Farrow Road Multi-Deck Car Park, Campbelltown

Flood Impact Assessment

Revision 1
May 2022

Catchment Simulation Solutions

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1 INTRODUCTION

Campbelltown City Council are planning to construct a multi-deck car park near the corner of Farrow Road and New Farrow Road at Campbelltown. The multi-deck car park will replace part of an existing, single level car parking area that extends from Farrow Road to Bow Bowing Creek. The extent of the existing car park and the location of the proposed multi-deck car park is shown on **Figure 1**.

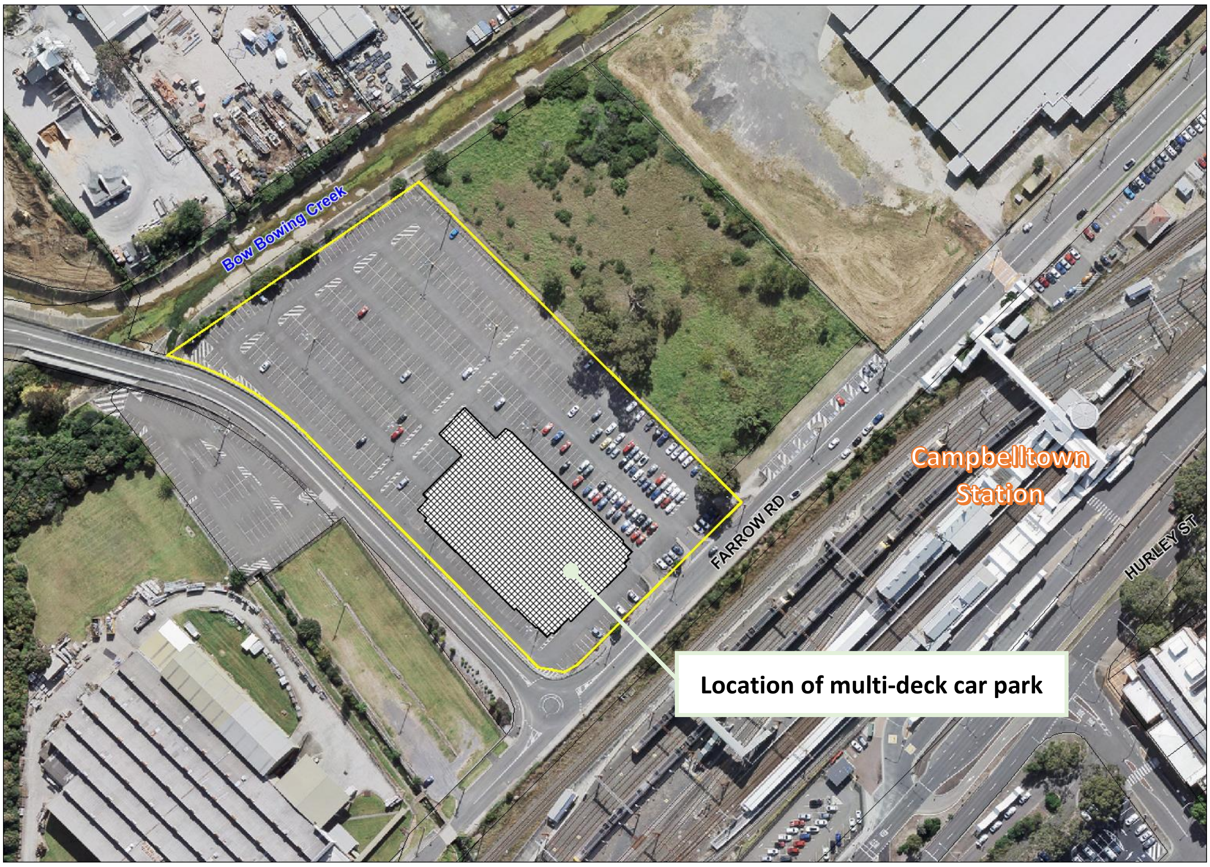

Figure 1 Location of proposed multi-deck car park

As shown in **Figure 1,** the site is located adjacent to Bow Bowing Creek. The results of computer flood modelling completed as part of the 'Campbelltown Locality Flood Study' (Catchment Simulation Solutions, 2018) shows there is potential for inundation of the existing car park following heavy rainfall in the local catchment. This can include "mainstream" flooding from Bow Bow Creek and "overland" flooding from the local Dumaresq Street Main Drain catchment. Therefore, there is potential for the proposed car park to impede or otherwise change the distribution of floodwaters, which may adversely impact on existing flood behaviour.

In recognition of the potential for the proposed works to impact on existing flood behaviour, Catchment Simulation Solutions were engaged to undertake a flood impact assessment for the proposed works. The following report summarises the outcomes of the assessment.

2 EXISTING FLOOD BEHAVIOUR

2.1 Introduction

To understand the potential impact of the development on flood behaviour, it is first necessary to define flood behaviour for 'existing' conditions. 'Existing' flood behaviour across the development site has been defined as part of the 'Campbelltown Locality Flood Study' (Catchment Simulation Solutions, 2018). This project included the development of a TUFLOW hydraulic model that was used to simulate flood behaviour for topographic and development conditions at that time for a range of design floods.

This TUFLOW model was used as part of the current flood assessment. However, it was considered necessary to update and refine the TUFLOW model in the vicinity of the existing car park to ensure the best representation of existing flood behaviour could be provided. A summary of the updates that were completed to the TUFLOW model and the results of the updated flood simulations are presented in the following sections.

2.2 TUFLOW Model Updates

The TUFLOW model that was used as part of the 'Campbelltown Locality Flood Study', reflected the best available modelling technology and input information at that time. However, new technology, knowledge and datasets have become available since the flood study was completed. Therefore, the TUFLOW model was updated to take advantage of this new information and ensure the best possible description of existing flood behaviour.

The updates that were completed to the TUFLOW model included:

- Inclusion of 2019 LiDAR across the site and adjoining areas. This replaced the 2011 LiDAR and, therefore, provides a much more contemporary representation of topographic conditions.
- Refinement of fence alignments.
- Refinement of materials/hydraulic roughness. This included the existing car park to better reflect the impediment to flow afforded by parked cars versus aisles where little impediment to flow would be provided.

In addition to the updates above, it was noted that the existing modelling assumed the car park was "full" of cars as part of all simulations. This assumption was adopted as it provided the most conservative flood level estimates upstream of car parking areas. However, it was acknowledged that there is also potential for the car park to be largely empty (e.g., if flooding occurred at night) which could alter flooding impacts across the site as well as adjoining properties. Therefore, two alternate "existing" conditions models were setup reflecting the following scenarios:

- Car park empty
- Car park full of cars.

2.3 Results

2.3.1 Car Park Empty

The updated model was first used to re-simulate the 1% AEP flood assuming the existing car parking areas contained no cars. Peak floodwater depths and velocity vectors for this "car park empty" scenario for the 1%AEP event are presented on **Figure 2**.

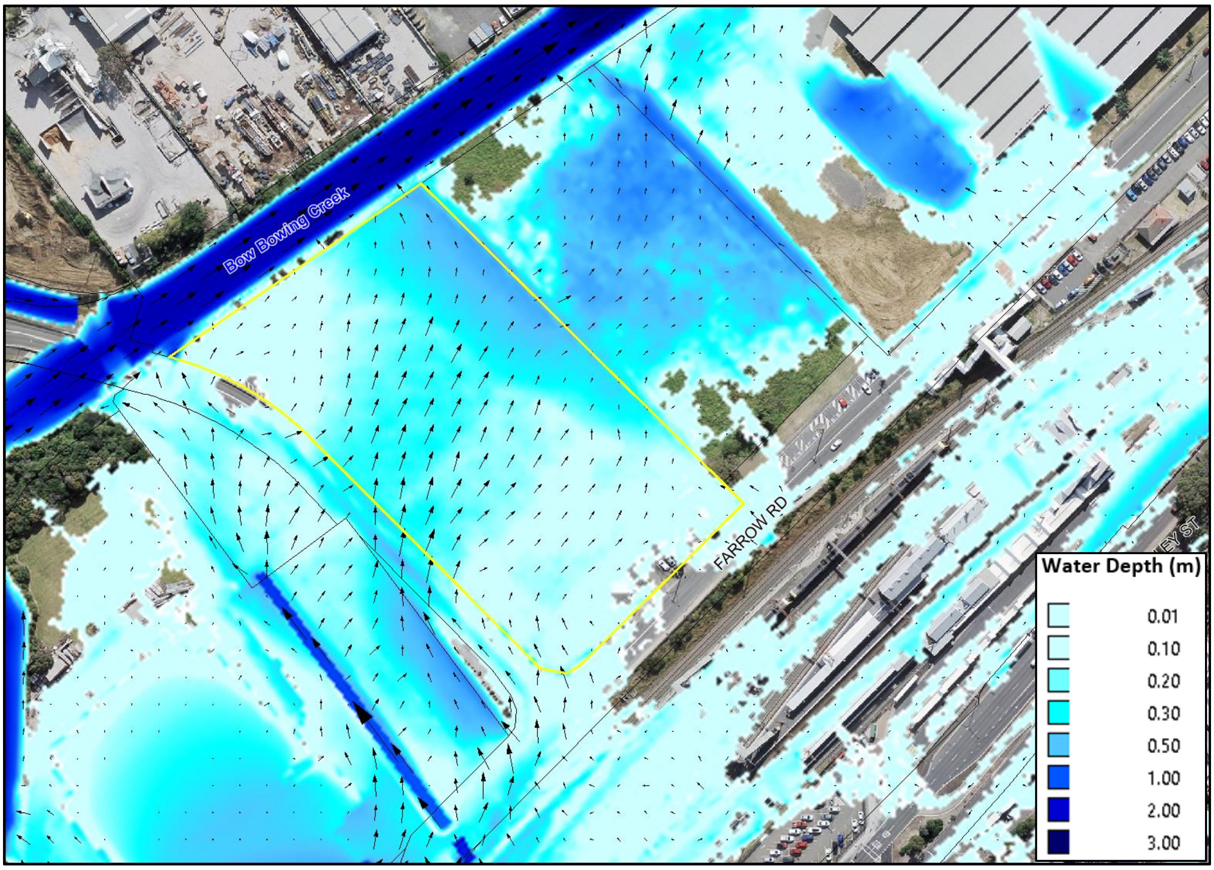

Figure 2 Peak 1% AEP Water Depths for Existing Conditions (Car Park Empty)

Peak flood levels were also extracted at discrete locations around the car parking area as well as areas adjacent to the car park. The location where flood levels were extracted is shown in **Figure 3** and the flood levels at each location are provided in **Table 1**.

The depth and velocity information presented in **Figure 2** shows that most of the existing car park would be exposed to inundation at the peak of the 1% AEP flood. Most of the flow entering the existing car park travels south-west along Dumaresq Street before flowing across the railway line and entering the car park site from the south-western property boundary. The most significant water depths of 0.5 to 0.6 metres are predicted adjacent to the north-eastern site boundary. At the location of the proposed multi-deck car park, the peak water depths are typically less than 0.2 metres.

Peak flow velocities are predicted to vary from less than 0.8 m/s in the southern and western corners of the site to more than 2 m/s through the central parts of the site. The central sections of the site correspond to where most of the overland flow travels through the site towards Bow Bowing Creek under the car park empty scenario. Part of this flow path continues through to the adjacent, vacant block of land (#4 Farrow Road) and is the main reason the car park empty scenario produces the higher flood levels downstream of the car park (discussed further below).

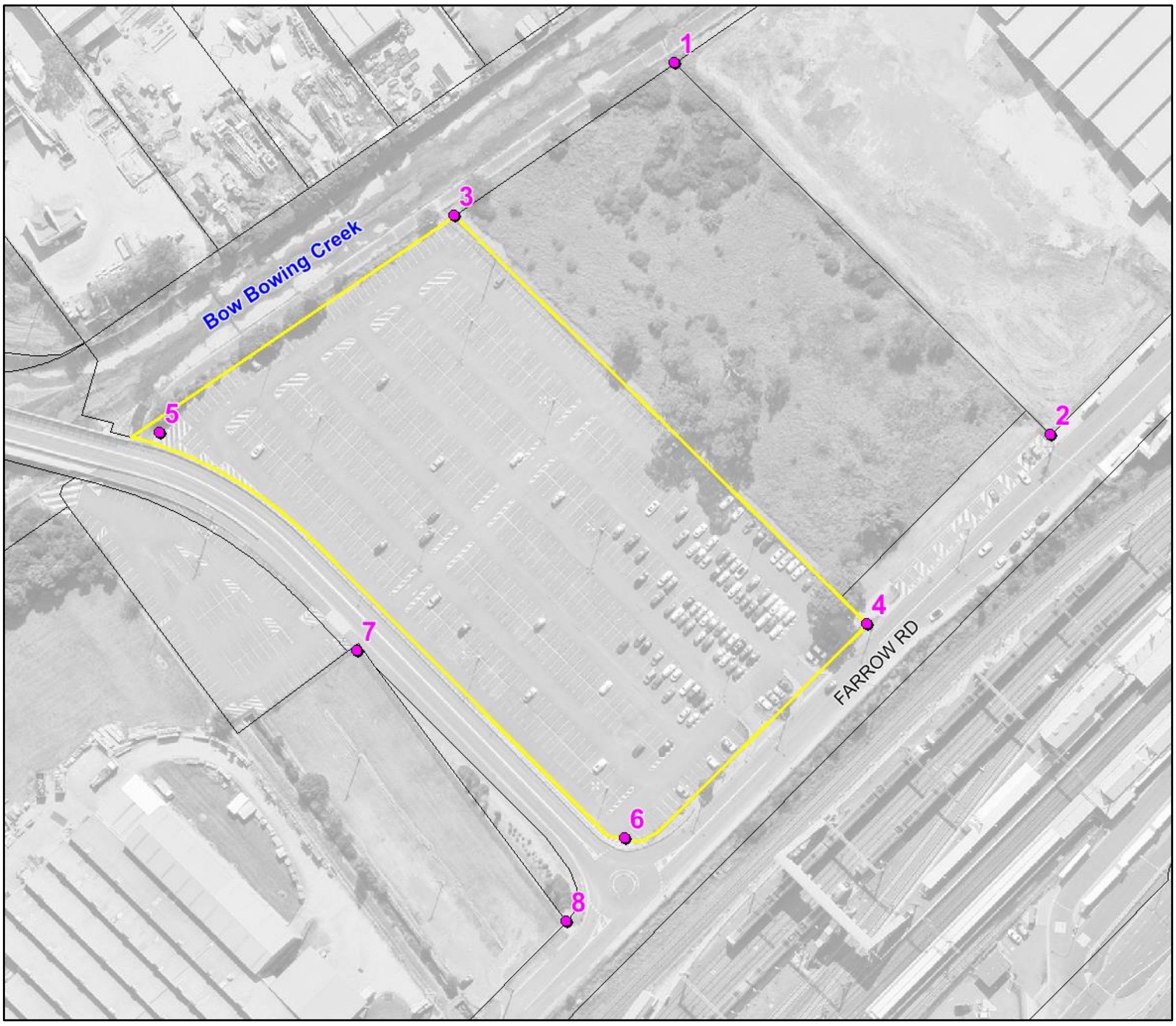

Figure 3 Flood level reporting locations

Table 1 Peak 1% AEP Flood Level for Existing Conditions

ID (refer to Figure 3 for locations)	Peak Flood Level (mAHD)	
	Car Park Empty	**Car Park Full**
1	60.66	60.57
2	61.58	61.58
3	60.89	60.79
4	61.94	61.94
5	61.29	61.46
6	61.83	61.95
7	61.60	62.09
8	62.58	62.59

The flood levels included in **Table 1** confirm that the assumptions regarding whether the car park is full or empty do impact on peak flood levels in the vicinity of the car park. More specifically, the "car park full" scenario produces higher flood levels upstream (i.e., south) of the car park while the "car park empty" scenario produces higher flood levels immediately downstream of the car park. In areas located away from the car park (e.g., reporting location 2), the results are less sensitive to the car park assumptions. Nevertheless, either car park scenario is equally probable and, therefore, both scenarios require assessment.

2.3.2 Car Park Full

Peak floodwater depths and velocity vectors were extracted from the results of the "car park full" scenario for the 1%AEP flood and are presented on **Figure 4**. Although the results look broadly similar to the "car park empty" scenario, the following differences are evident:

- 1% water depths across the existing car park are higher under the car park full scenario. This include peak depths of around 0.9 metres along the south-western edge of the car park and depths of at least 0.5 metres across much of the area where the multi-deck car park is proposed.
- 1% AEP flow velocities are lower under the car park full scenario (generally <0.5 m/s). This is associated with the additional impediment to flow afforded by the parked cars. The main flow paths under this scenario are shown in **Figure 4** and correspond to the location of internal aisles within the car park. Peak velocities along these internal isles are typically greater than 1 m/s.

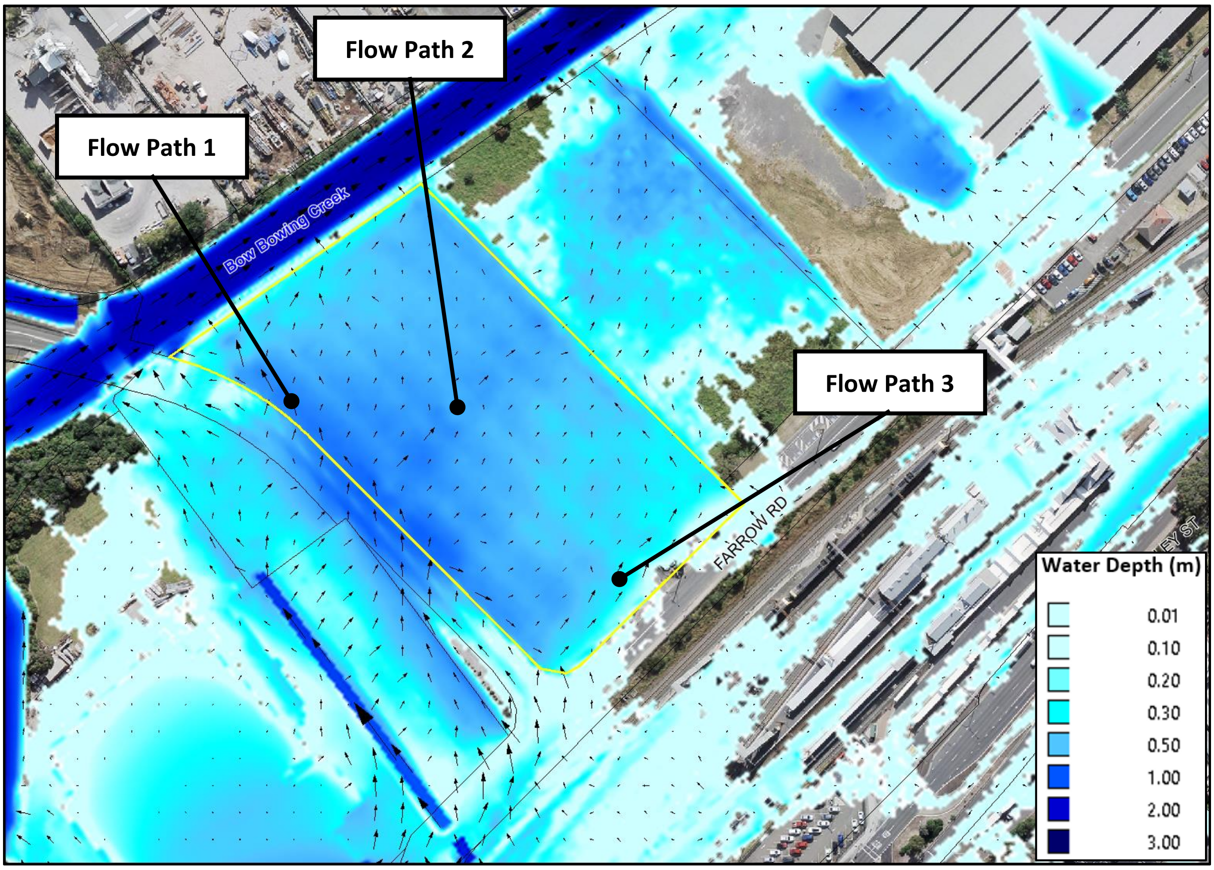

Figure 4 Peak 1% AEP Water Depths for Existing Conditions (Car Park Full)

2.3.3 Summary

The results of the existing flood assessment show that there is potential for inundation across most of the existing car park as a result of heavy rainfall in the catchment. The flood behaviour within and adjacent to the car park is influenced by whether the car park is full of cars or empty at the time of the flood with the "car park full" scenario producing higher water depths and the "car park empty" scenario producing higher flow velocities across the car park.

3 POST-DEVELOPMENT FLOOD BEHAVIOUR

3.1 Description of the Proposed Development

The proposed development will include construction of a new multi-deck car park near the corner of Farrow Road and New Farrow Road. The multi-deck car park will replace part of the existing car park and will also include regarding and landscaping across the permitter of the new car park. Plans for the proposed works are included in **Appendix A**.

As shown in **Appendix A**, the proposed car park will incorporate some filling to elevate parts of the lower level of the car park as well as part sections of the car park comprising solid walls. Therefore, there is potential for these works to impede and/or redistribute floodwaters approaching from the southern corner of the site. To aid in managing the existing overland flow through the site, the following features were incorporated into the design of the car park:

- Provision of grass-lined swales along the south-eastern and south-western edges of the car park to redirect flow in a northerly direction around the car park.
- Inclusion of a new car park entry midway along New Farrow Road that will also allow overland flow to drain from New Farrow Road more readily through the existing car park.
- Allowance for the western parts of the lower ground floor to be located close to existing ground levels to allow water to pass through this area relatively unimpeded.

Preliminary flood simulations with the above features in place identified the potential for flow to be concentrated from Farrow Road through the existing car park and into the adjoining #4 Farrow Road and into #2 Farrow Road under a car park empty scenario. This was predicted to increase existing flood levels across parts of #2 Farrow Road. Therefore, regrading was also incorporated into the design concept across the north-western section of #4 Farrow Road to allow overland flow to be re-directed into Bow Bowing Creek.

Further details on how the proposed development was represented in the TUFLOW model along with the outcomes of the post-development flood simulations are presented below.

3.2 Post-Development Flood Assessment

3.2.1 Model Updates

To assess the potential for the proposed works to impact on existing flood behaviour, the TUFLOW hydraulic model that was used to define 'existing' flood behaviour was updated to include a representation of the proposed works and simulate design flood behaviour for 'post-development' conditions. This involved the following TUFLOW model updates:

- Inclusion of the topographic modifications associated with the proposed lower ground floor and ground floor. This included regrading of the eastern side of the car park to 61.455 mAHD, elevating the western side of the car park to 62 mAHD (with ramps linking the two levels) and the area around the proposed elevators was elevated to 62.35 mAHD.

- Inclusion of proposed terrain modifications around the permitter of the car park. This was informed by a digital terrain model provided by Northrop Consulting Engineers (dated 18 Mary 2022).
- Inclusion of all "solid" walls on the ground floor as complete flow obstructions.
- Representation of the blockage afforded by the various columns on the ground floor. This was represented in the TUFLOW models using "flow constriction" lines between the car parking spaces with 20% blockage applied.
- Inclusion of the new car park "entries" off Farrow Road and New Farrow Road. This included widening the central aisle between the new, New Farrow Road entry and the north-eastern side of the car park (to match the width of the car park entry).
- Modification of hydraulic roughness across the car park and around the car park to reflect proposed landscaping (a copy of the landscaping plan is enclosed in **Appendix B**). The adopted "post-development" materials and associated roughness coefficients are shown in **Figure 6**.
- Regrading of the north-western half of #4 Farrow Road from 60.4 mAHD near the centre of #4 Farrow Road down to approximately 60.2 mAHD along the north-western site boundary adjacent to Bow Bowing Creek.

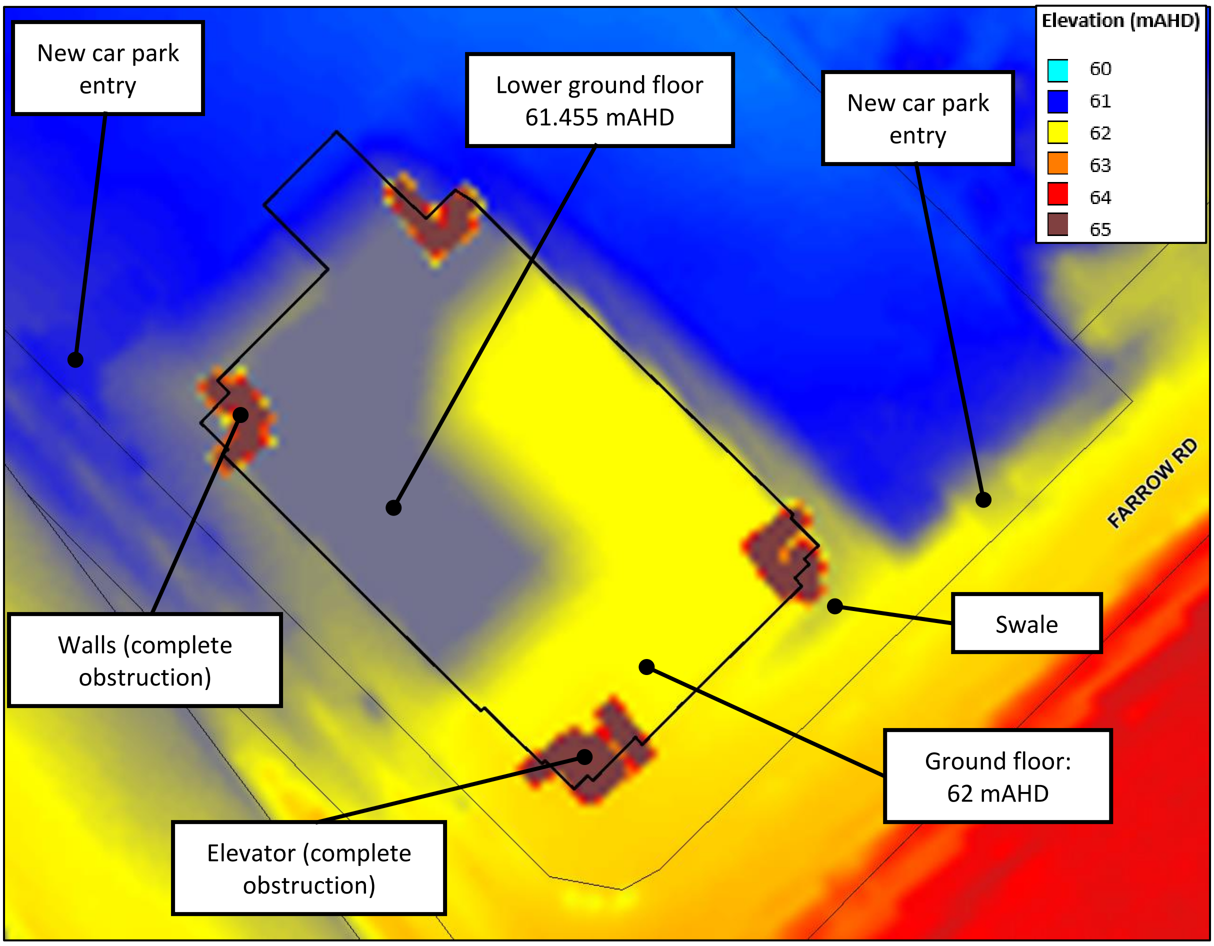

Figure 5 Adopted post-development terrain

Figure 6 Adopted post-development materials/roughness

3.2.2 Results

Car Park Empty

The updated model was first used to re-simulate the 1% AEP flood for 'post-development' conditions under the "car park empty" scenario (i.e., no cars parked in the ground/lower ground levels of the multi-deck car park or the balance of the existing car park). Peak floodwater depths and velocity vectors were extracted from the results of the flood simulation and are presented in **Figure 5**. Peak water levels were also extracted from the results of the post-development simulation at discrete locations (refer **Figure 3**) and are included in **Table 2**. The peak flood levels for existing conditions are also included in **Table 2**.

The velocity vectors included in **Figure 5** shows that under a car park empty scenario, overland flows would be conveyed through the western sections of the lower ground floor (velocities of more than 1 m/s are predicted across much of this area). Flow would also be redirected around the south-western side of the car park and towards the northern half of the existing car park where the flow would continue to move towards Bow Bowing Creek as well as the regraded section of #4 Farrow Road. Most of the flow entering the regraded section of #4 Farrow Road would flow into Bow Bowing Creek.

The lack of significant velocity vectors across the eastern parts of the multi-deck car park indicates the topographic changes and walls would impede the path of flow in this area.

Peak water depths across the lower ground floor are typically 0.3 to 0.4 metres during the 1% AEP flood, while peak water depths across the more elevated ground floor level are not greater than 0.05 metres.

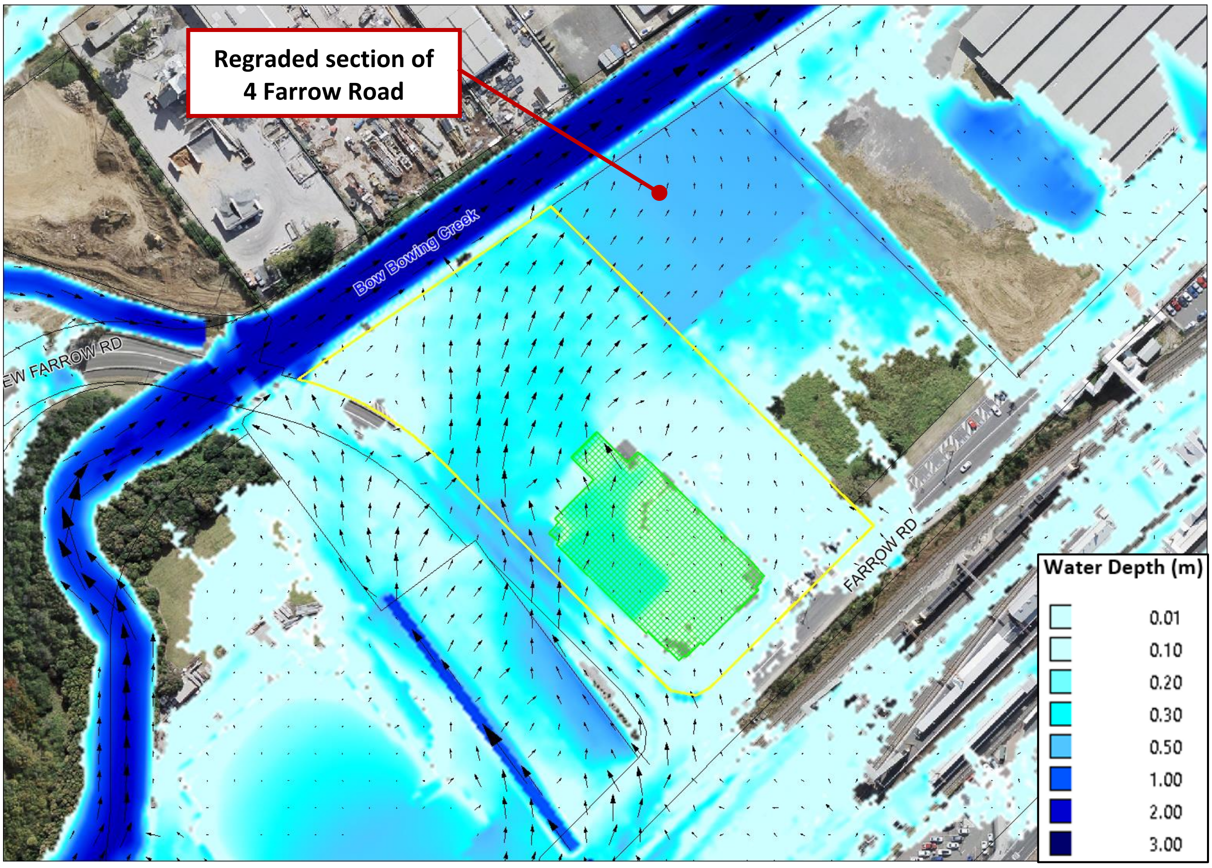

Figure 7 Peak 1% AEP Water Depths for Post-Development Conditions (Car Park Empty)

Table 2 Peak 1% AEP Flood Level for Post-development Conditions

ID (refer to Figure 3 for locations)	Peak Flood Level (mAHD)			
	Car Park Empty		Car Park Full	
	Existing	Post-development	Existing	Post-development
1	60.66	60.59	60.57	60.54
2	61.58	61.56	61.58	61.56
3	60.89	60.64	60.79	60.56
4	61.94	61.86	61.94	61.86
5	61.29	61.26	61.46	61.36
6	61.83	62.46	61.95	62.46
7	61.60	61.65	62.09	61.96
8	62.58	62.56	62.59	62.56

Car Park Full

The post-development model was also used to re-simulate the 1% AEP flood under a "car park full" scenario (i.e., cars occupying all available car parking spaces on the ground and lower ground floor of the multi-deck car park as well as the balance of the car park). Peak 1% AEP water depths and velocity vectors for this scenario were extracted and are provided in **Figure 8**. Peak water levels for this scenario are included in **Table 2**.

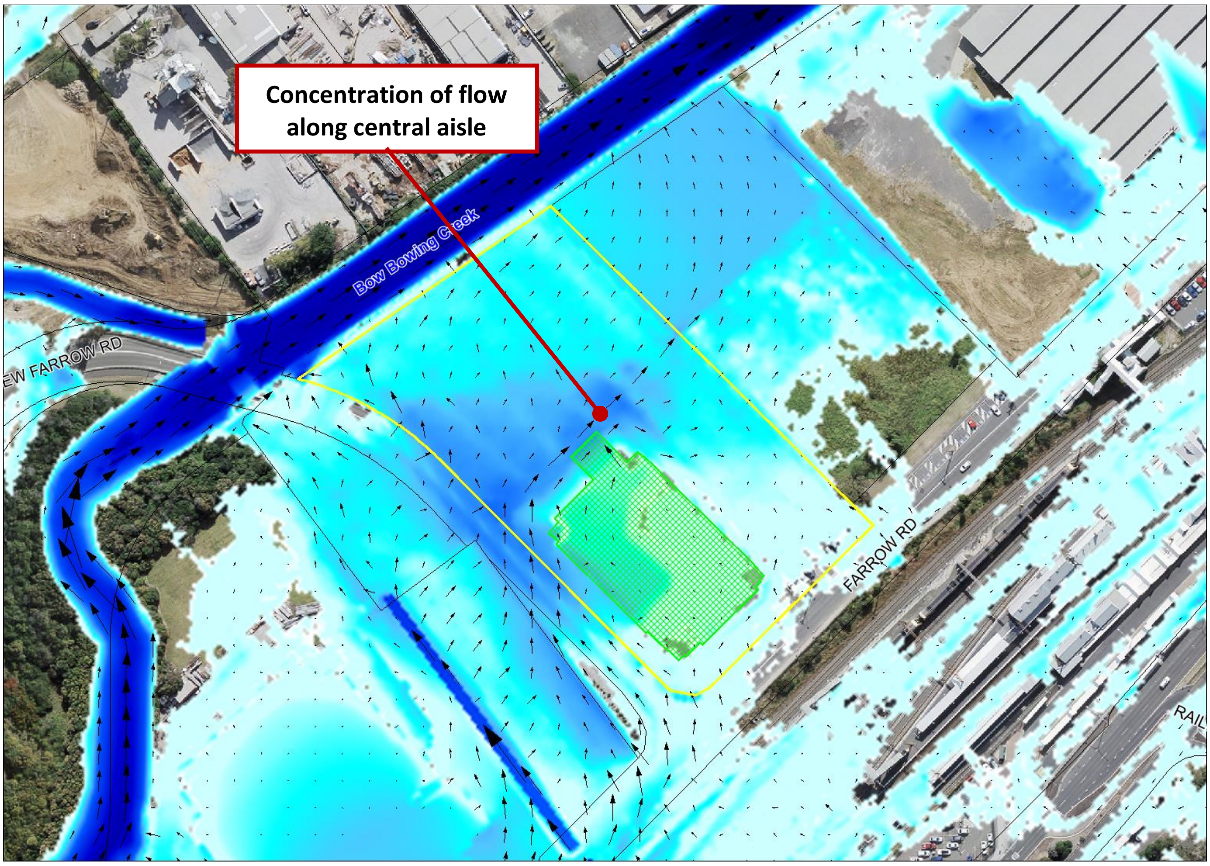

Figure 8 Peak 1% AEP Water Depths for Post-Development Conditions (Car Park Full)

Relative to the 'car park empty' scenario, the velocity vectors shown in **Figure 8** indicate much lower velocities across the lower ground floor under a car park full scenario (i.e., from >1 m/s down to <0.5 m/s). It also shows that the redirection of flow along the south-western side of the multi-deck car park coupled with the new car park entrance on New Farrow Road concentrates flow in a north-easterly direction along the central aisle of the existing car park (flow velocities of more than 2 m/s are predicted along this aisle). This directs additional flow towards #4 Farrow Road, however, the regrading across #4 Farrow Road then redirects that flow towards Bow Bowing Creek.

Peak 1% AEP water depths are predicted to exceed 0.4 metres across the lower ground floor of the multi-deck car park under the car park full scenario. The depths across the ground floor levels are not predicted to exceed 0.05 metres.

3.2.3 Flood Impact Assessment

The peak flood level comparison provided in **Table 2** suggests that the proposed multi-deck car park will produce flood level reductions at the locations shown in **Figure 3**. The most notable exception is Location #6 (i.e., immediately south of the car park) where existing flood level are predicted to increase by more than 0.5 metres. Therefore, further interrogation of the flood level results was completed to establish the magnitude and extent of flood level changes to determine if there was potential for flood level increases to extend across adjoining properties.

This was completed by preparing flood level difference mapping. The difference mapping was prepared by subtracting peak 'existing' water levels from 'post-development' water levels. The resulting difference maps provide a contour map showing the magnitude and location of changes in flood level associated with the proposed works. The flood level difference map is presented in **Figure 9** (car park full) and **Figure 10** (car park empty).

Figure 9 and **Figure 10** confirms that the proposed car park is predicted to produce flood level increases immediately south and south-east of the car park under both car parking scenarios. The flood level increases are predicted to exceed 0.5 metres under both car park scenarios across this area. However, the flood level increases are contained in close proximity to the site boundary and only extend onto the edge of the Farrow Road/New Farrow Road pavement. That is, the flood level increases are not predicted to extend across private property.

The impediment to flow afforded by the proposed car park when combined with the regrading across #4 Farrow Road is predicted to reduce flood levels across much of the existing car park as well as properties located upstream and downstream of the car park. Therefore, the proposed car park and the associated flood management measures are predicted to afford reductions in flood levels across private properties.

As discussed, the regrading across #4 Farrow Road is predicted to result in the efficient re-direction of overland flow into Bow Bowing Creek. Although this is predicted to reduce existing flood levels across most of the area, flood levels increases are predicted within the creek channel. However, the flood level increases are not predicted to exceed 0.06 metres under either car park scenario and all increases are fully contained to the Bow Bowing Creek drainage reserve (i.e., properties adjacent to Bow Bowing Creek are not impacted).

3.2.4 Discussion

Overall, the proposed multi-storey car park and flood management measures are predicted to result in flood level increases as well as flood level reductions across the existing car park as well as areas adjoining the car park. However, the flood level increases are contained near the site boundary and do not extend across private property. Furthermore, flood level reductions are predicted to extend across neighbouring properties (including private property) providing a net flood benefit to these properties.

However, this outcome is highly influenced by the regrading work across #4 Farrow Road that was represented as part of the flood modelling. If these regrading works are not completed there is potential for the proposed car park to redirect additional flow into downstream properties leading to adverse flood impacts.

It is noted that the area where regrading is suggested is highly vegetated and the LiDAR that is used to define the terrain in this area may not fully capture the ground level beneath this vegetation. Therefore, as a starting point, it is suggested that ground survey is collected across the north-western parts of #4 Farrow Road to confirm if there is a section of higher ground in the first instance and confirm the extent of any regrading that may be required to complement the car park works.

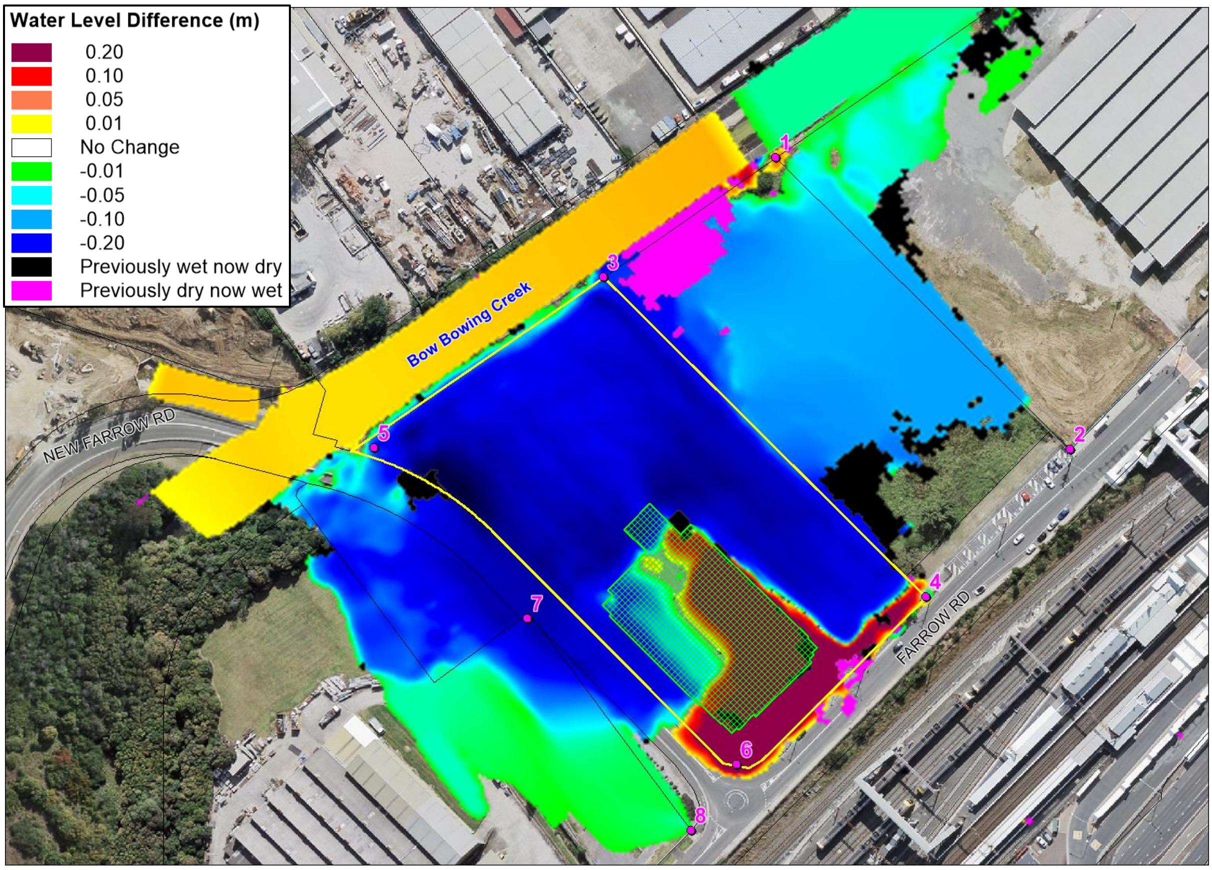

Figure 9 Peak 1% AEP Flood Level Difference Map (Car Park Empty)

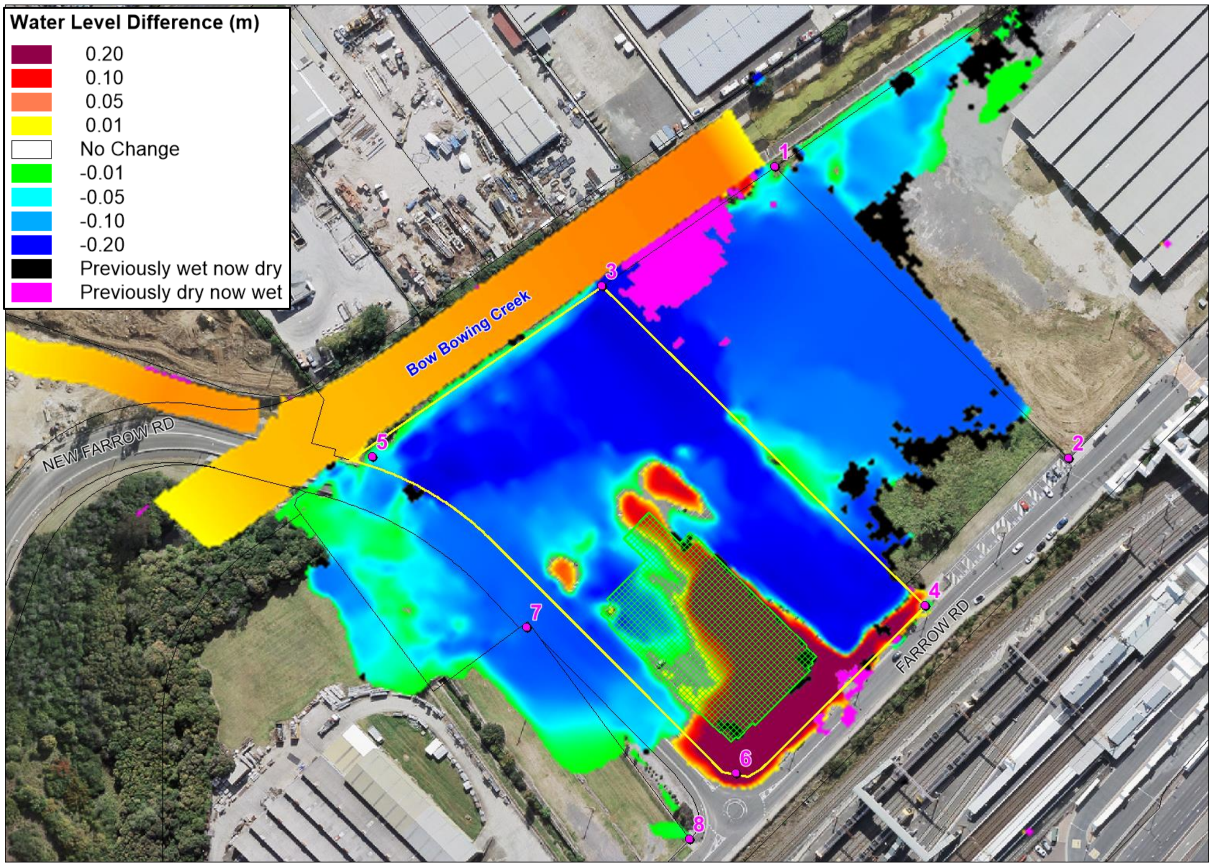

Figure 10 Peak 1% AEP Flood Level Difference Map (Car Park Full)

4 SUMMARY

This report has summarised the outcomes of a flood impact assessment that was completed to quantify the potential impacts that a proposed multi-storey car park development at Farrow Road, Campbelltown may have on existing flood behaviour.

The flood impact assessment was completed using a TUFLOW computer flood model that was originally developed as part of the *'Campbelltown Locality Flood Study'* (Catchment Simulation Solutions, 2018). The TUFLOW model was refined as part of the current study and was used to simulate the 1% AEP design flood for both 'existing' as well as 'post-development' conditions under two difference car park scenarios (i.e., car park empty and car park full of cars).

The results of the flood simulations indicate that the proposed works will serve to impede and redirect flows in the immediate vicinity of the proposed car parks. This is predicted to produce changes to existing flood levels in the vicinity of the car park as well as across nearby properties. However, all flood level increases are contained to the existing car parking area, the Farrow Road reserve or the Bow Bowing Creek drainage reserve. That is, private property is not predicted to be exposed to flood level increases as a result of the proposed development.

In addition, the proposed development is predicted to generate flood level reductions across some neighbouring properties. However, this outcome is reliant on implementing a range of flood management measures (as discussed in Section 3.1) including regrading works that will likely be required across #4 Farrow Road.

Overall, if the multi-storey car park is implemented with the appropriate flood management measures, the proposed development is not predicted to adversely impact on flood behaviour across private property.

5 REFERENCES

- Blacktown City Council (2020) *Blacktown Council WSUD Developer Handbook 2020* Prepared by Blacktown City Council.
- Blacktown City Council (2015) *Blacktown Local Environment Plan 2015* Prepared by Blacktown City Council.
- Catchment Simulation Solutions (2020) *Blacktown Local Overland Flow Path Study*
- Ball J, Babister M, Nathan R, Weeks W, Weinmann E, Retallick M, Testoni I, (Editors) (2019) Australian Rainfall and Runoff: A Guide to Flood Estimation, © Commonwealth of Australia (Geoscience Australia).

APPENDIX A

PLANS OF MULTI-DECK CAR PARK

- Use figured dimensions only.
- Do not scale.
- Comply with relevant Authorities' requirements
- Comply with the Building Code of Australia
- Comply with all relevant Australian Standards

REV	DATE	BY	AMENDMENTS
A	10/5/22	BS	PRELIMINARY ISSUE
B	13/5/22	BS	Tanks/revise ramp

LEGEND

AFD	Aluminium framed glazed door
AFW	Aluminium framed window
AWN	Metal framed awning
BAL 1	Metal Balustrade
BAL 2	Concrete Balustrade/Crash Barrier
CB	Steel Crash Barrier
DP	Downpipe
GU	Gutter
HR	Handrail
LA	Landscaping to Landscape Architect's documentation
MR	Metal roof
PA	Path to Landscape Architect's documentation
PAV	Paving to Landscape Architect's documentation
PF	Paint finish
PV	Photovoltaic panels (indicative layout to future detail)
RC	Concrete Finish
SCR1	Vertical coloured batten screening integrated art wall
SCR2	Mesh screen
SCR3	Chain wire screen

HYDRAULIC/MECHANICAL/ELECTRIC
O & S Consulting Pty Ltd
Suite 6, Level 1, 30-36 Albany St, St Leonards NSW 2065
M +61 417 836 752

CIVIL ENGINEERS
Northrop Consulting Engineers Pty Ltd
T 02 9241 4188
Level 2, 3 Horwood Place Parramatta NSW 2150

PLANNER
Civic Assessments Urban Planner
M 0405 535 097

STRUCTURAL
SDA Structure Pty Ltd
T 02 9810 6911
Studio 2, 61 Victoria Road, Rozelle, NSW 2039

NCC/ACCESS
Credwell Consulting Pty Ltd
Level 6, 233 Castlereagh Street, Sydney NSW 2000
T +612 4017 8530 | M 0488 003 867

TRAFFIC
Traffix
Suite 2.08, 50 Holt St, Surry Hills, NSW, 2010
Ph 02 8324 8700

LANDSCAPE
JMD design
190 James St Redfern NSW 2016
T (02) 9310 5644

SURVEYOR
Premise
Suite 301, Level 3 Oran Park Podium
T 02 4632 6500

ARCHITECTS
hill thalis
ARCHITECTURE + URBAN PROJECTS PTY LTD
LEVEL 4, 68-72 Wentworth Ave
Surry Hills NSW 2010 Australia
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E admin@hillthalis.com.au www.hillthalis.com.au
Nominated Architects: Philip Thalis #6780 Sarah Hill #5285

PROJECT
Farrow Rd Multi-Deck Carpark
Client : Campbelltown City Council

PROJECT ADDRESS
Lot 245 Farrow Road Campbelltown. DP 1222763

PACKAGE
Development Application

DRAWING
Ground Floor Plan

DRAWN	CHECKED	PLOT DATE	JOB NO
BS	PT	26/5/22	Proj No.

SCALE	DRAWING NO	REV
1:200@A1	DA2.10	B

Appendix B
Landscaping Plans

Landscape Plan

- Property Boundary
- Existing Asphalt Paving
- Decorative Paving Treatment - *High Spec Finish*
- Alternate Paving Treatment - *Medium Spec Finish*
- Existing trees to be retained
- Existing trees to be removed
- Tree Protection Zone (TPZ)
- Structural Root Zone (SRZ)
- Proposed Trees
- Extent of mass planting area
- Extent of turfed area
- 69.2 Existing Spot Level
- 70.5 Proposed Spot Level

Client	Architect	Revisions							Project	Date	Drawing No.	Issue No.
Campbelltown City Council	hill thalis ARCHITECTURE + URBAN PROJECTS PTY LTD	Issue	Date	Description	Drawn	Check	JMD design	190 James Street Redfern NSW 2016 T (02) 9310 5644 info@jmddesign.com.au	FARROW ROAD CARPARK	MARCH 2022	SK01	ADV
		ADV	11/05/2022	FOR FLOOD MODEL INPUT	HL	AJ			Drawing title Landscape Plan	Scale 1:500 @ A3		