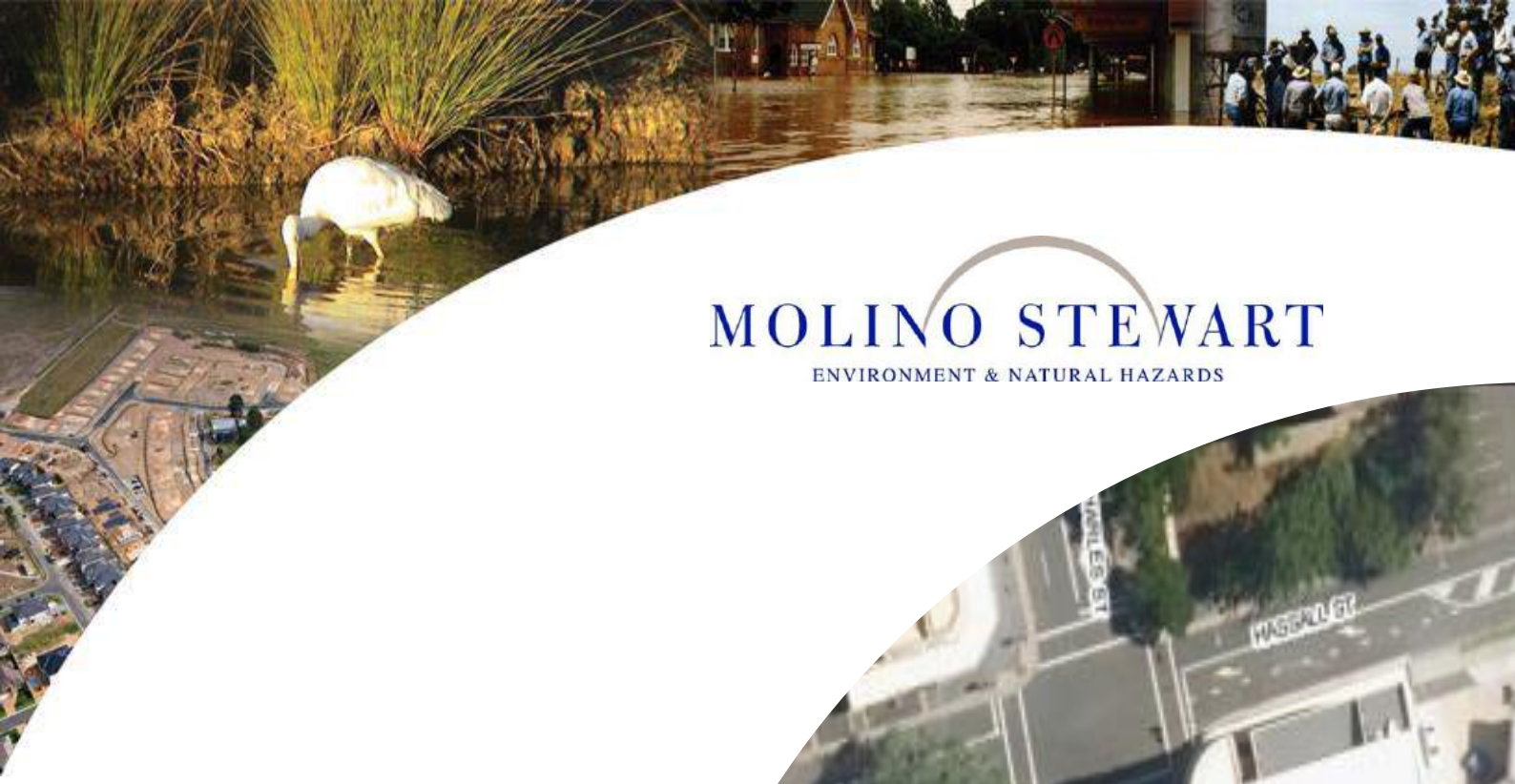

MOLINO STEWART

ENVIRONMENT & NATURAL HAZARDS


# 12A Parkes Street, Harris Park

*Independent Flood Assessment*

*Final Report*

# 12A Parkes Street, Harris Park

INDEPENDENT FLOOD ASSESSMENT FINAL REPORT

for

City of Parramatta Council

by

Molino Stewart Pty Ltd

ACN 067 774 332

MAY 2018

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# 1 INTRODUCTION

This report sets out the results of our independent flood assessment for 12A Parkes St Harris Park.

## 1.1 BACKGROUND

Development approval was granted for construction of a seven storey mixed use development on the site in 2012 following a review, by Bewsher Consulting on behalf of Council, of the accompanying flood analysis.

A modification to the development was then approved in June 2015 to permit an eight storey residential flat building with ground floor retail/office units. The flooding aspects of this development were reviewed by Parramatta Council's Development Engineering Unit.

In the meantime, a site specific planning proposal was lodged in November 2014 to permit a maximum 9.2:1 floor space ratio (FSR) on the site (Mecone, 2014). At the same time the Parramatta CBD Planning Proposal was evolving. It would permit a maximum FSR of 5:1 and it is contemplating development controls to better manage risk to life than the current DCP does. Preliminary analysis at the scale of the whole CBD suggests that this site would require the most stringent of those development controls.

In September 2015 the applicant submitted a flood assessment report (HKMA Engineers, 2015) in support of the planning proposal and Bewsher Consulting advised Council that it was consistent with the S117 Direction.

In June 2016 a Gateway Determination was issued (Department of Planning and Environment, 2016) for the planning proposal conditional on an updated flood impact assessment report being prepared to satisfy Council that the planning proposal is consistent with the S117 Direction. The required report was submitted in February 2017 and Council's Development Engineering team determined that it was not consistent with the Direction.

A development application was lodged in December 2016 with a density of 9.2:1 as per the planning proposal. It was for a 22 storey mixed use development comprising 102 residential units with ground level commercial and five levels of basement parking. Council engineers did not support the application because of associated flood risks.

Also in February 2017 a development application was lodged for the demolition of an existing sales office and construction of a temporary sales office. This was not supported by Council's Catchment Engineering Team and has not been approved.

As there is variation between the advice provided by Council's engineers, its flood consultant and the applicant's consultants, Council sought another opinion to assist it in assessing the planning proposal and the development applications before it.

To this end Council engaged Steven Molino of Molino Stewart Pty Ltd to provide that opinion.

During that process it became apparent that local conditions had changed in the vicinity of the site such that these were likely to affect flood behaviour in and around the site. Accordingly, Council commissioned Lyall and Associates to prepare an up to date two dimensional flood model for the site and its surrounds (Lyall and Associates, 2018). The results of that investigation are reported elsewhere but are referenced where relevant in this report.

Also during the investigations the proponent submitted an alternative design for the development which included only three levels of basement car parking rather than five.

# 2 SCOPE

The brief issued by Parramatta Council stated:

*"The objectives of this project are to independently review the site specific PP flood impact assessment; as well as the flood impact assessment and relevant plans associated with the associated DA to determine:*

- *The consistency/inconsistency of the planning proposal application against the S117 direction and the Floodplain Development Manual 2005.*
- *The adequacy of the development application and the suitability of this site for the proposed development (in respect to flooding)*

*The current site specific PP and associated DA must be assessed on their own merits notwithstanding any previous approvals. The previous approvals should be used to provide context for this task but do not require a review.*

*Given that the current site specific PP and associated DA are predicated on Council's evolving draft Parramatta CBD PP, the independent review of the site specific PP and associated DA must be assessed against using the relevant policy, including the draft LEP provisions and maps (Clause 7.19) and draft DCP controls within Draft Update Flood Risk Management Plan (Molino Stewart), as well as the current policy framework. See previous web link for a copy of these documents.*

*The review must deliver an assessment report which includes the following:*

*1. Review of flood impact assessment report 21 September 2015 prepared by HKMA engineers and revised impact assessment report 9 February prepared by Mance Arraj engineers.*

*2. Prepare a S117 Direction 4.3. assessment report that details whether or not the site specific PP is consistent with the direction including any further recommendations on how the proposal could be made to be consistent with the direction, or justify its inconsistency in accordance with section 4.3(9).*

*3. Prepare an assessment of the proposal against the Floodplain Development Manual 2005 including any recommendations on how the proposal could be made to be consistent with the Manual, or justify its inconsistency.*

*4. Review the flood assessment report (prepared by Mance Arraj 12 December 2016) and relevant plans accompanying DA/1263/2016 (It is noted that the flood risk category in the Mance Arraj report is based on Council's current flood risk precincts.) Prepare an assessment report using the draft Parramatta CBD PP and Draft Update of Parramatta Floodplain Risk Management Plans as the policy context.*

*a) A flood risk category must be proposed for the site, taking into consideration the development proposed in the DA. It must consider the following:*

- *Hydraulic hazard on the site during different flood events.*
- *Any intensification of use between the existing and proposed development.*
- *The length of time of inundation of the site for different flood events.*
- *The expected warning time for a flood event.*
- *The number and vulnerability of people being housed in/exposed to high hazard flood conditions, and any potential increased risks to human health and safety associated with this.*
- *When the site will be used.*
- *The level of inconvenience expected to be experienced by occupants of, businesses in and visitors to the site during a flood event.*
- *Potential consequences of a flood event greater than the 1% AEP in terms of damage to property and risk to human life.*
- *Evacuation of people on site based on PMF flooding conditions.*
- *Potential issues associated with deep excavation close to a natural watercourse and within a floodplain.*
- *Impacts on neighbouring properties due to changes in flood behaviour as a result of the development.*

- *The effects of possible culvert blockages on the flood levels and behaviour within the site.*
- *Any potential obstruction, diversion or change to Clay Cliff Creek as a result of the development, including construction.*

*b) Based on the proposed flood risk, the development application must then be assessed against the DCP recommendations contained within the Draft Molino Stewart report. The assessment must also include:*

- *A recommendation as to the suitability of this site for the proposed development.*
- *The appropriateness of basement car parking on this site with a recommendation given on whether basement parking should be permitted.*
- *A recommendation for approval or refusal of the development application (on flooding grounds). If approval is recommended, draft conditions of consent must be proposed.*

# 3 THE SITE

The site is located at 12A Parkes St (formerly 122 Wigram St) Harris Park (Fig 1). It is bounded by Charles Street to the west, Parkes Street to the south and Wigram Road to the east. To the north is a block of residential home units. The subject site is separated from the residential unit development by a concrete lined drainage canal which flows from west to east in an easement which straddles the boundary of the two sites. The canal is an open, lined section of Clay Cliff Creek which flows to the Parramatta River (Figure 1).


*Figure 1 Subject Site*

# 4 FLOOD BEHAVIOUR

## 4.1 LOWER PARRAMATTA RIVER FLOOD STUDY

Various flood studies by the developer's engineers have relied upon the following flood level data for all of their analyses. This has been extracted from the Lower Parramatta River Flood Study (SKM, 2015):

- Western Boundary – Charles St – Cross Section CLAYCLIFF 2015
    - 5% - 7.62m AHD
    - 1% - 7.75m AHD
    - PMF – 9.59m AHD
- Eastern Boundary – Wigram St – Cross Section CLAYCLIFF 2050
    - 5% - 7.39m AHD
    - 1% - 7.59m AHD
    - PMF – 9.43m AHD

It has been verified from the Lower Parramatta River Flood Study that these are the correct cross sections to use (Figure 2) and that the levels for these cross sections have been correctly looked up and transcribed from the report. The green shading on the map shows the estimated extent of the 1% flooding as mapped in the Lower Parramatta River Flood Study.

This flood extent looks similar, although not identical to, the 1% flood extent (dark blue) in (Figure 3) which was copied from Council's Catchment Development Engineer's report of 16/1/2017. That image also shows the extent of the 5% flood (light blue) which covers the entire site (green) and extends north from the site along Charles St.

However this appears to be at odds with the information which can be derived from the various architectural plans for the development proposals which have been submitted over the years (and checked by Council's engineers and consultants).

Figure 5 is an extract from the 2016 development application for the site. It shows ground levels around the perimeter of the site which represent existing pavement levels. It is noted that the pavement in Charles St in the north western corner is about 8.1m AHD placing it 0.35m higher than the 1% flood level at this location and nearly 0.5m higher than the 5% flood level. It would therefore be physically impossible to have either of those flood extents in this location but that is at odds with the mapped flood extents in Figure 2 and Figure 3.

This discrepancy was raised with Council's Senior Engineer Catchment Management and upon further investigation he was able to advise that the flood modelling undertaken by SKM predated the current configuration of Charles Street. Charles St had formerly been a dead end street which terminated at the canal. In the early 2000s it was extended to Parkes St by way of a bridge over the canal. To ensure that the bridge did not cause afflux in a 1% AEP flood, the bridge was designed to be above the level of the 1% flood. To achieve this Charles St had to be raised from the canal for about 20m towards Hassall St.

The consequence of this raising is that the flood extents shown along Charles St in Figure 2 and Figure 3 are not correct and the whole of Charles St between Parkes St and Hassall St is above the 5% AEP flood level and the footpath along the eastern side of Charles St is above the 1% AEP flood level.

It is also noted that the footpath at the corner of Parkes St and Wigram St is proposed to be built at about the level of the 1% AEP flood peak and will have a rising gradient towards Charles St. Charles St has a continually rising gradient from Parkes St to Hassall St and Hassall St rises above the reach of the probable maximum flood (PMF) as shown in Figure 5 .

## 4.2 TWO DIMENSIONAL FLOOD MODELLING

In light of the aforementioned discrepancies, Parramatta City Council commissioned Lyall and Associates to remodel flooding in and around the site. The report on that work is available as a separate document (Lyall and Associates, 2018).

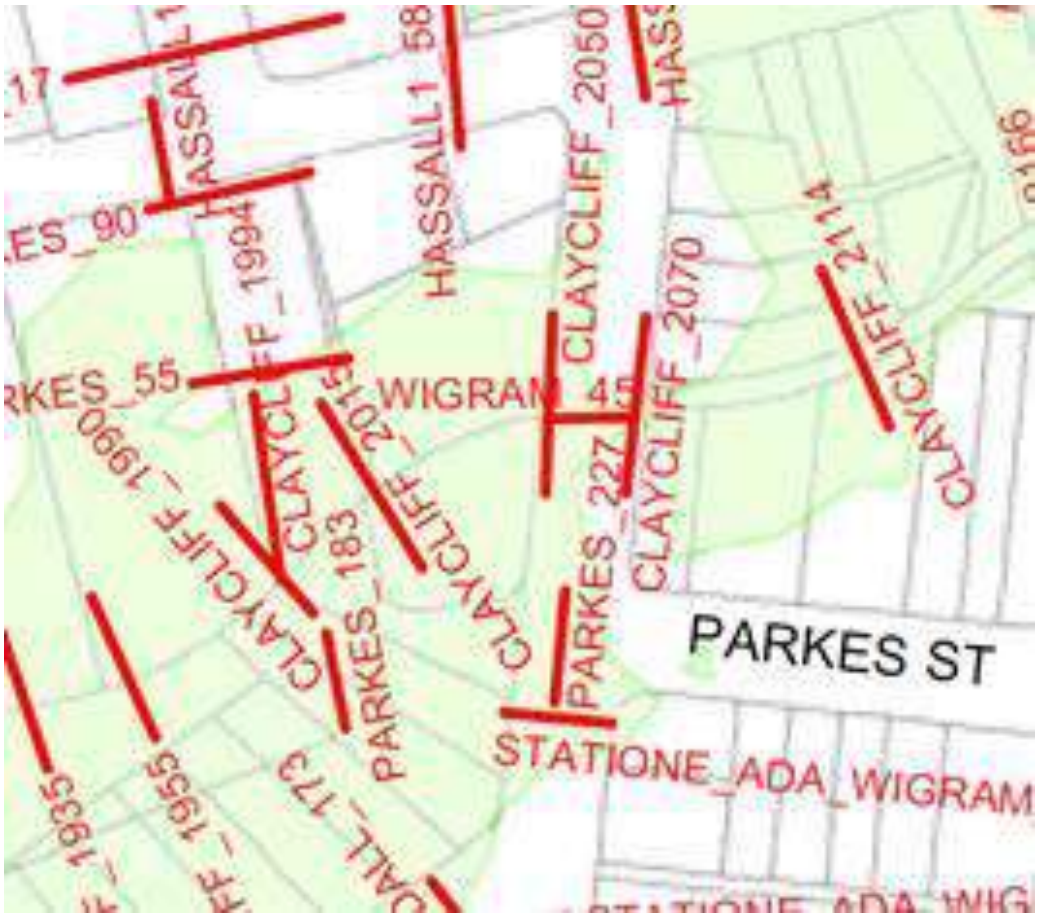



*Figure 2 SKM (2015) Flood Study Extract*

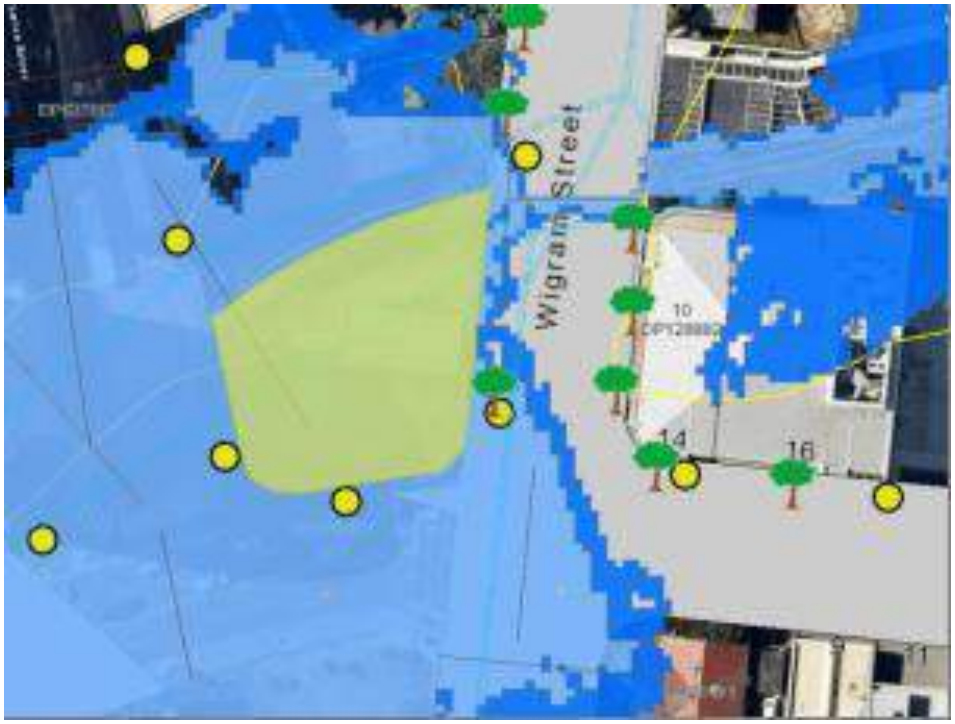



*Figure 3 Flood Extent Map from CoPC Development Engineer's Report (2017)*

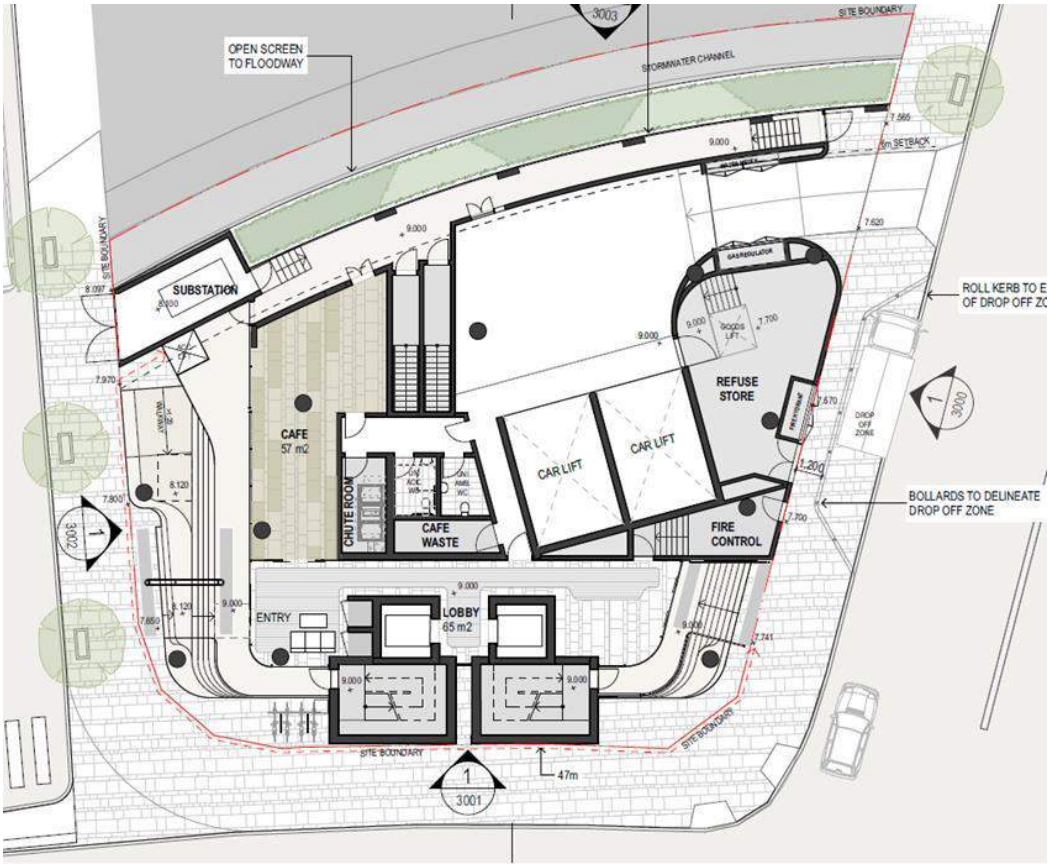



*Figure 5 Extract from DA/1263/2016 Plans*


*Figure 4 PMF Extent*

The original flood modelling undertaken for the Lower Parramatta River Flood Study used a one dimensional flood modelling program called MIKE 11. Since that time flood modelling techniques have improved and it is now common practice to use two dimensional flood modelling for estimating flood behaviour in areas such as this.

For this study a model was developed using TUFLOW modelling software and it extended from where Clay Cliff Creek emerges from the culvert under Parkes Street to Alfred Street which is about 730m downstream where backwater flooding from the Parramatta River controls flood levels in the 1% AEP flood.

Lyall and Associates had recently completed a flood study for the Upper Clay Cliff Creek Catchment for the former Holroyd Council. It compared the outflows it estimated at Ollie Webb Reserve in that model with the inflows at the same location in the Lower Parramatta River Flood Study MIKE 11 model and found the flows to be roughly comparable. That provided confidence that using the flows in the MIKE 11 model would give reasonable results. An inflow rate of 34.2m$^3$/sec was therefore adopted at the western edge of the TUFLOW model for the 1% AEP flood.

The TUFLOW model showed that only about 20m$^3$/sec of the inflow would be able to be conveyed by the culvert under Parkes St and the remainder would flow east along Parkes St as an overland flow. However, there is a low point in Parkes St just west of the Charles St intersection. The water ponds here with most of it flowing into the Clay Cliff Creek canal along an 80m section west of Charles St. A flow of about 0.3m$^3$/sec would enter the canal from Parkes St through the site at 12A Parkes St. This is all based on the assumption that there are no blockages to flow which is the same assumption used in the MIKE 11 model.

The TUFLOW model shows that once all of the overland flows along Parkes St (including contributions from catchments to the south) have found their way into Clay Cliff Creek, the canal has sufficient capacity to convey all of the 1% AEP flows at least beyond Wigram Street. Figure 6 show the flood depths and flow rates for the 1% AEP in the TUFLOW model.

The TUFLOW Modelling also shows that a 5% AEP event would flow down Parkes St only as far as the sag point near Charles St at which point all of the flow would return to Clay Cliff Creek and there would be no flooding of the site at all.

It is noted that the 1% AEP mapping in Figure 6 assumes ideal flow conditions in the canal which experiences supercritical flow in these conditions. Should there be a disturbance to the flow in the canal (e.g. debris catching on the bed or edge of the canal), subcritical flow conditions could occur in which case the flood level adjacent to the site could rise to above the top of the canal but no higher than 8.2m AHD.

The TUFLOW modelling also considered the potential impacts of blockages within the canal and showed that a 50% blockage at Wigram Street would have the greatest impact on flood levels across the site. This would increase the levels in the canal by about 0.5m and cause the entire site to flood.

## 4.3 ACCOUNTING FOR DIFFERENCES

There is a stark contrast between the 1% AEP flood extent in Figure 3 derived from the MIKE 11 model and that in Figure 6 derived from the TUFLOW model.

The reasons for the differences were investigated by Lyall and Associates and two important observations were made.

Firstly, a study of the Clay Cliff Creek channel capacity undertaken by Sydney Water (Sydney Water, 2002) estimated the channel capacity to be 33m$^3$/sec which is consistent with the results in the TUFLOW model.

The MIKE 11 model was not available for forensic analysis of its internal set up but the levels being produced at each cross section along Clay Cliff Creek suggests that each bridge over the canal has been included in the model as a flow constriction. However, each bridge clear spans the canal and creates no constriction to flow in the canal when the canal is flowing up to capacity and minimal constriction to flow up to a level below the soffit of each bridge.

In summary, it would appear that the MIKE model has used appropriate flow rates but has included constrictions in the channel which overestimate flood levels on the site and surrounding areas. However, the levels which have been extracted from the MIKE 11 model are those which have been adopted by Council for flood planning purposes and there is a significant process to be followed to get them changed.

Accordingly, for the purposes of this assessment, the planning and development proposals have been assessed against the flood levels, flood hazards and flood risk precincts for the site as adopted by Council. Nevertheless, the report does make reference to the implications of the TUFLOW modelling for each of the above where relevant. The TUFLOW modelling has been specifically taken into account when assessing the proposed development's potential impact on flood levels.

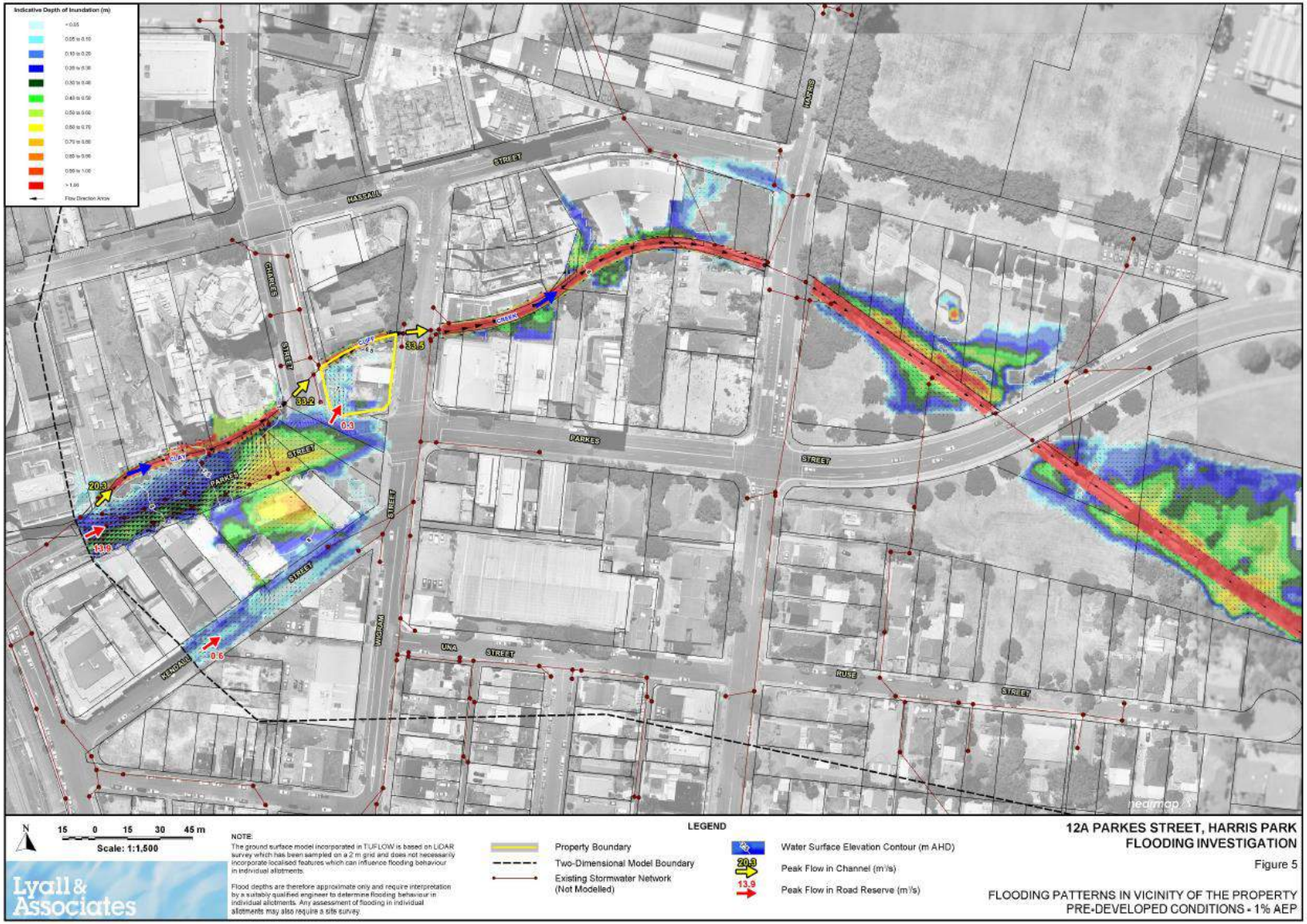



*Figure 6: TUFLOW Modelled 1% AEP Flood (Lyall and Associates, 2018)*

# 5 FLOOD RISK CLASSIFICATION

Parramatta City Council adopts a "Floodplain Matrix" to specify development controls in "flood risk precincts". There are three flood risks precincts: low; medium and high. Council's website states:

*"A High Flood Risk Precinct is generally defined as the area of land below the 100 year flood that is either subject to a high hydraulic hazard or where there are significant evacuation difficulties."*

As shown in Figure 3 the site sits fully within an area mapped by Council as being below the 1% AEP (100 year) flood and Figure 7 shows the site is also classified as high hazard. These two maps combined therefore indicate the site is within a High Flood Risk Precinct according to Council's current flood mapping.

However, Figure 6 shows that according to the TUFLOW model the majority of the site is unaffected by the 1% AEP flood and where the water flows across the site it is less than 0.2m deep. In a 1% AEP flood the site would have access to Wigram St which sits above the 1% AEP flood level.

Based on the TUFLOW modelling outputs the western part of the site would be classified medium hazard and the eastern portion low hazard. The assessment of the planning proposal and development proposal are based on the site being a high flood risk precinct but makes reference, where appropriate, to the implications of revision of the flood risk precinct in the future.

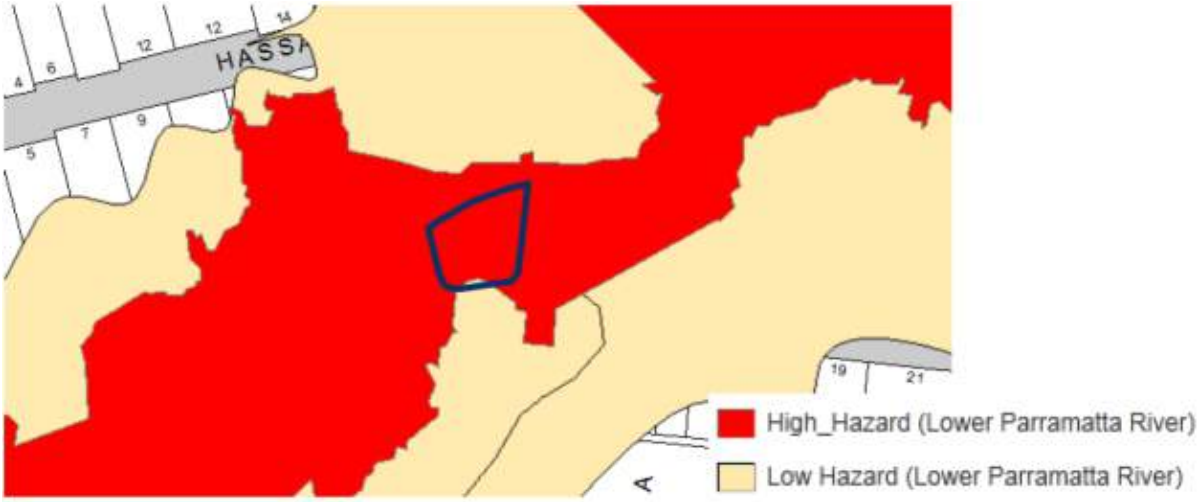



*Figure 7 Flood Hazard Mapping (SKM2005)*

# 6 REVIEW OF FLOOD IMPACT ASSESSMENT REPORTS

Molino Stewart reviewed the flood impact assessment report dated 21 September 2015 prepared by HKMA Engineers and the revised impact assessment report of 9 February, 2017 prepared by Mance Arraj, in support of the 2014 planning proposal for the site and make the following observations.

The reports correctly identify the land as being in a 1% AEP floodway (according to Council mapping) and that the appropriate Flood Planning Level (FPL) for the site is the 1% AEP flood level plus 0.5m freeboard. They correctly nominate the 1% AEP and PMF levels which apply to the site as per the levels adopted by Parramatta City Council.

In attempting to address the issues in the Section 117 Direction in relation to flooding, the September 2015 report frequently refers back to developments which have previously been approved on the site or alternatively suggests that unresolved issues can be dealt with at the DA stage.

Molino Stewart accepts that previous flood modelling for the site, which was independently peer reviewed by Don Still of Bewsher Consulting, concluded that particular development proposals could be constructed in such a way that they did not significantly impede flood flows. It is beyond Molino Stewart's role or expertise to review that flood modelling but it acknowledges that there would appear to be ways to develop the site which does not impede flood flows. Therefore the report's assessment is accepted that if a floodway zone is retained through the site as part of the planning proposal, development would not result in significant impacts to other properties and would therefore be consistent with the S117 Direction in this regard.

The report also correctly concludes that an appropriately designed development would not *"result in a substantially increased requirement for government spending on flood mitigation measures, infrastructure or services"*.

The report also acknowledges that the planning proposal for the site would "*permit development in a floodway area*" and "*permit a significant increase in the development of that land*". These are two provisions which the S117 Direction explicitly states that a planning proposal on a flood planning area must not permit.

It does not directly address these two issues but obliquely suggests that they need not apply to this site because of the features which could be incorporated into the development proposal for the site. While the report identifies features of the proposed development which would mitigate flood risks, it fails to stipulate what planning controls need to be included to mitigate the flood risks which the S117 Direction sets out to manage.

Furthermore, the S117 Direction states:

*"A planning proposal may be inconsistent with this direction only if the relevant planning authority can satisfy the Director-General (or an officer of the Department nominated by the Director-General) that:*

*a) The planning proposal is in accordance with a floodplain risk management plan prepared in accordance with the principles and guidelines of the Floodplain Development Manual 2005 or*

*b) The provisions of the planning proposal that are inconsistent are of minor significance"*

The report fails to make reference to these requirements let alone demonstrate compliance with them.

The report is incorrect in stating (based on Council's adopted flood mapping):

*"For storm events up to the 100 year event, it is possible to evacuate the site via the south eastern corner of the site and travel in a southerly direction along Wigram Street. The footpath at the corner of Wigram Street and Parkes Street is at or above the 100 year flood level and Wigram Street to the south of the site is flood free ground. Vehicle [sic] are also able to evacuate the basement car park as flood depths at the driveway entry are below the maximum allowable depth of 200mm for vehicle egress."*

The currently adopted mapping shows Parkes St being inundated in a 5% AEP flood, including at the intersection with Wigram St which is clearly lower than the proposed car park exit in Wigram St. Furthermore, the architectural plans shown in Figure 5 show the footpath near the corner of Wigram St and Parkes St being at 7.74m which is just below the level of the 1% AEP flood. Stepping off the kerb in a 1% AEP flood to cross Parkes St and head south on Wigram St would necessitate stepping into floodwaters. This is all evidence that it is not a safe option to drive or walk from the building south along Wigram St. However, there are safe options for pedestrian egress in events up to the 1% AEP flood and these are discussed in following sections.

The report only makes passing mention of the NSW Floodplain Development Manual and therefore does not demonstrate that the planning proposal is consistent with the manual.

The February 2017 report includes additional references to the NSW Floodplain Development Manual and provides some quantitative and qualitative assessment of flood risk. As part of its argument that the planning proposal is consistent with the manual it states:

*"The future flood risk is addressed by the development achieving and/or exceeding the requirement of Council's Floodplain Matrix as given in the Parramatta DCP 2011."*

However, the report fails to acknowledge that the site is in a "high flood risk precinct". The Floodplain Matrix (See Appendix A) shows residential and commercial development being unsuitable land uses in the high flood risk precinct. Accordingly, a development on the site cannot achieve the requirements of the DCP in this regard.

It makes reference to the Appendix 10 and Appendix 17 of the CBD Planning Proposal and correctly states that future development of the site would be able to comply with the requirements set out in the Draft Floodplain Risk Management Plan in that document but does not explain how that would occur.

In most other respects it repeats the information in the earlier report including the incorrect assertion that it is appropriate to evacuate, on foot or by vehicle, south along Wigram St.

The two reports as they stand fail to demonstrate that the site specific planning proposal is consistent with S117 Direction 4.3 in either its absolute requirements or its intent.

# 7 FLOODPLAIN DEVELOPMENT MANUAL CONSISTENCY ASSESSMENT

## 7.1 FDM PRINCIPLES

The NSW Floodplain Development Manual is a manual which provides guidance in implementing the NSW Flood Prone Land Policy. The NSW Flood Prone Land Policy is produced within Section 1.1 of the Manual. The Manual States:

*The primary objective of the New South Wales Flood Prone Land Policy, as outlined below, recognises the following two important facts:*

- *flood prone land is a valuable resource that should not be sterilised by unnecessarily precluding its development; and*
- *if all development applications and proposals for rezoning of flood prone land are assessed according to rigid and prescriptive criteria, some appropriate proposals may be unreasonably disallowed or restricted, and equally, quite inappropriate proposals may be approved.*

*The primary objective of the policy is to reduce the impact of flooding and flood liability on individual owners and occupiers of flood prone property, and to reduce private and public losses resulting from floods, utilising ecologically positive methods wherever possible. That is:*

- *a merit approach shall be adopted for all development decisions in the floodplain to take into account social, economic and ecological factors, as well as flooding considerations;*
- *both mainstream and overland flooding shall be addressed, using the merit approach, in preparation and implementation by councils of strategically generated floodplain risk management plans;*
- *the impact of flooding and flood liability on existing developed areas identified in floodplain risk management plans shall be reduced by flood mitigation works and measures, including on-going emergency management measures, the raising of houses where appropriate and by development controls; and*
- *the potential for flood losses in all areas proposed for development or redevelopment shall be contained by the application of ecologically sensitive planning and development controls.*

Therefore, for the planning proposal to be consistent with the objective of the Floodplain Development Manual it must be assessed on its merits not through the application of rigid and prescriptive criteria and must take into account social, economic and ecological factors as well as flooding. It must also contain the potential for flood losses taking into consideration mainstream and overland flooding. Development should not be precluded unnecessarily.

It goes on to say:

The policy provides for:

- *"a merit based approach to selection of appropriate flood planning levels (FPLs). This recognises the need to consider the full range of flood sizes, up to and including the probable maximum flood (PMF) and the corresponding risks associated with each flood, whilst noting that with few exceptions, it is neither feasible nor socially or economically justifiable to adopt the PMF as the basis for FPLs. FPLs for typical residential development would generally be based around the 1% AEP flood event plus an appropriate freeboard (typically 0.5m);*
- *floodway definition to be based on hydraulic, hazard and potential damage considerations related to the effect of loss of flow conveyance on flood conditions, with provision for restricted development depending on circumstances;*
- *recognition of the importance of the continuing flood risk addressed in the State Emergency Service Act 1989 and State Flood Plan, and the close relationship between the emergency*

*management and floodplain risk management processes;*

The State Flood Plan places a heavy emphasis on the protection of lives.

Therefore to be consistent with the manual, a planning proposal must consider flood risks up to and including the PMF and must consider the implications for flow conveyance, property loss and personal safety.

The NSW Floodplain Development Manual also provides guidance in implementing the NSW Flood Prone Land Policy. The Manual requires the level of flood risk acceptable to the community to be determined through a process typically overseen by a committee comprised of local elected representatives, community members, and state and local government officials (including the SES).

## 7.2 PARRAMATTA LGA PLANNING INSTRUMENTS

The Parramatta Floodplain Risk Management Committee meets the requirements of the manual and has been established for many years. It oversaw the development of the Lower Parramatta River Floodplain Risk Management Plan, which applies to the subject site, in accordance with the manual. The flood planning controls in the Parramatta DCP 2011 were developed as part of that process and are therefore consistent with the Floodplain Development Manual. The proposed changes to the flood planning controls in the LEP and DCP as part of the Parramatta CBD Strategy have also gone through a floodplain risk management process in accordance with the manual and, if adopted, would also be deemed to be consistent with the manual.

It is noted that in relation to flooding, the planning proposal for the site states:

*"Parramatta City Centre LEP 2007 contains flood prone land provisions and this Planning Proposal does not seek to amend them. Initial flooding advice is contained in this report (refer to Appendix 4). Flooding will be addressed as part of any future development of the land."*

The Parramatta City Centre LEP 2007 lists the following objectives in relation to development on flood prone land (Section 33A):

*"The objectives of this clause are:*

*(a) to maintain the existing flood regime and flow conveyance capacity, and*

*(b) to enable safe occupation of flood prone land, and*

*(c) to avoid significant adverse impacts upon flood behaviour, and*

*(d) to avoid significant adverse effects on the floodplain environment that would cause avoidable erosion, siltation, destruction of riparian vegetation or a reduction in the stability of the river bank or watercourse, and*

*(e) to limit uses to those compatible with flow conveyance function and flood hazard."*

These objectives are consistent with the Floodplain Development Manual.

The Parramatta DCP 2011 states that it applies to all land within the Parramatta Local Government Area so it would apply to this site. The planning proposal therefore is proposing to adopt the requirements of the Parramatta DCP 2011.

The existing Parramatta DCP 2011 uses a floodplain matrix of planning and development controls to guide development in the floodplain. The Floodplain Planning Matrix and associated controls can be found in Appendix A.

It is noted that the matrix lists new residential or commercial development in the High Flood Risk Precinct as being unsuitable but makes provision for concessional development in this precinct. Concessional development involves a limited extension to existing development. The proposed development therefore does not fulfil the definition of concessional development.

Accordingly, neither the planning proposal nor the development proposal comply with the requirements of the existing planning instruments which have been prepared in accordance with the requirements of the Floodplain Development Manual. However, it is noted that neither instrument prohibits commercial or residential development in the

high flood risk precinct and the Manual explicitly states:

*"if all development applications and proposals for rezoning of flood prone land are assessed according to rigid and prescriptive criteria, some appropriate proposals may be unreasonably disallowed or restricted, and equally, quite inappropriate proposals may be approved."*

The Manual therefore encourages the consideration of development proposals on their merits. The following sections consider the merits of the planning and development proposals in accordance with the principles set out in the manual.

## 7.3 FLOW CONVEYANCE

The site is part of the floodway associated with Clay Cliff Creek as well as a path for overland flows in Parkes St to reach the creek. It will be important that development controls are imposed on the site that ensures that these functions are not impeded in the more frequent floods otherwise development on the site may increase flood risks to property and people on nearby sites.

Where nearby sites have been developed in accordance with current planning controls they will have had to have minimum habitable floor levels above the 1% AEP flood level. It would therefore be equitable for any development on the site not to impede flood flows in events up to and including the 1% AEP flood event so that existing properties can expect to not have an increase in flood losses or risk to life in events up to those for which they have been designed. This is a minimum requirement placed on commercial and residential developments in the Low and Medium Flood Risk Precinct under the Parramatta DCP 2011.

There have been at least three designs for the site which have been independently reviewed by a flood engineer and have been assessed to be able to be constructed without compromising flow conveyance along Clay Cliff Creek up to the 1% AEP event.

It has also been recognised that there is an overland flow path from Parkes St through the site to the canal. Compliance with the same development condition would ensure this flow path is kept open. There has been at least one development proposal in the past which has demonstrated the ability for this to be achieved on the site.

In larger events the extent of flooding would be so widespread that the presence of the development is not likely to significantly increase flood levels off site.

According to Council's adopted flood modelling, to maintain the required flow conveyance through the site it would be necessary to create a void under the building's ground floor slab. The use of this void for storage of materials would reduce the flow conveyance and so that needs to be prohibited. The Floodplain Planning Matrix includes a management and design development control which prohibits the storage of materials below the 100 year ARI flood level. This applies to commercial and residential development in the Medium Flood Risk Precinct and application of this control would manage this risk for the site.

The potential for blockage of the floodway and its impact on flow conveyance also needs to be considered. It is observed that Clay Cliff Creek alternates between open channel and culvert along its length. Notably the creek goes from an open channel through Jubilee Park into a culvert under Parkes St, opening up as a channel again behind the Heritage Tower on the corner of Station St East and Parkes St then passing as a channel under Charles St then Wigram St bridges.

Blockage of the Wigram St Bridge could potentially increase flood levels on the site and neighbouring properties. However, the Wigram St Bridge opening is larger than the Jubilee Park culvert and similar to the Charles St Bridge (Figure 9 to Figure 10) and so any large items which pass through the upstream culverts would also pass under the Wigram St Bridge. It is also noted that the channel is fenced on both sides along Parkes St so that there is no potential for large items to enter the channel after it emerges from under the Heritage Tower.

To ensure that development of the subject site does not have the potential to cause blockage, development controls will be required which

prevent large items from floating off the site and into the canal. There is a development control in the matrix which requires parking areas to have restraints or vehicles barriers to prevent cars floating off site. This applies to commercial and residential development within the Medium Flood Risk Precinct. This control would need to be applied to the site to ensure cars did not have the potential to block the canal. Considering the size of the canal under Wigram St, any devices which prevent cars from leaving the site would also prevent other items large enough to block the canal from leaving the site (e.g. commercial waste bins).

Furthermore, the application of the control prohibiting the storage of materials below the 100 year ARI flood level (see discussion above) would also contribute to the management of this risk.

It would therefore be possible to develop the site without having an unacceptable adverse impact on flow conveyance or impacts on flood levels on neighbouring properties by applying to this site the existing planning controls for commercial and residential development in the Medium Flood Risk Precinct. This approach would be consistent with the principles of the Floodplain Development Manual.

*Figure 8 Charles St Bridge*

*Figure 9 Wigram St Bridge*

## 7.4 PROPERTY DAMAGE

Parramatta City Council has adopted the 1% AEP flood level plus 0.5m freeboard as its flood planning level for residential and commercial development across the CBD including at this site. This is consistent with the typical flood planning levels for residential development cited in the Floodplain Development Manual. There is nothing distinctive about this site which would warrant it having a lower or higher flood planning level to protect property. The FPL for the site adopted by Council is therefore 8.25m AHD.

It is noted that the TUFLOW modelling estimates that the 1% AEP flood level in the canal adjacent to the site is 6.37m AHD compared to the 7.75m AHD adopted by Council. While this suggests that a lower FPL might be able to be adopted for the site, the following two things need to be considered:

- The TUFLOW modelling shows supercritical flow in the channel but should that be disturbed then subcritical flow may ensue in which case the water level could rise above the top of the channel and cause the site to flood but no higher than 8.2m AHD.
- Sensitivity analysis showed that blockage at Wigram St Bridge could cause the site to flood up to 7.63m AHD although there is a low chance of this happening.

More importantly, however, is that the TUFLOW modelling has estimated the 1% AEP flood level where overland flows enter the site from Parkes St and this is 7.56m AHD, rising to as much as 7.67m AHD in some blockage scenarios. These levels are not very much below the 7.75m AHD which has been used to set the currently adopted FPL.

Similarly, the DCP adopts the 1% AEP flood as the design flood event for the protection of motor vehicles in car parks. Again there is nothing distinctive about this development which warrants it having a greater or lesser protection of motor vehicles on site.

Applying to this site the controls on car parking which apply to commercial and residential development in the Medium Flood Risk Precinct would protect cars from inundation in a 1% AEP flood which is consistent with the requirements on all development throughout the LGA.

The DCP also requires that for commercial and residential development in the Medium Flood Risk Precinct, building materials below the 1% AEP flood be flood compatible and that the design and management of buildings ensure that no materials are stored below the 1% AEP flood level. These controls, if applied to this site would also minimise property damage in events up to the 1% AEP flood level and would be consistent with the Floodplain Development Manual.

Therefore application to this site of current planning controls in relation to minimum floor levels, car parking, building materials and design and management for commercial and residential development in the Medium Flood Risk Precinct would manage property damage in a way which is consistent with the Floodplain Development Manual.

It would be possible to meet the objectives of the planning proposal with the imposition of these planning controls.

## 7.5 RISK TO LIFE

Section K4.1 of the NSW Floodplain Development Manual addresses risk to life and states:

*"Risk to life issues relate to the consequences of the full range of floods including the flood used to derive the FPL and rarer floods.*

*Selection of the flood event upon which the FPL is based and associated development controls, such as minimum fill and floor levels, need to ensure that risk to life is effectively managed for the full range of floods. A flood larger than that used to derive the FPL will result in increased risk to life and property as:*

- *water enters buildings or overtops levees built at the FPL and may result in the need for evacuation;*
- *high hazard or flow conditions may develop in areas where floodwaters simply pond in the flood event used to derive the FPL; and*
- *significant access problems may develop. This is not a serious issue in*

> *a floodplain with continuously rising roads leading out of it. However, any flood which cuts access and isolates parts of a community can cause serious additional danger to personal safety. This is a particular problem where there is a large flood range between the flood used to derive the FPL and the PMF.*

*These issues need consideration in the development of specific areas of land, the type and scale of such developments (discussed in Section G6), and in selecting FPLs for mitigation works and development control.*

*These considerations need to address the cumulative impacts of future development (Section G9.1), particularly for emergency planning and response."*

Therefore to be consistent with the Floodplain Development Manual the planning proposal needs to consider risk to life up to the PMF as well as the cumulative impact of this planning proposal as part of the risk to life across the broader floodplain.

### 7.5.1 PMF Flood Hazard

The PMF level on the site is 9.59m AHD which is 1.84m AHD higher than the 1% AEP flood level. However, it is noted that a void is proposed under the ground floor slab of the buildings to meet flow conveyance requirements and the underside of the slab needs to be at or above the 1% AEP flood level. While the minimum floor level would need to be 8.25m AHD to provide the necessary freeboard, the thickness of the ground floor slab and the level of its underside may mean that the ground floor level of any building on site would be higher than 8.25m AHD. For example, the 2017 development proposal for the site nominated a ground floor level at 9.00m AHD.

If it is assumed conservatively that the ground floor level is 8.25m AHD, then in a PMF, flooding would be 1.34m deep through the ground floor of the building. However, were the ground floor level to be at 9.00m AHD then the depth of ground floor flooding would be 0.59m.

The minimum permissible ceiling height in Australian buildings is 2.4m AHD and at least 0.3m needs to be allowed for floor slabs and services. On this basis the first floor level would be at a minimum of 10.65m AHD but probably higher. This would place it well above the PMF level.

The level of the footpath outside the building ranges from 7.57m at the north eastern corner on Wigram St to 7.97m at the north western corner on Charles St. In a PMF then the depth of flooding on the footpath would range from about 1.6m to 2m deep.

Australian Rainfall and Runoff recommends the use of the thresholds show in Figure 11 to determine the impacts of flooding on the stability of people, vehicles and buildings.

On this basis the flooding on the footpath surrounding the building would be unsafe for people or vehicles irrespective of the flood velocity at the peak of the PMF.

Flood velocities inside the building are likely to be low if doors remain closed and intact, in which case the range of depths and velocities on the ground floor of the building may be safe for able bodied adults even in a PMF.

### 7.5.2 Chance of People Coming in Contact with Floodwaters

It is not recommended that people come in contact with floodwaters but the chance of them doing so will depend on how they respond to the flooding on site which itself is likely to be influenced by a number of factors.

The planning proposal is for mixed use development with commercial ground floor development and residential development above. If the commercial space is open for 12 hours per day, seven days per week then there is a 50% chance that the commercial space will be unoccupied when a flood occurs. If it is open for 9 hours per day six days per week then there is a 66% chance that it will be unoccupied. By comparison the residential dwellings could be occupied at any time of day, any time of the week and for a high proportion of the time that they are occupied residents will be asleep.

The catchment is comparatively small and flooding is likely to happen very quickly with little warning. It is reasonable to assume that the earliest that building occupants might be aware of flooding is when there is flooding in Parkes St. Alternatively, they may not become aware of the flooding until it has entered the premises. The duration of the flooding on the site and in the surrounding streets would be between three and five hours in a PMF (Molino Stewart, 2016) and considerably less in smaller events. It is entirely possible for residents in the building to be unaware that flooding has occurred until they leave the building after the flooding has receded.

If people become aware of the flooding there are six ways in which they may respond:

1) Remain where they are – this is a likely response from residents who are in their dwellings when the flooding isolates the building because even in the peak of a PMF the flooding will not directly affect them and the duration will be reasonably short. People in the commercial space within the building may also respond in this way if water does not enter the building, the building remains functional and the duration of isolation does not extend very far past the time at which they would expect to leave the building in the normal course of the day. This response poses no risk to life.
2) Move to a higher location within the building – this is only a likely response from people occupying the commercial space on the ground floor and only then if floodwaters are threatening to enter the building. This response poses no risk to life.
3) Leave the building by car – this is a possible response of those who have parked in the building, particularly those who are in the commercial space and do not wish to wait until the flooding has receded. This is likely to pose a risk to life because by the time people become aware that flooding is occurring the surrounding streets will be flooded and heading north or south on Wigram St would take them into deep floodwaters than at the exit.
4) Leave the building on foot – this is a possible response of those who have occupied the commercial space but do not have vehicular transport or have decided that leaving by vehicle is too dangerous. It is noted that the footpath on the corner or Wigram St and Parkes St is at about the level of the 1% AEP flood and the footpath rises continuously along Parkes St to Charles St and along Charles St to Hassel St which extends beyond the reach of the PMF. This means that the footpath on two sides of the building is flood free up to the 1% AEP flood and there is a rising pedestrian access to a flood free location. In fact there is a flood free route to Parramatta Station, the Bus interchange and Westfield Shopping Centre. The risk which this response poses depends on when during a flood they leave, where the building exits are and in what direction they head after thy have left the building.
5) Enter the carpark to remove goods – any building occupants with valuables in their car or the storage areas in the carpark may choose to enter the carpark to remove them. This only poses a risk to life if they do so when flooding has reached a level which would enter the carpark. Water could cascade into a basement carpark at a very rapid rate and fill it to ceiling height quite quickly
6) Enter the building from a flood free location – there may be building occupants who are outside of the building when flooding isolates the building and they decide that they want to get inside the building but must traverse floodwaters to do so. This is more likely a response from residents who want to get home rather than those who occupy the ground flood commercial space. This can pose a considerable risk to life.

### 7.5.3 Secondary Risks to Life

In addition to people coming in direct contact with floodwaters there are secondary risks to life which are caused by flooding.

1) Building Failure – There is a risk that the building is not structurally suitable to resist the flood forces and those sheltering in the building are not safe.
2) Building Fire - It is quite possible that during a flood people isolated in buildings will experience a power

outage. In some instances, particularly if the isolation lasts for a few hours, people might try to compensate for the lack of power by using improvised lighting, heating or cooking methods which might involve a naked flame. This increases the risk of fire as does water coming in contact with live electrical circuits. If the building is surrounded by floodwaters occupants will not have a safe place to evacuate from the fire, fire crews may not be able to reach the building to extinguish the fire and access to fire hydrants may be restricted due to the flooding.

3) Medical Emergency - Medical emergencies may arise while the building is isolated by floodwaters and isolation would prevent paramedics reaching the patient or the patient being transported to hospital grade care. For some medical emergencies this could be life threatening. These medical emergencies would include those that arise in the course of a normal day as well as injuries people might sustain responding to the flooding. Other building occupants might have pre-existing medical conditions that stress and isolation can worsen to a point where medical assistance is required.

### 7.5.4 Potential Risk to Life Mitigation Measures

The NSW Floodplain Development Manual recognises that it is not practical to eliminate all risks to life but to consider the full range of risks and to reduce the residual risks to a tolerable level.

The flood provisions in Parramatta DCP 2011 were developed in accordance with the provisions of the manual and many of the above risks to life are managed by existing provisions various development types in various Flood Risk Precincts. Others are managed by the proposed draft amendments to the LEP and DCP. For example:

- Structural Soundness - *An engineer's report is required to certify that the structure can withstand the forces of floodwater, debris and buoyancy up to and including a PMF level*. In Parramatta DCP 2011 this is applied to critical uses and facilities but in the draft amendments it is recommended to apply to all development in the floodplain. Application of this control ensures that building failure does not pose a risk to the lives of anyone sheltering in the building in all events up to the PMF
- People Entering Carparking Areas at Risk of flooding - Parramatta DCP 2011 includes the provisions that *"Garages capable of accommodating more than 3 motor vehicles on land zones for urban purposes, or enclosed car parking, must be protected from inundation by floods equal to or greater than the 100 year ARI flood. Ramp levels to be no lower than 0.5m above the 100 year ARI flood level."* and *"Enclosed car parking and car parking areas accommodating more than 3 vehicles, with a floor below the 100 year ARI flood level, shall have adequate warning systems, signage, exits and evacuation routes."* In the draft amendments it is recommended that these apply to all development in the floodplain.
- Evacuation - Parramatta DCP 2011 includes the provisions: *"Reliable access for pedestrians and vehicles is required from the site to an area of refuge above the PMF level, either on site (e.g. second storey) or off site", "Applicant is to demonstrate the development is consistent with any relevant flood evacuation strategy or similar plan."* and *"Adequate flood warning is available to allow safe and orderly evacuation without increased reliance upon SES or other authorised emergency services personnel." These all apply to concessional development in the High Flood Risk Precinct.* In the draft amendments it is recommended that the reference to vehicles in the first of these controls is removed because it has been demonstrated that vehicular evacuation of the Parramatta CBD in a flood is neither safe nor practical. Furthermore, it recommends that any residential developments in locations which are below the 1% AEP flood level must have an exit from the development to land which is at or above the 1% AEP flood level. This also reduces the probability of people trying to access the building through hazardous floodwaters.

- Management and Design – *"Site Emergency Response Flood Plan required where the site is affected by the 100 year ARI flood level, (except for single dwelling-houses)".* In Parramatta DCP 2011 this applies to all built development in the Medium Flood Risk Precinct. The proposed amendment is that this also apply to buildings which are isolated by moderate to high hazard flooding in the PMF so that anyone who can't safely leave the building has an emergency plan available which keeps them safe in the building.
- Fire Emergency – there are no provisions in Parramatta DCP 2011 which deal directly with this risk but there are two in the proposed DCP amendments for buildings below the 1% flood level. (a) Fire safety features are included within the building to meet the requirements of the ABCB for high rise buildings whether the building is high rise or not; and (b) residential buildings must have an exit from the development to land which is at or above the 1% AEP flood level. This reduces the risk of fire spreading, reduces the probability that people will not be able to evacuate the building and reduces the probability that fire fighters will not be able to enter the building.
- Medical Emergency - there are no provisions in Parramatta DCP 2011 which deal directly with this risk but there is one in the proposed DCP amendments for buildings below the 1% flood level. (a) residential buildings must have an exit from the development to land which is at or above the 1% AEP flood level. This reduces the probability that people will not be able to evacuate the building and reduces the probability that paramedics will not be able to enter the building.

Two frontages of the site are above the adopted 1% AEP flood level and therefore it is possible to design a development on the site which is not isolated by the 1% AEP flood. It is noted, that this highlights an inconsistency between Council's adopted flood levels and mapped flood extents along these frontages. However, more recent two dimensional flood modelling has explained these discrepancies and the assumption that there is access above the 1% AEP flood level with rising access to flood free land is reasonable.

Therefore, existing planning controls for commercial and residential development in the Medium Flood Risk Precinct in relation to structural soundness and the additional planning controls in relation to flooding proposed in the Parramatta CBD and DCP could be applied to the development to site to satisfactorily manage risk to life, .

## 7.6 CONCLUSION

The currently adopted flood modelling suggests that the site is in a High Flood Risk Precinct and Parramatta DCP 2011 indicates that commercial and residential development is not suitable in a High Flood Risk Precinct. The NSW Floodplain Development Manual however, encourages a merits based assessment of floodplain development rather than the strict application of planning controls.

The imposition on the site of existing planning controls for commercial and residential development for the Medium Flood Risk Precinct would satisfactorily manage flow conveyance and risk to property in a way which is consistent with the requirements of the floodplain development manual.

The fact that the site's frontages on Parkes St and Charles St are at or above Council's adopted 1% AEP flood level mean that risk to life is not as significant as the mapped Flood Risk Precinct suggests. Adoption of the proposed flood planning controls for Parramatta CBD would satisfactorily manage risk to life.

Therefore application of existing Medium Flood Risk Precinct controls to the site and adoption of the proposed Parramatta CBD flood planning controls would enable the site to be developed for commercial and residential development in a way which is consistent with the NSW Floodplain Development Manual.

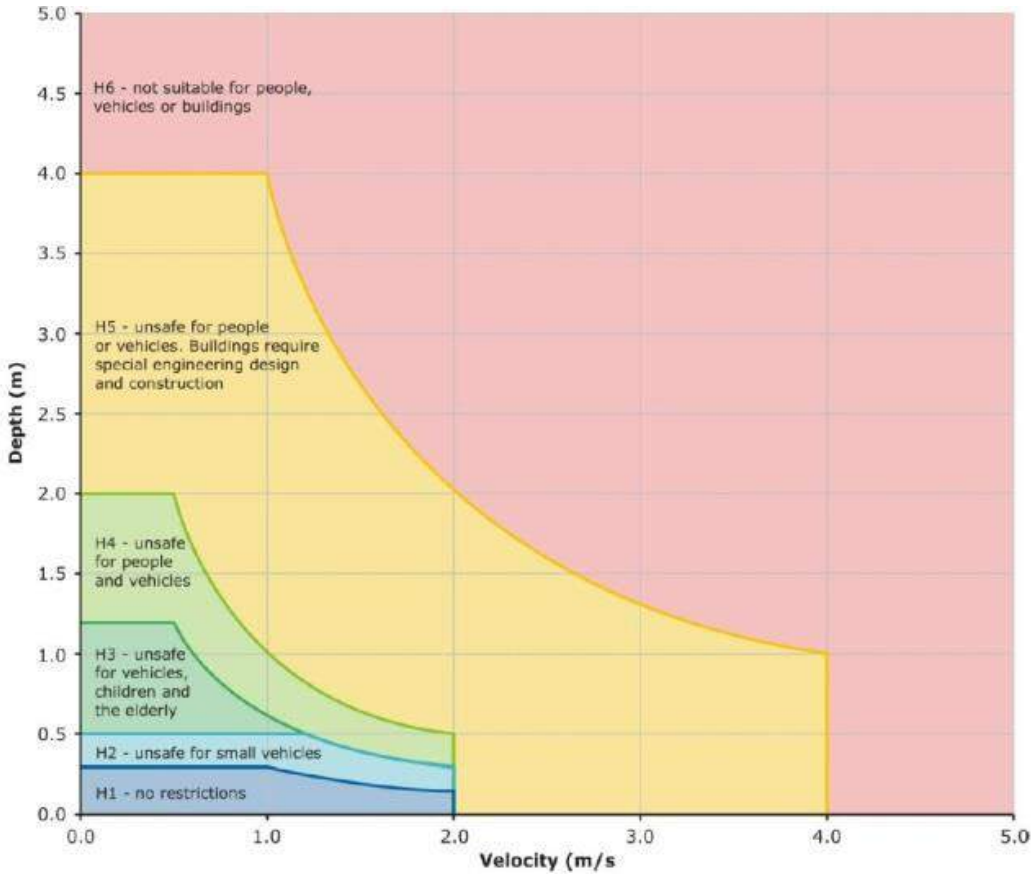



*Figure 11 Flood Stability Thresholds*

# 8 S117 DIRECTION 4.3 CONSISTENCY AGREEMENT

Amendments to the Environmental Planning Assessment Act 1979 came into effect on 1 March 2018". S117 Directions are now referred to as Directions by the Minister (s9.1 of the EP&A Act 1979). However, the brief for this work and the draft of this report was prepared before those changes came into effect. Accordingly, this Section refers to the S117 Direction.

S117 Direction 4.3 states:

*"(3) This direction applies when a relevant planning authority prepares a planning proposal that creates, removes or alters a zone or a provision that affects flood prone land.*

*(4) A planning proposal must include provisions that give effect to and are consistent with the NSW Flood Prone Land Policy and the principles of the Floodplain Development Manual 2005 (including the Guideline on Development Controls on Low Flood Risk Areas).*

*(5) A planning proposal must not rezone land within the flood planning areas from Special Use, Special Purpose, Recreation, Rural or Environmental Protection Zones to a Residential, Business, Industrial, Special Use or Special Purpose Zones*

*(6) A planning proposal must not contain provisions that apply to the flood planning areas which:*

*a) permit development in floodway areas*

*b) permit development that will result in significant flood impacts to other properties*

*c) permit a significant increase in the development of that land*

*d) are likely to result in a substantially increased requirement for government spending on flood mitigation measures, infrastructure or services*

*e) permit development to be carried out without development consent except for the purposes of agriculture… roads or exempt development*

*(7) Must not impose flood related development controls above the residential flood planning level for residential development on land, unless a relevant planning authority provides adequate justification for those controls to the satisfaction of the Director-General (or an officer of the Department nominated by the Director-General).*

*(8) For the purposes of a planning proposal, a relevant planning authority must not determine a flood planning level that is inconsistent with the Floodplain Development Manual 2005 (including the Guideline on Development Controls on Low Flood Risk Areas) unless a relevant planning authority provides adequate justification for the proposed departure from that Manual to the satisfaction of the Director-General (or an officer of the Department nominated by the Director-General).*

*(9) A planning proposal may be inconsistent with this direction only if the relevant planning authority can satisfy the Director-General (or an officer of the Department nominated by the Director-General) that:*

*a) the proposal is in accordance with a floodplain risk management plan prepared in accordance with the principles and guidelines of the Floodplain Development Manual 2005, or*

*b) the provisions of the planning proposal are inconsistent are of minor significance"*

A discussion regarding consistency with each of the above provisions follows.

## 8.1 CLAUSE 3

The subject site is flood prone and the planning proposal proposes to alter the provisions in the Parramatta LEP 2011 and therefore Directions by the Minister (formerly known as s117 Directions) are required to be considered.

## 8.2 CLAUSE 4

It is noted that the current planning proposal states in Table 9 on Page 24, "Parramatta City

Centre LEP 2007 contains flood prone land provisions and this Planning Proposal does not seek to amend them." If this is the case, then existing planning provisions in Parramatta DCP 2011 apply and these identify the proposed land use as unsuitable in that location. To this extent the planning proposal is inconsistent with this clause.

As discussed in Section 7 of this report, the current planning proposal for the site can be consistent with the NSW Floodplain Development Manual if it is considered on its merits. This requires applying to the site the Medium Flood Risk Precinct development controls from Parramatta DCP 2011 and the adoption of the flood planning controls proposed in the Draft CBD LEP and DCP.

## 8.3 CLAUSE 5

The land is currently zoned B4 mixed use so this clause does not apply.

## 8.4 CLAUSE 6

Providing the flood development controls recommended in Section 7 of this report form part of the planning proposal, the planning proposal would be consistent with Clause 6 in as much as it would not:

- *permit development that will result in significant flood impacts to other properties*
- *likely result in a substantially increased requirement for government spending on flood mitigation measures, infrastructure or services*
- *permit development to be carried out without development consent*

It is not consistent with the balance of Clause 6 because it would:

- *permit development in a floodway*
- *permit a significant increase in the development of that land*

Those inconsistencies are discussed further under Clause 9 below.

## 8.5 CLAUSE 7

The planning proposal is consistent with this clause because it would not impose flood related development controls above the residential flood planning level for residential development on land.

## 8.6 CLAUSE 8

The planning proposal is consistent with this clause because it would not propose a flood planning level that is inconsistent with the Floodplain Development Manual 2005.

## 8.7 CLAUSE 9

The inconsistencies with Clause 6 which have been identified are not insignificant. However, as demonstrated in Section 7 of this report, the risks associated with increasing the development of the land and developing in the floodway can be managed appropriately with the imposition of flood planning controls from either Parramatta DCP 2011 or the draft DCP, both of which have been produced by following the provisions of the NSW Floodplain Development Manual.

Furthermore, recent detailed two dimensional flood modelling of the area suggests that the site is not a floodway.

## 8.8 CONCLUSION

The current planning proposal does not propose to deviate from the existing planning controls. The site is in the High Flood Risk Precinct and the existing DCP lists commercial and residential development as being unsuitable for this precinct and therefore does not stipulate any flood related development controls for the site. The planning proposal as it currently stands is not consistent with S117 Direction 4.3.

The planning proposal for the site would be consistent with S117 Direction 4.3 if planning controls for the Medium Flood Risk Precinct in Parramatta DCP 2011 were applied to the site along with additional and alternative controls

proposed in the Parramatta CBD LEP and DCP. This would be consistent with the merits based approach promoted by the Floodplain Development Manual.

# 9 DA/1263/2016 REVIEW

Molino Stewart reviewed the flood assessment report (prepared by Mance Arraj 12 December 2016) and relevant architectural plans accompanying DA/1263/2016 along with revised plans provided in February 2017 and make the following observations.

## 9.1 FLOOD RISK CATEGORY

The Mance Arraj report makes reference to Section 6 of Parramatta City Council's Local Floodplain Risk Management Policy in determining the flood risk precinct which applies to the site. The policy states in relation to the High Flood Risk Precinct:

*"The high flood risk precinct is where high flood damages, potential risk to life, evacuation problems are anticipated or development would significantly and adversely affect flood behaviour….This has been defined generally as the area of land below the 100 year flood that is either subject to a high hydraulic hazard or where there are significant evacuation difficulties."*

The report then goes on to make an assessment of flood impacts on the current building and concludes that the site is a high risk precinct. It then undertakes a similar assessment for the proposed development and concludes that the site can be reclassified as a medium risk precinct because flooding would have less significant impacts on the proposed development.

These analyses demonstrate a fundamental misunderstanding of the flood risk precinct classification hierarchy. The flood risk precinct categorisation is based on the underlying hazard and probability of floods at a locality not on the vulnerability of particular developments in that locality. Rather, development controls are proposed for particular development types in particular precincts taking into account both the underlying flood risk and the vulnerability of the development.

What this means is that the flood risk precinct categorisation does not change in response to proposed development but is fixed unless something is done to change the flood behaviour (e.g. construction of a detention basin upstream) or our understanding of the flood risk (revised flood modelling).

According to Council's adopted flood mapping, the existing site sits below the 5% AEP flood level and cannot be filled without affecting flood conveyance and consequently flood levels on surrounding land. The site has been mapped as having a high hydraulic hazard in the 1% AEP flood event. For these reasons the site fits within Council's definition of a High Flood Risk Precinct.

Other flood characteristics which support this classification are:

- The small catchment size means that flooding will occur quickly (probably in less than 2 hours)
- The PMF depth on the footpaths surrounding the site would range from between 1.6m to 2.0m. According to Australian Rainfall and Runoff, a depth which is unsafe for able bodied adults even at low velocities is 1.2m. This means that events more frequent that the PMF would be a high hazard for people trying to exit the building.
- The duration of inundation of the site and the surrounding streets during a PMF is between three and five hours which is not insignificant

That flood risk categorisation is fixed irrespective of the type of development proposed on the site.

## 9.2 SUITABLE USES

The Mance Arraj report assesses the proposed development against the development controls required for commercial and residential development in a medium risk precinct because of its erroneous reclassification of the land.

The Parramatta DCP 2011 indicates that residential and commercial development is not suitable in the High Flood Risk Precinct. Having said that, Section 7 of this report demonstrates that a mixed use development on the site could be suitable if appropriate development controls are imposed to manage the risks to flow conveyance, property and life.

This anomaly highlights a limitation of the flood risk precinct approach to flood planning control in a narrow floodplain in a CBD. In essence the proposed development for the site maintains the flow conveyance and high hydraulic hazard on the site but proposes to suspend a structure above this and protect development below this such that the flood features which classify the site as a High Flood Risk Precinct are effectively neutralised. This can be done because a substantial structure is proposed which can absorb the costs of creating these protections and the size of the floodplain is relatively small compared to the footprint of the building.

Such an approach is consistent with the NSW Floodplain Development Manual as elaborated upon in Section 7 of this report.

It is noted that the footpath on the southern and western sides of the site are at or above the 1% AEP flood level and where the building interfaces with these frontages the above ground structure has the same risks as a development which is constructed in the Low Flood Risk Precinct. The site has benefitted in this regard from the construction of the Charles St Bridge which has eliminated the isolation of the site by the 5% AEP flood. Council's flood extent and hazard mapping has not been updated to show this significant change. More recent flood mapping suggests that the flood levels in the 5% AEP and 1% AEP flood are even lower than the levels currently adopted so the flood risks may be considerably less than assumed in these analyses.

The proposed tanking of the basement car park to 9.00m AHD would afford the basement parking a protection 0.75m higher than required of any basement parking in a low or medium flood risk precinct. Once built, and assuming it is possible to keep the underground structure watertight, a flood would have to be within 0.6m of a PMF peak before the basement areas began flooding.

Taking the above into consideration, the application of the flood planning controls in Parramatta DCP 2011 for residential and commercial development in a Medium Flood Risk Precinct would appropriately manage the flow conveyance and property risks and most of the risks to life.

However, the Draft Update of Parramatta Floodplain Risk Management Plans found that some of the current DCP controls need to be modified and others added to better manage risk to life in the Parramatta CBD given the potential duration of flooding and the cumulative impacts of higher density development.

If these combinations of development controls were applied to the proposed development it would be a suitable use of the site.

## 9.3 DCP 2011 COMPLIANCE

Despite the Mance Arraj report incorrectly categorising the site as a Medium Flood Risk Precinct, as explained in Section 9.2 of this report, the assessment of the proposed development has been made against the Medium Flood Risk Precinct development controls.

In that regard the Mance Arraj report correctly observes that the proposed development would be able to be designed and built to comply with the Medium Flood Risk Precinct development controls.

## 9.4 RISK TO LIFE MANAGEMENT

Draft Update of Parramatta Floodplain Risk Management Plans (Molino Stewart, 2017) recommends that additional development control criteria be applied to improve risk to life management in the Parramatta CBD. This particular site is within risk to life Category 4. Accordingly, apart from the requirements of the Flood Planning Matrix the building must either have:

a) flood free pedestrian access to an area outside the PMF – which it does not; OR

b) (i) Shelter for all building occupants above the PMF – the communal terrace, which is above the PMF, is accessible to occupants of the ground floor. All other habitable floors are above the PMF level; AND
(ii) Fire safety to ABCB requirements for high rise whether high rise or not – the building is more than 13 storeys

and will therefore need to meet this requirement irrespective of flood considerations; AND
(iii) Flood emergency response plan for the building maintained by the building owner or body corporate – this is already proposed to meet the DCP 2011 requirements; AND
(iv) Residents able to exit above the 1% flood level – the exit to Charles St satisfies this criterion

The Draft Update of Parramatta Floodplain Risk Management Plans recommends that the requirement for buildings in the CBD to have driveways which allow safe access in a 100 year ARI flood be removed and consideration be given to including a provision that prevents vehicles from leaving the car parking areas if water has reached hazardous levels in the access roads. It also recommends removing requirements for vehicular evacuation. There does not appear to be any technical impediment to the proposed development at 12A Parkes St meeting this requirement.

## 9.5 RESILIENCE ISSUES

The flood related development controls in the Parramatta DCP 2011 are very much focussed on the mitigation of flood risks at each individual building during a flood. However, as the 2011 floods in Brisbane highlighted, delays to the reopening of high rise buildings in the CBD can have a significant impact on the economic recovery of a city. For this reason the review of the Parramatta Floodplain Risk Management Plans recommended consideration of development controls which would improve the resilience of buildings during a flood and accelerate their recovery following a flood.

Specifically the following was recommended:

*"Critical services infrastructure that could be damaged by flooding; such as electrical, lift, sewer and water are placed above the PMF."*

In this regard it is noted that the proposed development as per the plans submitted in 2016 has:

- The substation at 8.1m AHD
- The fire pump in B3
- The comms room in B2
- The switch room in B1

This means that should flooding exceed 8.1m AHD restoration of the building's power supply would be considerably delayed. If flooding exceeds 9m then further damage would occur. The building could not be reoccupied until these services were completely restored. This could take some months, particular if numerous other buildings in the city are similarly affected.

It is noted that the revised architectural plans submitted in February 2017 did not have sufficient detail about these items to determine if there were proposed changes to their location.

## 9.6 CONSTRUCTION ISSUES

The flood related development controls in the Parramatta DCP 2011 relate to the final development and do not consider flood issues which may need to be managed during construction. This development proposal presents some specific challenges because of its location next to the creek and the need to maintain flow conveyance.

The survey plan of the existing site as provided in Appendix B of the Mance Arraj report shows the top of the storm water canal at 6.3m AHD and site rising gradually to 7m towards Parkes St. This means that a 5% AEP flood would be between 0.6m and 1.3m deep across the site. More critically, it means that floods much more frequent than a 5% AEP event would flood the site.

Furthermore, because the basement excavation will abut the canal, the top of the canal wall will be the lip of the basement excavation and water will flow into the excavation and construction site whenever flows in the canal exceed 6.3m AHD. Because flooding of the site is critical for maintaining flow conveyance, it will not be possible to erect an impermeable barrier along the top of the canal to prevent it overtopping into the excavation.

According to data provided by Mance Arraj in a letter dated 29th January, 2018, the construction phase below the ground floor level will take about 150 days for a

development with three levels of basement. If the 10% AEP flood overtops the canal then there is less than a 5% chance of the canal flooding the work site when works are taking place at or below ground level. The consequences of this could be quite significant with a large excavation being filled with water and having to be pumped out.

However, the more recent two dimensional flood modelling suggests that a 1% AEP flood will be contained within the canal, in which case there would be less than a 0.5% chance of this happening during construction.

There is also a flow path from Parkes St through the site into the canal but this too would need an event close to a 1% AEP event to be activated.

# 10 PLANNING INSTRUMENT COMPARISON

Table 1 provides a summary of the provisions in the following planning instruments:

- S117 4.3
- Parramatta LEP 2011
- Parramatta DCP 2011
- Draft CBD LEP
- Draft Site Specific DCP provisions

It compares the details provided in Planning Proposal – RZ/22/2014 and Development Application –DA/1263/2016 with those provisions and provides commentary of the adequacy of the planning proposal and development application in that regard.

It is noted that with regards to DCPs, planning proposals do not explicitly adopt their provisions but for this planning proposal to satisfy the requirements of S117 4.3 there needs to be a mechanism for DCP provisions which would not otherwise apply to this site to be applied to the site.

Table 1 Compliance Summary Table

| *Planning Instrument* | Requirement | Planning Proposal – RZ/22/2014 | Development Application –DA/1263/2016 |
|---|---|---|---|
| *S117 4.3* | *(3) This direction applies when a relevant planning authority prepares a planning proposal that creates, removes or alters a zone or a provision that affects flood prone land.* | Applies to the planning proposal because it is proposed to change the FSR | Does not apply to development applications |
| | *(4) A planning proposal must include provisions that give effect to and are consistent with the NSW Flood Prone Land Policy and the principles of the Floodplain Development Manual 2005 (including the Guideline on Development Controls on Low Flood Risk Areas).* | The planning proposal for the site does not propose to deviate from the existing DCP. The site is in the High Flood Risk Precinct and the existing DCP lists commercial and residential development as being unsuitable for this precinct. There are significant flood risks on the site which would need to be mitigated. Therefore the planning proposal is not consistent with the NSW Floodplain Development Manual.<br><br>However, there are planning controls in the existing DCP and additional and alternative controls in the draft DCP which would satisfactorily manage flood risks in accordance with the requirements of the NSW Floodplain Development Manual. | Does not apply to development applications |
| | *(5) A planning proposal must not rezone land within the flood planning areas from Special Use, Special Purpose, Recreation, Rural or Environmental Protection Zones to a Residential, Business, Industrial, Special Use or Special Purpose Zones* | The land is currently zoned B4 mixed use so this clause does not apply | Does not apply to development applications |

| Planning Instrument | Requirement | Planning Proposal – RZ/22/2014 | Development Application –DA/1263/2016 |
|---|---|---|---|
| | *(6) A planning proposal must not contain provisions that apply to the flood planning areas which:*<br>*a) permit development in floodway areas* | Would permit development in a floodway area and is therefore inconsistent.<br>However, reference to Cl 9 must be considered | Does not apply to development applications |
| | *b) permit development that will result in significant flood impacts to other properties* | DCP includes provisions to ensure no significant flood impacts to other properties and planning proposal does not propose changes to these provisions | Does not apply to development applications. However any development proposal will need to demonstrate that it would not increase flood impacts on neighbouring properties |
| | *c) permit a significant increase in the development of that land* | Increased FSR would permit a significant increase in development.<br>However, reference to Cl 9 must be considered | Does not apply to development applications |
| | *d) are likely to result in a substantially increased requirement for government spending on flood mitigation measures, infrastructure or services* | Would not require increased government spending on flood mitigation measures, infrastructure or services | Does not apply to development applications |
| | *e) permit development to be carried out without development consent except for the purposes of agriculture… roads or exempt development* | Would not permit development without consent | Does not apply to development applications |
| | *(7) Must not impose flood related development controls above the residential flood planning level for residential development on land, unless a relevant* | No such controls are proposed by the planning proposal | Does not apply to development applications |

| Planning Instrument | Requirement | Planning Proposal – RZ/22/2014 | Development Application –DA/1263/2016 |
|---|---|---|---|
| | *planning authority provides adequate justification for those controls to the satisfaction of the Director-General (or an officer of the Department nominated by the Director-General).* | | |
| | *(8) For the purposes of a planning proposal, a relevant planning authority must not determine a flood planning level that is inconsistent with the Floodplain Development Manual 2005 (including the Guideline on Development Controls on Low Flood Risk Areas) unless a relevant planning authority provides adequate justification for the proposed departure from that Manual to the satisfaction of the Director-General (or an officer of the Department nominated by the Director-General).* | The planning proposal is consistent with this clause because it would not propose a flood planning level that is inconsistent with the Floodplain Development Manual 2005. | Does not apply to development applications |
| | *(9) A planning proposal may be inconsistent with this direction only if the relevant planning authority can satisfy the Director-General (or an officer of the Department nominated by the Director-General) that:*<br>*a) the proposal is in accordance with a floodplain risk management plan prepared in accordance with the principles and guidelines of the Floodplain Development Manual 2005, or*<br>*b) the provisions of the planning proposal* | The inconsistencies with Clause 6 (a) and (c) which have been identified are not insignificant. However, as demonstrated in Section 7 of this report, the risks associated with increasing the development of the land and developing in the floodway can be managed appropriately with the imposition of flood planning controls from either Parramatta DCP 2011 or the draft DCP, both of which have been produced by following the provisions of the NSW Floodplain Development manual. | Does not apply to development applications |

| Planning Instrument | Requirement | Planning Proposal – RZ/22/2014 | Development Application –DA/1263/2016 |
|---|---|---|---|
| | *are inconsistent are of minor significance"* | | |
| *Parramatta LEP 2011* | *6.3 (3) Development consent must not be granted to development on land to which this clause applies unless the consent authority is satisfied that the development:*<br>*(a) is compatible with the flood hazard of the land* | Is not consistent with suitable uses identified in the DCP but this assessment suggests that providing additional development controls are incorporated the planning proposal would be compatible with the flood hazard | Is not consistent with suitable uses identified in DCP but this assessment suggests that providing additional development controls are incorporated a development could be compatible with the flood hazard. This development application has not demonstrated all aspects of that compatibility. |
| | *(b) is not likely to significantly adversely affect flood behaviour resulting in detrimental increases in the potential flood affectation of other development or properties* | DCP includes provisions to ensure no significant flood impacts to other properties. The planning proposal does not propose changes to this LEP provision. | This specific development proposal has not yet been independently reviewed. However, in a previous development application for the site Don Still was satisfied that a previous development proposal for the site would not increase flood potential. |
| | *(c) incorporates appropriate measures to manage risk to life from flood* | The planning proposal for the site does not propose to deviate from the existing DCP. There are significant flood risks to life on the site which would need to be mitigated by adopting additional and alternative controls in the draft CBD DCP. | Built development would appropriately manage risk to life providing an appropriate site flood emergency response plan was developed and implemented. Risk during construction is yet to be evaluated |
| | *(d) Is not likely to significantly adversely affect the environment or cause avoidable erosion, siltation, destruction of riparian vegetation or reduction in the stability of river banks or watercourses* | The planning proposal does not propose to permit development which would do this | The only question that the proposed development poses in this regard is the stability of the canal wall during construction, particularly during a flood |

| Planning Instrument | Requirement | Planning Proposal – RZ/22/2014 | Development Application –DA/1263/2016 |
|---|---|---|---|
| *Parramatta DCP 2011* | *High Flood Risk Precinct – Suitable Uses* | Residential and commercial development are listed as not suitable in High Flood Risk Precinct. The following discussion therefore compares the planning proposal with the requirements for Medium Flood Risk Precinct which could be applied to the site to satisfactorily manage impacts on flow paths and property damage | Residential and commercial development are listed as not suitable in High Flood Risk Precinct. The following discussion therefore compares the planning proposal with the requirements for Medium Flood Risk Precinct |
| | *Floor Level*<br>*2. Habitable floor levels to be equal to or greater than the 100 year ARI flood level plus freeboard (freeboard equals an additional height of 500mm)* | Adoption of this control would satisfactorily manage risks. | All habitable floors at or above 9.00m AHD which is 1250mm higher than 1% flood level. |
| | *Floor Level*<br>*5. A restriction is to be placed on the title of the land, pursuant to S.88B of the Conveyancing Act, where the lowest habitable floor area is elevated more than 1.5m above finished ground level, confirming that the subfloor space is not to be enclosed* | Adoption of this control would satisfactorily manage risks. | Floodway ground level is at 6.48m AHD more than 2.5m lower than the lowest habitable floor level. Flood report accompanying the DA acknowledges restrictions regarding its use and other flood mitigation features need to be placed on title |
| | *Building Components*<br>*1 All structures to have flood compatible building components below the 100 year ARI flood level plus freeboard* | Adoption of this control would satisfactorily manage risks to property but additional controls are needed to manage risk to life. | DA suggests that type of structure dictates such materials are needed but no engineering certificate accompanies DA |
| | *Structural Soundness* | Adoption of this control would satisfactorily | No engineering certificate accompanies DA. |

| *Planning Instrument* | Requirement | Planning Proposal – RZ/22/2014 | Development Application –DA/1263/2016 |
|---|---|---|---|
| | *1. An engineer's report is required to certify that the structure can withstand the forces of floodwater, debris and buoyancy up to and including a 100 year ARI flood level plus freeboard* | manage risks to property but additional controls are needed to manage risk to life. | DA documentation suggests this be a consent condition |
| | *Flood Affectation*<br>*1 An engineer's report is required to certify that the development will not increase flood affectation elsewhere, having regard to: (i) loss of flood storage; (ii) changes in flood levels, flows and velocities caused by alterations to flood flows; and (iii) the cumulate impact of multiple potential developments in the vicinity.* | Adoption of this control would satisfactorily manage risks. | Quantitative evidence provided that flood storage will increase<br>Qualitative discussion only about flood flows along direction of creek. Not quantitative analysis nor consideration of overland flows from Parkes St to canal. No quantitative analysis of blockage of either flow path. |
| | *Car Parking and Driveway Access*<br>*1 The minimum surface level of open spaces or carports shall be as high as practical, but no lower than 0.1m below the 100 year ARI flood level. In the case of garages, the minimum surface level shall be as high as practical, but no lower than the 100 year ARI flood level.* | Adoption of this control would satisfactorily manage risks. | Open car parking and loading docks at 9.0m AHD 1.25m above 1% flood level |
| | *Car Parking and Driveway Access*<br>*3 Garages capable of accommodating more than 3 motor vehicles on land zones for urban purposes, or enclosed car parking, must be protected from inundation by floods equal to or greater than the 100 year ARI* | Adoption of this control would satisfactorily manage risks. | Basement parking accessed by a lift which is protected up to 9.0m AHD |

| Planning Instrument | Requirement | Planning Proposal – RZ/22/2014 | Development Application –DA/1263/2016 |
|---|---|---|---|
| | *flood. Ramp levels to be no lower than 0.5m above the 100 year ARI flood level* | | |
| | *Car Parking and Driveway Access*<br>*5 The level of the driveway providing access between the road and parking spaces shall be no lower than 0.2m below the 100 year ARI flood level.* | Adoption of this control would satisfactorily manage risks. | Gutter where driveway crossed Wigram St is 0.17m below 100 year ARI flood level |
| | *Car Parking and Driveway Access*<br>*6 Enclosed car parking and car parking areas accommodating more than 3 vehicles, with a floor below the 100 year ARI flood level, shall have adequate warning systems, signage, exits and evacuation routes.* | Adoption of this control would satisfactorily manage risks. | Basement parking is below ground but is bunded up to 9.0m AHD, 1.25m above the 100 year ARI flood level. Development proposal does not provide details of warning systems, signage or exits. |
| | *Car Parking and Driveway Access*<br>*7 Restraints or vehicle barriers to be provided to prevent floating vehicles leaving a site during a 100 year ARI flood.* | Adoption of this control would satisfactorily manage risks. | Basement parking is below ground but is bunded up to 9.0m AHD and open parking is at 9.0m AHD, 1.25m above the 100 year ARI flood level. No additional restraints required. |
| | *Evacuation*<br>*3 Reliable access for pedestrians and vehicles is required from the site to an area of refuge above the PMF level, either on site (e.g. second storey) or off site.* | Adoption of this control would satisfactorily manage risks. | All dwellings above PMF. Commercial ground floor area will have access to communal terrace which is above PMF. Early evacuation would be needed for vehicles to reach land above PMF (Hassall St) and proposal in DA is not practical. However, Draft CBD DCP is recommending against vehicular evacuation |
| | *Evacuation*<br>*4 Applicant is to demonstrate the* | Adoption of this control would satisfactorily manage risks. | CoPC nor NSWSES currently have a flood evacuation strategy for Parramatta. |

| Planning Instrument | Requirement | Planning Proposal – RZ/22/2014 | Development Application –DA/1263/2016 |
|---|---|---|---|
| | *development is consistent with any relevant flood evacuation strategy or similar plan.* | | |
| | *Evacuation*<br>*6Adequate flood warning is available to allow safe and orderly evacuation without increased reliance upon SES or other authorised emergency services personnel* | Adoption of this control would satisfactorily manage risks. | DA proposes a site specific Site Emergency Response Plan be submitted at CCA stage which will recommend vertical evacuation. This would comply with this requirement. |
| | *Management and Design*<br>*2 Site Emergency Response Flood Plan required where the site is affected by the 100 year ARI flood level, (except for single dwelling-houses).* | Adoption of this control would satisfactorily manage risks. | DA proposes a site specific Site Emergency Response Plan be submitted at CCA stage which will recommend vertical evacuation. This would comply with this requirement. |
| | *Management and Design*<br>*3 Applicant is to demonstrate that area is available to store goods above the 100 year flood level plus freeboard.* | Adoption of this control would satisfactorily manage risks. | All goods will be stored above the 100 year ARI flood level |
| | *Management and Design*<br>*4 No storage of materials below the 100 year ARI flood level.* | Adoption of this control would satisfactorily manage risks. | All goods will be stored above the 100 year ARI flood level |
| *Parramatta CBD Draft LEP* | *a. Provide a safe area for all occupants to take refuge in that is located above the probable maximum flood level, or*<br>*b. Provide a flood free pedestrian access between the building and land that is above the probable maximum flood level* | Planning proposal does not explicitly adopt this planning provision but needs to to appropriately manage risk to life. | All dwellings above PMF. Commercial ground floor area will have access to communal terrace which is above PMF. |

| *Planning Instrument* | Requirement | Planning Proposal – RZ/22/2014 | Development Application –DA/1263/2016 |
|---|---|---|---|
| | *c. Provide certification by an engineer that a building can withstand the forces of floodwaters resulting from a probable maximum flood event.* | Planning proposal does not explicitly adopt this planning provision but needs to to appropriately manage risk to life. | DA only talks about ability to resist forces up to 100 year ARI flood level and no engineers certificate accompanies DA |
| *Draft Site Specific DCP provisions* | *A safe area above the probable maximum flood level with emergency electricity and water for all occupants* | Planning proposal does not explicitly adopt this planning provision but needs to to appropriately manage risk to life. | All dwellings above PMF. Commercial ground floor area will have access to communal terrace which is above PMF but the substation is at 8.1m AHD so would not provide emergency power in a PMF. |
| | *Consideration be given to permitting some types of commercial development at street level where this is below the current flood planning level, providing they are designed to minimise damage to property and risk to life* | No commercial development proposed below FPL | No commercial development proposed below FPL |
| | *Where the street entrance for a dwelling could be flooded in a PMF for more than three hours require safe refuge for all occupants above the level of the PMF plus a freeboard* | Planning proposal does not explicitly adopt this planning provision but needs to to appropriately manage risk to life. | All dwellings above PMF plus freeboard |
| | *Where the street entrance for a dwelling could be flooded in a PMF for more than eight hours require that the minimum floor level for the dwelling be constructed above the level of the PMF plus a freeboard and have access to emergency water and power* | Flood duration at site is less than 8 hours | Flood duration at site is less than 8 hours |

| Planning Instrument | Requirement | Planning Proposal – RZ/22/2014 | Development Application –DA/1263/2016 |
|---|---|---|---|
| | *Ensure all residents in all buildings have access to an exit at street level which is above the 1% flood level* | Planning proposal does not explicitly adopt this planning provision but needs to to appropriately manage risk to life. | Exit in Charles St is above 1% flood level |
| | *Additional requirements be considered with regard to flood affectation provisions to try and eliminate the construction of buildings with under building flow paths which are architecturally unattractive and/or hydraulically questionable* | Planning proposal does not explicitly adopt this planning provision but needs to to appropriately manage risk to life. | Proposal includes underbuilding flow path but DA does not provide sufficient detail to determine whether it is architecturally unattractive and/or hydraulically questionable |
| | *Remove the requirement for buildings in the CBD to have driveways which allow safe access in a 100 year ARI flood and consider including a provision that prevents vehicles from leaving the car parking areas if water has reached hazardous levels in the access roads* | Planning proposal does not explicitly adopt this planning provision but needs to to appropriately manage risk to life. | Current development proposal does not have provision to prevent vehicles from leaving when Wigram Street is flooding but it would be easily incorporated into the design |
| | *Remove requirements for vehicular evacuation* | Planning proposal does not explicitly adopt this planning provision but needs to to appropriately manage risk to life. | Vehicles do not have to evacuate from site |
| | *Introduce development incentives such as increased floor space ratios to developments which provide building egress points with a lower depth of flooding in a PMF. This will encourage lot consolidation or elevated walkways to provide pedestrian connection* | Planning proposal does not explicitly adopt this planning provision but needs to to appropriately manage risk to life. | Development has minimum floor levels 750mm above flood planning level and is proposing an increased FSR |

| Planning Instrument | Requirement | Planning Proposal – RZ/22/2014 | Development Application –DA/1263/2016 |
|---|---|---|---|
| | *to lower flood risk areas* | | |
| | *Prohibit residential and commercial habitable floors in the current high flood risk precinct unless there is a flood free pedestrian access to a building outside of the high flood risk precinct* | Planning proposal does not explicitly adopt this planning provision but needs to to appropriately manage risk to life. | Includes habitable floors within the high flood risk precinct but has building exit above the 1% flood level which is therefore exiting into a low flood risk precinct |
| | *Introduce development incentives such as increased floor space ratios to developments which dedicate high flood risk land to open space uses as an alternative to habitable buildings on that land* | Does not dedicate high flood risk land to open space as the entire site is high flood risk land | Does not dedicate high flood risk land to open space as the entire site is high flood risk land |
| | *If commercial developments are permitted at street level below the flood planning level then permit the storage of goods below the flood planning level provided they are protected from floods up to the flood planning level* | No development proposed below FPL | No development proposed below FPL |
| | *Require buildings which have their highest building egress more than 0.6m below the level of the PMF to have:*<br>• *a building fire management system to meet ABC requirements for high rise buildings*<br>• *The building management review* | Does not dedicate high flood risk land to open space as the entire site is high flood risk land | Building egress is more than 0.6m below PMF but it is a high rise building so will be required to meet ABC fire requirements regardless of flood risks.<br>DA does not specify frequency with which Site Emergency Response Plan is reviewed |

| Planning Instrument | Requirement | Planning Proposal – RZ/22/2014 | Development Application –DA/1263/2016 |
|---|---|---|---|
| | *the Site Emergency Response Flood Plan annually or following a flood exceeding a 20 year ARI event and communicate the plan to all occupants* | | |
| | *External fire doors be above the level of the 100 year ARI flood plus 0.5m* | Does not dedicate high flood risk land to open space as the entire site is high flood risk land | Fire doors exit building at 9.0m AHD, 0.75m above 100 year ARI flood plus 0.5m |
| | *Critical services infrastructure that could be damaged by flooding; such as electrical, lift, sewer and water are placed above the PMF.* | Does not dedicate high flood risk land to open space as the entire site is high flood risk land | The substation at 8.1m AHD and the fire pump is in B3, comms room is in B2 and the switch room is in B1. Each basement could flood in events exceeding 9.0m AHD therefore these critical services are not protected from the PMF |

# 11 CONCLUSIONS AND RECOMMENDATIONS

The flood reports prepared in support of the planning proposal and development proposal for 12A Parkes St do not adequately consider all of the issues in relation to the consistency of the proposals with the requirements of the relevant planning instruments and policies in relation to flooding on the site.

This report makes a more thorough analysis and notes the following:

- The site is currently mapped as a High Flood Risk Precinct and a Floodway by Parramatta City Council
- The S117 Direction 4.3 does not permit the proposed development in a floodway
- Parramatta DCP 2011 identifies the proposed development as unsuitable in a High Flood Risk Precinct

However, the scale of the proposed development compared to the width of the floodplain means that the development is able to be constructed such that most of it sits at a level well above the 1% AEP flood level and it can function like a development in a Low Flood Risk Precinct.

For this to be possible it needs to comply with development controls for commercial and residential development in a Medium Flood Risk Precinct as set out in Parramatta DCP 2011 as well as additional controls set out in the Draft Parramatta CBD LEP and DCP to minimise risk to life.

The NSW Floodplain Development Manual encourages a merits based approach to floodplain development rather than a strict application of prescriptive planning controls. This alternative approach to flood risk management on this site would therefore be consistent with the provisions of the Manual.

S117 4.3 permits a planning proposal that is inconsistent with this direction if it is in accordance with a floodplain risk management plan prepared in accordance with the principles and guidelines of the Floodplain Development Manual 2005. Parramatta LEP 2011 and DCP 2011 and the Draft Parramatta CBD LEP and DCP have been developed as part of floodplain risk management plans prepared in accordance with the Manual.

Therefore compliance with appropriate provisions from those planning instruments, as detailed in this report, would mean that the planning proposal is consistent with a floodplain risk management plan prepared in accordance with the principles and guidelines of the Floodplain Development Manual 2005 and accordingly permissible under S117 4.3.

The development proposal itself would need modifications as well as provision of additional details before it could be assessed to be compliant with the relevant planning instrument provisions.

It is also noted that more recent two dimensional flood modelling undertaken for Parramatta City Council suggests that the currently adopted flood risk for the site may be conservative. If so then the proposed development would not be prohibited by the S117 Direction 4.3 nor deemed unsuitable by Parramatta DCP 2011 but the proposed flood planning controls would still need to be applied.

While the two dimensional flood modelling suggests the adopted flood risks for the site may be conservative, its mapping of overland flow paths and sensitivity analysis with regards to blockages indicate that the adopted FPL for the site is appropriate.

# 12 REFERENCES

Bewsher Consulting, 2015, *Planning Proposal RZ/22/2014, 122a Wigram Street Parramatta Review of Flood Affectation Issues*, September 2015

Department of Planning and Environment, 2016, *Gateway Determination Planning Proposal (Dept Ref: PP_2016_PARRA_006_00),* June 2016

HKMA Engineers, 2015, *122 Wigram St Harris Park Planning Proposal (response to key issues in S117 Direction),* September 2015

Lyall and Associates, 2018, *12A Parkes Street Flooding Investigation*, April 2018

Mance Arraj, 2016, *Flood Risk Assessment Report for the Proposed Development at 12A Parkes St Harris Park,* December 2016

Mance Arraj, 2017, *12A Parkes St Harris Park Planning Proposal (response to key issues in S117 Direction),* February 2017

Mecone, 2014, *Planning Proposal 122 Wigram Street Harris Park*, November 2014

Molino Stewart, 2016, *Update of Parramatta Floodplain Risk Management Plans*, Draft February 2016

SKM, 2005, *Lower Parramatta River Floodplain Risk Management Study and Plan – Flood Study Review*, prepared for Parramatta City Council, May 2005.

SKM, 2005, *Lower Parramatta River Floodplain Risk Management Study and Plan*, prepared for Parramatta City Council, August 2005.

Sydney Water, 2002, *Clay Cliff Creek (SWC 27) Capacity Assessment*, September 2002.

# APPENDIX A – PARRAMATTA DCP 2011 FLOODPLAIN MATRIX

**Table 2.12.2.1.2**
Flood Plain Matrix Planning and Development Controls

| Flood Risk Precincts (FRP's) | Planning Consideration | Floor Level | Building Components | Structural Soundness | Flood Affectation | Car Parking & Driveway Access | Evacuation | Management & Design |
|---|---|---|---|---|---|---|---|---|
| High Flood Risk | Concessional Development | 4, 5 | 1 | 1 | 1 | 1, 5 | 3, 4, 6 | 2, 3, 4 |
| | Open Space & Non-Urban | 1, 5 | 1 | 1 | 1 | 2, 4, 6, 7 | 1, 4 | 2, 3, 4 |
| | Tourist Related Development | X | X | X | X | X | X | X |
| | Commercial & Industrial | X | X | X | X | X | X | X |
| | Residential* | X | X | X | X | X | X | X |
| | Filling | X | X | X | X | X | X | X |
| | Subdivision | X | X | X | X | X | X | X |
| | Critical Uses & Facilities | X | X | X | X | X | X | X |
| | Sensitive Uses & Facilities | X | X | X | X | X | X | X |
| Medium Flood Risk | Concessional Development | 4, 5 | 1 | 1 | 1 | 1, 5 | 3, 6 | 2, 3, 4 |
| | Open Space & Non-Urban | 1, 5 | 1 | 1 | 2 | 2, 4, 6, 7 | 1, 4 | 2, 3, 4 |
| | Tourist Related Development | 2, 5 | 1 | 1 | 1 | 1, 3, 5, 6, 7 | 3, 4, 6 | 2, 3, 4 |
| | Commercial & Industrial | 2, 5 | 1 | 1 | 1 | 1, 3, 5, 6, 7 | 3, 4, 6 | 2, 3, 4 |
| | Residential* | 2, 5 | 1 | 1 | 1 | 1, 3, 5, 6, 7 | 3, 4, 6 | 2, 3, 4 |
| | Filling | X | X | X | X | X | X | X |
| | Subdivision | | | | 1 | | 5, 3, 4 | 1 |
| | Critical Uses & Facilities | X | X | X | X | X | X | X |
| | Sensitive Uses & Facilities | X | X | X | X | X | X | X |
| Low Flood Risk | Concessional Development | | | | | | | |
| | Open Space & Non-Urban | | | | | 2, 4, 6, 7 | | |
| | Tourist Related Development | 2, 5 | | | 2 | 1, 3, 5, 6 | 4 | |
| | Commercial & Industrial | 2, 5 | | | 2 | 1, 3, 5, 6 | 4 | |
| | Residential* | 2, 5 | | | 2 | 1, 3, 5, 6 | 3, 4 | |
| | Filling | | | | 1 | | | |
| | Subdivision | | | | 2 | | 5 | 1 |
| | Critical Uses & Facilities | 3 | 2 | 2 | 2 | 1, 3, 5, 6 | 2, 4, 6 | 2, 3, 4 |
| | Sensitive Uses & Facilities | X | X | X | X | X | X | X |

*for redevelopment of existing dwellings refer also to 'Concessional Development Provisions"

Legend

Not Relevant  X Unsuitable Land Use

i. Freeboard equals an additional height of 500mm.

ii. The Parramatta LEP 2011 identifies development permissible with consent in various zones. Notwithstanding, constraints specific to individual sites may preclude Council granting consent for certain forms of development on all or part of a site. The above matrix identifies where flood risks are likely to determine where certain development types will be considered "unsuitable" due to flood related risks.

iii. Filling of the site, where acceptable to Council, may change the FRP considered to determine the controls applied in the circumstances of individual applications.

iv. Any fencing that forms part of a proposed development is subject to the relevant Flood Effects and Structural Soundness planning considerations of the applicable land use category.

v. Development within the floodplain may be subject to Clause 6.7 Foreshore Building Line in the Parramatta LEP 2011.

**Table 2.12.2.1.3**
Development Controls

| | |
|---|---|
| **Floor Level** | |
| 1 | All floor levels to be equal to or greater than the 20 year Average Recurrence Interval (ARI) flood level plus freeboard. |
| 2 | Habitable floor levels to be equal to or greater than the 100 year ARI flood level plus freeboard. |
| 3 | All floor levels to be equal to or greater than the Probable Maximum Flood (PMF) level plus freeboard. |
| 4 | Floor levels to be equal to or greater than the 100 year ARI flood level plus freeboard. Where this is not practical due to compatibility with the height of adjacent buildings, or compatibility with the floor level of existing buildings, or the need for access for persons with disabilities, a lower floor level may be considered. In these circumstances, the floor level is to be as high as practical, and, when undertaking alternations or additions, no lower than the existing floor level. |
| 5 | A restriction is to be placed on the title of the land, pursuant to S.88B of the Conveyancing Act, where the lowest habitable floor area is elevated more than 1.5m above finished ground level, confirming that the subfloor space is not to be enclosed. |
| **Building Components & Method** | |
| 1 | All structures to have flood compatible building components below the 100 year ARI flood level plus freeboard. |
| 2 | All structures to have flood compatible building components below the PMF. |
| **Structural Soundness** | |
| 1 | An engineers report is required to certify that the structure can withstand the forces of floodwater, debris and buoyancy up to and including a 100 year ARI flood level plus freeboard. |
| 2 | An engineers report is required to certify that the structure can withstand the forces of floodwater, debris and buoyancy up to and including a PMF level. |
| **Flood Affectation** | |
| 1 | An engineers report is required to certify that the development will not increase flood affectation eleswhere, having regard to: (i) loss of flood storage; (ii) changes in flood levels, flows and velocities caused by alterations to flood flows; and (iii) the cumulate impact of multiple potential developments in the vicinity. |
| 2 | The impact of the development on flooding elsewhere to be considered having regard to the three factors listed in consideration 1 above. |
| **Car Parking and Driveway Access** | |
| 1 | The minimum surface level of open spaces or carports shall be as high as practical, but no lower than 0.1m below the 100 year ARI flood level. In the case of garages, the minimum surface level shall be as high as practical, but no lower than the 100 year ARI flood level. |
| 2 | The minimum surface level of open parking spaces or carports shall be as high as practical, but no lower than 0.3m above the 20 year ARI flood level. |
| 3 | Garages capable of accommodating more than 3 motor vehicles on land zones for urban purposes, or enclosed car parking, must be protected from inundation by floods equal to or greater than the 100 year ARI flood. Ramp levels to be no lower than 0.5m above the 100 year ARI flood level. |
| 4 | The driveway providing access between the road and parking spaces shall be as high as practical and generally rising in the egress direction. |
| 5 | The level of the driveway providing access between the road and parking spaces shall be no lower than 0.2m below the 100 year ARI flood level. |
| 6 | Enclosed car parking and car parking areas accommodating more than 3 vehicles, with a floor below the 100 year ARI flood level, shall have adequate warning systems, signage, exits and evacuation routes. |
| 7 | Restraints or vehicle barriers to be provided to prevent floating vehicles leaving a site during a 100 year ARI flood. |
| **Evacuation** | |
| 1 | Reliable access for pedestrians required during a 20 year ARI peak flood. |
| 2 | Reliable access for pedestrians and vehicles required to a publicly accessible location during the PMF peak flood. |

| | |
|---|---|
| 3 | Reliable access for pedestrians and vehicles is required from the site to an area of refuge above the PMF level, either on site (eg. second storey) or off site. |
| 4 | Applicant is to demonstrate the development is consistent with any relevant flood evacuation strategy or similar plan. |
| 5 | Applicant is to demonstrate that evacuation in accordance with the requirements of this DCP is available for the potential development resulting from the subdivision. |
| 6 | Adequate flood warning is available to allow safe and orderly evacuation without increased reliance upon SES or other authorised emergency services personnel. |
| **Management and Design** | |
| 1 | Applicant is to demonstrate that potential development as a consequence of a subdivision proposal can be undertaken in accordance with this the relevant FRMS and FRMP |
| 2 | Site Emergency Response Flood plan required where the site is affected by the 100 year ARI flood level, (except for single dwelling-houses). |
| 3 | Applicant is to demonstrate that area is available to store goods above the 100 year flood level plus freeboard. |
| 4 | No storage of materials below the 100 year ARI flood level. |

**Further Information**

Flood Risk Management Plan, Flood Studies, Sub-Catchment Management Plans and Local Floodplain Risk Management Policy available from the City of Parramatta Council.

NSW Government's *Floodplain Development Manual 2005* – www.dnr.nsw.gov.au/floodplains/manual.shtml

City of Parramatta Council's *Local Floodplain Risk Management Policy*, 2006.

# APPENDIX B – FLOOD MODELLING REPORT

Molino Stewart
PO Box 614
PARRAMATTA CBD BC

Job No. EO441

Attn: Mr Steven Molino

26 April 2018

**Re: 12A Parkes Street Flooding Investigation**

Dear Sir

This letter sets out the findings of an investigation which has been undertaken to define the nature of flooding in the vicinity of 12A Parkes Street, Harris Park (**the property**) and to the assess the impact a proposed multi-storey commercial and residential development within the property would have on flooding behaviour. The need for the investigation has arisen due to Parramatta City Council (**Council**) requiring additional flood related information to assist in the development application process.

## 1. Catchment and Site Description

The property is located adjacent to the main arm of Clay Cliff Creek, which is a minor tributary of the Parramatta River. **Figure 1** attached shows the location of the property relative to the main arm of Clay Cliff Creek, as well as the extent of the 2 $km^2$ highly urbanised catchment which contributes to flow in the watercourse at its location.

The main arm of Clay Cliff Creek has been concrete lined over most of its length extending from Ollie Webb Reserve, which lies to the west (upstream) of the property to its confluence with the Parramatta River, noting that several relatively short sections of the channel have been enclosed, such as the reach of Clay Cliff Creek which extends from Jubilee Park to a location 120 metres west (upstream) of the property. As an asset, the main arm of Clay Cliff Creek and several of its tributary arms are owned and maintained by Sydney Water Corporation (**SWC**).

A large detention basin has been constructed on the main arm of Clay Cliff Creek upstream of the property in Ollie Webb Reserve. The basin controls a catchment area of about 1.3 $km^2$, which represents about 65 per cent of the total catchment which contributes to flow in Clay Cliff Creek at the location of the property. No details were available at the time of writing regarding the attenuating effects that the basin has on flow generated by the upstream catchment.

The concrete lined section of channel (**the channel**) measures about 3.8 metres in width and about 1.7 metres in depth where it runs along the northern boundary of the property. Bridges have been constructed across the channel in the vicinity of the property at Charles Street, Wigram Street, Harris Street and Parkes Street. All four bridges comprise single spans, with their abutments set back from the parapet of the channel. The bed slope of the channel is about 0.64 per cent extending from a location 120 m west (upstream) of the property to a location midway between the Harris Street and Parkes Street bridges. Downstream of this location the bed slope of the channel flattens to about 0.15 per cent.

As shown in **Figure 2**, the property is bounded by Charles Street to its west, Parkes Street to its south and Wigram Street to its east, while the centreline of the channel aligns with its northern boundary. While the existing structures in the property have been demolished, Google Streetview shows that a two-storey residential flat building was once present, the approximate outline of which is shown on **Figure 2**. Google Streetview also shows that a wooden paling fence once extended along the western and southern boundaries of the property.

Available LiDAR and site survey data shows that natural surface levels in the property fall in a northerly direction toward the channel. The available survey data also shows that there is a low point in the footpath of Parkes Street near its intersection with Charles Street, with footpath levels shown to rise toward the Charles Street and Wigram Street bridges. The back-of-footpath level at the location of the low point is shown to be about RL 7.5 m AHD.

A sag is present in Parkes Street to the west (upstream) of the Charles Street bridge. The available survey data shows that the elevation of the footpath which runs along the northern side of the road at the location of the sag is about 500 millimetres below the low point which is present in the footpath of Parkes Street adjacent to the property (i.e. it has a minimum elevation of about RL 7.0 m AHD).

## 2. Previous Studies

The *Lower Parramatta River Floodplain Risk Management Study* (SKM, 2005) sets out the findings of an investigation which was undertaken to define the nature of flooding in the Lower Parramatta River and several of its tributaries (which included Clay Cliff Creek). A hydrologic model was developed using the RAFTS software of the catchments which contribute to flow in the Lower Parramatta River. The RAFTS model was used to generate discharge hydrographs which were used as input to a quasi-two-dimensional hydraulic model which was developed using the MIKE 11 software. The MIKE 11 model was used to convert flows to peak flood levels and flow velocities in the study area. The results of the flooding investigation have been adopted by Council and are currently used for planning purposes.

**Table 1** sets out the peak 5 and 1% annual exceedance probability (**AEP**) flow, as well as the peak Probable Maximum Flood (**PMF**) flow on the main arm of Clay Cliff Creek a short distance west (upstream) of the property.

**TABLE 1**
**PEAK FLOWS[1]**
**($m^3/s$)**

| Location | 5% AEP | 1% AEP | PMF |
|---|---|---|---|
| Outlet of culvert discharging to the channel which commences about 120 m west (upstream) of the property | 19.8 | 20.3 | 40 |
| Discharging overland via the Parkes Street underpass of the Main Western Railway | 5.9 | 13.9 | 171 |
| **Total** | **25.7** | **34.2** | **211** |

1. Source: SKM, 2005

**Table 2** over the page sets out the peak 5 and 1% annual exceedance probability (**AEP**) flood levels, as well as the PMF levels that are presented in SKM, 2005 at several key locations in the vicinity of the property. By inspection of the peak flood levels set out in **Table 1**, the MIKE 11 model results indicate that there would be a significant head drop across the Charles Street, Wigram Street and Harris Street bridges in a 1% AEP flood event, a feature which the hydraulic models developed as part of the present investigation could not reproduce (refer **Section 3.3** of this letter for further details).

**TABLE 2**
**PEAK FLOOD LEVELS[1]**
**(m AHD)**

| Location | 5% AEP | 1% AEP | PMF |
|---|---|---|---|
| Channel adjacent to sag in Parkes Street | 8.01 | 8.32 | 9.68 |
| Channel on upstream face of Charles Street bridge[2] | 8.07<br>[0.45] | 8.38<br>[0.67] | 9.81<br>[0.22] |
| Channel on downstream face of Charles Street bridge | 7.62 | 7.75 | 9.59 |
| Channel on upstream face of Wigram Street bridge[2] | 7.39<br>[1.26] | 7.59<br>[1.16] | 9.43<br>[-0.01] |
| Channel on downstream face of Wigram Street bridge | 6.13 | 6.43 | 9.44 |
| Channel on upstream face of Harris Street bridge[2] | 5.60<br>[0.39] | 6.19<br>[0.49] | 9.44<br>[-0.04] |
| Channel on downstream face of Harris Street bridge | 5.21 | 5.70 | 9.48 |
| Parkes Street at location of sag in the road west of Charles Street | 8.03 | 8.33 | 9.70 |
| Parkes Street at intersection with Charles Street | 8.03 | 8.33 | 9.70 |
| Parkes Street at intersection with Wigram Street | 8.02 | 8.30 | 9.57 |

1. Source: SKM, 2005
2. Value in [ ] represents the computed head drop across the existing bridge structure in metres. Note that a negative value represents a rise in peak flood levels in the downstream direction.

The results of the MIKE 11 modelling also indicate that the footpath which runs along the northern side of Parkes Street adjacent to the sag in the road would be inundated to a maximum depth of about 1.33 metres (RL 8.33 m AHD – RL 7.0 m AHD = 1.33 metres), while the low point in the Parkes Street footpath adjacent to the property would be inundated to a maximum depth of about 0.73 metres (RL 8.33 m AHD – RL 7.5 m AHD = 0.83 metres) in a 1% AEP flood event. Again, this is a feature which could not be reproduced by the hydraulic models that were developed as part of the present investigation (refer **Section 3.3** of this letter for further details).

An assessment undertaken by SWC in 2002 for Clay Cliff Creek (SWC, 2002) identified that the channel has a capacity of about 32.5 $m^3/s$ in the vicinity of the property, which approximates the peak 1% AEP flow at the same location as presented in SKM, 2005 (refer **Table 1**). It is noted that the capacity assessment undertaken as part of SWC, 2002 was based on the Manning's Equation and therefore assumed free flow conditions.

SWC, 2002 also assessed the hydrologic standard of the channel in the vicinity of the property at about 20% AEP based on a peak flow estimate that was derived using the Urban Rational Method (**URM**), procedures for which are set out in the 1987 version of Australian Rainfall & Runoff (IEAust, 1987). SWC estimated the 20% AEP flow in the channel at 33.6 $m^3/s$, which approximates the 1% AEP flow derived by SKM, 2005 at the same location. It is noted that the URM is likely to overestimate the peak flow in a drainage system which comprises temporary flood storage, which is the case in the Clay Cliff Creek catchment (i.e. because it doesn't take account of the attenuating effects temporary flood storage areas will have on the flood wave as it travels down the drainage system).

## 3. Definition of Flooding Behaviour under Pre-Developed Conditions

### 3.1 Background to TUFLOW Model Development

In order to more accurately define flooding behaviour in the vicinity of the property a two-dimensional (in plan) hydraulic model was developed using the TUFLOW software. **Figure 3** shows the layout of the TUFLOW model that was developed as part of the present investigation.

TUFLOW is a true two-dimensional hydraulic model which does not rely on a prior knowledge of the pattern of flood flows in order to set up the various fluvial and weir type linkages which describe the passage of a flood wave through the system. The basic equations of TUFLOW involve all of the terms of the St Venant equations of unsteady flow. Consequently the model is "fully dynamic" and once tuned will provide an accurate representation of the passage of the floodwave through the drainage system (both surface and piped) in terms of depth, velocity and distribution of flow.

**Two-dimensional Model Domain**

An important consideration of two-dimensional modelling is how best to represent the roads, fences, buildings and other features which influence the passage of flow over the natural surface. Two-dimensional modelling is very computationally intensive and it is not practicable to use a mesh of very fine elements without excessive times to complete the simulation, particularly for long duration flood events. The requirement for a reasonable simulation time therefore influences the way in which these features are represented in the model.

A grid spacing of 2 m was found to provide an appropriate balance between the need to define features on the floodplain versus model run times, and was adopted for the investigation. Ground surface elevations for model grid points were initially assigned using a digital terrain model (**DTM**) derived from the available LiDAR survey data.

The footprints of a large number of individual buildings located in the two-dimensional model domain were digitised and the grid points raised to reflect their blocking effects on flow. An alternative approach was adopted for several large buildings where site inspection identified that overland flow could freely access storage/conveyance areas which had been incorporated in their design. The footprint of these buildings were assigned a high hydraulic roughness value relative to the more hydraulically efficient roads and flow paths through allotments. This accounted for their partial blocking effect on flow while maintaining a correct estimate of floodplain storage in the model.

**One-dimensional Model Elements**

Cross sections of the channel were derived from SWC, 2002, while the invert level of the channel was based on the cross section data contained in the MIKE 11 model that was developed as part of SKM, 2005.

The deck levels of the various road bridges were based on the available LiDAR survey data, while the thickness of each bridge deck was based on field measurements, as was the position of the bridge abutments.

Details of the local stormwater drainage system were not incorporated in the TUFLOW model.

**Boundary Conditions**

As per the requirements of the Study Brief, discharge hydrographs used as input to the upstream boundary of the TUFLOW model were taken from the output of the MIKE 11 model that was developed as part of SKM, 2005. Discharge hydrographs were extracted from the MIKE 11 output files for design floods of 5 and 1%, as well as the PMF.

The downstream boundary of the hydraulic model comprises a static water level which represented the elevation to which backwater flooding from the Parramatta River influenced flooding behaviour in the lower reaches of the Clay Cliff Creek drainage system for the 5 and 1% AEP flood events. Note that the results presented in SKM, 2005 for the 45 minute duration Probable Maximum Precipitation (**PMP**) storm were used to derive the coincident tailwater condition for assessing flooding behaviour in the vicinity of the property for the PMF event.

### 3.2 Background to HEC-RAS Model Development

In order to check the results of the TUFLOW model, as well as those of previous studies, a one-dimensional cross sectional based hydraulic model was developed of the channel using the HEC-RAS software.

The cross section data used as input to the model were the same as those used for input to the TUFLOW model. The model extended from the upstream limit of the channel to a location downstream of the Parkes Street bridge.

A peak flow of 34 $m^3/s$ was applied to the upstream boundary, while a tailwater level of RL 5.18 m AHD was applied to the downstream boundary of the model. This combination of peak flow and tailwater level approximates 1% AEP conditions in the vicinity of the property.

### 3.3 Hydraulic Model Results – Ideal Flow Conditions

**Figures 4** and **5** show flooding behaviour in the vicinity of the property as defined by the TUFLOW model for the 5 and 1% AEP events, respectively. Note that these results assume ideal flow conditions, with no blockage of the existing culverts and bridges, or the fences that border the channel in the vicinity of the property (**Section 3.4** of this letter deals with the findings of an analysis that was undertaken to assess the sensitivity of flooding behaviour in the vicinity of the property to a partial blockage of these structures).

While a significant amount of overland flow surcharges the main arm of Clay Cliff Creek upstream of the Main Western Railway and approaches the property via the Parkes Street underpass during events as frequent as 5% AEP, the majority of the approach flow discharges to the channel upstream of the Charles Street bridge for events up to the 1% AEP. For example, the TUFLOW model shows that a peak flow of only 0.3 $m^3/s$ will discharge into the property at the location of the low point in the Parkes Street footpath during a 1% AEP flood event under ideal flow conditions.

The maximum depth of flow discharging to the property over the footpath in Parkes Street is about 50 millimetres, while depths of overland flow in the property are generally less than 100 millimetres in a 1% AEP flood event. It is noted that overland flow would have ponded to a slightly greater depth along the southern side of the now demolished two-storey residential flat building in a 1% AEP flood event. It is also noted that the channel has sufficient capacity to convey the peak flow of 33.5 $m^3/s$ which is shown to be conveyed beneath the Wigram Street bridge without surcharge into the property. This finding is consistent with SWC, 2002 which assessed the hydraulic capacity of the channel at this location as being about 32.5 $m^3/s$.

**Figure 6** shows the design 1% AEP water surface profile along the channel as computed by the HEC-RAS model. The profile shows that the design water surface profile for a peak flow of 34 $m^3/s$ lies below the critical depth profile, indicating that the flow in the channel is supercritical in nature. **Figure 6** also shows that the water surface profile upstream of the tailwater induced hydraulic jump near the Parkes Street bridge generally lies just above the parapet level of the channel. This finding is also generally consistent with the capacity assessment undertaken as part of SWC, 2002.

Another feature of the flow in the channel is its inherently unstable nature. This is characteristic of mildly supercritical flow, where any minor change in the bed slope of the channel or any obstruction to the flow will cause the water surface to rise rapidly toward critical depth, and under certain conditions even higher to its conjugate subcritical flow depth.[1] This effect can be observed in the water surface profile shown on **Figure 6** where minor changes in the bed slope translate into relatively large changes in the depth of flow in the channel. This finding is important as it indicates that under less than ideal flow conditions floodwater could surcharge the channel during a flood event and exacerbate flooding conditions in the property.

**Figure 7** shows that high hazard flooding conditions are generally confined to the inbank area of the channel, with the exception being the overland flow which discharges along Parkes Street, west (upstream) of Charles Street.

Depths of inundation in the vicinity of the property would generally exceed 1 metre during a PMF, with hazardous flooding conditions generally being experienced in properties that border the main arm of Clay Cliff Creek (refer **Figure 8**).

**Table 3** over the page provides a comparison of the peak 5 and 1% AEP flood levels, as well as the PMF levels that are presented in SKM, 2005 with those derived as part of the present investigation. By inspection, peak 5% and 1% AEP flood levels in the vicinity of the property are significantly lower than those presented in SKM, 2005. The main reason for this is attributed to the reduced head loss across the existing bridge structures.

While PMF levels are comparable to those presented in SKM, 2005 upstream of the Wigram Street bridge, they are lower further downstream. The reason for this is that the peak flood levels presented in SKM, 2005 are the upper envelope of PMF events of different duration, whereas only the 45 minute duration storm, which is critical for maximising the peak flow in Clay Cliff Creek, was adopted as part of the present investigation.

### 3.4 Sensitivity Analyses

An analysis was undertaken to assess the sensitivity of flooding behaviour to a partial blockage of the existing culverts and bridges in the vicinity of the property, as well as a partial blockage of the safety fence which runs along the northern side of Parkes Street west of Charles Street. The blockage scenarios that were analysed as part of the present investigation for the 1% AEP flood event were as follows:

- **Blockage Scenario 1** – A 50 per cent reduction in the hydraulic capacity of the existing culvert which runs from Jubilee Park west of the Main Western Railway to the start of the channel (refer **Figure 9** for TUFLOW model results).

[1] Note that should the flow velocity in the channel reduce significantly, then water levels would rise toward the energy grade line, which as shown on **Figure 6**, has an elevation of about RL 8.2 m AHD at the upstream boundary of the property (i.e. this represents the upper limit to which peak 1% AEP flood levels could rise in the channel.

## TABLE 3
## COMPARISON OF PEAK FLOOD LEVELS[1]

| Location | Peak Flood Level (m AHD) | | | | | | Difference (m) | | |
|---|---|---|---|---|---|---|---|---|---|
| | SKM, 2005 | | | Present Investigation | | | | | |
| | 5% AEP | 1% AEP | PMF | 5% AEP | 1% AEP | PMF | 5% AEP | 1% AEP | PMF |
| Channel adjacent to sag in Parkes Street | 8.01 | 8.32 | 9.68 | 7.06 | 7.32 | 9.65 | -0.95 | -1.00 | -0.03 |
| Channel on upstream face of Charles Street bridge[2] | 8.07 [0.45] | 8.38 [0.67] | 9.81 [0.22] | 6.76 [0.40] | 7.10 [0.47] | 9.65 [-0.03] | -1.31 | -1.28 | -0.16 |
| Channel on downstream face of Charles Street bridge | 7.62 | 7.75 | 9.59 | 6.36 | 6.63 | 9.68 | -1.26 | -1.12 | 0.09 |
| Channel on upstream face of Wigram Street bridge[2] | 7.39 [1.26] | 7.59 [1.16] | 9.43 [-0.01] | 6.10 [0.03] | 6.37 [0.04] | 9.61 [0.94] | -1.29 | -1.22 | 0.18 |
| Channel on downstream face of Wigram Street bridge | 6.13 | 6.43 | 9.44 | 6.07 | 6.33 | 8.67 | -0.06 | -0.10 | -0.77 |
| Channel on upstream face of Harris Street bridge[2] | 5.60 [0.39] | 6.19 [0.49] | 9.44 [-0.04] | 4.93 [0.03] | 5.75 [0.31] | 6.99 [0.34] | -0.67 | -0.44 | -2.45 |
| Channel on downstream face of Harris Street bridge | 5.21 | 5.70 | 9.48 | 4.90 | 5.44 | 6.65 | -0.31 | -0.26 | -2.83 |
| Parkes Street at location of sag in the road west of Charles Street | 8.03 | 8.33 | 9.70 | 7.33 | 7.53 | 9.72 | -0.70 | -0.80 | 0.02 |
| Parkes Street at intersection with Charles Street | 8.03 | 8.33 | 9.70 | 7.35 | 7.56 | 9.77 | -0.68 | -0.77 | 0.07 |
| Parkes Street at intersection with Wigram Street | 8.02 | 8.30 | 9.57 | Not Flooded | Not Flooded | Not Flooded | - | - | - |

1. Peak flood levels have been quoted to two decimal places to highlight the differences between the two sets of results. Typically, peak flood levels are quoted to one decimal place to reflect the degree of accuracy which can be achieved in flood modelling.
2. Value in [ ] represents the computed head drop across the existing bridge structure in metres. Note that a negative value represents a rise in peak flood levels in the downstream direction.

- **Blockage Scenario 2** – A top-down blockage of the Charles Street bridge, where it was assumed that debris would build up on its upstream face to the parapet level of the channel (refer **Figure 10** for TUFLOW model results).
- **Blockage Scenario 3** – A top-down blockage of the Wigram Street bridge, where it was assumed that debris would build up on its upstream face to the parapet level of the channel (refer **Figure 11** for TUFLOW model results).
- **Blockage Scenario 4** – A top-down blockage of both the Charles Street and Wigram Street bridges, where it was assumed that debris would build up on their upstream faces to the parapet level of the channel (refer **Figure 12** for TUFLOW model results).
- **Blockage Scenario 5** – A 50 per cent reduction in the width of flow along the line of the safety fence which runs along the northern side of Parkes Street west of Charles Street (refer **Figure 13** for TUFLOW model results).

The sensitivity analysis showed that while a partial blockage of the culverts which extends downstream of Jubilee Park would double the flow in Parke Street, the majority of the surcharge flow is able to discharge to the channel upstream of the Charles Street bridge (refer **Figure 9**). The peak 1% AEP flow entering the property from Parkes Street would increase from 0.3 $m^3/s$ to 2 $m^3/s$. The resulting increase in peak flow would increase depths of overland flow in the property by slightly more than 100 millimetres.

As the channel has sufficient capacity to convey the 1% AEP flow beneath the Charles Street bridge without surcharge, a top-down blockage to the height of the channel parapet would not have a significant impact on flooding behaviour (refer **Figure 10**).

The impact of a partial blockage of the Wigram Street bridge is much greater, with peak 1% AEP flood levels in the property increased by almost 0.5 metre (refer **Figure 11**).[2] The resulting increase in peak 1% AEP flood levels would extend south through the property to the back of the Parkes Street footpath.

While a coincident partial blockage of both the Charles Street and Wigram Street bridges would increase the peak 1% AEP flow entering the property from the direction of Parkes Street from 0.3 $m^3/s$ to 0.9 $m^3/s$, peak 1% AEP flood levels in the property would only be increased by up to 0.3 metre, principally due to the partial blocking effects of debris building up on the Wigram Street bridge (refer **Figure 12**).

A partial blockage of the safety fence which runs along the northern side of Parkes Street west of Charles Street would increase the peak flow entering the property from the adjacent road reserve from 0.3 $m^3/s$ to 1.3 $m^3/s$. The resulting increase in peak flow would increase depths of overland flow in the property by slightly more than 100 mm (refer **Figure 13**).

The aforementioned sensitivity analyses indicate that flooding behaviour in the property would not be significantly impacted by a partial blockage of the existing culverts and bridges. The reasons for this are:

i. there is sufficient side-weir capacity available along the northern footpath of Parkes Street west of Charles Street for floodwater to discharge back into the channel without building to a depth which greatly increases the rate of flow discharging to the property; and

[2] Inspection of the TUFLOW model results shows that there would be a pressurisation of the flow due to the partial blockage, hence the relatively large increase in peak 1% AEP flood levels on the upstream side of the bridge crossing, when compared to those for Blockage Scenario 2.

ii. the hydrologic standard of the channel is about 1% AEP, indicating that any top-down blockage at the two bridges would need to extend below the parapet level before it would cause a significant disruption to the flow.

The reason set out in point i) above also applies for the case where the aforementioned safety fence experiences a partial blockage during a flood event.

## 4. Impact of Future Development on Flooding Behaviour

### 4.1 Ideal Flow Conditions

In order to allow floodwater which enters the property from Parkes Street to discharge unimpeded to the channel it would be necessary to provide an overland flow path along its Charles Street frontage. The development would also need to be set back about 1 metre from the parapet of the channel in order to match the setback which has been adopted at the Charles Street and Wigram Street bridge abutments.

The structure of the TUFLOW model representing present day conditions was adjusted by removing the existing two-storey residential flat building and incorporating a new building footprint which achieved the above objectives.

**Figures 14**, **15** and **16** show flooding behaviour under post-developed conditions, as well as the impact future development within the property could have on flooding behaviour for the 5 and 1% AEP events, as well as the PMF event, respectively, while **Table 4** sets out the peak flood levels at the corners of the assessed developable area under ideal flow conditions.

Provided future development within the property is confined to the assessed developable area at street level, then it would not have an impact on flooding behaviour for storm events with intensities up to 1% AEP. While the obstruction caused by the building would divert floodwater north along Wigram Street in a PMF event, increases in peak flood levels would generally be less than 50 millimetres.

**TABLE 4**
**PEAK FLOOD LEVELS(1)**
**POST-DEVELOPED CONDITIONS**
**(m AHD)**

| Peak Flood Level Identifier(2) | Ideal Flow Conditions | | | Partially Blocked Conditions (1% AEP Only)(3) | | | | |
|---|---|---|---|---|---|---|---|---|
| | 5% AEP | 1% AEP | PMF | BS1 | BS2 | BS3 | BS4 | BS5 |
| A | 7.35 | 7.56 | 9.89 | 7.67 | 7.56 | 7.56 | 7.63 | 7.63 |
| B | 6.29 | 6.56 | 9.67 | 6.55 | 6.56 | 7.22 | 7.05 | 6.56 |
| C | 6.11 | 6.37 | 9.62 | 6.38 | 6.37 | 7.09 | 6.98 | 6.38 |
| D | 7.35 | 7.57 | 9.33 | 7.67 | 7.56 | 7.56 | 7.63 | 7.64 |

1. Peak flood levels have been quoted to two decimal places to show the minor differences between the various blockage scenarios. Typically, peak flood levels are quoted to one decimal place to reflect the degree of accuracy which can be achieved in flood modelling.
2. Refer **Figures 14** to **21** for location of Peak Flood Level Identifiers
3. BS1 = Blockage Scenario 1 BS2 = Blockage Scenario 2 BS3 = Blockage Scenario 3
   BS4 = Blockage Scenario 4 BS5 = Blockage Scenario 5

## 4.2 Partial Blockage Conditions

**Figures 17**, **18**, **19**, **20** and **21** show the impact future development in the property would have on flooding behaviour under Blockage Scenarios 1, 2, 3, 4 and 5, respectively for a 1% AEP flood event, while **Table 4** sets out the peak 1% AEP flood levels at the corners of the assessed developable area for the five assessed blockage scenarios.

The analyses show that peak 1% AEP flood levels in adjacent development would generally not be increased by more than 20 millimetres for the various blockage scenarios, with the exception of Blockage Scenario 1, where they would be increased by a maximum of 25 millimetres immediately upstream of the Charles Street bridge.

## 5. Concluding Remarks

While the peak flood levels generated by the TUFLOW model that was developed as part of the present investigation are significantly lower than those presented in SKM, 2005 for storms up to 1% AEP in intensity (refer **Table 3** for comparison), it is believed that the MIKE 11 model that was developed as part of the earlier study overestimated the head losses at the existing bridge structures. This conclusion is supported by the findings of SWC, 2002 which assessed the hydraulic capacity of the channel as 32.5 $m^3/s$, which approximates the 1% AEP flow presented in SKM, 2005. It is also supported by the results of the HEC-RAS modelling which was undertaken as part of the present investigation.

Based on the findings of the present investigation, it will be necessary to provide an overland flow path along the Charles Street frontage of the property extending between Parkes Street and the channel. The overland flow path will need to be configured to cater for the impact a partial blockage of major hydraulic structures and the adjacent safety fence would have on the rate of flow discharging through the property for storms up to 1% AEP in intensity.

It is understood that Council has set the Flood Planning Level (**FPL**) for the property at RL 8.25 m AHD, which is 0.65 metres above the peak 1% AEP flood level in Parkes Street as defined by the present investigation (RL 8.25 m AHD – RL 7.6 m AHD = 0.65 metres)

The adoption of an FPL equal to RL 8.25 m AHD would provide a minimum freeboard of 1.65 metres to peak 1% AEP flood levels in the channel under ideal flow conditions and approximates the elevation of the energy grade line at the upstream boundary of the property (refer Footnote 1 of this letter for further explanation of the importance of this finding). The adoption of an FPL equal to RL 8.25 m AHD would also provide adequate freeboard to peak 1% AEP flood levels under the various post-developed blockage scenarios which were assessed as part of the present investigation.

Note that the basis for setting the FPL for the property would need to be reviewed should the owner adopt an enlarged footprint for the proposed development, as this may result in higher peak flood levels in Parkes Street upon which a revised FPL would need to be based (i.e. assuming Council would allow an increase in peak flood levels in Parkes Street attributable to the proposed development).

## 6. References

IEAust (Institution of Engineers, Australia), 1987. *"Australian Rainfall & Runoff"*

SKM (Sinclair Knight Merz), 2005. "*Lower Parramatta River Floodplain Risk Management Study"*

SWC (Sydney Water Corporation), 2001. *"Clay Cliff Creek SWC 27 Capacity Assessment"*

We trust that the findings of the flooding investigation will assist Council in its assessment of the development application process. However, please do not hesitate to contact the undersigned should you wish to discuss any aspect of the investigation findings.

Yours faithfully
**Lyall & Associates Consulting Water Engineers**

**Scott Button**
**Principal**


N

80 0 80 160 240 m

Scale: 1:8,000

Lyall & Associates

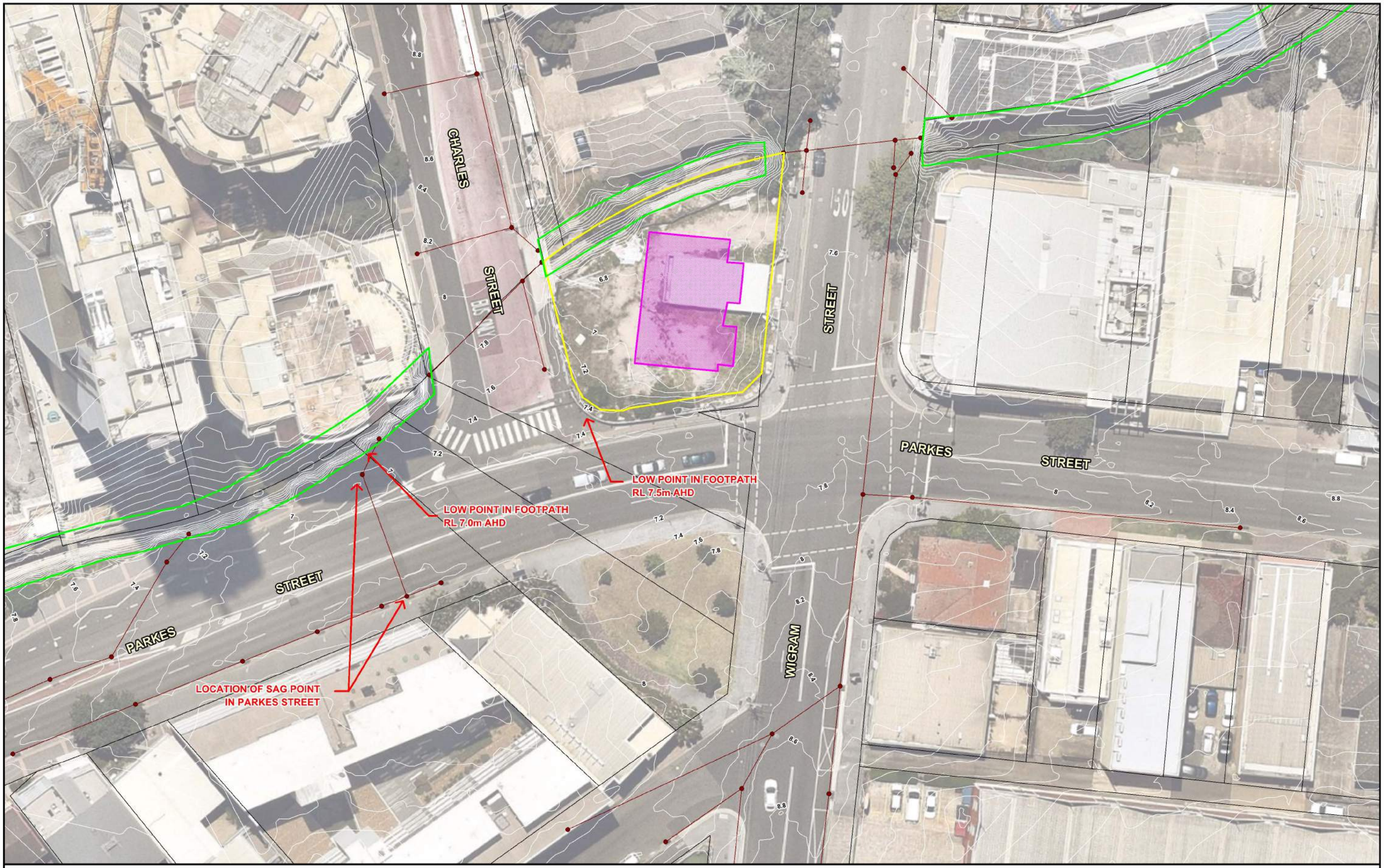
**LEGEND**

- Concrete Lined Section of Channel
- Bridge/Culvert Structure
- Catchment Upstream of Property
- Property Boundary

**12A PARKES STREET, HARRIS PARK**
**FLOODING INVESTIGATION**

Figure 1

LOCATION AND CATCHMENT PLAN




N

5 0 5 10 15 m

Scale: 1:500

Lyall & Associates

**LEGEND**

- Existing Stormwater Network
- Property Boundary
- Concrete Lined Channel
- Footprint of Recently Demolished Building

**12A PARKES STREET, HARRIS PARK**
**FLOODING INVESTIGATION**

Figure 2

KEY FEATURES IN THE VICINITY OF THE PROPERTY


N

40 0 40 80 120 m

Scale: 1:4,000

**LEGEND**

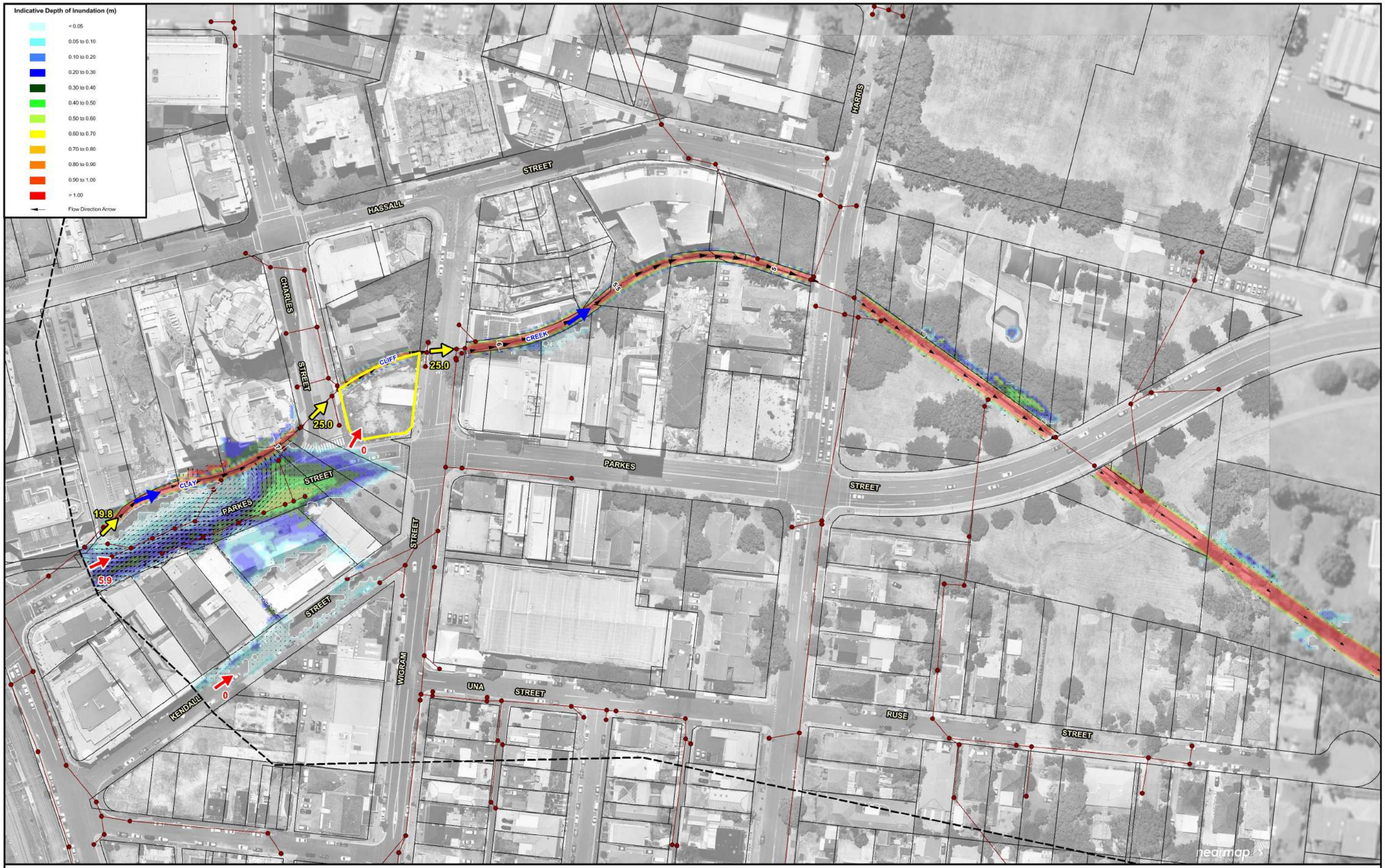
- Property Boundary
- Two-Dimensional Model Boundary
- Existing Stormwater Network (Not Modelled)

Lyall & Associates

**12A PARKES STREET, HARRIS PARK**
**FLOODING INVESTIGATION**

Figure 3

TUFLOW MODEL LAYOUT




N

15 0 15 30 45 m

Scale: 1:1,500

Lyall & Associates

NOTE:

The ground surface model incorporated in TUFLOW is based on LiDAR survey which has been sampled on a 2 m grid and does not necessarily incorporate localised features which can influence flooding behaviour in individual allotments.

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.

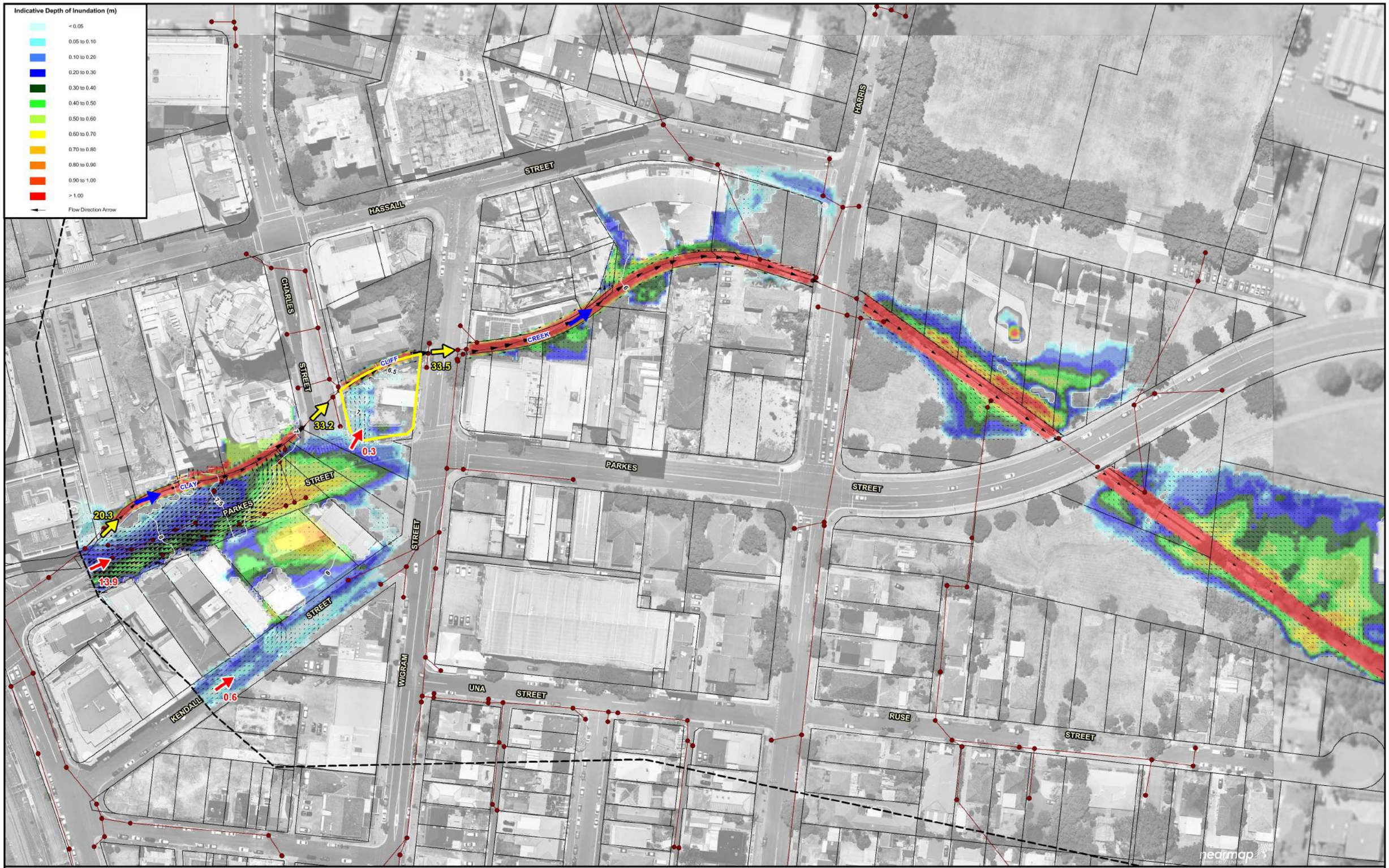
LEGEND

- Property Boundary
- Two-Dimensional Model Boundary
- Existing Stormwater Network (Not Modelled)
- Water Surface Elevation Contour (m AHD)
- 19.8 Peak Flow in Channel ($m^3/s$)
- 5.9 Peak Flow in Road Reserve ($m^3/s$)

**12A PARKES STREET, HARRIS PARK**
**FLOODING INVESTIGATION**

Figure 4

FLOODING PATTERNS IN VICINITY OF THE PROPERTY
PRE-DEVELOPED CONDITIONS - 5% AEP




N

15 0 15 30 45 m

Scale: 1:1,500

Lyall & Associates

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.

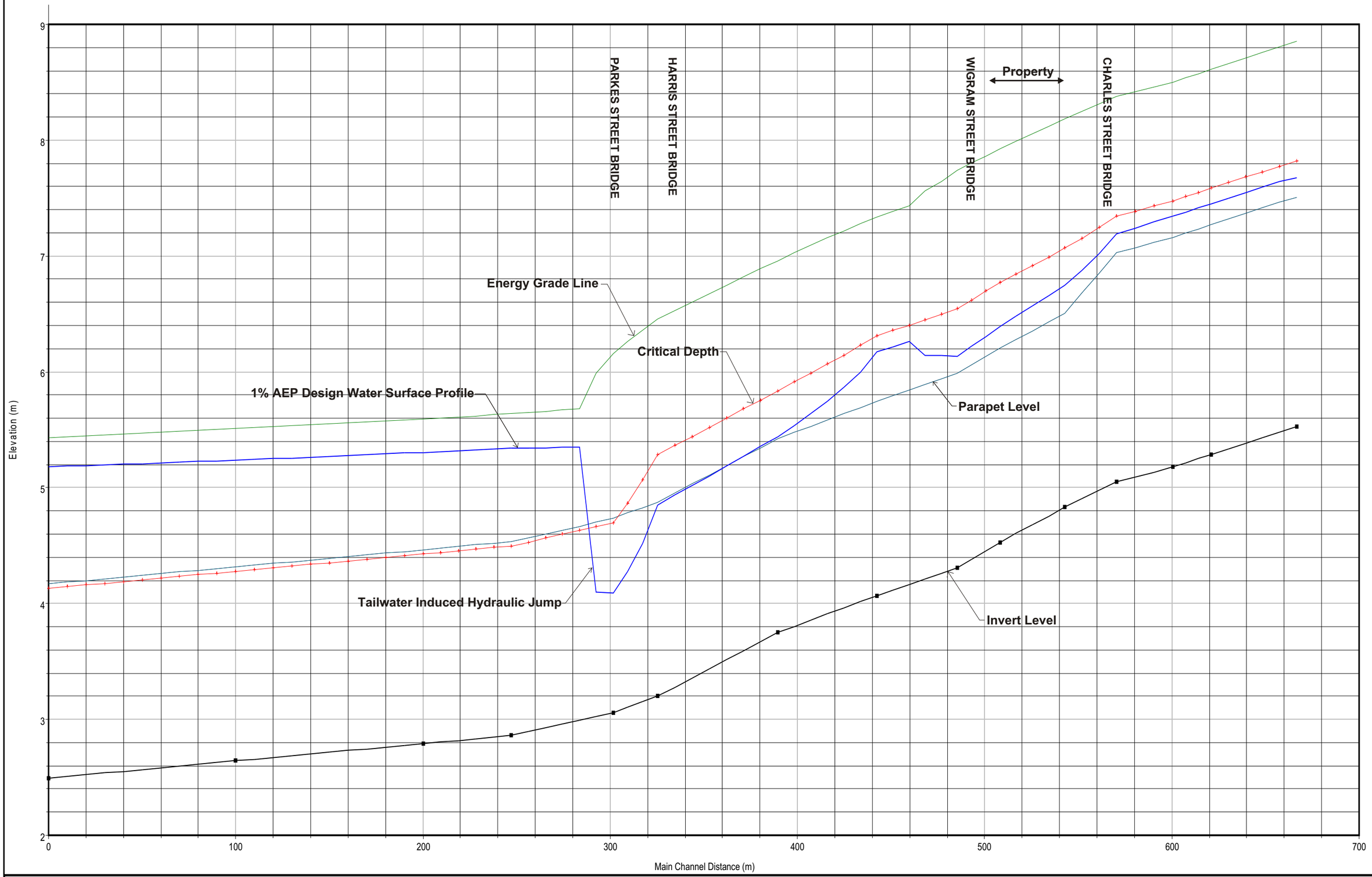
LEGEND

- Property Boundary
- Two-Dimensional Model Boundary
- Existing Stormwater Network (Not Modelled)
- Water Surface Elevation Contour (m AHD)
- 20.3 Peak Flow in Channel ($m^3/s$)
- 13.9 Peak Flow in Road Reserve ($m^3/s$)

**12A PARKES STREET, HARRIS PARK**
**FLOODING INVESTIGATION**

Figure 5

FLOODING PATTERNS IN VICINITY OF THE PROPERTY
PRE-DEVELOPED CONDITIONS - 1% AEP




**12A PARKES STREET, HARRIS PARK**
**FLOODING INVESTIGATION**

Figure 6

HEC-RAS DERIVED DESIGN WATER SURFACE PROFILE
1% AEP

Lyall & Associates


N

15 0 15 30 45 m

Scale: 1:1,500

Lyall & Associates

NOTE:

The ground surface model incorporated in TUFLOW is based on LiDAR survey which has been sampled on a 2 m grid and does not necessarily incorporate localised features which can influence flooding behaviour in individual allotments.

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.

LEGEND

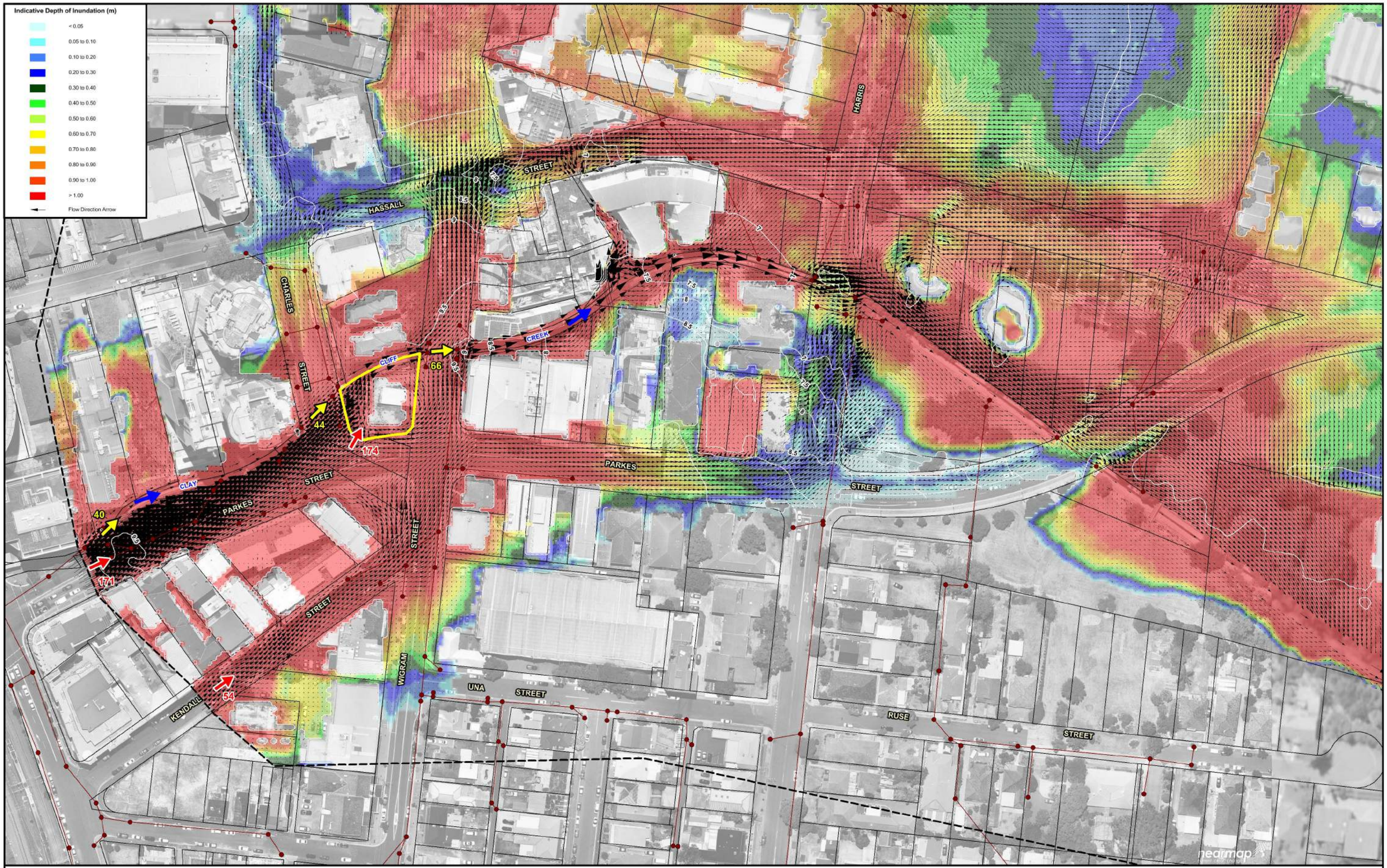
- Property Boundary
- Two-Dimensional Model Boundary
- Existing Stormwater Network (Not Modelled)
- High Provisional Hydraulic Hazard
- Low Provisional Hydraulic Hazard

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

**12A PARKES STREET, HARRIS PARK**
**FLOODING INVESTIGATION**

Figure 7

PROVISIONAL FLOOD HAZARD IN VICINITY OF THE PROPERTY
PRE-DEVELOPED CONDITIONS - 1% AEP

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15 0 15 30 45 m

Scale: 1:1,500

Lyall & Associates

NOTE:

The ground surface model incorporated in TUFLOW is based on LiDAR survey which has been sampled on a 2 m grid and does not necessarily incorporate localised features which can influence flooding behaviour in individual allotments.

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.

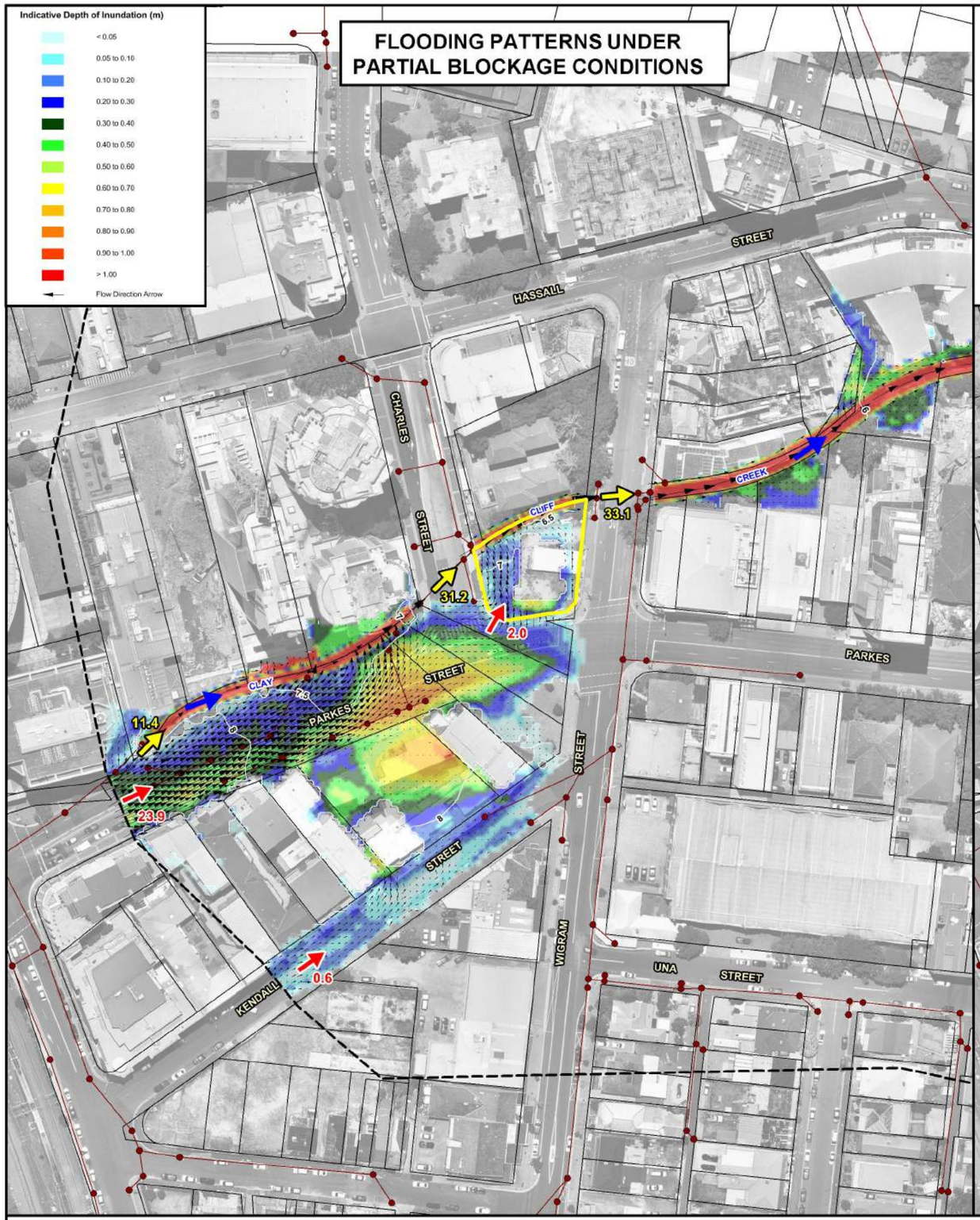
LEGEND

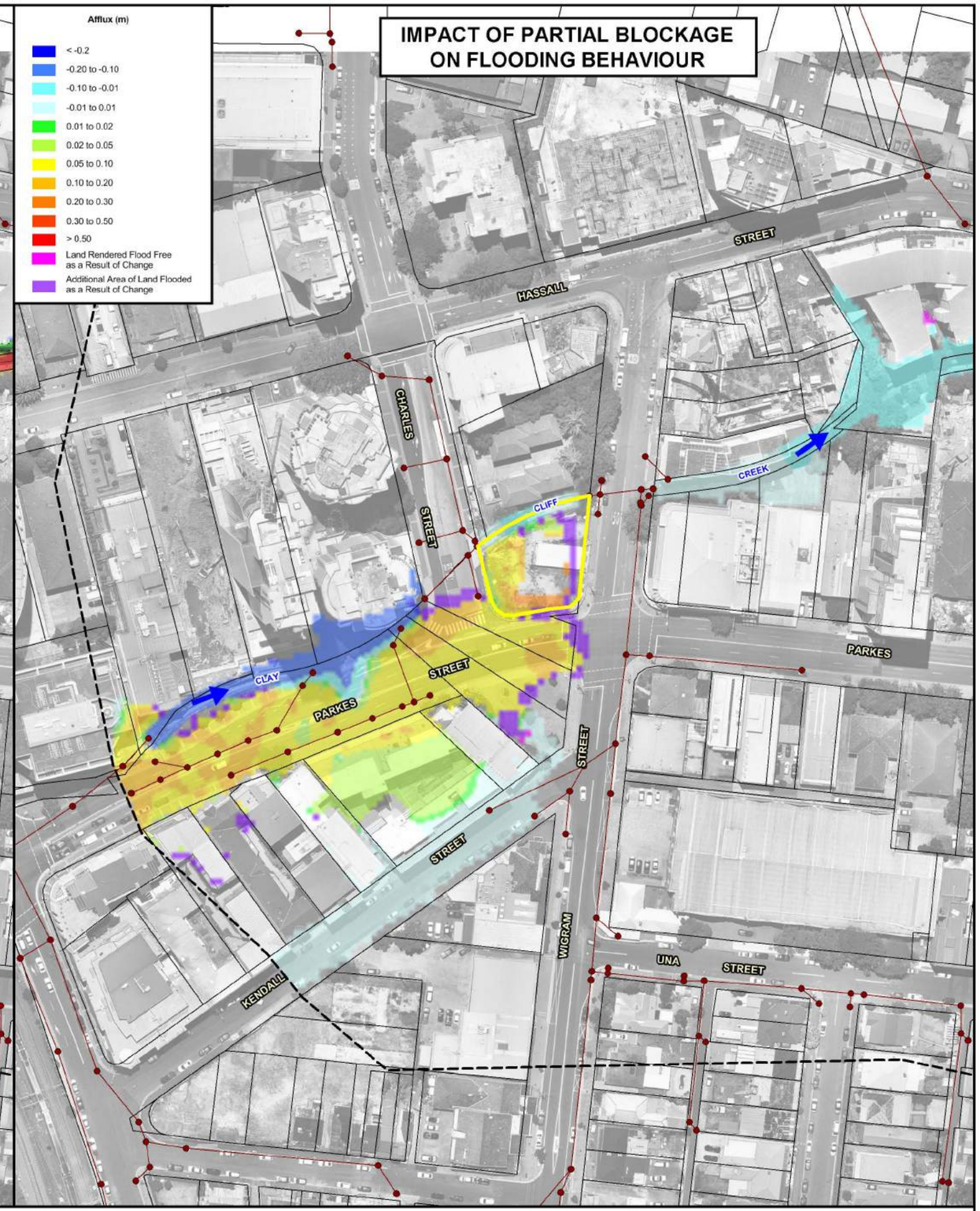
- Property Boundary
- Two-Dimensional Model Boundary
- Existing Stormwater Network (Not Modelled)
- 0.5 Water Surface Elevation Contour (m AHD)
- 40 Peak Flow in Channel ($m^3/s$)
- 171 Peak Flow in Road Reserve ($m^3/s$)

**12A PARKES STREET, HARRIS PARK**
**FLOODING INVESTIGATION**

Figure 8

FLOODING PATTERNS IN VICINITY OF THE PROPERTY
PRE-DEVELOPED CONDITIONS - PMF




N

15 0 15 30 45 m

Scale: 1:1,500

Lyall & Associates

NOTE:

The ground surface model incorporated in TUFLOW is based on LiDAR survey which has been sampled on a 2 m grid and does not necessarily incorporate localised features which can influence flooding behaviour in individual allotments.

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.

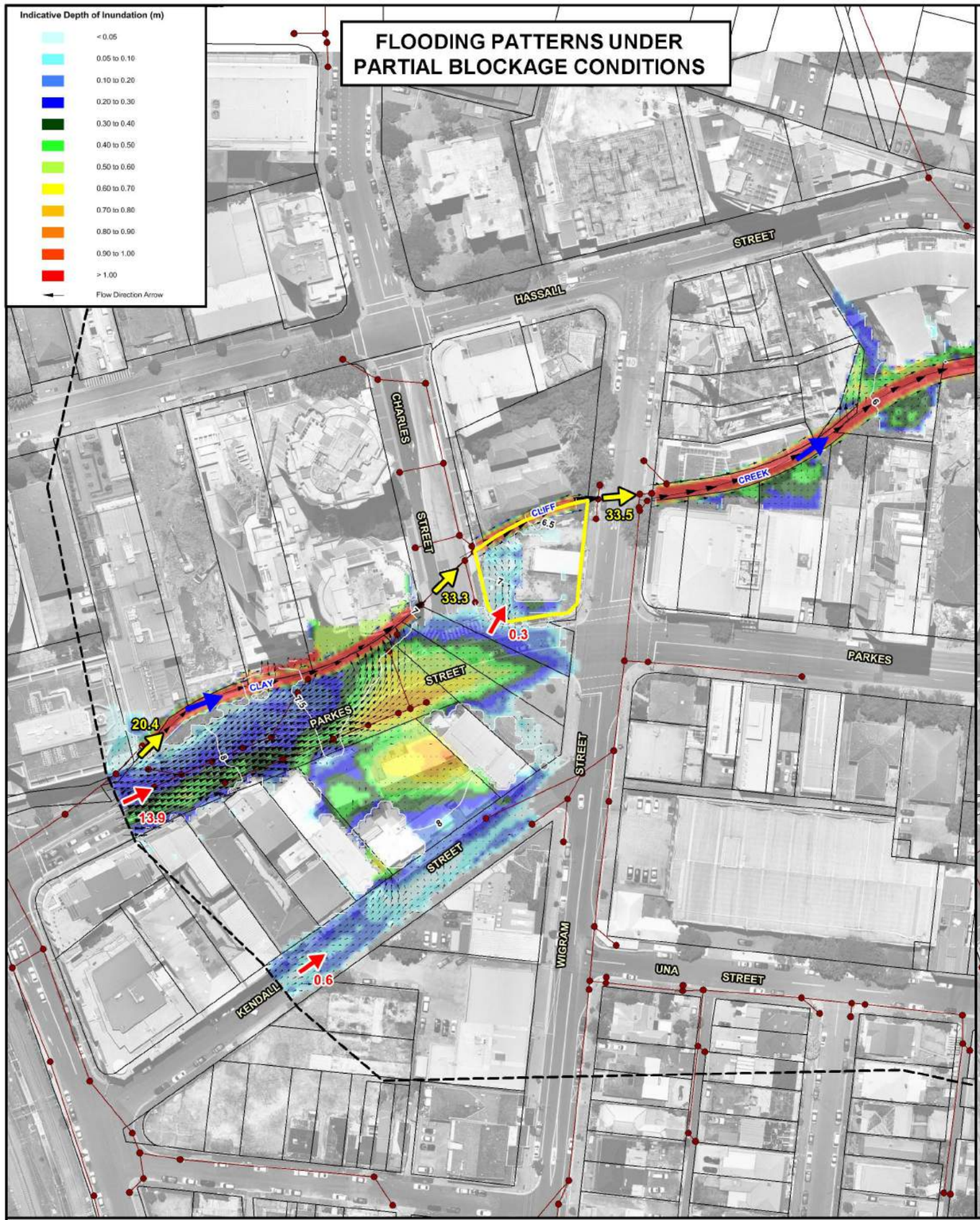
LEGEND

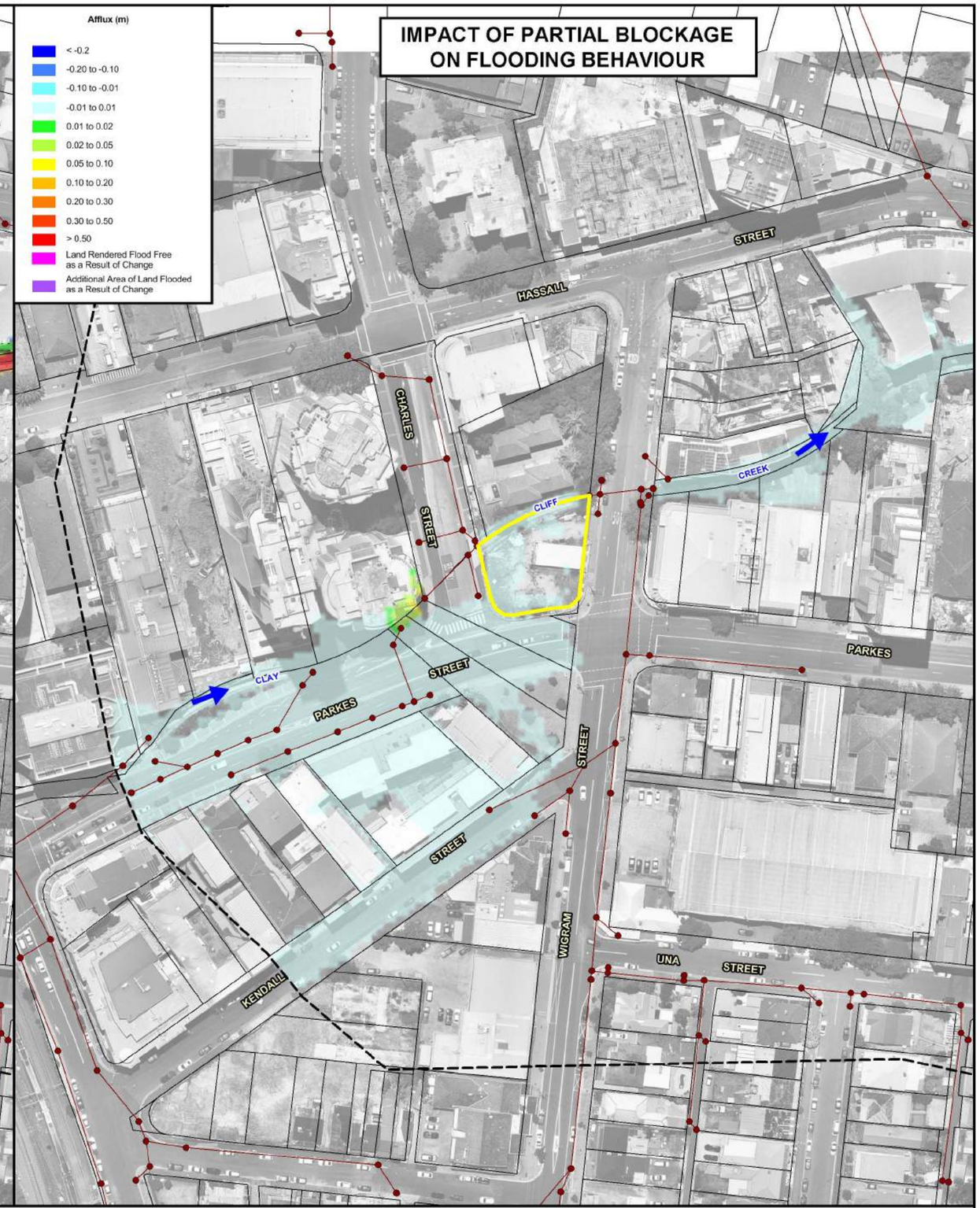
- Property Boundary
- Two-Dimensional Model Boundary
- Existing Stormwater Network (Not Modelled)
- Water Surface Elevation Contour (m AHD)
- 11.4 Peak Flow in Channel ($m^3/s$)
- 23.9 Peak Flow in Road Reserve ($m^3/s$)

**12A PARKES STREET, HARRIS PARK**
**FLOODING INVESTIGATION**

Figure 9

IMPACT OF BLOCKAGE SCENARIO 1 ON FLOODING BEHAVIOUR
PRE-DEVELOPED CONDITIONS - 1% AEP




N

15 0 15 30 45 m

Scale: 1:1,500

Lyall & Associates

NOTE:

The ground surface model incorporated in TUFLOW is based on LiDAR survey which has been sampled on a 2 m grid and does not necessarily incorporate localised features which can influence flooding behaviour in individual allotments.

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.

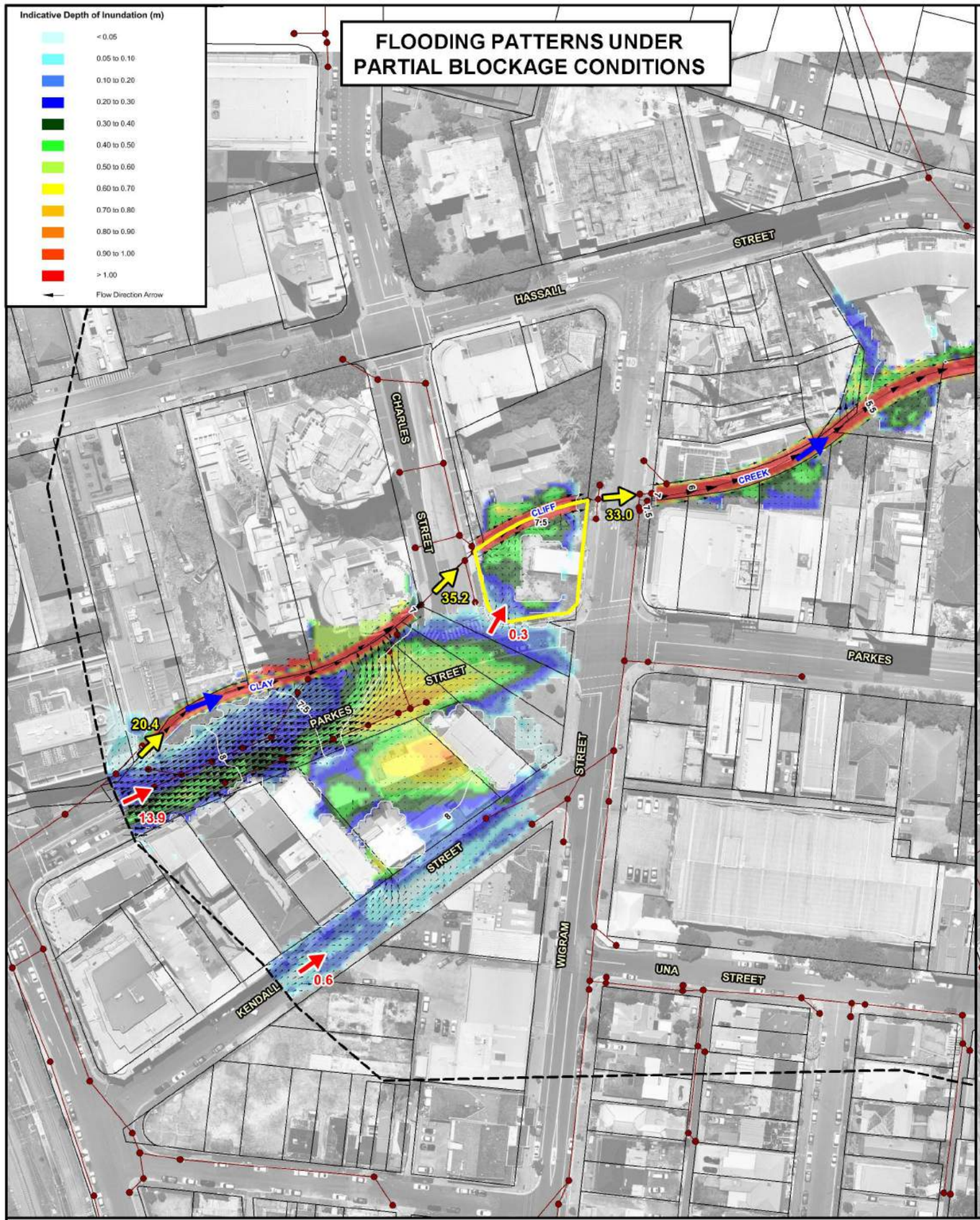
LEGEND

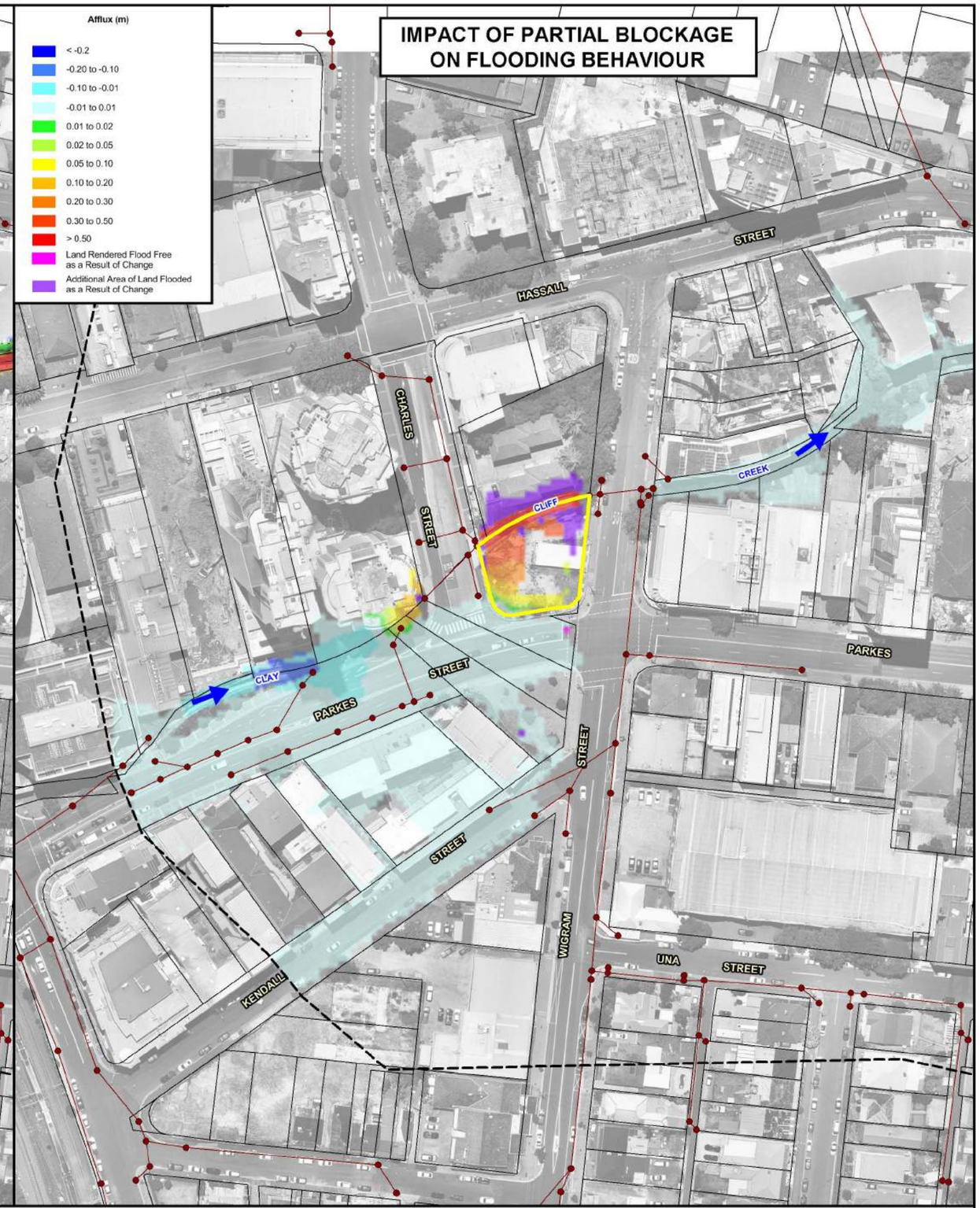
- Property Boundary
- Two-Dimensional Model Boundary
- Existing Stormwater Network (Not Modelled)
- Water Surface Elevation Contour (m AHD)
- 20.4 Peak Flow in Channel ($m^3/s$)
- 13.9 Peak Flow in Road Reserve ($m^3/s$)

**12A PARKES STREET, HARRIS PARK**
**FLOODING INVESTIGATION**

Figure 10

IMPACT OF BLOCKAGE SCENARIO 2 ON FLOODING BEHAVIOUR
PRE-DEVELOPED CONDITIONS - 1% AEP




N

15 0 15 30 45 m

Scale: 1:1,500

Lyall & Associates

NOTE:

The ground surface model incorporated in TUFLOW is based on LiDAR survey which has been sampled on a 2 m grid and does not necessarily incorporate localised features which can influence flooding behaviour in individual allotments.

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.

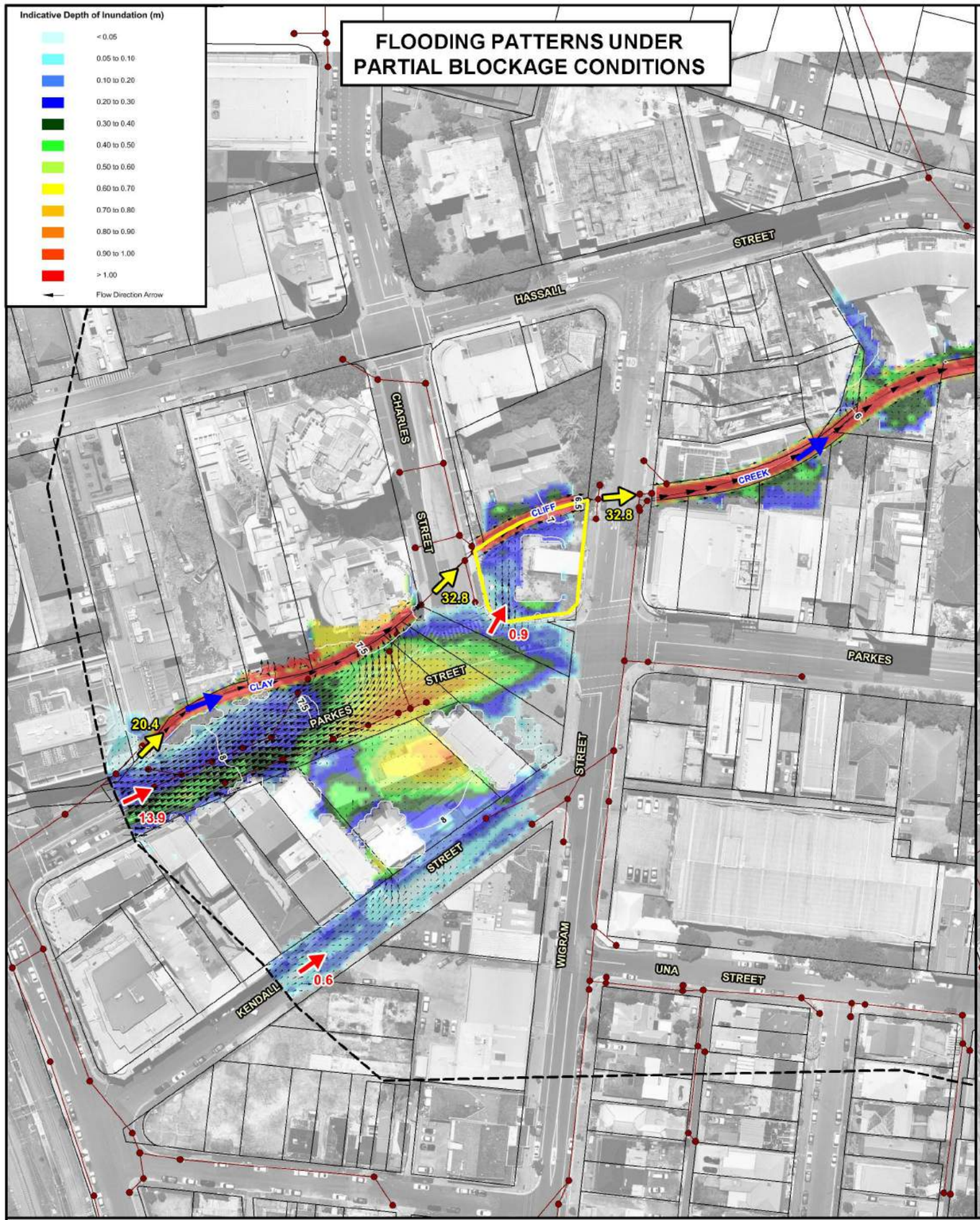
LEGEND

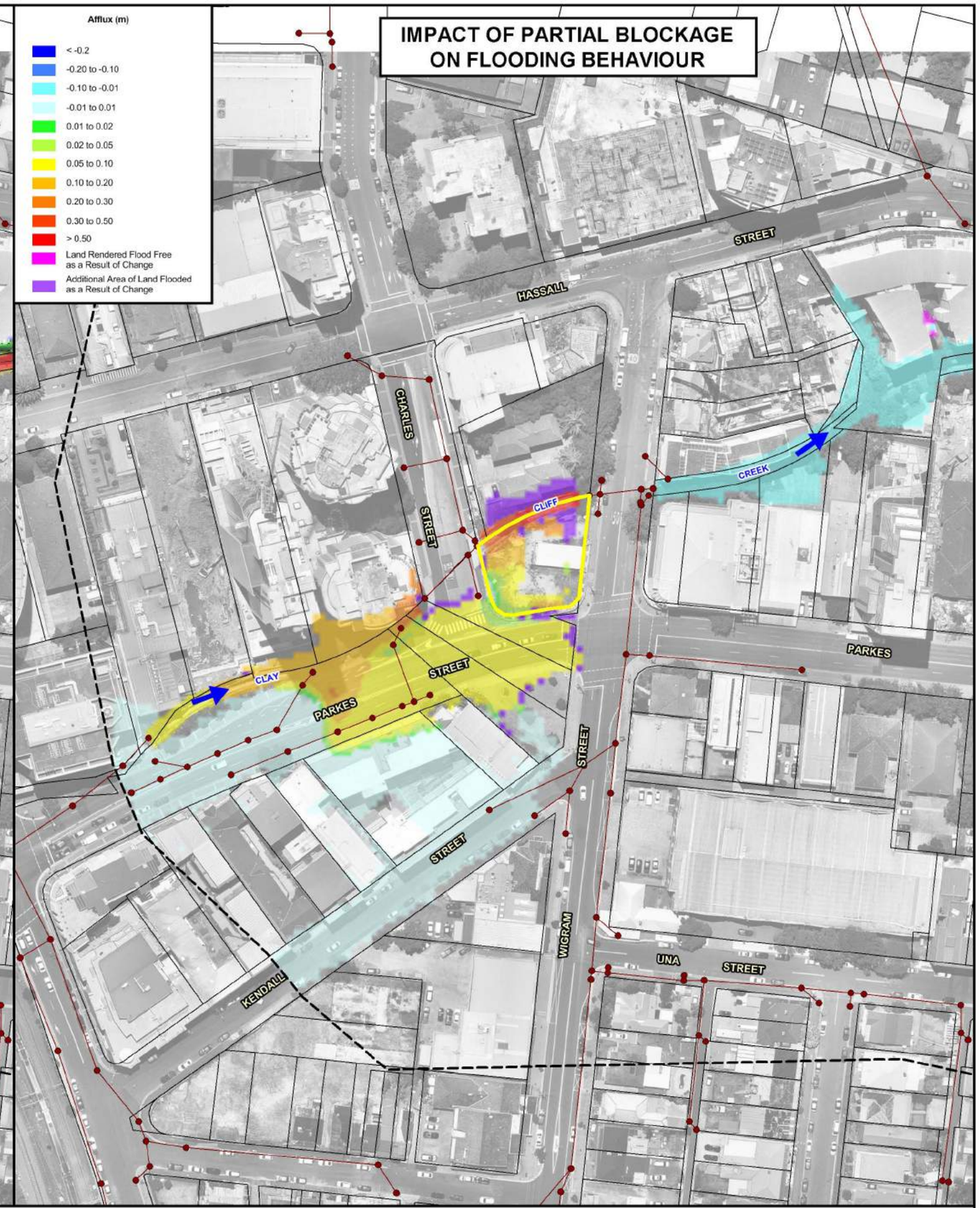
- Property Boundary
- Two-Dimensional Model Boundary
- Existing Stormwater Network (Not Modelled)
- Water Surface Elevation Contour (m AHD)
- 20.4 Peak Flow in Channel ($m^3/s$)
- 13.9 Peak Flow in Road Reserve ($m^3/s$)

**12A PARKES STREET, HARRIS PARK**
**FLOODING INVESTIGATION**

Figure 11

IMPACT OF BLOCKAGE SCENARIO 3 ON FLOODING BEHAVIOUR
PRE-DEVELOPED CONDITIONS - 1% AEP




N

15 0 15 30 45 m

Scale: 1:1,500

Lyall & Associates

NOTE:

The ground surface model incorporated in TUFLOW is based on LiDAR survey which has been sampled on a 2 m grid and does not necessarily incorporate localised features which can influence flooding behaviour in individual allotments.

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.

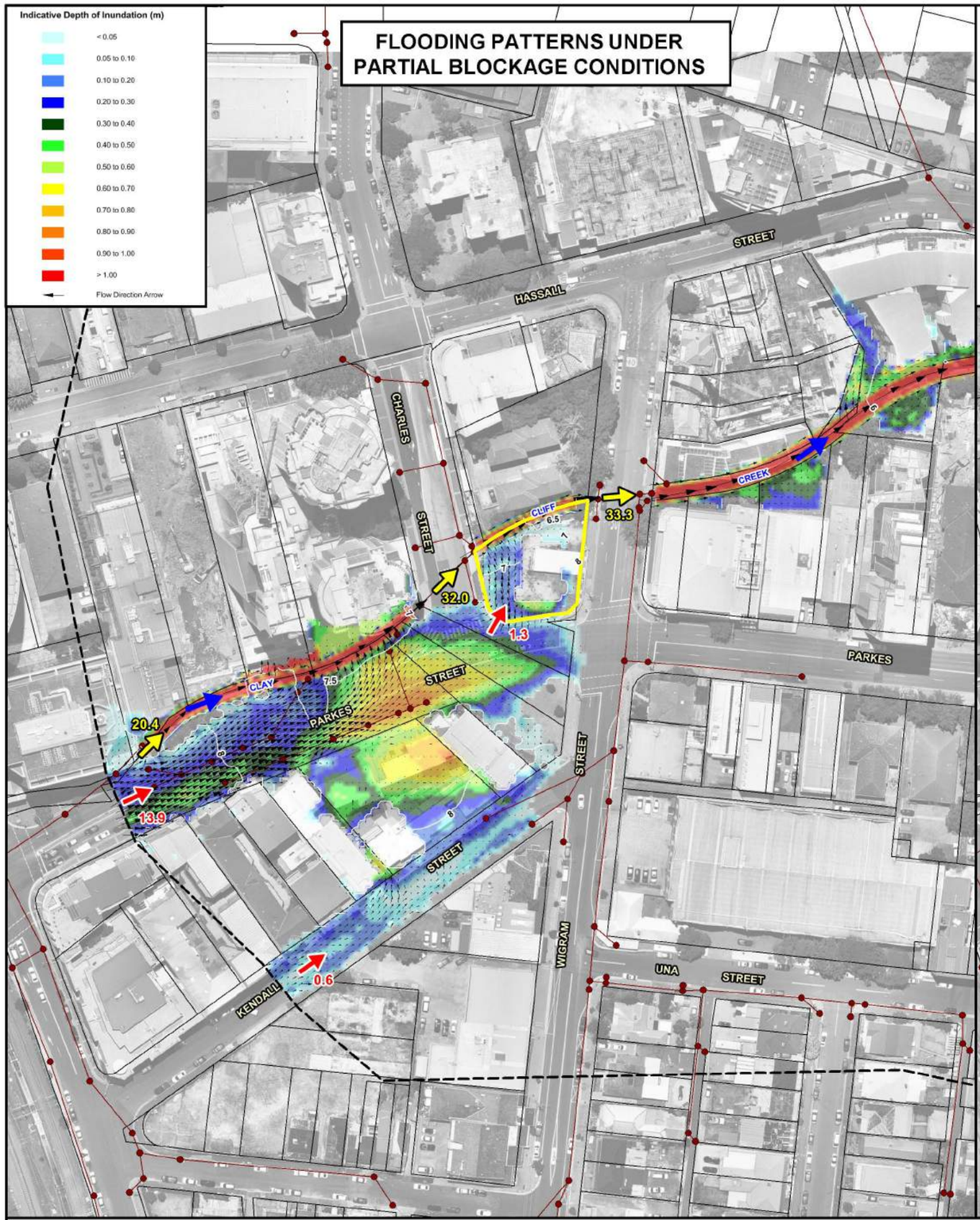
LEGEND

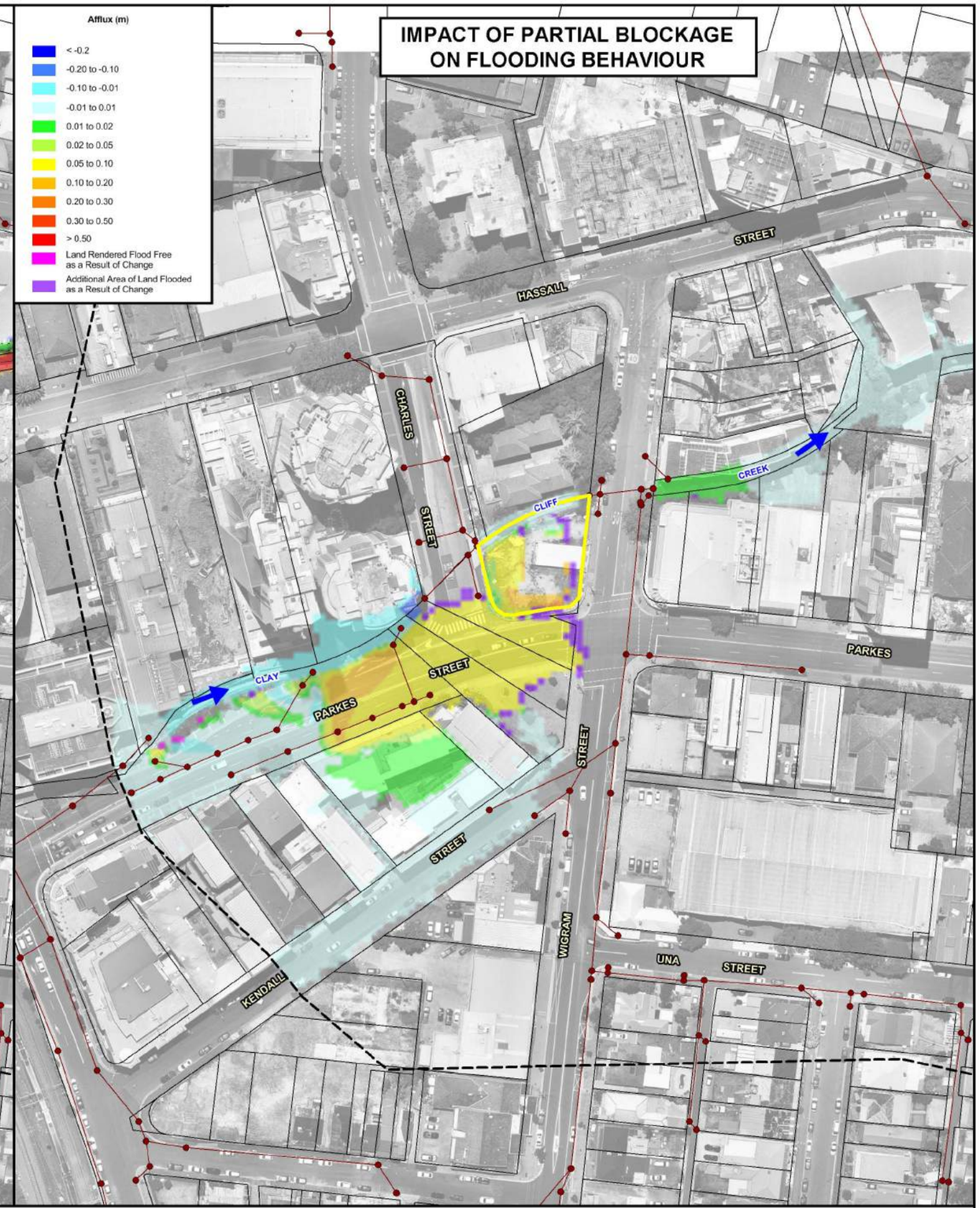
- Property Boundary
- Two-Dimensional Model Boundary
- Existing Stormwater Network (Not Modelled)
- Water Surface Elevation Contour (m AHD)
- 20.4 Peak Flow in Channel ($m^3/s$)
- 13.9 Peak Flow in Road Reserve ($m^3/s$)

**12A PARKES STREET, HARRIS PARK**
**FLOODING INVESTIGATION**

Figure 12

IMPACT OF BLOCKAGE SCENARIO 4 ON FLOODING BEHAVIOUR
PRE-DEVELOPED CONDITIONS - 1% AEP




N

15 0 15 30 45 m

Scale: 1:1,500

Lyall & Associates

NOTE:

The ground suRF50ace model incorporated in TUFLOW is based on LiDAR survey which has been sampled on a 2 m grid and does not necessarily incorporate localised features which can influence flooding behaviour in individual allotments.

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.

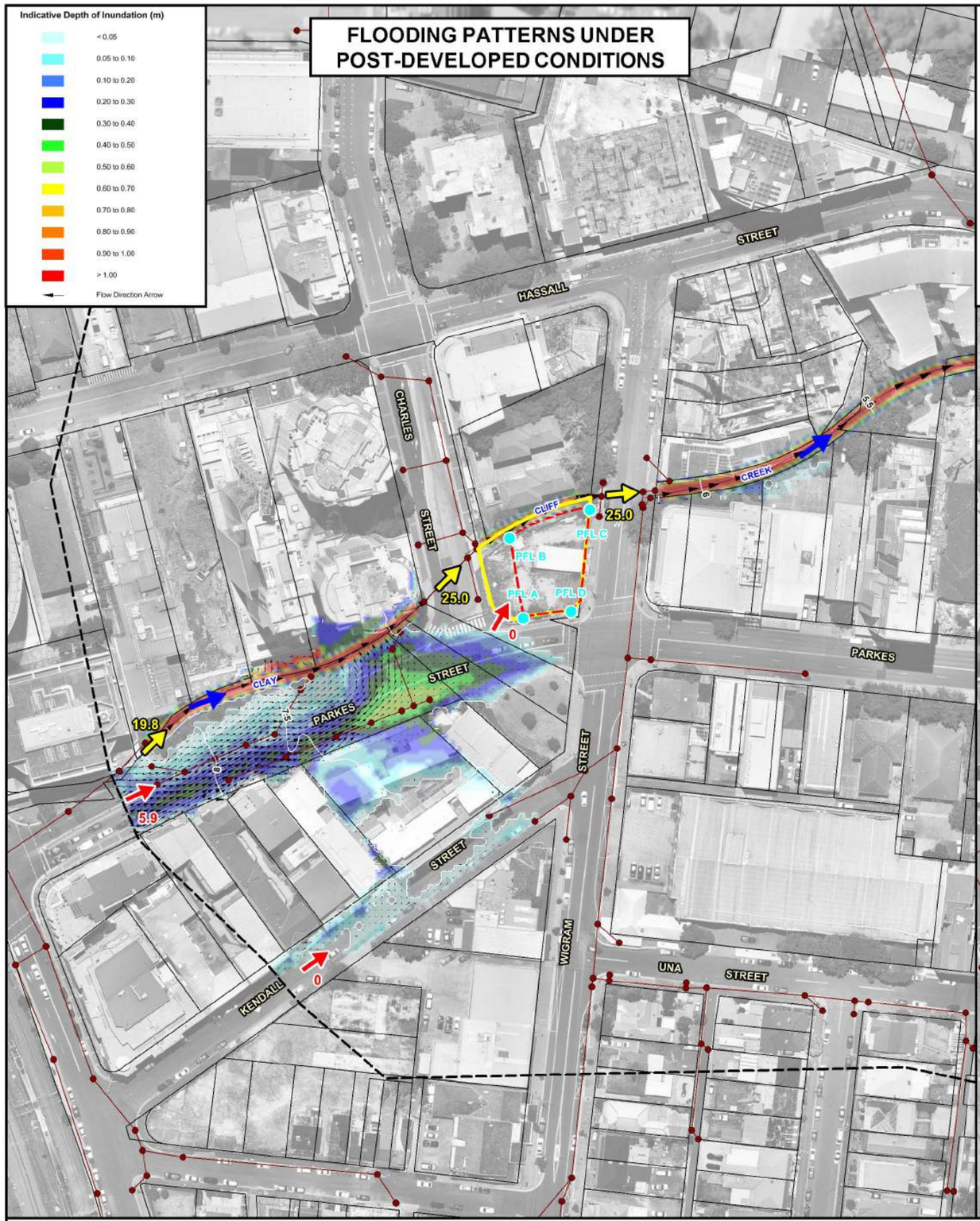
LEGEND

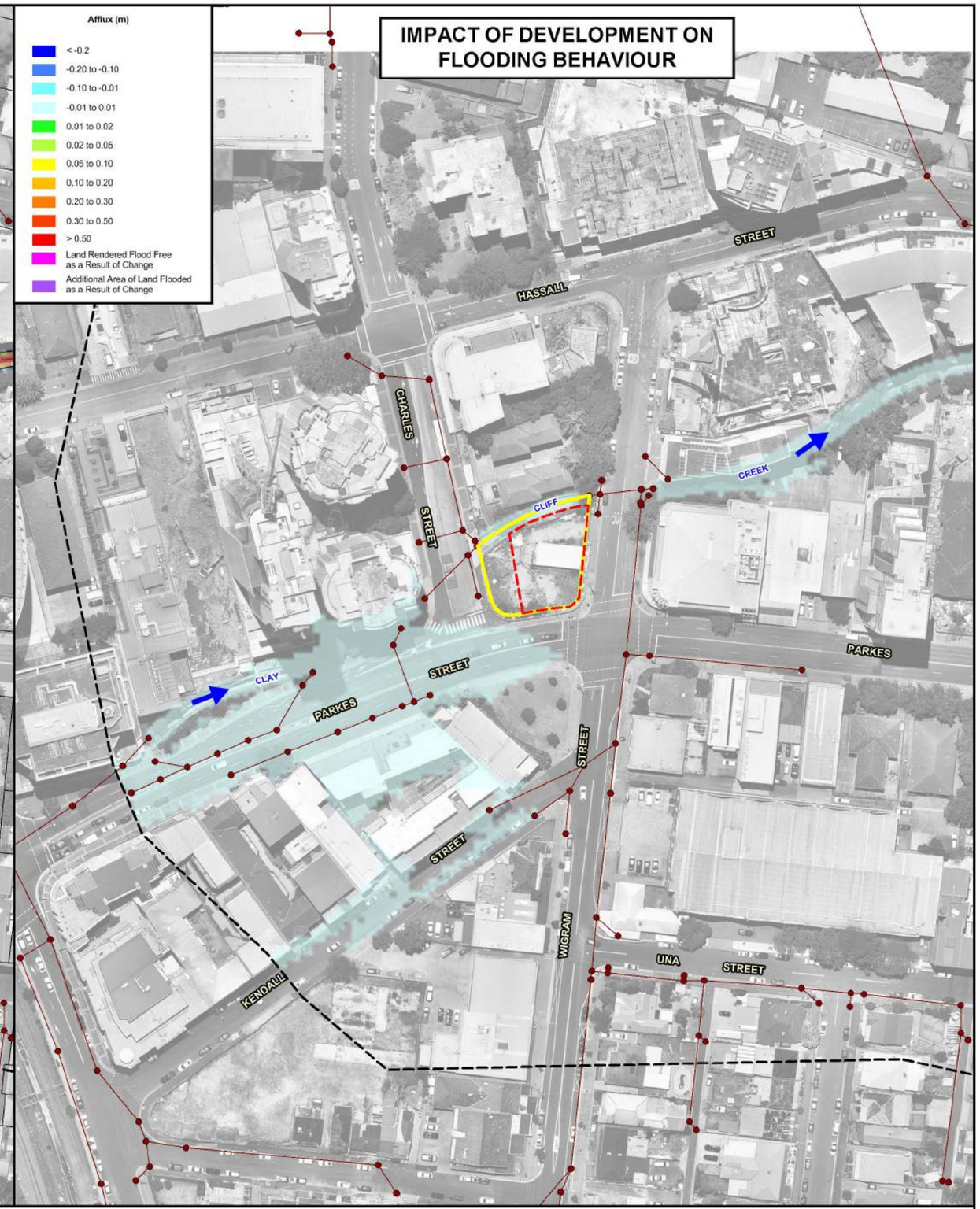
- Property Boundary
- Two-Dimensional Model Boundary
- Existing Stormwater Network (Not Modelled)
- Water Surface Elevation Contour (m AHD)
- 20.4 Peak Flow in Channel ($m^3/s$)
- 13.9 Peak Flow in Road Reserve ($m^3/s$)

**12A PARKES STREET, HARRIS PARK**
**FLOODING INVESTIGATION**

Figure 13

IMPACT OF BLOCKAGE SCENARIO 5 ON FLOODING BEHAVIOUR
PRE-DEVELOPED CONDITIONS - 1% AEP




N

15 0 15 30 45 m

Scale: 1:1,500

Lyall & Associates

NOTE:

The ground surface model incorporated in TUFLOW is based on LiDAR survey which has been sampled on a 2 m grid and does not necessarily incorporate localised features which can influence flooding behaviour in individual allotments.

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.

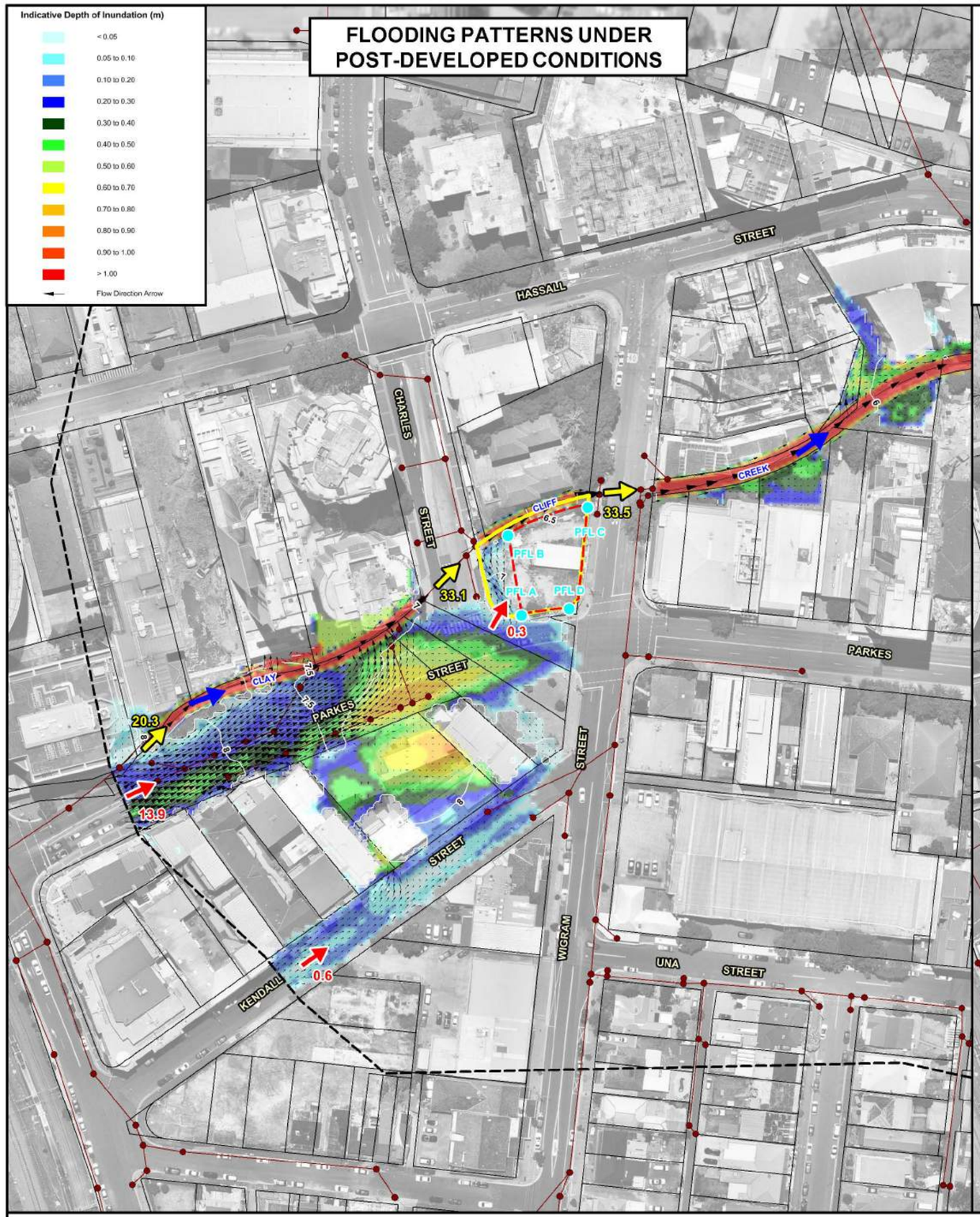
LEGEND

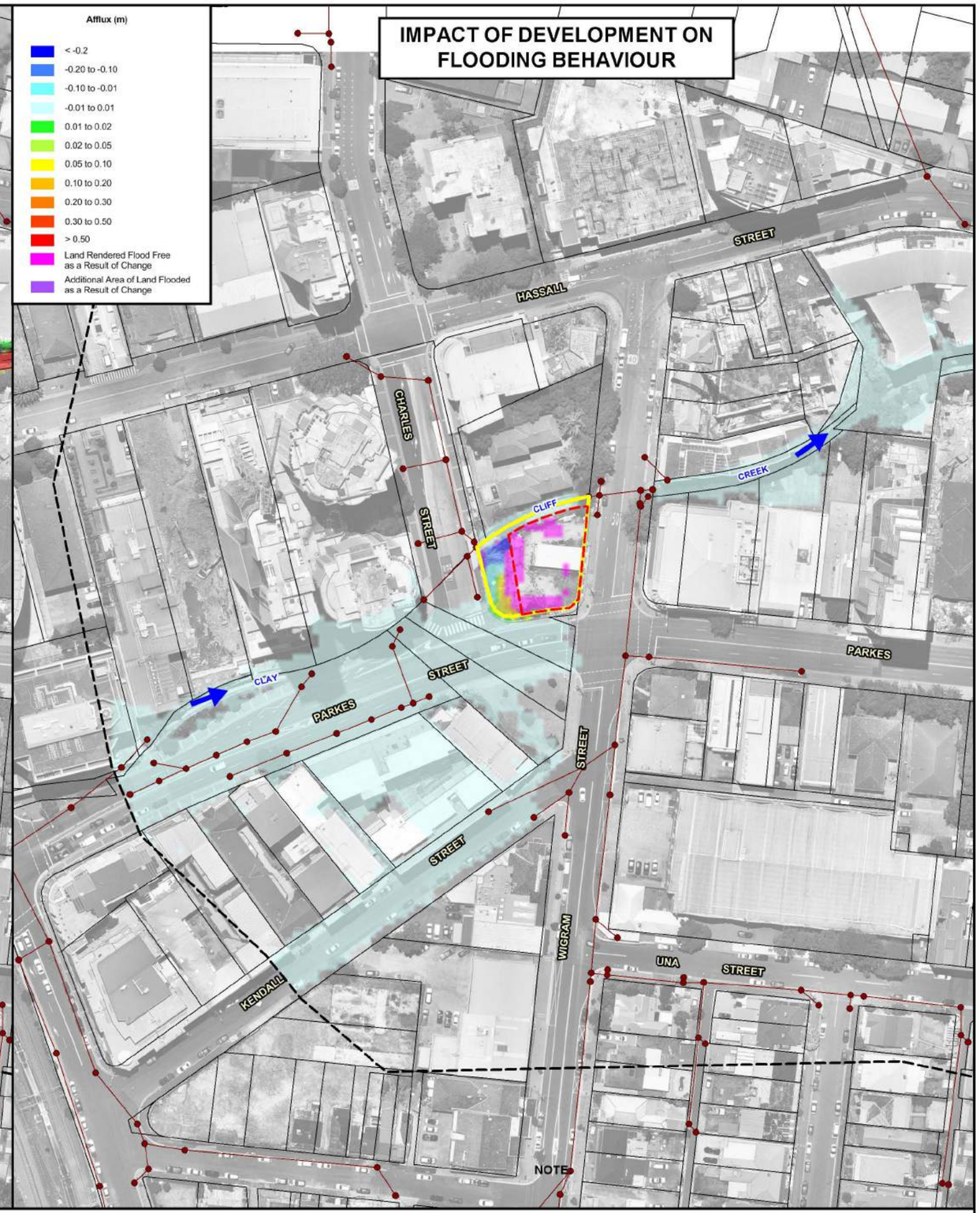
- Property Boundary
- Two-Dimensional Model Boundary
- Existing Stormwater Network (Not Modelled)
- PFL A — Peak Flood Level Identifier (Refer table in report for peak flood levels (m AHD))
- Water Surface Elevation Contour (m AHD)
- 19.8 — Peak Flow in Channel ($m^3/s$)
- 5.9 — Peak Flow in Road Reserve ($m^3/s$)
- Assessed Developable Area

**12A PARKES STREET, HARRIS PARK**
**FLOODING INVESTIGATION**

Figure 14

POTENTIAL IMPACT OF FUTURE DEVELOPMENT ON FLOODING BEHAVIOUR - 5% AEP




N

15 0 15 30 45 m

Scale: 1:1,500

Lyall & Associates

NOTE:

The ground surface model incorporated in TUFLOW is based on LiDAR survey which has been sampled on a 2 m grid and does not necessarily incorporate localised features which can influence flooding behaviour in individual allotments.

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.

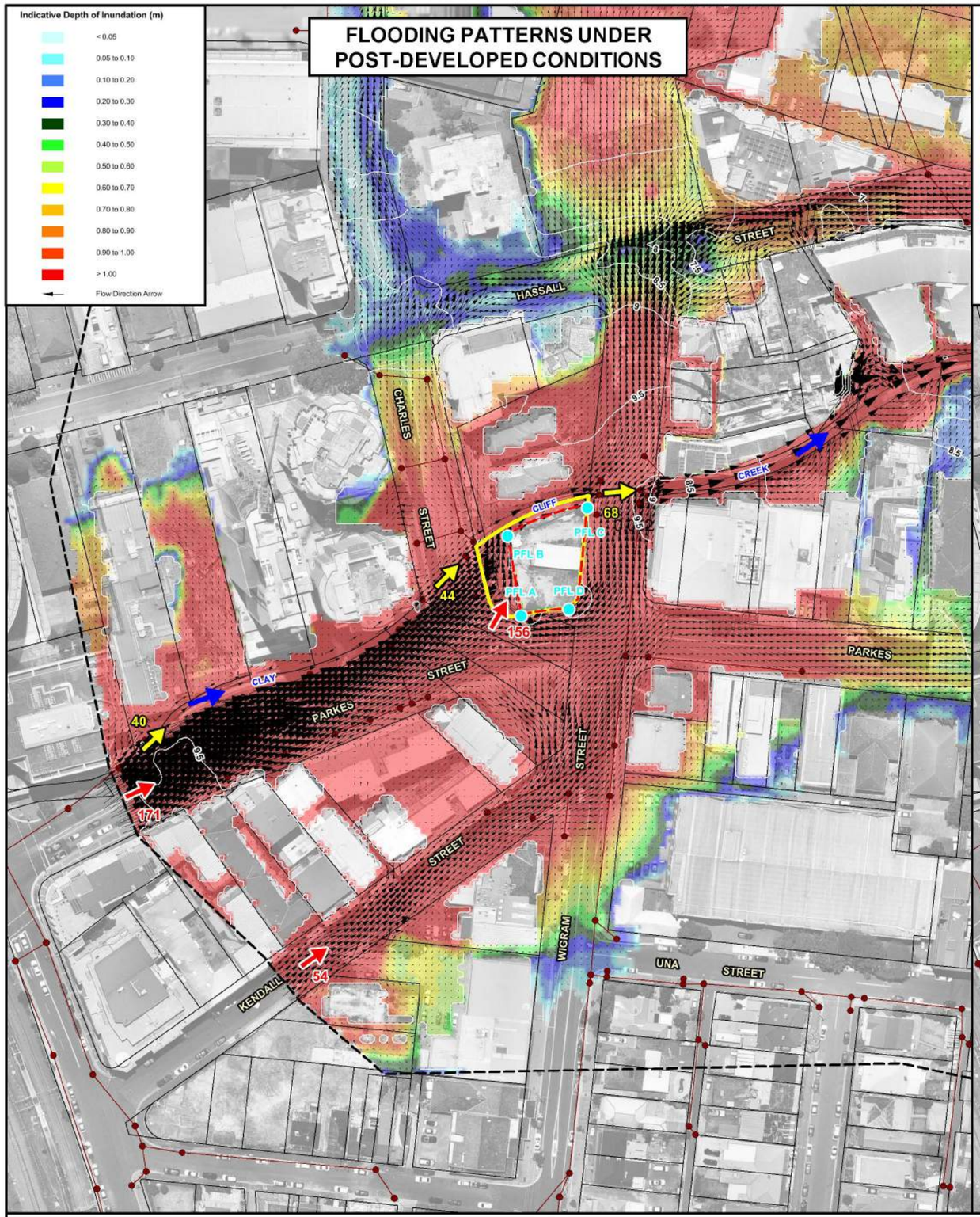
LEGEND

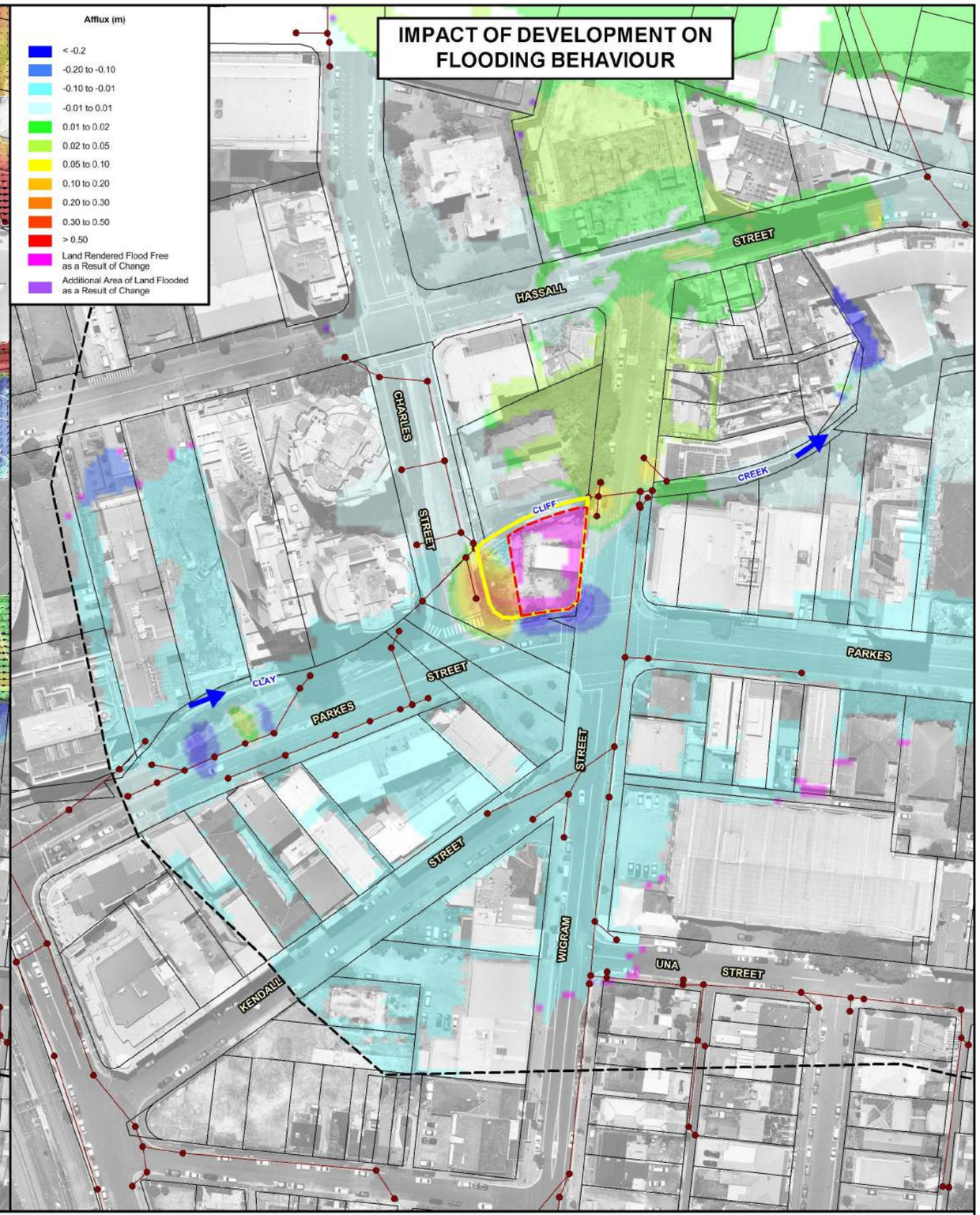
- Property Boundary
- Two-Dimensional Model Boundary
- Existing Stormwater Network (Not Modelled)
- PFL A — Peak Flood Level Identifier (Refer table in report for peak flood levels (m AHD))
- Water Surface Elevation Contour (m AHD)
- 20.3 — Peak Flow in Channel ($m^3/s$)
- 13.9 — Peak Flow in Road Reserve ($m^3/s$)
- Assessed Developable Area

**12A PARKES STREET, HARRIS PARK**
**FLOODING INVESTIGATION**

Figure 15

POTENTIAL IMPACT OF FUTURE DEVELOPMENT ON FLOODING BEHAVIOUR - 1% AEP




N

15 0 15 30 45 m

Scale: 1:1,500

Lyall & Associates

NOTE:

The ground surface model incorporated in TUFLOW is based on LiDAR survey which has been sampled on a 2 m grid and does not necessarily incorporate localised features which can influence flooding behaviour in individual allotments.

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.

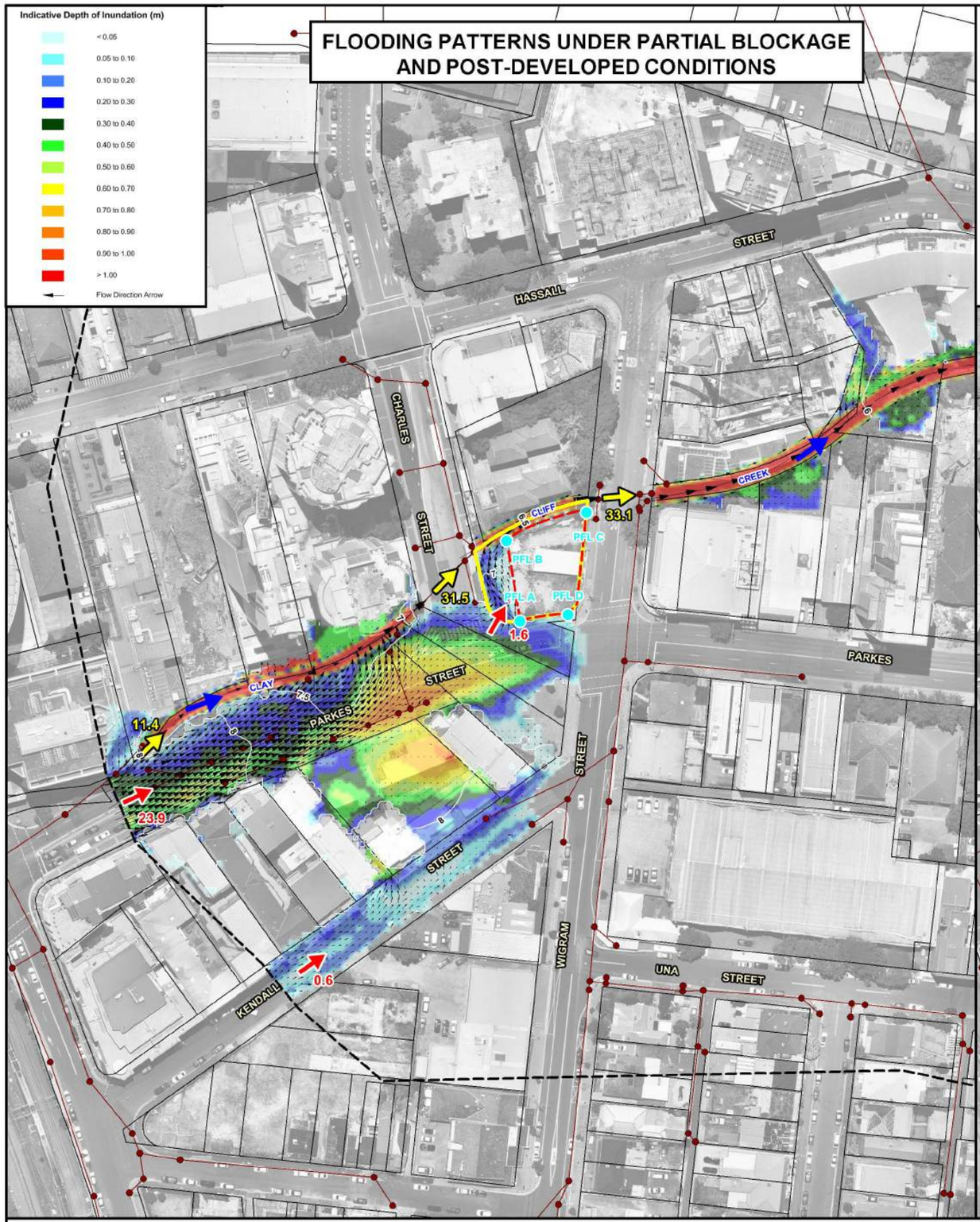
LEGEND

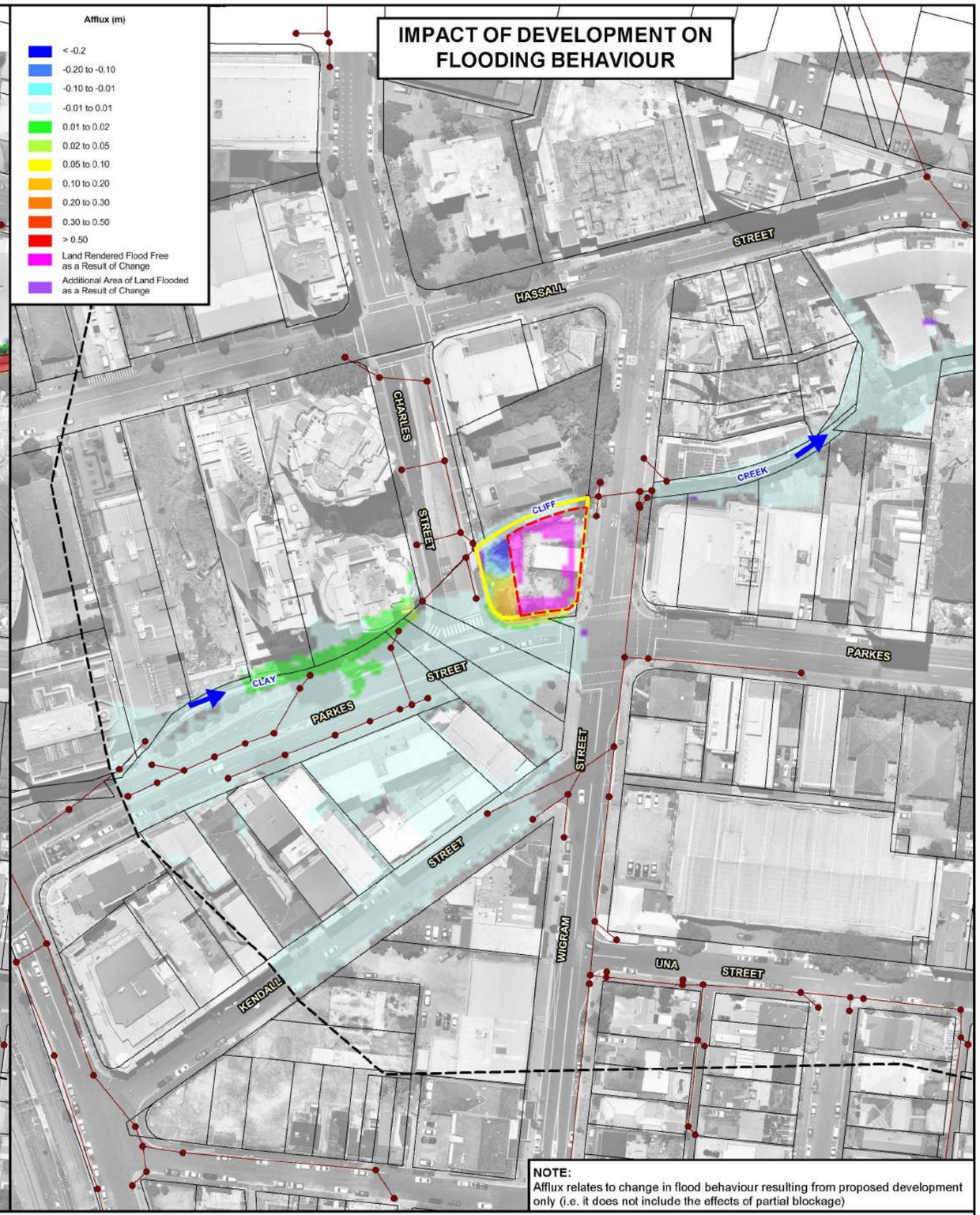
- Property Boundary
- Two-Dimensional Model Boundary
- Existing Stormwater Network (Not Modelled)
- PFL A — Peak Flood Level Identifier (Refer table in report for peak flood levels (m AHD))
- 8.5 — Water Surface Elevation Contour (m AHD)
- 40 — Peak Flow in Channel ($m^3/s$)
- 54 — Peak Flow in Road Reserve ($m^3/s$)
- Assessed Developable Area

**12A PARKES STREET, HARRIS PARK**
**FLOODING INVESTIGATION**

Figure 16

POTENTIAL IMPACT OF FUTURE DEVELOPMENT ON FLOODING BEHAVIOUR - PMF




**NOTE:**
Afflux relates to change in flood behaviour resulting from proposed development only (i.e. it does not include the effects of partial blockage)

N

15 0 15 30 45 m

Scale: 1:1,500

Lyall & Associates

**NOTE:**
The ground surface model incorporated in TUFLOW is based on LiDAR survey which has been sampled on a 2 m grid and does not necessarily incorporate localised features which can influence flooding behaviour in individual allotments.

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.

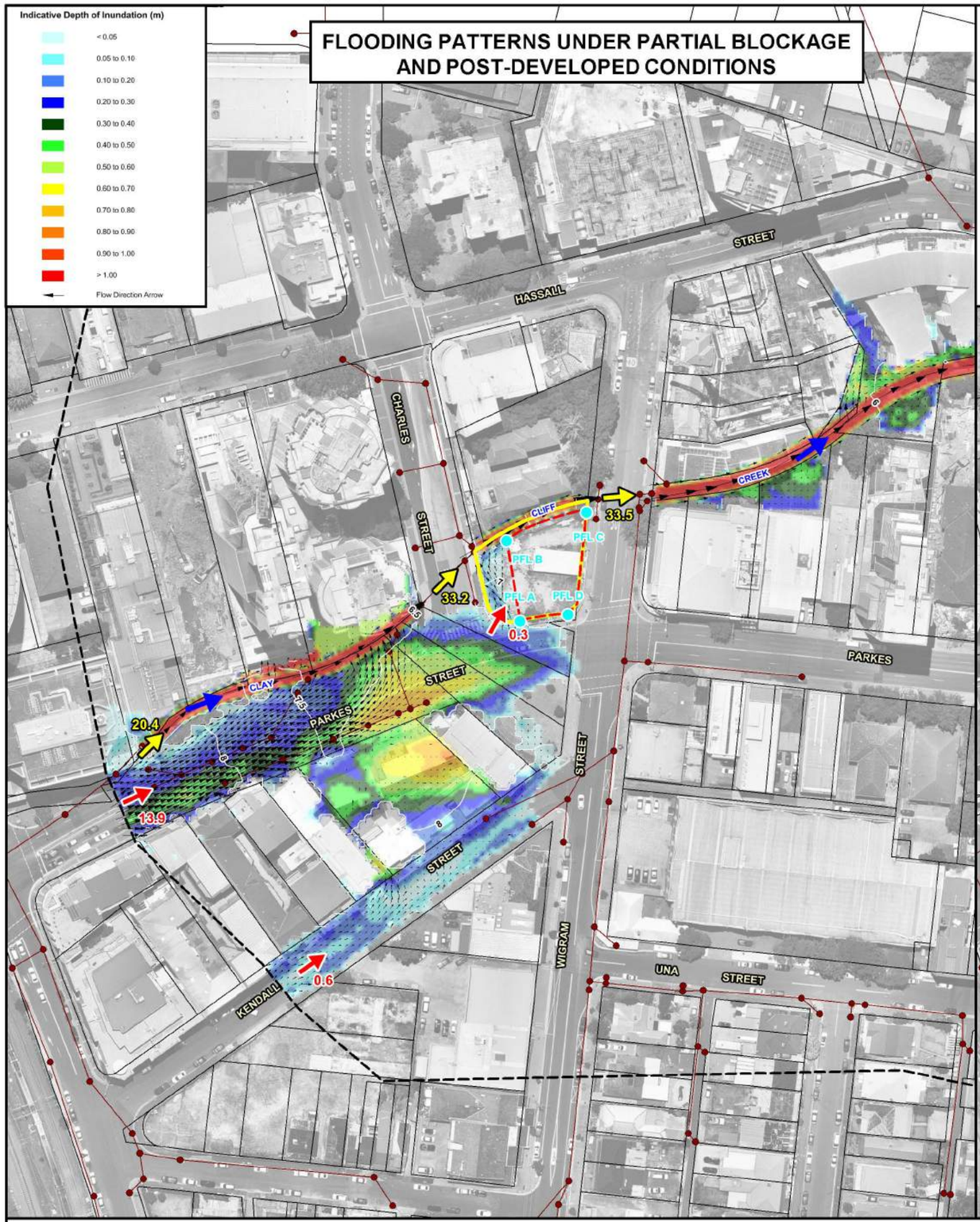
**LEGEND**

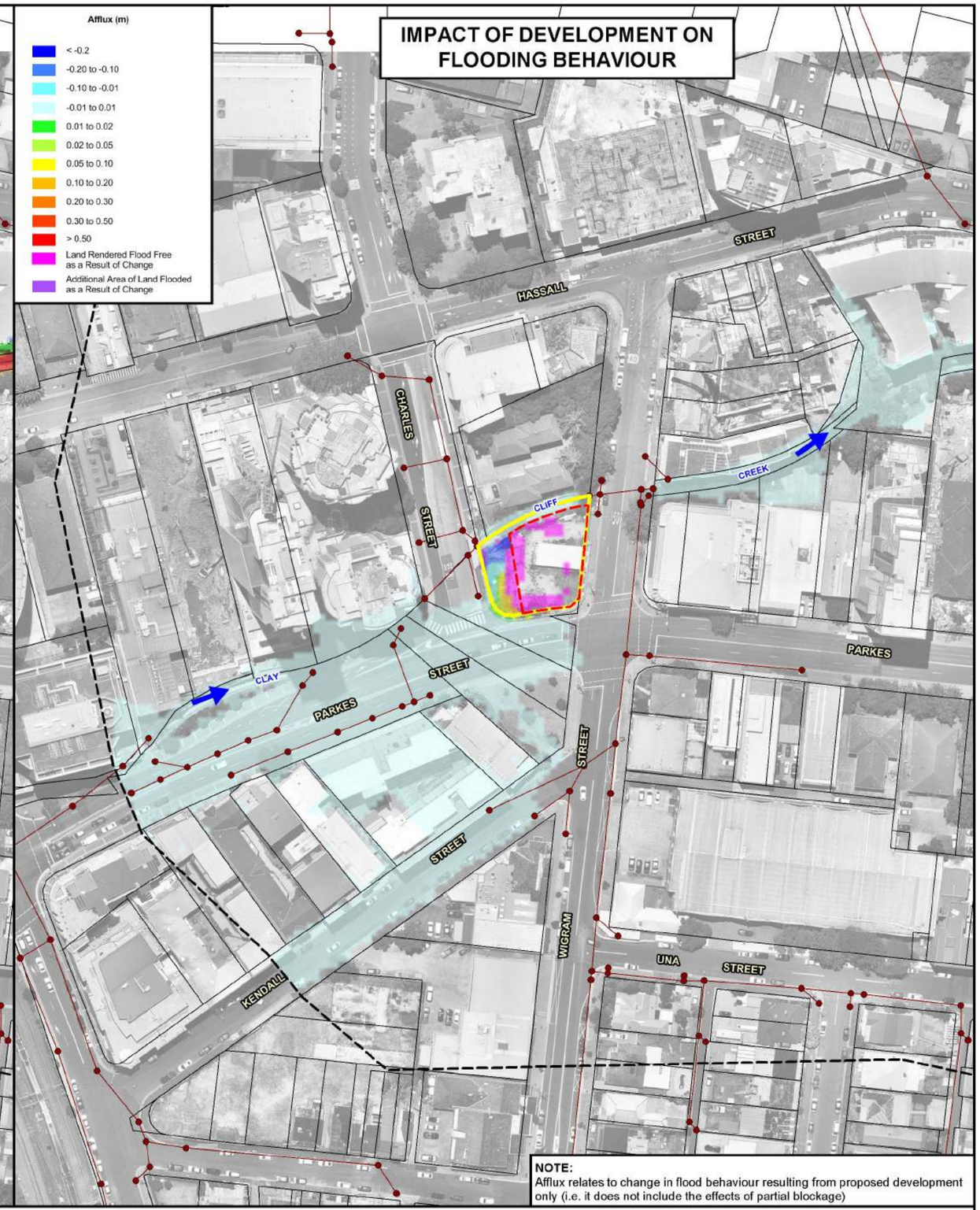
- Property Boundary
- Two-Dimensional Model Boundary
- Existing Stormwater Network (Not Modelled)
- PFL A — Peak Flood Level Identifier (Refer table in report for peak flood levels (m AHD))
- Water Surface Elevation Contour (m AHD)
- 11.4 — Peak Flow in Channel ($m^3/s$)
- 0.6 — Peak Flow in Road Reserve ($m^3/s$)
- Assessed Developable Area

**12A PARKES STREET, HARRIS PARK**
**FLOODING INVESTIGATION**

Figure 17

POTENTIAL IMPACT OF FUTURE DEVELOPMENT ON FLOODING BEHAVIOUR UNDER BLOCKAGE SCENARIO 1 CONDITIONS
1% AEP




**NOTE:**
Afflux relates to change in flood behaviour resulting from proposed development only (i.e. it does not include the effects of partial blockage)

N

15 0 15 30 45 m

Scale: 1:1,500

Lyall & Associates

**NOTE:**
The ground surface model incorporated in TUFLOW is based on LiDAR survey which has been sampled on a 2 m grid and does not necessarily incorporate localised features which can influence flooding behaviour in individual allotments.

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.

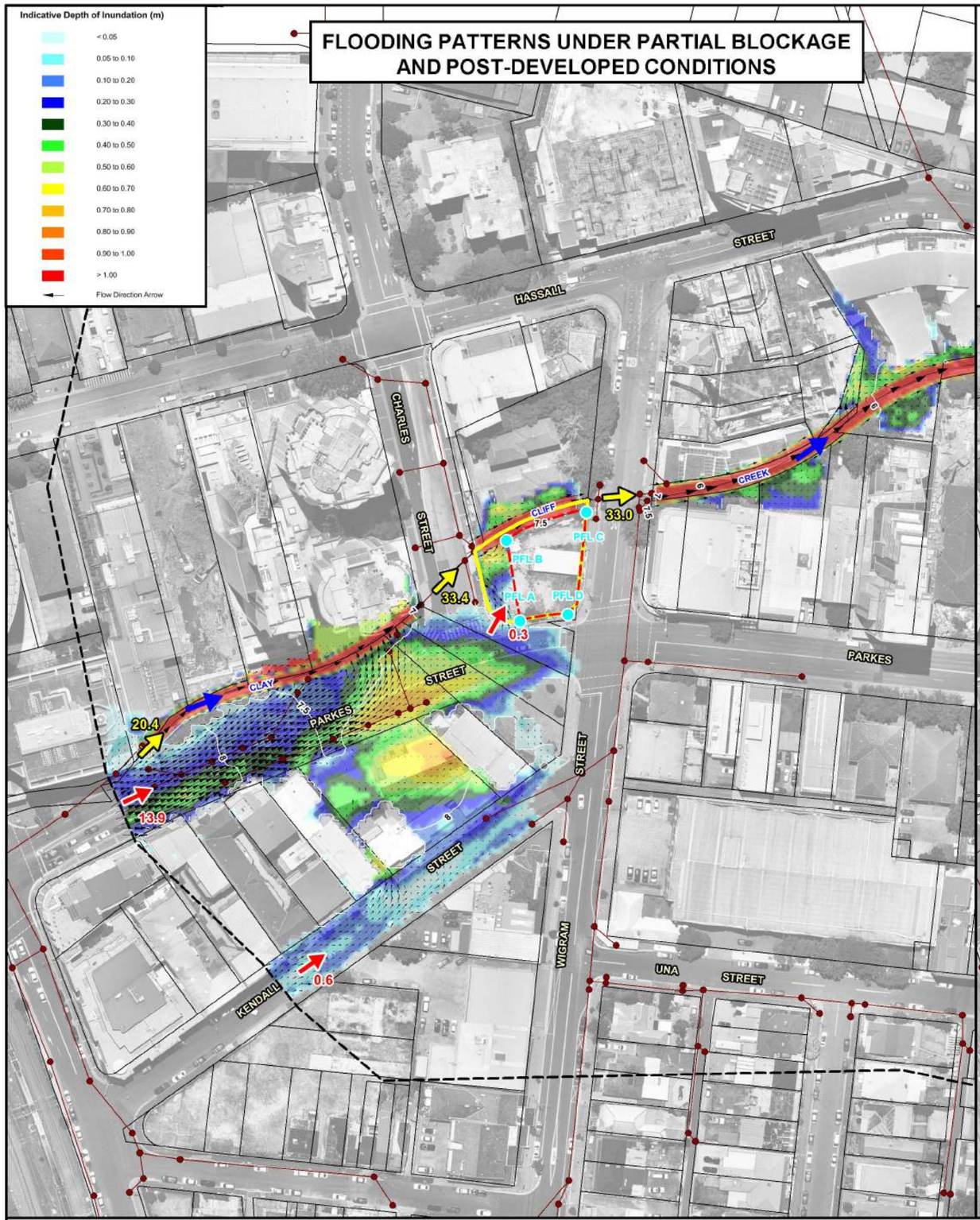
**LEGEND**

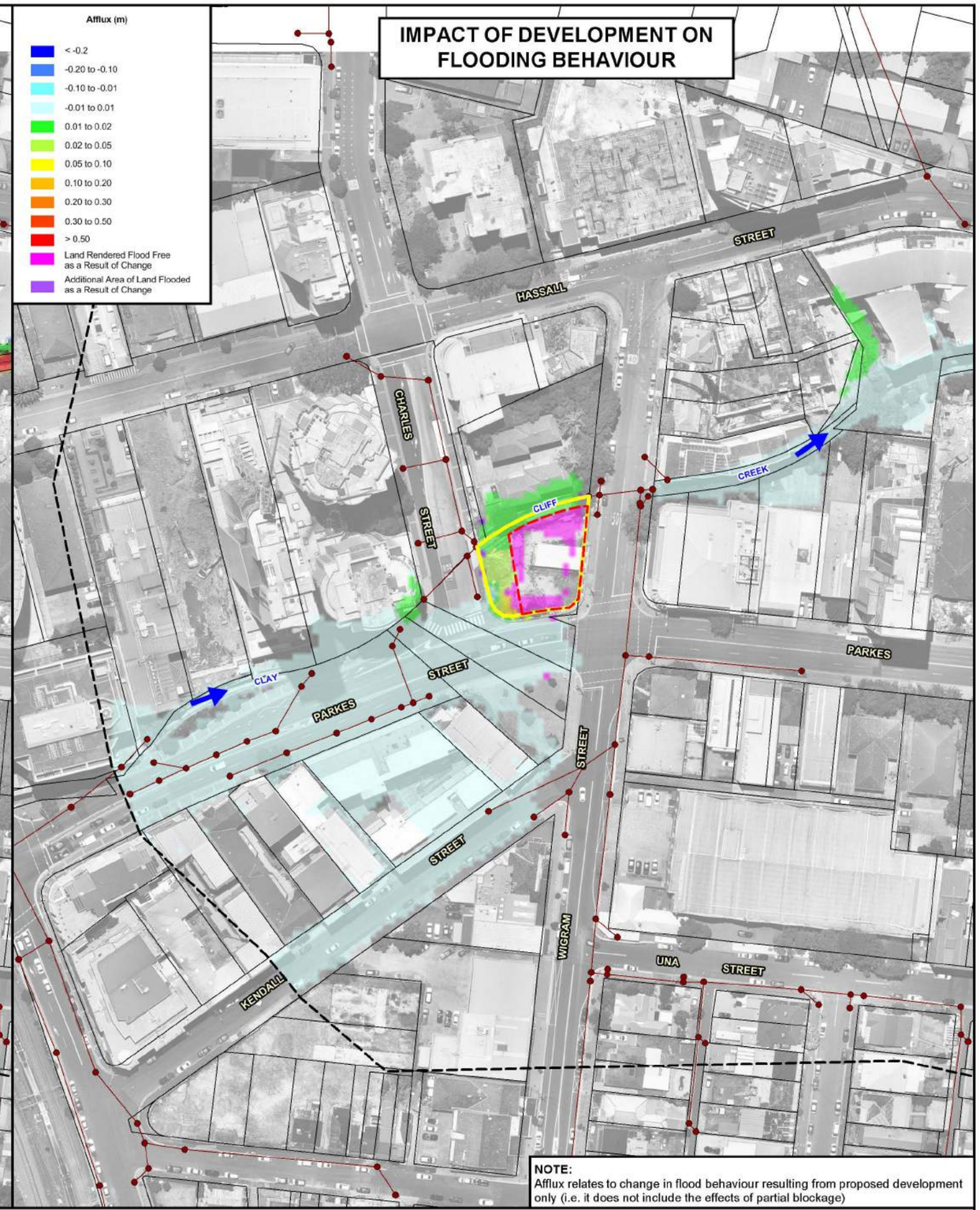
- Property Boundary
- Two-Dimensional Model Boundary
- Existing Stormwater Network (Not Modelled)
- PFL A — Peak Flood Level Identifier (Refer table in report for peak flood levels (m AHD))
- Water Surface Elevation Contour (m AHD)
- 20.4 — Peak Flow in Channel ($m^3/s$)
- 13.9 — Peak Flow in Road Reserve ($m^3/s$)
- Assessed Developable Area

**12A PARKES STREET, HARRIS PARK**
**FLOODING INVESTIGATION**

Figure 18

POTENTIAL IMPACT OF FUTURE DEVELOPMENT ON FLOODING BEHAVIOUR UNDER BLOCKAGE SCENARIO 2 CONDITIONS
1% AEP




**NOTE:**
Afflux relates to change in flood behaviour resulting from proposed development only (i.e. it does not include the effects of partial blockage)

N

15 0 15 30 45 m

Scale: 1:1,500

Lyall & Associates

**NOTE:**
The ground surface model incorporated in TUFLOW is based on LiDAR survey which has been sampled on a 2 m grid and does not necessarily incorporate localised features which can influence flooding behaviour in individual allotments.

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.

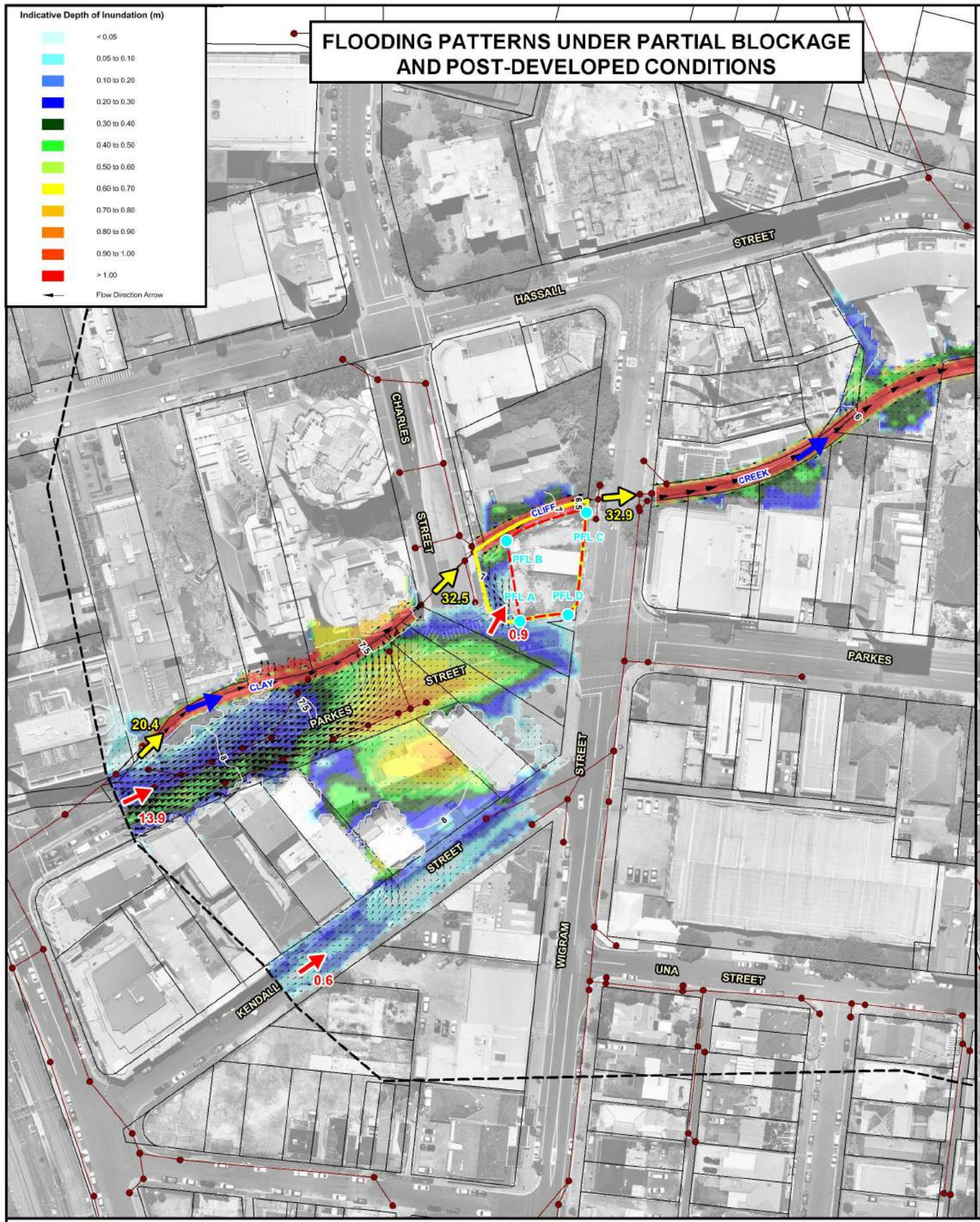
**LEGEND**

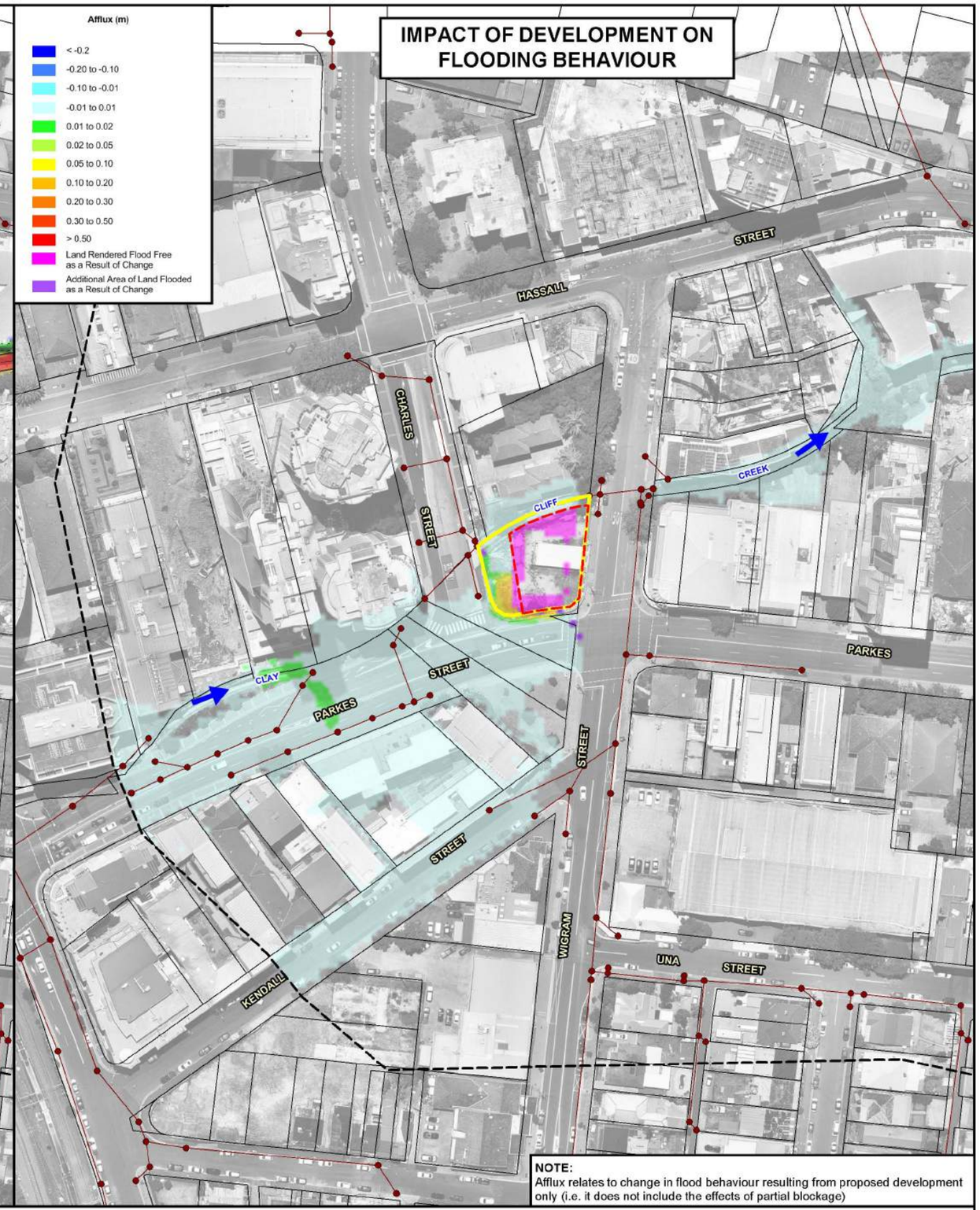
- Property Boundary
- Two-Dimensional Model Boundary
- Existing Stormwater Network (Not Modelled)
- PFL A — Peak Flood Level Identifier (Refer table in report for peak flood levels (m AHD))
- Water Surface Elevation Contour (m AHD)
- 20.4 — Peak Flow in Channel ($m^3/s$)
- 13.9 — Peak Flow in Road Reserve ($m^3/s$)
- Assessed Developable Area

**12A PARKES STREET, HARRIS PARK**
**FLOODING INVESTIGATION**

Figure 19

POTENTIAL IMPACT OF FUTURE DEVELOPMENT ON FLOODING BEHAVIOUR UNDER BLOCKAGE SCENARIO 3 CONDITIONS
1% AEP




**NOTE:**
Afflux relates to change in flood behaviour resulting from proposed development only (i.e. it does not include the effects of partial blockage)

N

15 0 15 30 45 m

Scale: 1:1,500

Lyall & Associates

**NOTE:**
The ground surface model incorporated in TUFLOW is based on LiDAR survey which has been sampled on a 2 m grid and does not necessarily incorporate localised features which can influence flooding behaviour in individual allotments.

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.

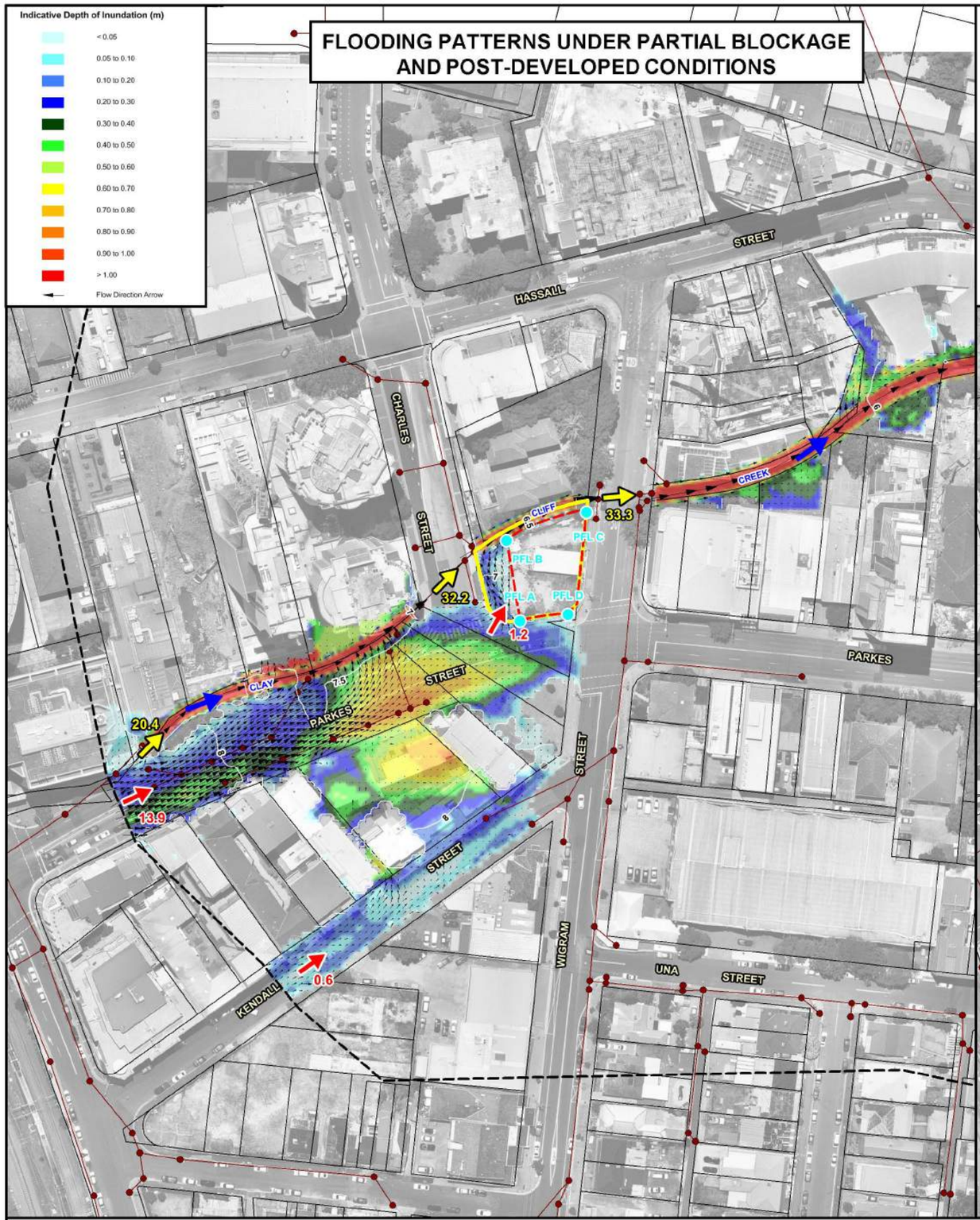
**LEGEND**

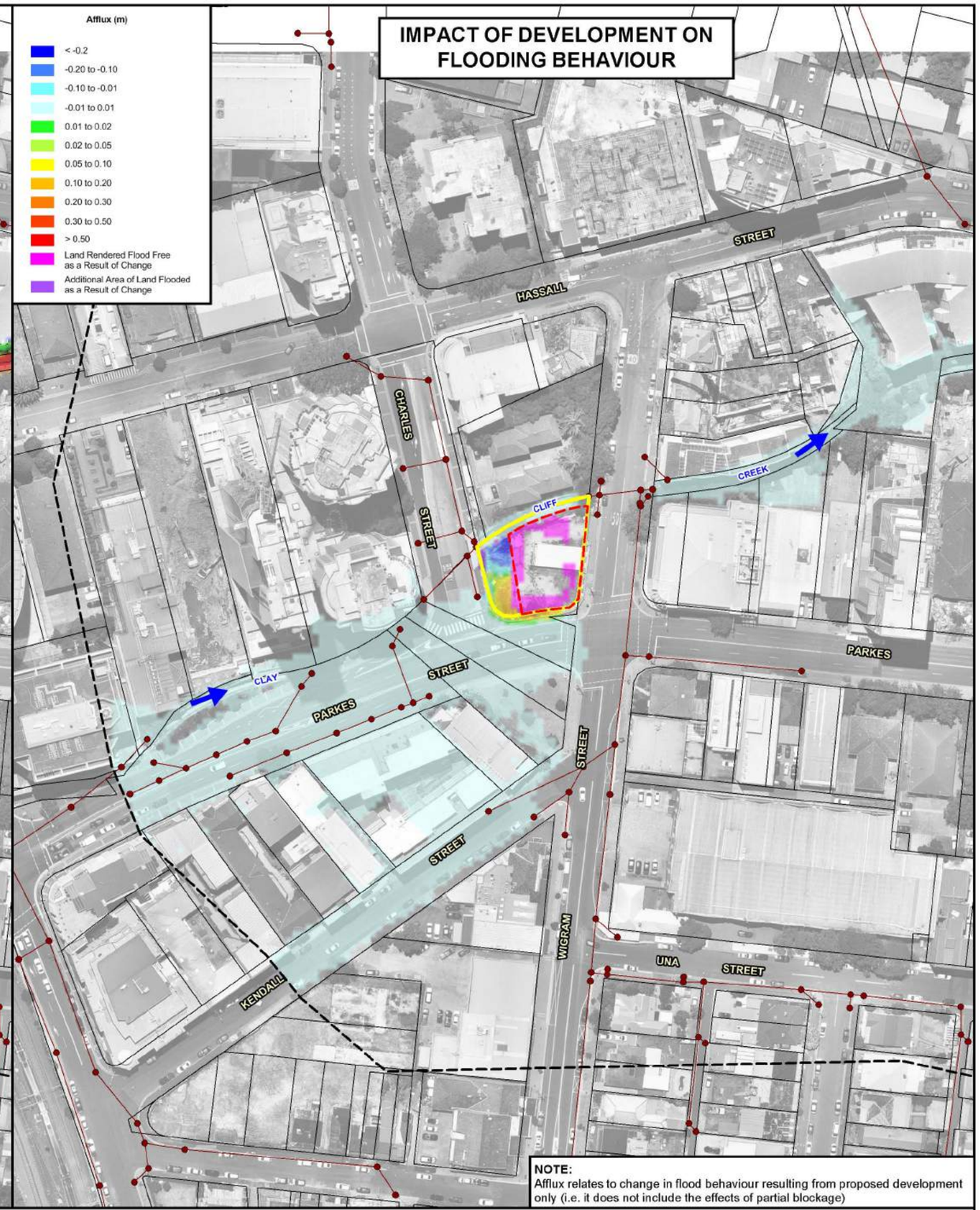
- Property Boundary
- Two-Dimensional Model Boundary
- Existing Stormwater Network (Not Modelled)
- PFL A — Peak Flood Level Identifier (Refer table in report for peak flood levels (m AHD))
- Water Surface Elevation Contour (m AHD)
- 20.4 — Peak Flow in Channel ($m^3/s$)
- 13.9 — Peak Flow in Road Reserve ($m^3/s$)
- Assessed Developable Area

**12A PARKES STREET, HARRIS PARK**
**FLOODING INVESTIGATION**

Figure 20

POTENTIAL IMPACT OF FUTURE DEVELOPMENT ON FLOODING BEHAVIOUR UNDER BLOCKAGE SCENARIO 4 CONDITIONS
1% AEP




**NOTE:**
Afflux relates to change in flood behaviour resulting from proposed development only (i.e. it does not include the effects of partial blockage)

N

15 0 15 30 45 m

Scale: 1:1,500

Lyall & Associates

**NOTE:**
The ground suRF50ace model incorporated in TUFLOW is based on LiDAR survey which has been sampled on a 2 m grid and does not necessarily incorporate localised features which can influence flooding behaviour in individual allotments.

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.

**LEGEND**

- Property Boundary
- Two-Dimensional Model Boundary
- Existing Stormwater Network (Not Modelled)
- PFL A — Peak Flood Level Identifier (Refer table in report for peak flood levels (m AHD))
- Water Surface Elevation Contour (m AHD)
- 20.4 — Peak Flow in Channel ($m^3/s$)
- 13.9 — Peak Flow in Road Reserve ($m^3/s$)
- Assessed Developable Area

**12A PARKES STREET, HARRIS PARK**
**FLOODING INVESTIGATION**

Figure 21

POTENTIAL IMPACT OF FUTURE DEVELOPMENT ON FLOODING BEHAVIOUR UNDER BLOCKAGE SCENARIO 5 CONDITIONS
1% AEP