

Holroyd City Council
PO BOX 42
MERRYLANDS NSW 2160

Job No. DL301.005

Attn: Ms Roopali Pandey

28 September 2015

Re: Merrylands CBD Neil Street Precinct Flooding Investigation

Dear Roopali

This letter sets out the findings of an investigation which was undertaken to assess the impact a proposed amendment to the layout of the proposed buildings within the Neil Street Precinct component of the Merrylands Central Business District (CBD) will have on flooding behaviour and to assess whether additional measures are required to mitigate the impacts of the proposed changes on flooding behaviour.

1. Key Findings of Present Investigation

The key findings of the present investigation were as follows:

- i. Post-developed flooding patterns will be similar in nature to those assessed as part of a previous investigation which was undertaken into the impact future development within the CBD will have on flooding behaviour (refer **Section 2** of this letter for background to previous study).
- ii. All of the elements comprising the preferred flood risk management scheme recommended as part of the previous investigation should be retained. However, a minor refinement to the previously proposed scheme is recommended which involves the partial closure of the existing reach of channel which is located on the northern (downstream) side of Neil Street.
- iii. While development could proceed within the Neil Street Precinct prior to the redevelopment of the remainder of the CBD, it will be necessary to construct the elements of the preferred flood risk management scheme which lie to the east of Stockland Mall as part of the precinct development, as otherwise adverse flooding conditions will arise in existing development which lies to the west (upstream) of Pitt Street when the remainder of the CBD is developed.
- iv. If the Neil Street Precinct is to be developed prior to the implementation of all of the elements comprising the preferred flood risk management scheme, then finished ground and floor levels will need to take into account the increased depths of flow which will be experienced in the new road network east of Stockland Mall.
- v. Care will need to be taken when setting finished ground levels in the Neil Street Precinct to ensure that overland flow is confined to the road and open-space areas and does not discharge in an uncontrolled manner between the proposed buildings (for example, flow will need to be prevented from discharging along the route of the existing trunk drainage line which generally follows the natural valley of the catchment east of Pitt Street).

- vi. While the impacts of development will generally be confined to the Neil Street Precinct, further design development will need to be undertaken which is aimed at improving the capture of overland flow at the location where the main arm of A'Becketts Creek crosses the northern boundary of the precinct. This will require a 3D model of the road network to be developed to enable a more accurate assessment of patterns of overland flow to be undertaken in this area.
- vii. Flow in the various overland flow paths for storms with average recurrence intervals (ARI's) up to 100 years would remain low hazard in nature should the Neil Street Precinct be developed prior to the implementation of the full range of measures comprising the preferred flood risk management scheme.
- viii. Climate change induced increases of up to 10 per cent in the intensity of 100 year ARI rainfall would only lead to an increase of between 10 and 100 mm in the depth of overland flow in the Neil Street Precinct.

The followings sections of this letter provide a brief background to the previous investigation which was undertaken to assess flooding behaviour in the CBD, the amendments which have been made to the layout of the Neil Street Precinct, the methodology adopted for assessing the proposed changes and the results of the updated flood modelling.

2. Background

Earlier this year Lyall & Associates (**L&A**) completed an investigation on behalf of Holroyd City Council which defined the nature of flooding in the CBD under present day conditions and included an assessment of the impact future development would have on flooding behaviour. The findings of the investigation are set out in the report entitled "*Merrylands CBD Flood Study and Flood Risk Management Options Review*" (L&A, 2015).

The previous investigation identified that the CBD is presently subject to flooding as a result of constraints in the capacity of the local stormwater drainage system which discharges to the Sydney Water Corporation owned trunk drainage system. **Figure 1** attached shows the characteristics of flooding in the CBD under present day conditions, while **Figure 2** shows the areas of low and high flood hazard for a 100 year ARI design storm event.¹

An assessment was undertaken of the impacts the enclosure of three short sections of open channel as part of the CBD redevelopment would have on flooding behaviour. **Figure 3** attached is a reproduction of Figure 4.1 of L&A, 2015 which shows the scope of the minor trunk drainage upgrade works which were assessed as part of L&A, 2015. The investigation found that additional improvements would be required to the existing stormwater drainage system in order to mitigate the impact of future development on flooding behaviour and to also reduce the flood risk in the CBD. The investigation identified a number of potential flood risk management options that were aimed at:

- a) mitigating the impact of future development on flood behaviour within the CBD and adjacent residential areas;
- b) increasing the hydraulic capacity of Sydney Water Corporation's trunk stormwater drainage system at identified 'choke' points; and
- c) reducing the frequency and severity of overland flooding that is currently experienced in the CBD.

¹ Note that in order to reduce run times, a design storm of 120 minutes duration, which is critical for maximising peak flows in the CBD, was used as part of the present investigation to assess the impacts of future development on flood behaviour.

A preferred flood risk management scheme was recommended which had an estimated capital cost of about \$21 Million. **Figure 4** attached is a reproduction of Figure 5.1 of L&A, 2015 showing the key elements comprising the scheme.

3. Proposed Amendments to Building Layout in Neil Street Precinct

As mentioned, Holroyd City Council is presently assessing the merits of amending the layout of the proposed buildings in the Neil Street Precinct. **Figure 5** provides a comparison of the building arrangement which was assessed as part of L&A, 2015 and the revised layout which is the subject of the present investigation. The key change in terms of the potential to impact flooding behaviour is the narrowing of the major overland flow path which will be located to the east of Pitt Street between Terminal Place and Neil Street from 40 m ($18.5\text{ m} + 21.5\text{ m} = 40\text{ m}$) to 35 m ($18.5\text{ m} + 16.5\text{ m} = 35\text{ m}$).

4. Study Methodology

The TUFLOW models developed as part of L&A, 2015 for pre- and post-developed conditions were used as the basis for assessing the impact the amended building layout would have on flooding behaviour and to assess whether any changes needed to be made to the preferred flood risk management scheme. As no DEM is presently available for post-developed ground levels in the CBD, existing ground levels were altered to approximate the level of the major overland flow paths which will generally be aligned with the future road network.

The hydraulic model was run for the following development scenarios:

- **Development Scenario 1** – Amended building arrangement in the Neil Street Precinct in combination with future development in the remainder of the Merrylands CBD, but with drainage upgrades limited to those shown on **Figure 3**. This scenario has been modelled to demonstrate that the drainage upgrade works cannot be limited to the enclosure of three short sections of channel within the CBD.
- **Development Scenario 2** - Amended building arrangement in the Neil Street Precinct in isolation, with drainage upgrades as per the preferred flood risk management scheme but limited to the area east (downstream) of Stockland Mall. This scenario has been modelled to assess flood behaviour in the Neil Street Precinct absent develop in other parts of the CBD, including implementation of the elements comprising the preferred flood risk management scheme west (upstream) of Pitt Street. Finished floor levels for future development may need to take into account that depths of inundation in the Neil Street Precinct will be greater than under ultimate development conditions given the possible staged approach to development within the CBD and also the implementation of the preferred flood risk management scheme.
- **Development Scenario 3** – Amended building arrangement in the Neil Street Precinct along with future development in the remainder of the Merrylands CBD, with drainage upgrades as per the preferred flood risk management scheme. This scenario was modelled to demonstrate the nature of flooding once the redevelopment of the CBD and the implementation of the preferred flood risk management scheme is complete.

Note that following discussions with HCC it was agreed that the preferred flood risk management scheme should include the partial enclosure of the short section of the A'Becketts Creek channel on the northern (downstream) side of Neil Street. This feature was incorporated in the structure of the TUFLOW models that were developed to represent Development Scenarios 2 and 3. It will be necessary to incorporate a short section of channel similar to the arrangement which has been adopted on the southern (upstream) side of Walpole Street on the main arm of A'Becketts Creek in order to maximise the capture of uncontrolled overland flow prior to it discharging to the downstream reach of drainage system.

5. TUFLOW Model Results

5.1 Development Scenario 1

Figure 6 shows the characteristics of flooding in the CBD under post-Development Scenario 1 conditions, while **Figure 7** shows the impact development within the CBD will have on flooding behaviour for a 100 year ARI design storm event.

Similar to the findings of L&A, 2015, the enclosure of three short reaches of channel within the CBD would result in adverse flooding conditions being experienced in development located to the west and south of the CBD. Furthermore, enclosure of the short sections of channel south of McFarlane Street will result in an increase in peak overland flows in the Neil Street Precinct (refer peak flows given in columns **D** and **G** of **Table 1** attached).

Based on the above, it is concluded that the trunk drainage works associated with Development Scenario 1 (refer **Figure 3** for details) are insufficient to mitigate the impacts of future development within the CBD and additional measures similar to the preferred flood risk management scheme (refer **Figure 4** for details) would need to be implemented as part of the overall redevelopment of the CBD.

5.2 Development Scenario 2

Figure 8 shows the characteristics of flooding in the CBD under post-Development Scenario 2 conditions, while **Figures 9** and **10** show the impact development within the Neil Street Precinct would have on flooding behaviour and flood hazard for a 100 year ARI design storm event, respectively.

While improvements in the hydraulic capacity of the trunk drainage system east of Stockland Mall would only provide limited benefit in terms of the peak flow approaching the Neil Street Precinct (refer peak flows given in columns **E** and **H** of **Table 1** attached), these works would need to be constructed in order to mitigate the adverse impacts of future development in the remainder of the CBD.

While depths of flow along the proposed overland flow path which will run between Terminal Place and Neil Street would reach up to about 700 mm in a 100 year ARI event, conditions would still be low hazard in nature given the slow moving nature of the flow (assessed at about 0.2 m/s).

While the impact of development would generally be conditioned to the Neil Street Precinct, the modelling does show that there is the potential for floodwater to discharge in a northerly direction along the existing engineered floodway which follows the alignment of the trunk drainage culverts on the main arm of A'Becketts Creek. While flow in the floodway would not adversely impact flooding conditions in existing development, it is recommended that the configuration of the trunk drainage upgrade be refined to maximise the capture of overland flow at the location where the main arm of the creek crosses the northern boundary of the Neil Street Precinct. This would require appropriate grading of the local road network to concentrate flow toward the proposed open section of channel south of Brickworks Drive.

5.3 Development Scenario 3

Figure 11 shows the characteristics of flooding in the CBD under post-Development Scenario 3 conditions, while **Figures 12** and **13** show the impact development within the Neil Street Precinct would have on flooding behaviour and flood hazard for a 100 year ARI design storm event, respectively.

Completion of the preferred flood risk management scheme as part of the overall development of the CBD would significantly reduce the peak flows and hence depths of inundation along the proposed overland flow path which will run between Terminal Place and Neil Street. Low hazard flooding conditions would also prevail throughout the CBD.

Similar to the recommendation for Development Scenario 2, further design development will need to be undertaken to maximise the capture of overland flow at the northern (downstream) boundary of the Neil Street Precinct.

Figure 14 shows depths of flow within the CBD assuming a climate change induced 10 per cent increase in design 100 year ARI rainfall intensities, while **Figure 15** shows the impact this would have on flooding behaviour under post-Development Scenario 3 conditions. While depths of inundation would be increased in the range 10-100 mm within the Neil Street Precinct, they would generally not be greater than under Development Scenario 2 conditions (refer **Figure 8**). While the extent of flooding within the Neil Street Precinct would not increase greatly, the intersection of Merrylands Road and Treves Street would be subject to shallow inundation under post-climate change conditions (refer purple shaded area on **Figure 15**).

6. Concluding Remarks

While development could proceed within the Neil Street Precinct prior to the redevelopment of the remainder of the CBD, it will be necessary to construct the elements of the preferred flood risk management scheme which lie to the east of Stockland Mall as part of the precinct development, as otherwise adverse flooding conditions will arise in existing development which lies to the west (upstream) of Pitt Street when the remainder of the CBD is developed.

If the Neil Street Precinct is to be developed prior to the implementation of all of the elements comprising the preferred flood risk management scheme, then finished ground and floor levels will need to take into account the increased depths of flow which will be experienced in the new road network east of Stockland Mall.

Lastly, care will need to be taken when setting finished ground levels in the Neil Street Precinct to ensure that overland flow is confined to the road and open-space areas and does not discharge in an uncontrolled manner between the proposed buildings (for example, flow will need to be prevented from discharging along the route of the existing trunk drainage line which generally follows the natural valley of the catchment east of Pitt Street).

We trust that the assessment addresses Council's concerns in regards the impact the revised precinct plan will have on flooding behaviour and whether additional measures are required to mitigate its impact on flooding behaviour. Please do not hesitate to contact the undersigned should you have any queries or require further information.

Yours faithfully

Lyall & Associates Consulting Water Engineers

Scott Button
Principal

Attachments

Figure 1 – TUFLOW Model Results - Present Day Conditions – 100 year ARI 120 Minute Storm

Figure 2 – Provisional Flood Hazard – Present Day Conditions - 100 year ARI 120 Minute Storm

Figure 3 – Minor Trunk Drainage Upgrade Works Assessed as part of L&A, 2015

Figure 4 – Preferred Flood Risk Management Scheme Assessed as part of L&, 2015

Figure 5 – Comparison of Revised Building and Road Layout - Neil Street Precinct

Figure 6 – TUFLOW Model Results – Post-Development Scenario 1 Conditions – 100 year ARI 120 Minute Storm

Figure 7 – Impact of Development Scenario 1 on Flooding Behaviour – 100 year ARI 120 Minute Storm

Figure 8 – TUFLOW Model Results – Post-Development Scenario 2 Conditions – 100 year ARI 120 Minute Storm

Figure 9 – Impact of Development Scenario 2 on Flooding Behaviour – 100 year ARI 120 Minute Storm

Figure 10 – Provisional Flood Hazard – Post-Development Scenario 2 Conditions - 100 year ARI 120 Minute Storm

Figure 11 – TUFLOW Model Results – Post-Development Scenario 3 Conditions – 100 year ARI 120 Minute Storm

Figure 12 – Impact of Development Scenario 3 on Flooding Behaviour – 100 year ARI 120 Minute Storm

Figure 13 – Provisional Flood Hazard – Post-Development Scenario 3 Conditions - 100 year ARI 120 Minute Storm

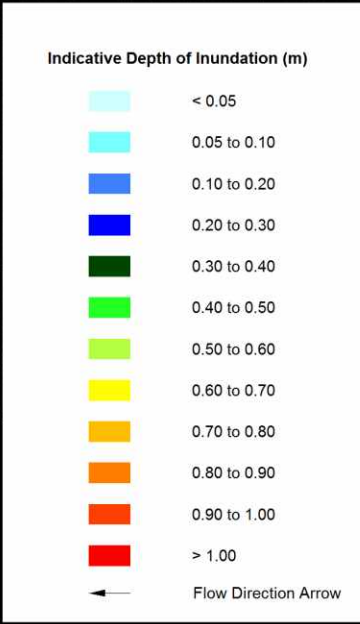
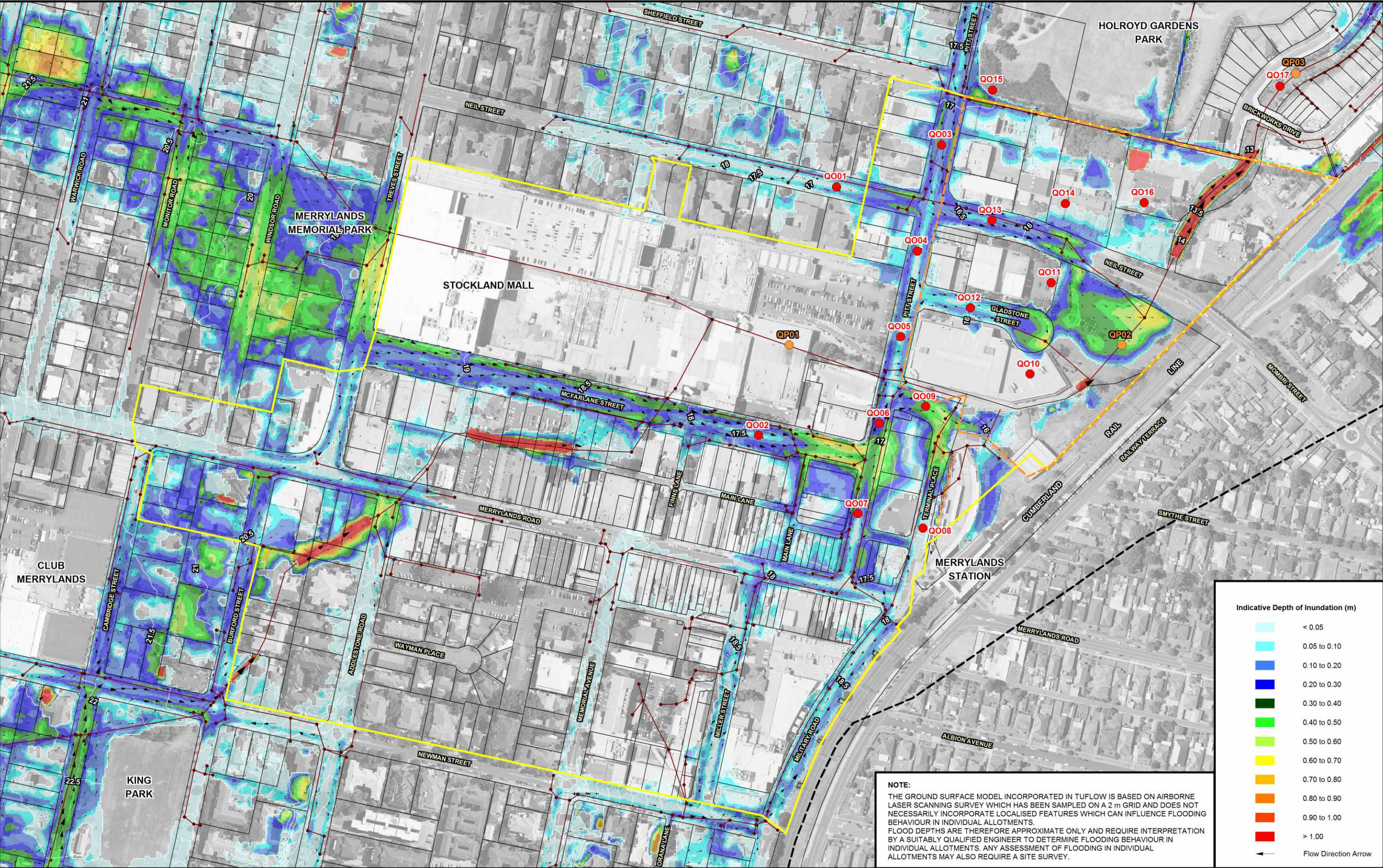
Figure 14 – TUFLOW Model Results – Post-Development Scenario 3 Conditions – 100 year ARI 120 Minute Storm + Climate Change

Figure 15 – Impact of Climate Change on Flooding Behaviour - Post-Development Scenario 3 Conditions – 100 year ARI 120 Minute Storm

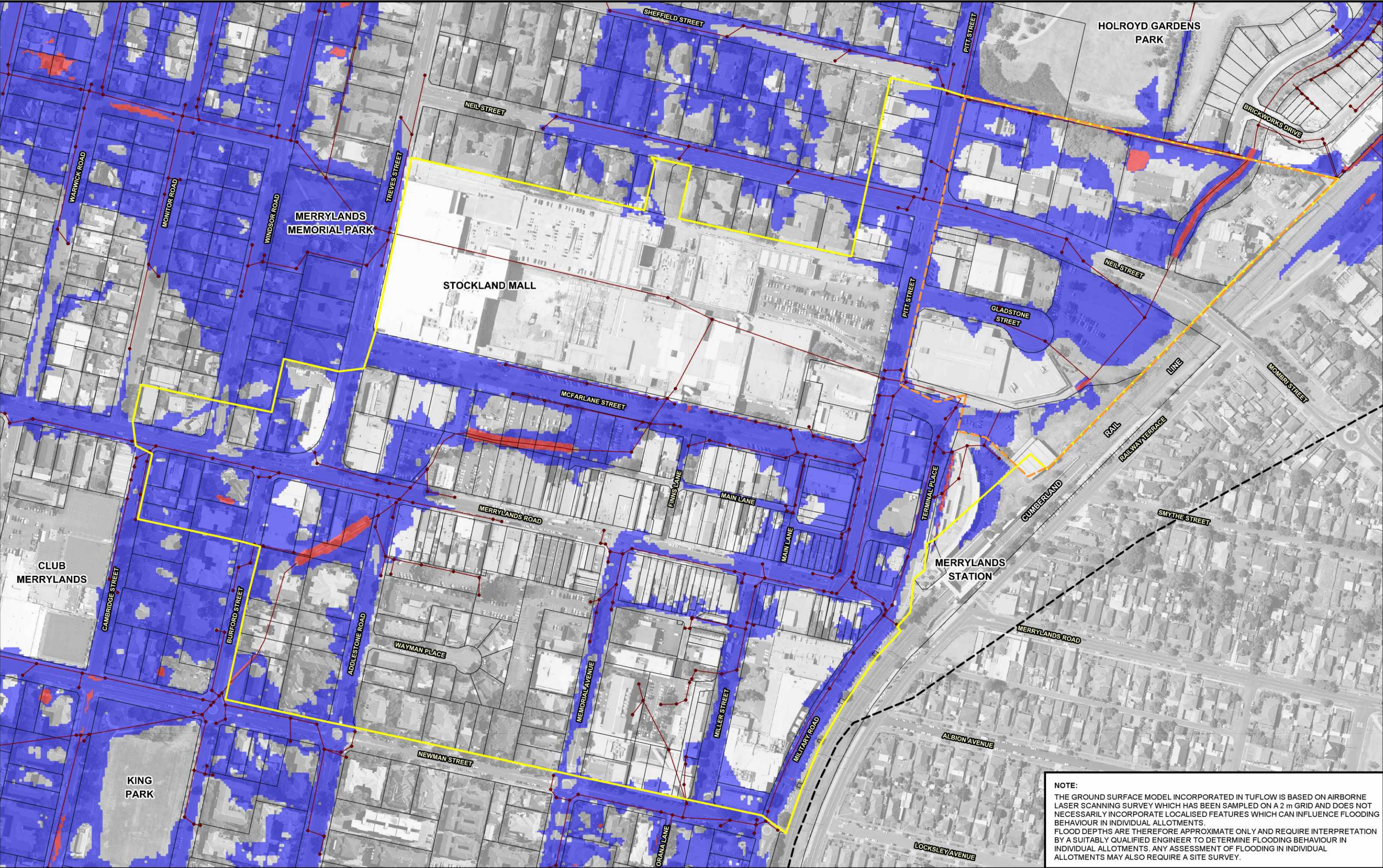
TABLE 1
SUMMARY OF PEAK FLOWS
100 YEAR ARI 120 MINUTE STORM

Identifier ⁽¹⁾	Flow Type	Peak Flow (m ³ /s)				Difference (m ³ /s) ⁽²⁾		
		Present Day	Development Scenario 1	Development Scenario 2	Development Scenario 3	Development Scenario 1	Development Scenario 2	Development Scenario 3
[A]	[B]	[C]	[D]	[E]	[F]	[G]	[H]	[I]
QO01	Overland	0.92	0.92	0.92	0.57	0.00	0.00	-0.35
QO02	Overland	6.58	7.23	6.43	2.71	0.65	-0.15	-3.87
QO03	Overland	4.00	2.65	2.63	1.69	-1.35	-1.37	-2.31
QO04	Overland	1.14	0.78	0.78	0.42	-0.36	-0.36	-0.72
QO05	Overland	1.00	1.69	0.86	0.45	0.69	-0.14	-0.55
QO06	Overland	6.10	7.08	5.84	2.90	0.98	-0.26	-3.20
QO07	Overland	1.42	1.79	1.21	1.78	0.37	-0.21	0.36
QO08	Overland	0.13	0.04	0.06	0.02	-0.09	-0.07	-0.11
QO09	Overland	3.87	3.88	3.63	1.27	0.01	-0.24	-2.60
QO10	Overland	0.00	2.11	1.92	0.52	2.11	1.92	0.52
QO11	Overland	0.00	2.72	1.27	0.15	2.72	1.27	0.15
QO12	Overland	1.04	1.59	0.89	0.47	0.55	-0.15	-0.57
QO13	Overland	3.92	2.96	2.85	0.90	-0.96	-1.07	-3.02
QO14	Overland	0.00	2.26	0.69	0.13	2.26	0.69	0.13
QO15	Overland	1.08	2.60	2.59	2.53	1.52	1.51	1.45
QO16	Overland	0.01	2.21	1.10	0.73	2.20	1.09	0.72
QO17	Overland	0.00	0.11	0.03	0.02	0.11	0.03	0.02
QP01	Piped	33.86	33.98	33.98	39.12	0.12	0.12	5.26
QP02	Piped	41.70	40.19	27.48	28.57	-1.51	-14.22	-13.13
QP03	Piped	48.65	48.77	49.23	53.49	0.12	0.58	4.84

1. Refer **Figures 1, 6, 8 and 11** for Peak Flow Location Identifiers.
2. A positive difference represents an increase in flow when compared to present day conditions and conversely, a negative value represents a reduction in peak flow when compared to present day conditions.



NOTE:
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FLOOD DEPTHS ARE THEREFORE APPROXIMATE ONLY AND REQUIRE INTERPRETATION BY A SUITABLY QUALIFIED ENGINEER TO DETERMINE FLOODING BEHAVIOUR IN INDIVIDUAL ALLOTMENTS. ANY ASSESSMENT OF FLOODING IN INDIVIDUAL ALLOTMENTS MAY ALSO REQUIRE A SITE SURVEY.





30 0 30 60 90 m

Scale: 1:3,000

Merrylands CBD

Neil Street Precinct

Two-Dimensional Model Boundary

Existing Stormwater Network

High Provisional Hydraulic Hazard

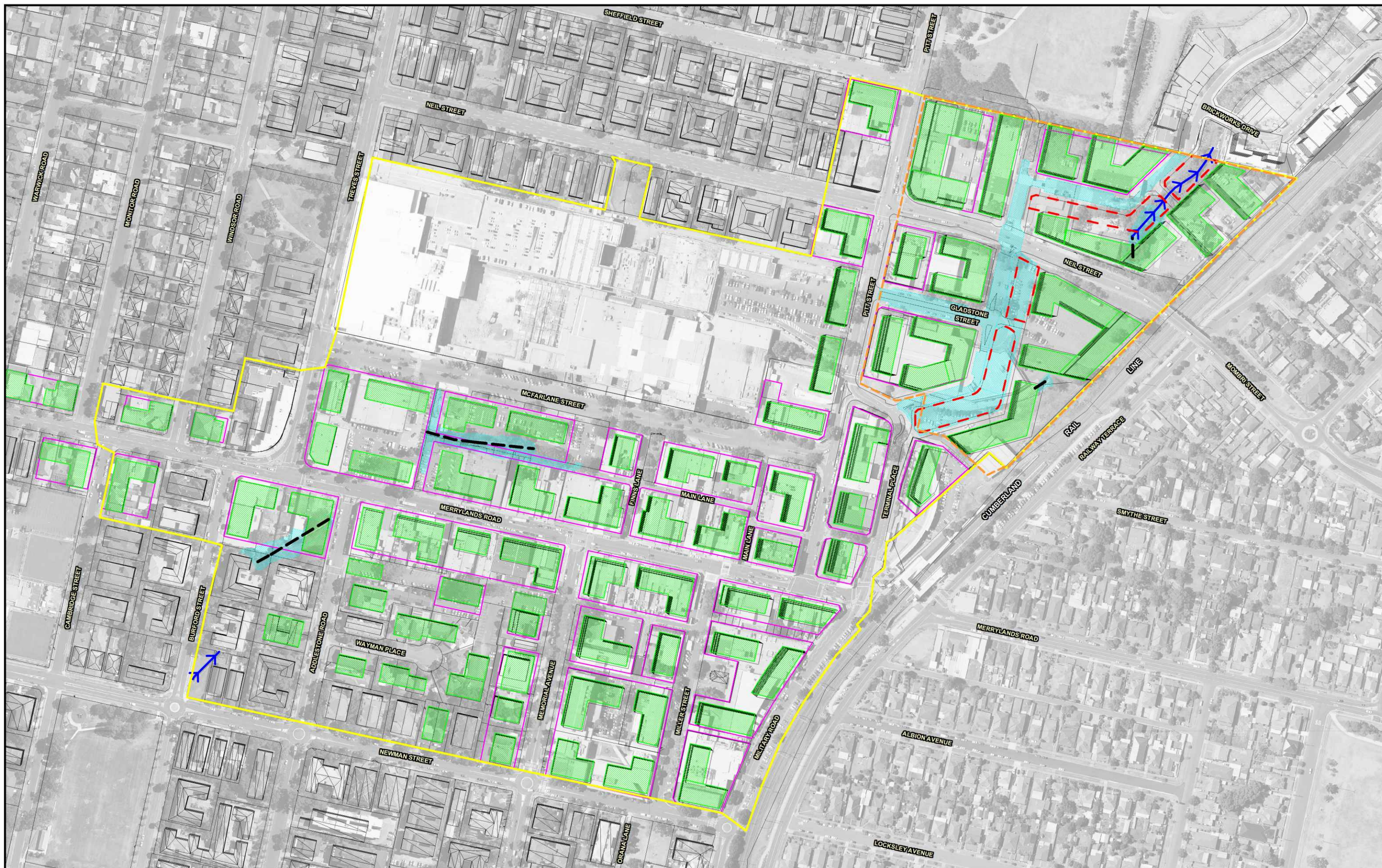
Low Provisional Hydraulic Hazard
(Categories based on Figure L2 of NSW Government's
Floodplain Development Manual, 2005)

Merrylands CBD NEIL STREET PRECINCT
FLOODING ADVICE

Figure 2

PROVISIONAL FLOOD HAZARD - PRESENT DAY CONDITIONS
100 YEAR ARI 120 MINUTE STORM

Lyall &
Associates



N

30 0 30 60 90 m

Scale: 1:3,000

Lyall & Associates

LEGEND

- Merrylands CBD
- Neil Street Precinct
- Location of Proposed Park / Open Space Corridor
- Footprint of Proposed Podiums
- Footprint of Proposed Buildings

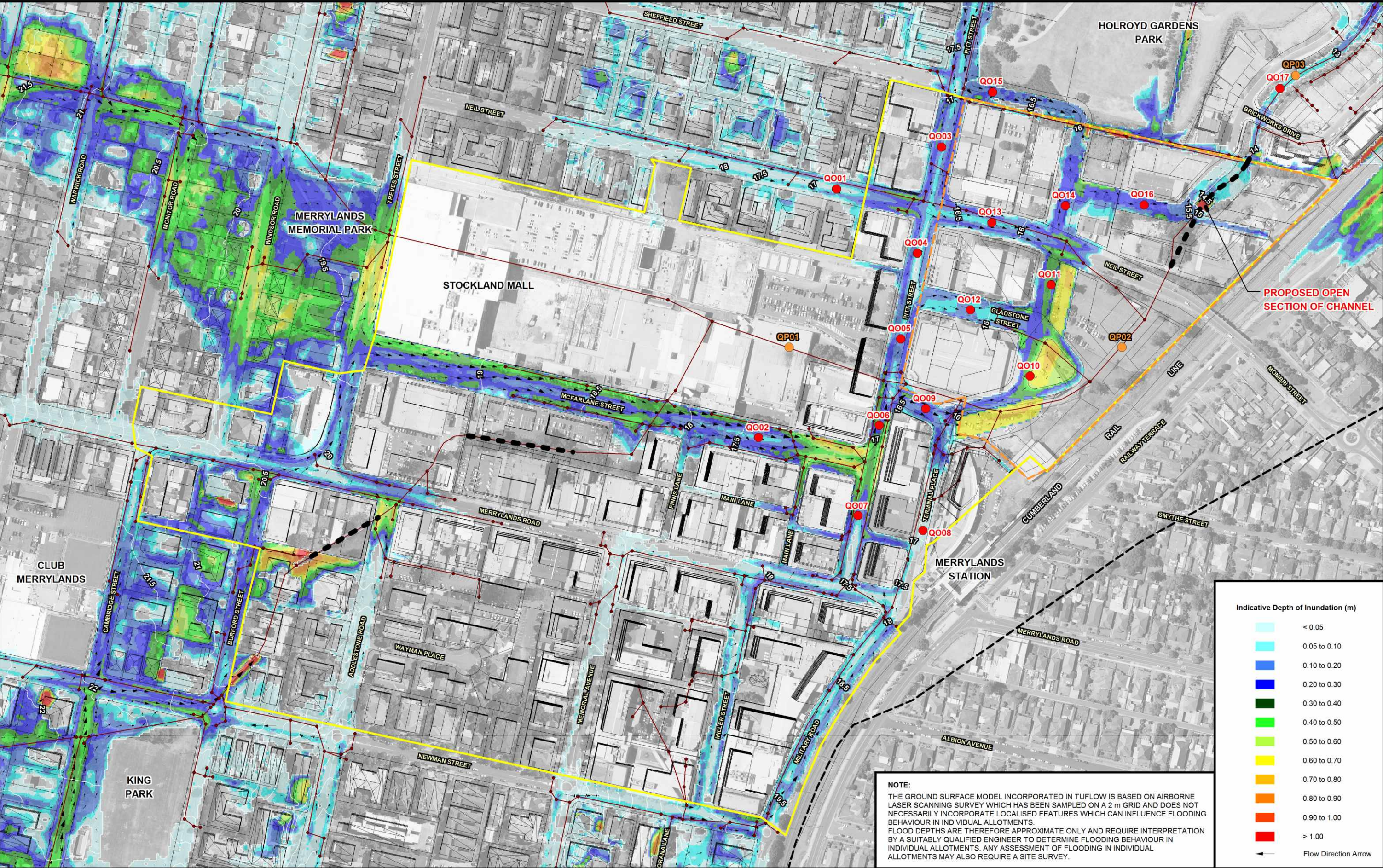
- Existing Channel Converted to Box Culvert
- Existing Channel Retained
- Extent of Topographic Modifications to Natural Surface Levels

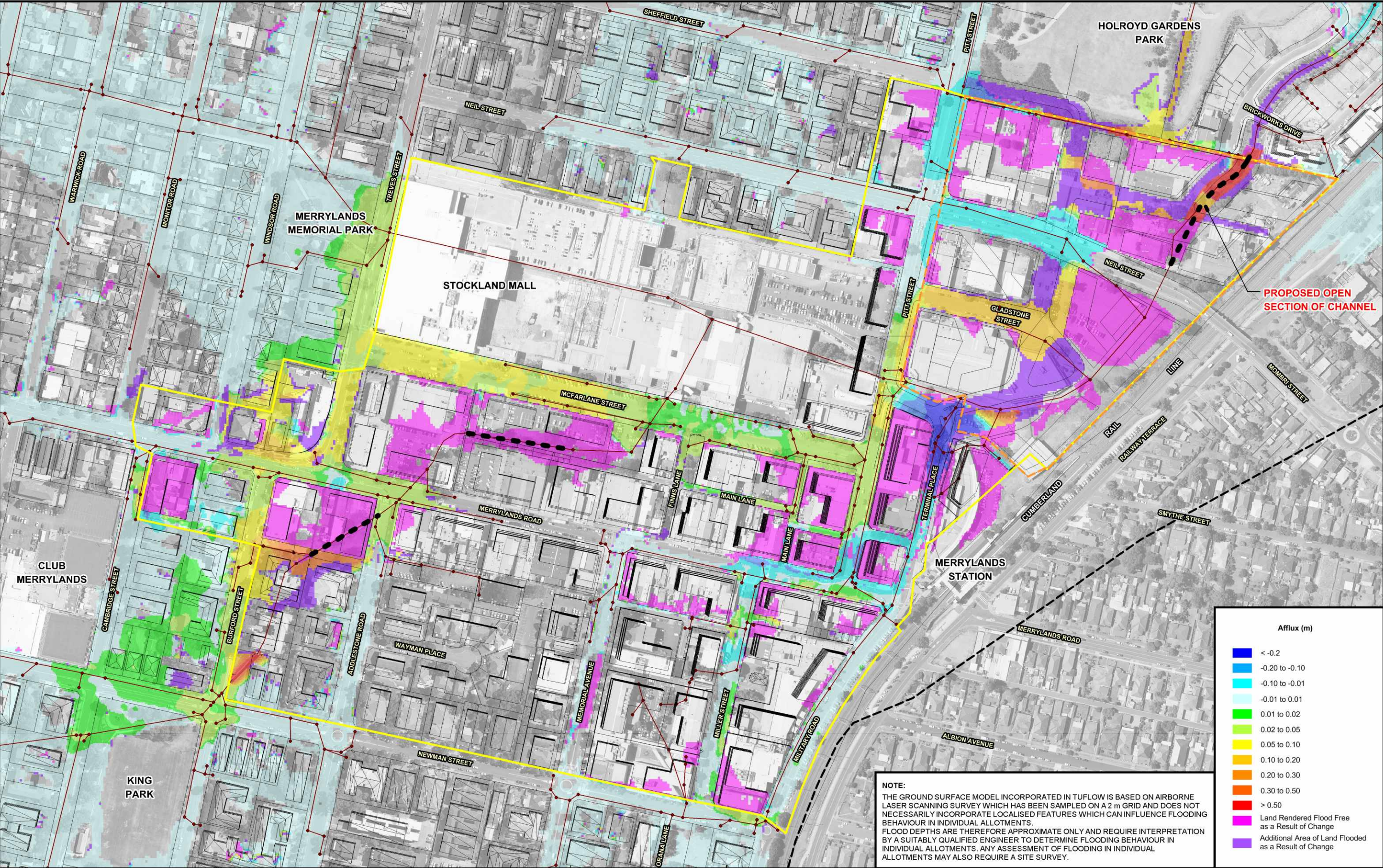
**MERRYLANDS CBD NEIL STREET PRECINCT
FLOODING ADVICE**

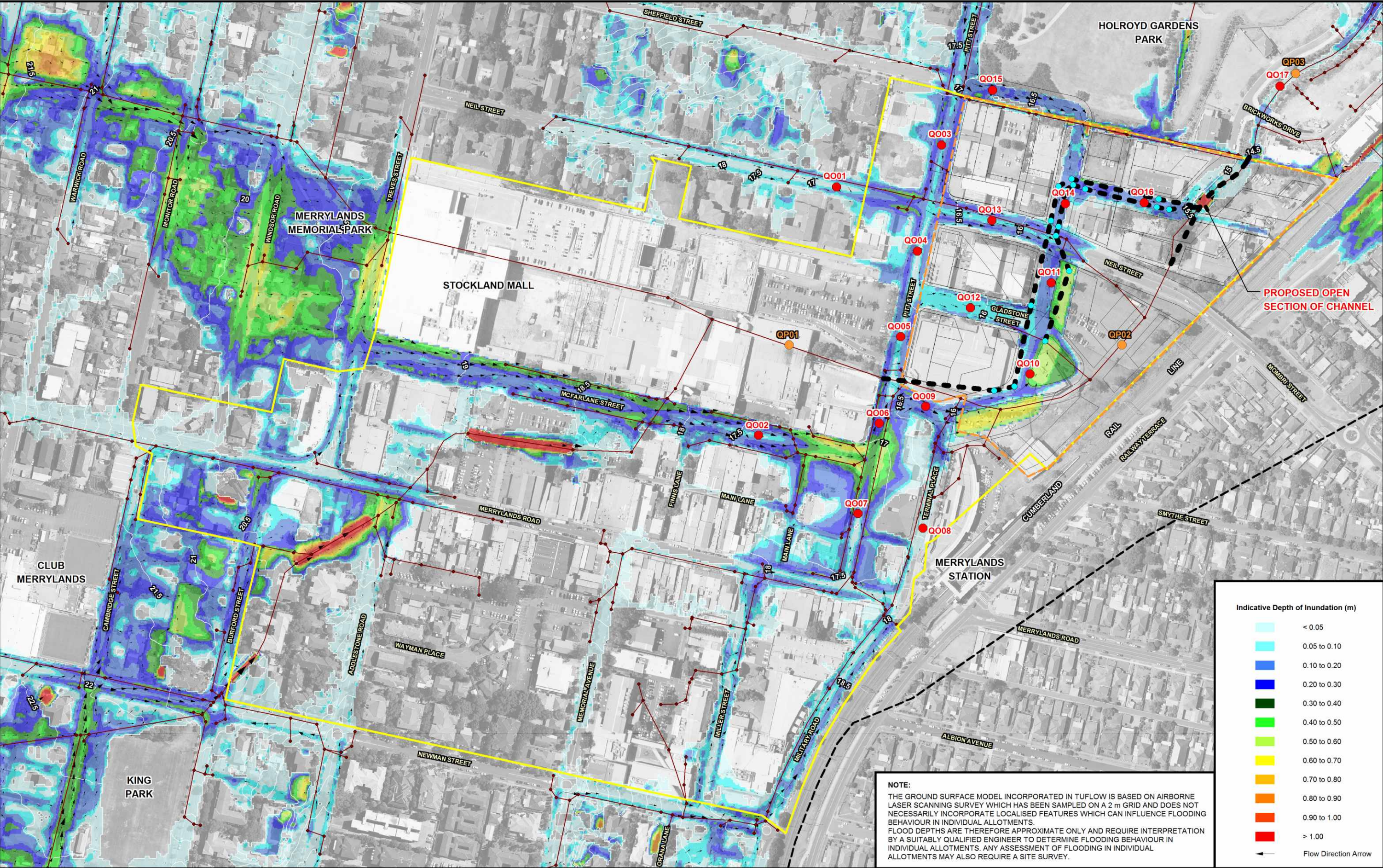
Figure 3

MINOR TRUNK DRAINAGE UPGRADE WORKS
ASSESSED AS PART OF L&A, 2015









N

30

0

30

60

90 m

Scale: 1:3,000

Merrylands CBD

Neil Street Precinct

Two-Dimensional Model Boundary

Existing Stormwater Network

Upgraded Reach of Stormwater Network

21

Peak Water Surface Elevation Contours (m AHD)
(Contours spaced at 0.5m intervals)

Q001

Peak Overland Flow Location and Identifier

QP01

Peak Piped Flow Location and Identifier

< 0.05

0.05 to 0.10

0.10 to 0.20

0.20 to 0.30

0.30 to 0.40

0.40 to 0.50

0.50 to 0.60

0.60 to 0.70

0.70 to 0.80

0.80 to 0.90

0.90 to 1.00

> 1.00

Flow Direction Arrow

NOTE:

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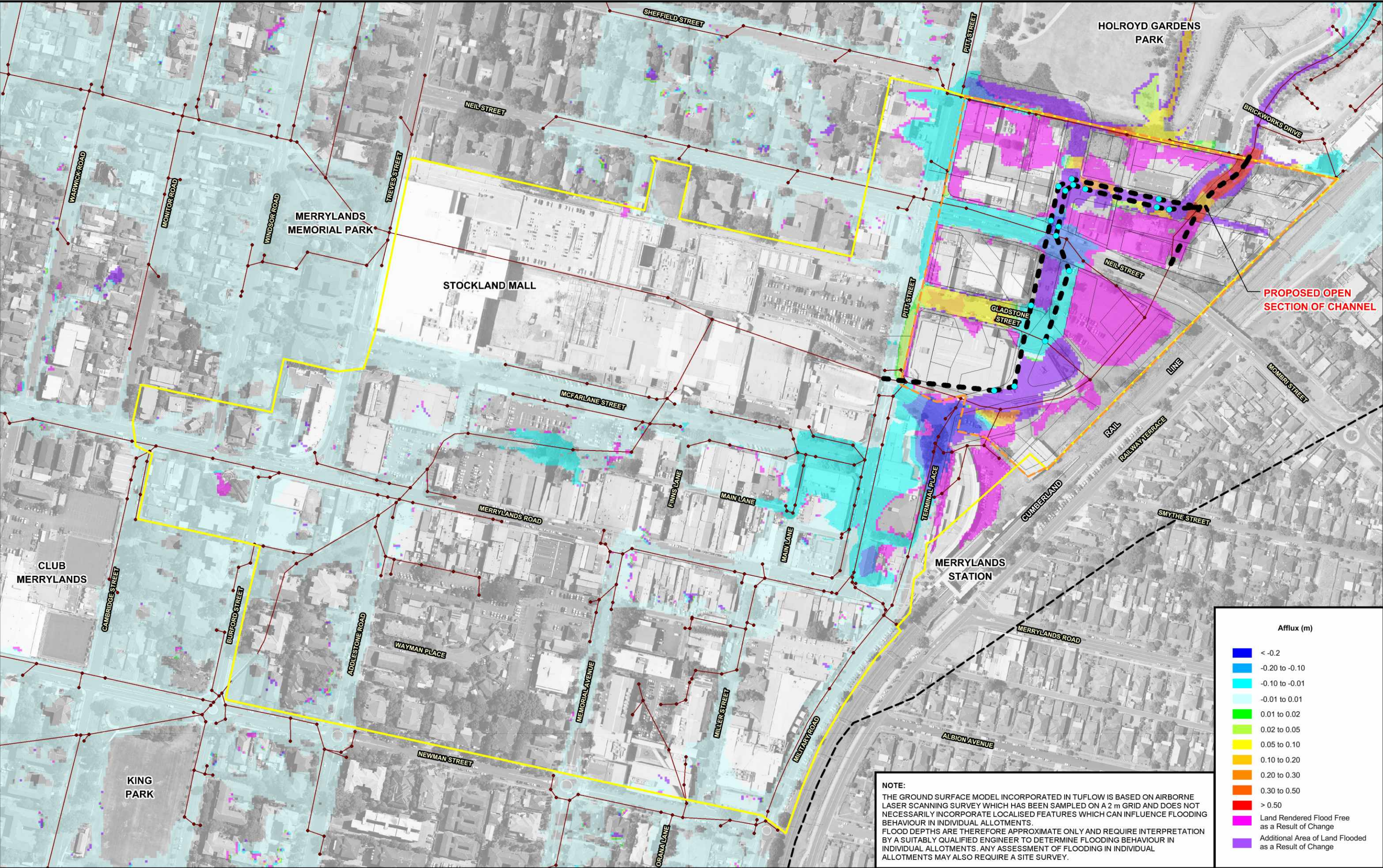
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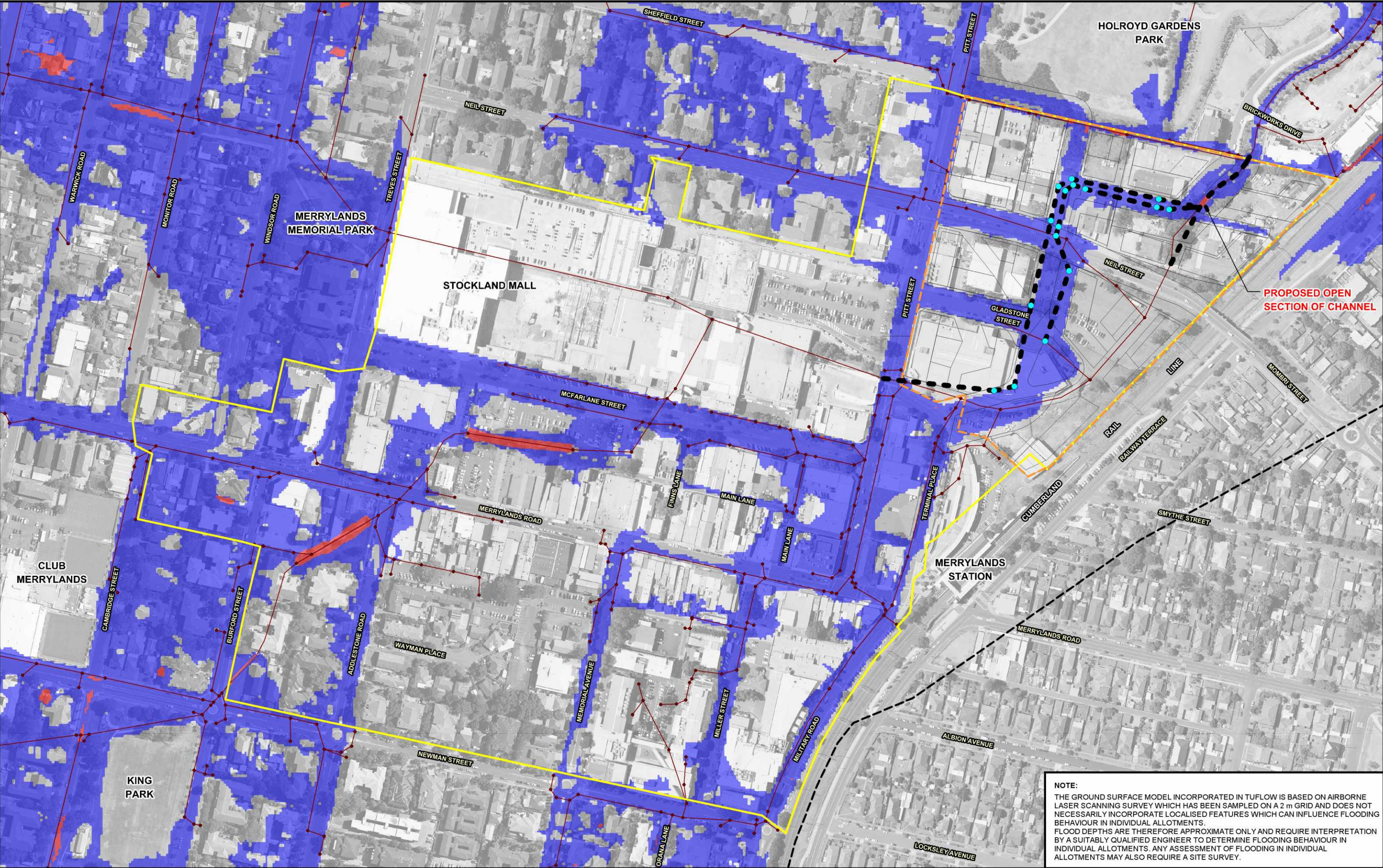
MERRYLANDS CBD NEIL STREET PRECINCT
FLOODING ADVICE

Figure 8

TUFLOW MODEL RESULTS - POST-DEVELOPMENT SCENARIO 2 CONDITIONS

100 YEAR ARI 120 MINUTE STORM





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Scale: 1:3,000
30 0 30 60 90 m

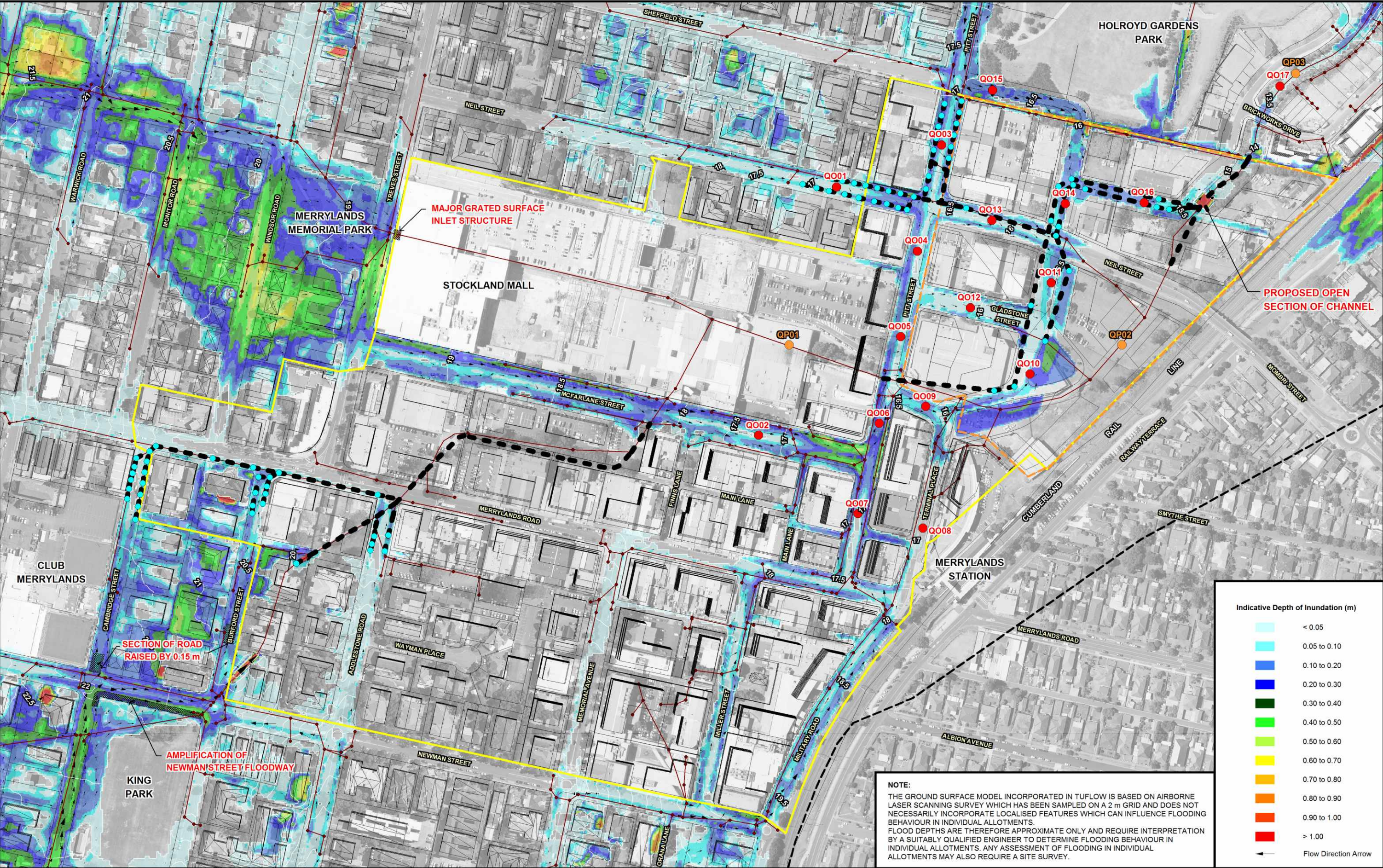
LEGEND

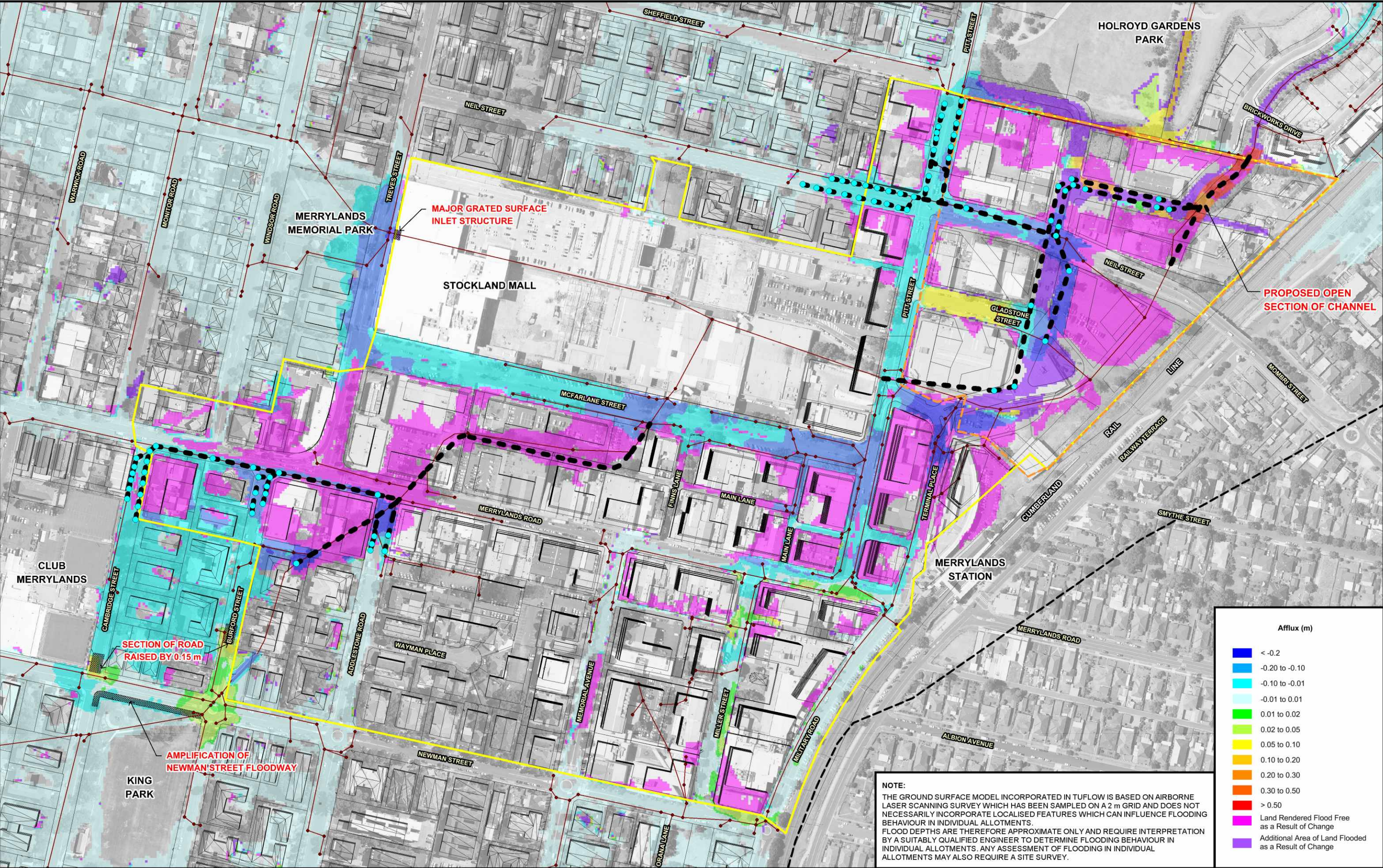
	Merrylands CBD		High Provisional Hydraulic Hazard
	Neil Street Precinct		Low Provisional Hydraulic Hazard (Categories based on Figure L2 of NSW Government's Floodplain Development Manual, 2005)
	Two-Dimensional Model Boundary		
	Existing Stormwater Network		
	Upgraded Reach of Stormwater Network		

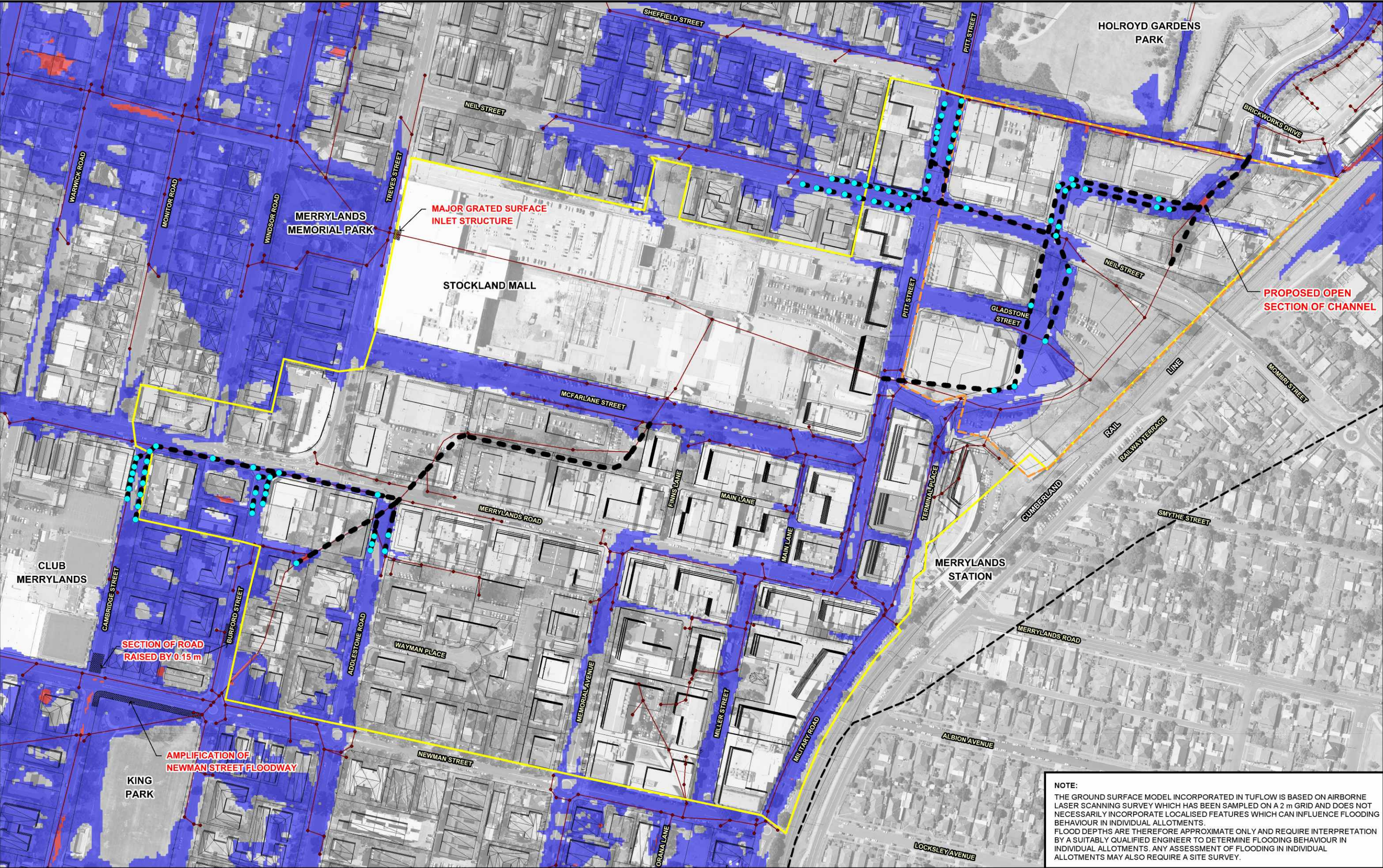
MERRYLANDS CBD NEIL STREET PRECINCT FLOODING ADVICE

Figure 10

PROVISIONAL FLOOD HAZARD - POST-DEVELOPMENT SCENARIO 2 CONDITIONS
100 YEAR ARI 120 MINUTE STORM







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LEGEND

	Merrylands CBD		High Provisional Hydraulic Hazard
	Neil Street Precinct		Low Provisional Hydraulic Hazard (Categories based on Figure L2 of NSW Government's Floodplain Development Manual, 2005)
	Two-Dimensional Model Boundary		
	Existing Stormwater Network		
	Upgraded Reach of Stormwater Network		

MERRYLANDS CBD NEIL STREET PRECINCT FLOODING ADVICE

Figure 13

PROVISIONAL FLOOD HAZARD - POST-DEVELOPMENT SCENARIO 3 CONDITIONS
100 YEAR ARI 120 MINUTE STORM

