threats, the assigned warden and deputy, preparation measures for a flood, actions in the likelihood of a flood (i.e. responses) and recovery after the flood. The plan will be adopted by the users of the development and will be reviewed regularly. The will be submitted with the development application as a separate document.

A flashing probe and an alarm system will be installed at the entry into the basement level and in the ground floor lobby. Flood warning signs will be installed at key locations within the development.

The above strategy will reduce the risk to life and to the safety of persons within the site to acceptable level that can be managed through the life of the development.

5.2.2 Effect of Sedimentation from Mangroves

We have reviewed the effect of the sedimentation within the mangroves and found that it is negligible in regards to flood levels. This was simulated by applying a 50% blockage to the culverts traversing across Homebush Bay Drive.

These results are shown in Appendix F.

5.3 Flood Risk Management Plan / Strategy

The Jacobs report indicates and Council officers have advised that a Flood Risk Management Strategy (FRMS) and a Flood Risk Management Plan (FRMP) have not been prepared for the Powells Creek catchment. Council has also advised that there is no anticipated timeline for the preparation of these documents as outlined in the NSW Floodplain Development Manual (FDM 2005).

The Jacobs report indicates that Council should consider forming a Floodplain Management Committee (FMC), which is a key requirement for the preparation of a Floodplain Risk Management Plan for the study area of which the development site falls into.

Jacobs has outlined works that should be carried out within the catchment to assist with improving the access to the development site. These works will be included in the future Floodplain Risk Management Plan for the Powells Creek catchment (unless previously completed). It is expected that Section 94 contributions for the proposed developments within the Study area will contribute to the cost of these works.

The findings of this report to be undertaken by Council, can assist in preparing the Flood Risk Management Plan / Strategy.

5.4 Provisional Flood Hazard

The provisional flood hazard for the development generally shows that the site is located within the low hazard

category. This is due to the low velocities of floodwater within and adjacent to the proposed development.

The flood maps in Appendix D indicate that the flood in the void is Low Hazard (i.e. below 0.4m^2/s). The flooding is also confined to the flood void and does not reach the development's proposed finished level.

In our opinion, this is an acceptable outcome and in line with industry best practice because:

- The proposed finished levels of the development are above the FPL;
- The development is located in a Low Hazard area; and
- The development does not increase the flooding elsewhere in the floodplain.

5.5 Emergency Access Plan

Access to the development is limited to George Street to the south of the site. In the event that George Street becomes inundated to an impassable depth, which is possible under the current circumstances, access to the site will be severely limited.

The report prepared by Jacobs outlines road regrading works, and lot development to be carried out on George Street to the south of the development site to improve access to the development site and surrounding properties. The proposed works involve lifting the road level in the sag along George Street to reduce the depth of ponding on George Street. In association with the regrading works, Jacobs has recommended the future development of 180 George Street provide a floodway to assist with reducing the depth of ponding of floodwaters on George Street to provide access to the properties to the north of the George Street sag.

The works is likely to be included in S94 Plan, where contributions can be made by all others in the area.

These proposed works will assist with emergency vehicle access during flooding events within the catchment.

As previously stated in Section 5.2.1, the proposed development will have a flood evacuation and response plan that will address the flood risk, and will propose a shelter in place strategy to avoid having to evacuate the site and getting caught in flooding in George Street. In our opinion, a shelter in place strategy in a flash flooding event is a safer and more reliable scenario.

An example flood emergency management plan is contained in Appendix H of this document.

5.6 Relationships between Flood Planning / Architecture / Landscape / Planning

Scenarios 1 and 2 require the lowering of the setbacks within the development site to assist with maintaining the existing flood levels up- and downstream of the development site. Council has indicated that this limits the amenity of the site and how the site may be used. This has been addressed with the development of Scenario 3. The third scenario created a flood void within the building footprint, while elevating the majority of the site setbacks to be more in line with the finished podium level.

Scenario 3 addresses Council's concerns of amenity and flood planning by allowing for more of the common open space to be used by the site occupants while maintaining safety from a potentially flood affected area. The architect and landscape consultant have prepared plans that reflect the flood planning for the site. There has been thought, consideration and innovation applied to the building architecture and landscaping to ensure the flooding has no detrimental effect on amenity. Refer to Appendix B for architectural and landscape plans.

5.7 Flooding & Amenity

As discussed, Scenario 3 for the proposed development provides better access to the site setbacks than Scenarios 1 and 2. These raised areas allow for additional common open space that better interacts with the

podium level of the development.

5.8 Maintainability

In all scenarios, the maintenance of the flood voids and floodway channels will be borne by the owners' corporation. Aesthetically pleasing screening will be applied to the openings to allow floodwaters to pass through unobstructed. Any screening will have wide enough openings to eliminate the risk of blockage. The opening along the eastern boundary can be increased in length by a factor of 1.5 to allow for blockage.

Access to the floodway voids will be limited to approved maintenance contractors with adequate training for confined spaces. Large debris within the floodway voids will be limited due to the fencing preventing public access to the voids.

The void itself offers at least 1m clear height at the upstream end fronting the rear courtyards of the properties along King Street. This height increases to 1.8m approximately at the south west corner (assuming a ground floor slab thickness of 0.5m). These clear heights are easily maintainable and large enough to resist blockages. Access openings will be provided at regular intervals to allow for the inspection and the maintenance of the overland flow and storage void.

This situation is no different to access and maintenance requirements to on-site detention tanks. This is quite a common requirement.

5.9 Section 117 Direction

The proposed scenarios for the future development of the site is consistent with the NSW Governments Flood Prone Land Policy and the principles of the NSW Floodplain Development Manual 2005.

The development has been assessed to address the impacts and hazards within and surrounding the development site.

Key criteria points of the NSW Floodplain Development Manual 2005 addressed in this report are as follows:

CRITERIA	RESPONSE
Access to the Site During Flooding Events	The report discusses issues of Access to the site during flooding events in Sections 5.1 and 5.2 and how this risk will be mitigated.
Fill or Excavation in the Floodplain	Scenario 3 looks at maintaining the floodwaters at the same levels / patterns and takes them through the void. Scenario minimises any effects of fill or excavation in the floodplain.
Freeboard	Freeboard is covered in Section 4.2. Habitable floor levels are proposed at RL 3.20m AHD, which is above the 1% AEP flood level plus 0.5m freeboard inclusive of Climate Change which is over and above the requirements of Council's Specification for the Management of Stormwater. The current architectural plans reflect these levels.
Floor Levels	As above.
Difference between Land Uses	Currently the land is zoned for industrial use and the planning proposal seeks rezoning to residential purposes. This report has determined that the flooding associated with the site can be mitigated via implementation
Services	Services are covered in Section 4.3 and 5.10. All services associated with the development shall be flood proofed to the nominated FPL. Services will be raised to be above the flood planning level or appropriately protected from floodwaters.
Impact on Flood Behaviour	Scenario 3 considers current flood behaviour and maintains this will no adverse change. On the contrary, Scenario 3 has demonstrated that it improves flood behaviour.
Structural Soundness When Flooded	Structural soundness is covered off in Section 4.3. Any portion of the building that is lower than the nominated flood planning level (FPL) shall be constructed from flood compatible materials. Materials suitable for construction of flood affected walls may comprise of reinforced concrete, solid brickwork or blockwork construction. All services associated with the development shall be flood proofed to the nominated FPL.
Building Materials	As Above
Fencing	There is no fencing within the development that will create an adverse effect on the flood behaviour. The 25m slot simulated in Scenario 3 has metal bars similar to pool type fencing behind to stop vermin, children and animals entering the void. This treatment allows the floodwaters to enter the void and be channelled through the site with no effect to flood behaviour.

5.10 Fail Safe Design

Different measures will be incorporated within the building to provide a fail safe design. The design includes flood proof construction materials up to the adopted flood planning level, services below the flood planning level will be raised to be above the flood planning level or appropriately protected from floodwaters.

In the event that the culverts under Homebush Bay Drive become partially blocked due to debris, there are alternate locations for floodwaters to pass under Homebush Bay Drive. These include a culvert to the north of the development site adjacent to Liberty Grove, and the road underpass at Victoria Avenue. These currently assist with the floodwaters, however would also assist in the event of blockages.

An assessment of blockage of the culverts under Homebush Bay Drive has been undertaken. A 50% blockage is applied to the culverts and is reported in the flood maps. The results indicate that with the blockage ratio applied, the podium level is still above the 100-yr flood level + 0.5m freeboard.

The podium level of the development is also above the flood planning level for the site to minimise the flooding of the podium level units during extreme flooding events, as well as in the event of blockages of the downstream culverts.

6 EXPERT PEER REVIEW – EXECUTIVE SUMMARY

An independent peer review of previous assessments of flooding and of the impact of the proposed development of Lot 1 DP 219742, Concord West has been undertaken.

As outlined by IGS, 2016 Jacobs have undertaken the Concord West Precinct Master Plan Flood Study (CWPMFS) (Jacobs, 2015) which was commissioned by the City of Canada Bay. This flood study identifies the existing conditions for the Concord West Precinct adjacent to the Powells Creek channel to the west of the site.

The 2016 Flood Impact Assessment outlines the approach taken for the development of a TUFLOW model for the proposed development on the site and the outcomes of an assessment of three alternative development scenarios (IGS, 2016).

Three (3) development scenarios were modelled by IGS. Two scenarios were based on the master plan concept prepared by Jacobs, 2015, while the third scenario is based on the approach adopted for several other developments located on the Parramatta River and Clay Cliff Creek floodplains and subject to similar flooding conditions.

Flood Modelling Approach

The floodplain model adopted for the flood impact assessment was assembled and described by Jacobs, 2015. The modelling approach adopted by Jacobs, 2015 is based on current best practice for 1D/2D floodplain modelling in urban areas. While model data files and results files have not been reviewed it is our understanding that the current assessment is consistent with the modelling assessments previously undertaken for the City of Canada Bay.

In our view this approach is acceptable and should give Council confidence in the assessments of flooding on Lot 1 DP 219742.

Assessment of Development Scenarios

While it was concluded from the flood impact assessments of Scenarios 1 and 2 that these scenarios have minimal impact on the design flood levels on the neighbouring properties in our view these development configurations are less robust than the Scenario 3 development configuration.

It is noted that for flood planning purposes it is proposed to adopt the 100 yr ARI flood under climate change (0.9 m of sea level rise and a 30% increase in rainfall intensity) as the benchmark for the flood planning level. This approach is supported because it recognises the potential climatic changes which will occur over the design life of the buildings.

It is further noted that it is proposed to adopt a flood planning level of 3.2 m AHD for ground floor apartments which provides 0.8 m – 0.9 m freeboard above the 100 yr ARI flood under climate change (0.9 m of sea level rise and a 30% increase in rainfall intensity).

This flood planning level is supported because inundation of the ground floor which only occur in floods greater than a 400,000 yr ARI (0.00025% AEP) event.

It was concluded from flood levels at a series of reference locations that:

- The flood levels reported for the "NW Corner" are anomalous and have been disregarded;
- Climate change is expected to locally increase the 100 yr ARI flood level by up to 0.27 m in some locations but more generally by up to 0.07 m;
- The assessed blockage scenario has nil impact of design flood levels;
- The PMF is around 1.4 m higher than the current 100 yr ARI flood level.

It is also noted that the driveway ramp into the basement car parking level will allow floodwaters to spill into the basement car parking level in an extreme flood. IGS, 2016 identify two options to address this issue as follows:

- *Protect the basement from flooding up to and including the PMF flood level via a flood gate installed at the crest of the driveway. All access stairs to the basement would discharge at RL 3.80m AHD minimum prior to coming down to the podium level. All mechanical shafts and openings would be also raised to RL 3.80m AHD; or*

- *Allow the basement to flood in storm events exceeding the 100 yr ARI and implement and maintain a flood management and response plan to evacuate the persons at risk from the basement efficiently and in a timely manner to a safe higher level within the development during extreme floods.*

The access stairs from the basement will be used for evacuation from the basement and will discharge at least at Level 1 which is elevated above the PMF flood level. This is to ensure that the evacuation from the basement is to a flood free area.

While it will be necessary to implement and maintain a flood emergency response plan for the development irrespective of the flooding or otherwise of the basement car parking level in our view consideration should be given to protecting the basement car parking level against the PMF based on the adopted flood planning level in comparison to the PMF level and the likelihood the many residents will inevitably store household items in their allocated car space(s) which have the potential to be damaged in an extreme flood.

Contemporary Planning Requirements

The stated objective of the IGS, 2016 assessment is

… to address the following considerations for planned development of the site which are based on contemporary planning requirements in other LGAs which consider the development of land with similar flood affectation as the subject site:

On the basis that developments located on the Parramatta River and Clay Cliff Creek floodplains are subject to similar flooding conditions the proposed development has been assessed against the requirements of the Parramatta DCP 2011 which detail contemporary planning requirements.

On the basis that the subject site is subject to low hazard in a 100 yr ARI flood (refer Maps C-27 and D-5 in Jacobs, 2015) the site would be classified as being located in a Medium Flood Risk Precinct.

The requirements of the Parramatta DCP 2011 cover:

- Floor Levels
- Building Components
- Structural Soundness
- Flood Affectation

- Car Parking and Driveway Access
- Evacuation
- Management & Design

It is concluded from the merit assessment that the proposed development (Scenario 3) on Lot 1 DP 219742 would satisfy the requirements of the Parramatta DCP 2011 for development in a Medium Flood Risk Precinct except in relation to the local adverse impact on 100 yr ARI flood levels at the western end of Station Avenue.

While it is concluded from the plots of flood level difference that the proposed development has a negligible impact on 100 year ARI and PMF levels in almost all locations it is noted however from Figure D6 that there are local increases in the 100 yr ARI flood level in the south-east corner of the site of up to around 0.3 m. This appears to be associated with the grading of the driveway up on to a podium under Scenario 3. Consideration needs to be given to re-grading the driveway and/or incorporating sloping grates in the driveway to maintain the capacity of the overland flowpath in this area and/or providing a comparable flowpath by diverting overland flows into the void before the driveway ramp.

It is also proposed to prepare, implement and maintain a flood emergency and response plan for the development on Lot 1 DP 219742, Concord West. This plan should describe:

- Flood behaviour at the site for the 100 yr ARI and Probable Maximum Flood (PMF),
- Flood protection measures, and
- The various components of the Flood Emergency Response Plan for the site, including but not limited to:
    - A Flood Warning System
    - Evacuation strategy, measures, procedures and plan
    - FloodSafe Plans

This plan needs to be prepared during the detailed design phase so that the requirements for instrumentation and any cabling to distribute flood warnings to each of the buildings can be incorporated into the buildings rather than retro-fitted after the design is completed.

The full expert peer review conducted by Cardno is contained in Appendix E of this document.

7 CONCLUSIONS

An assessment was undertaken to address the flooding considerations for planned development of at the site which are based on contemporary planning requirements in other LGAs which consider the development of land with similar flood affection as the subject site.

The preferred development configuration (Scenario 3) is based on the full tanking of the basement car parking level to provide a flood conveyance and flood storage area between the basement and the ground floor. Whilst the basement is protected from flooding for events up to the 100yr ARI, it would be subject to inundation in extreme events that exceed the 100 yr ARI because the driveway crest could potential be overtopped by flood waters.

Two options are available to address potential flooding of the basement car parking level in an extreme flood as follows:

- Protect the basement from flooding up to and including the PMF flood level by a a flood gate installed at the crest of the driveway. All access starts to the basement would discharge at RL 3.80m AHD minimum prior to coming down to the podium level. All mechanical shafts and opening would also be raised to RL 3.80m AHD; or
- Allow the basement to flood in storm events exceeding the 100 year ARI and implement and maintain a flood management and response plan to evacuate the persons at risk from the basement efficiently and in a timely manner to a safe higher level within the development during extreme floods.

The access stairs from the basement will be used for evacuation from the basement and will discharge to at least Level 1, which is elevated above the PMF flood level. This is to ensure that the evacuation form the basement is to a flood free area.

This preferred configuration is reflected in the latest architectural plans.

It is concluded form the flood impact assessment that the preferred development configurations:

- Preserves the current flood storage within the site by fully tanking the basement car parking level and creating a void between the basement and the ground floor which extends across the complete extent of the podium;
- Provides enhanced amenity such as common areas, private courtyards, internal roads which are raised substantially above the 100 year ARI flood level;
- Does not increase flood levels, velocities and hazards elsewhere on the floodplain;
- This void can be easily maintained through the provision of access openings at regular intervals to the flood void, which varies in height between 1.0m and 1.8m assuming a slab thickness on the ground floor of 0.5m;
- Responds to the residual flood risk in extreme floods by adopting a shelter-in-place strategy for residents and visitors.

It is further concluded that the preferred development configuration (Scenario 3) addresses Council's concerns, complies and exceeds industry flood planning principles and standards while preserving and enhancing the amenity within the proposed development.

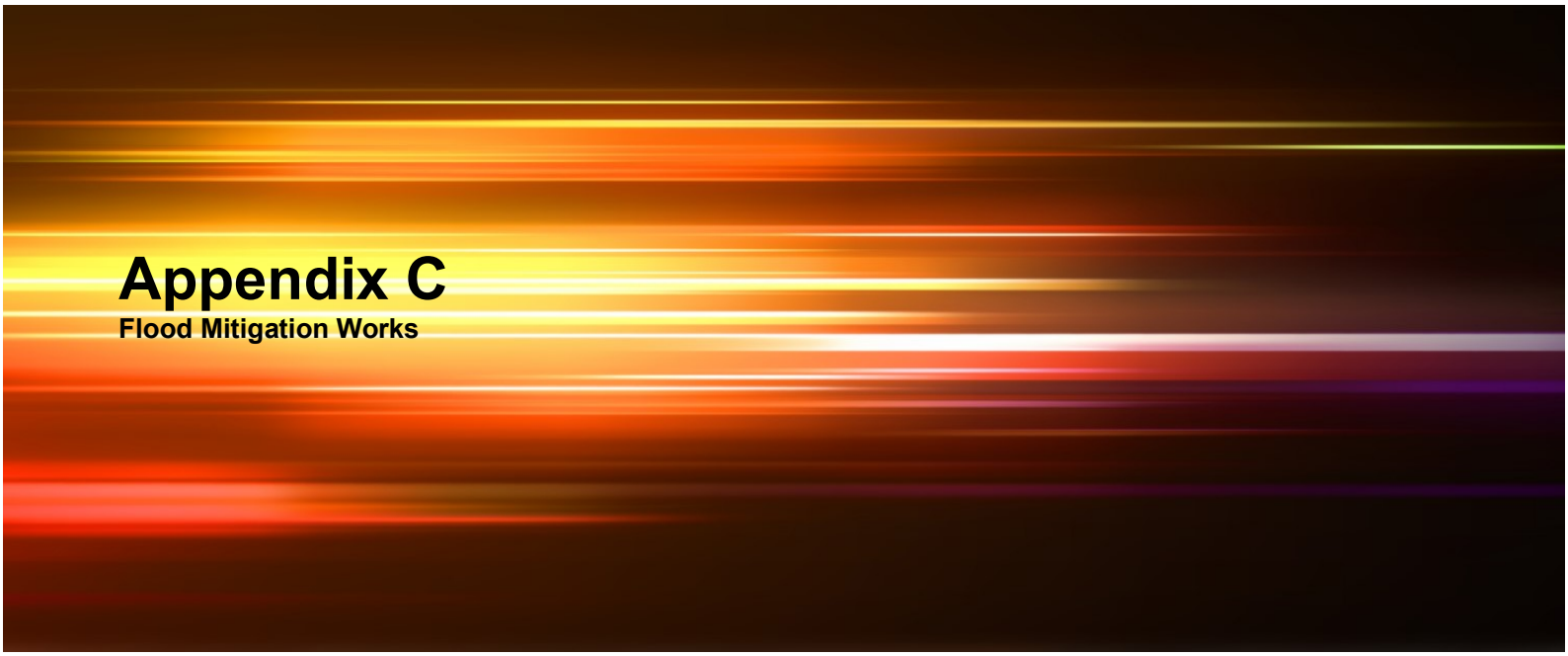
Scenario 3 is also supported by Cardno who conducted the expert peer review of this flood impact assessment.

Appendix A

Ground Survey of Existing Site

Appendix B

Concept Architectural Drawings

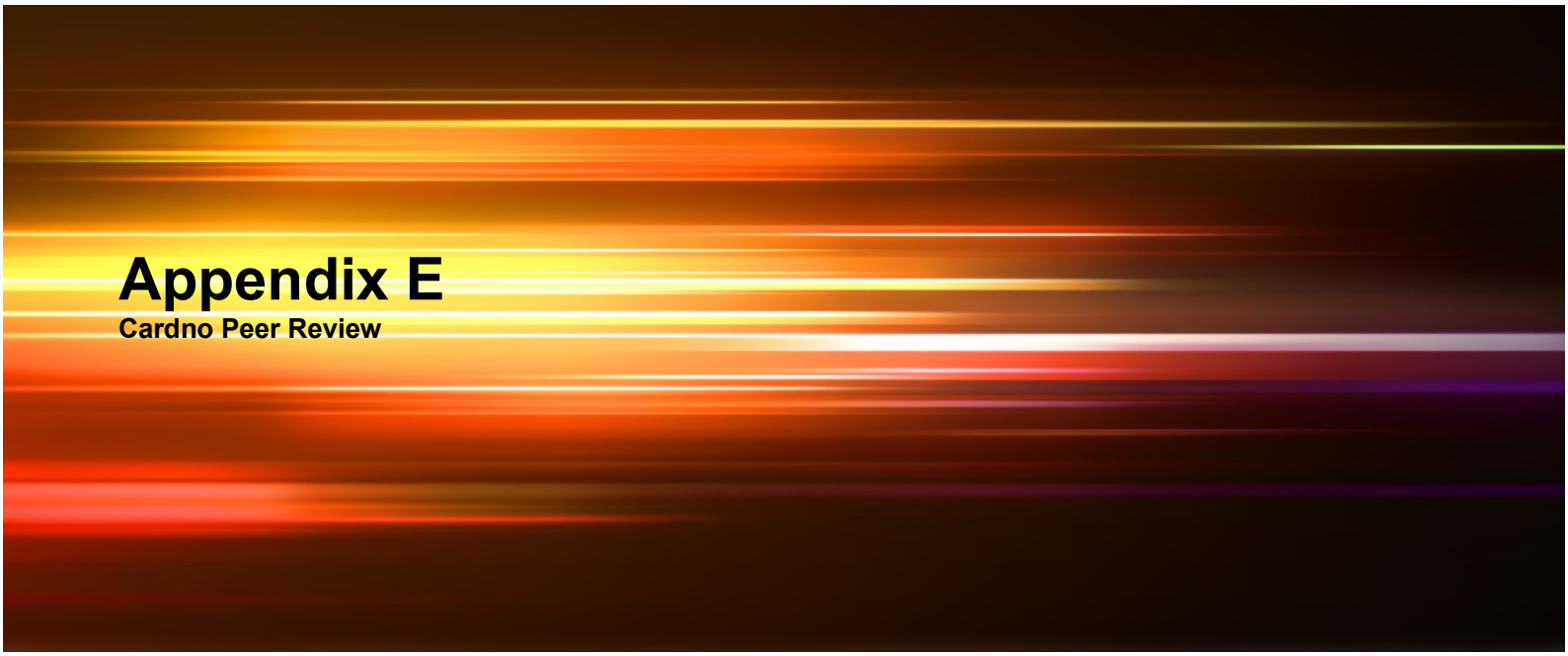


Appendix C

Flood Mitigation Works

Appendix D

Flood Impact Maps



Appendix E

Cardno Peer Review

Appendix F

Modelling Showing the Effect of Sedimentation from the Mangroves

Appendix G

Reference Projects / Case Studies

Green Square Precinct, Green Square	-	City of Sydney
Ashmore Precinct, Erskineville	-	City of Sydney
Lachlan Precinct, Waterloo	-	City of Sydney
The Dig Site, The Rocks	-	City of Sydney
*2-8 River Road West, Parramatta	-	Parramatta City Council
*27 Oak St and 19 & 21 Hope St, Harris Park	-	Parramatta City Council
*125-129 Arthur Street, Parramatta	-	Parramatta City Council
*32 Tramway Ave, Parramatta	-	Parramatta City Council
Royal Shores, Ermington	-	Parramatta City Council
Treacy Street, Hurstville	-	Hurstville City Council

**Detailed plans included in this report of these projects*

Appendix H

Example Flood Emergency Management Plan