MANAGING THE IMPACTS OF REDEVELOPMENT AT THE LOT SCALE IN SYDNEY, NSW

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Development Applications were submitted for the planned re-development of two separate large residential lots located beside the upper concrete lined reaches of Powells Creek and Boundary Creek respectively in eastern Sydney. Strathfield City Council refused the applications on both sites in part because the flooding assessment did not satisfy Council's Policy for Flooding and Stormwater Control of no increase in flood level adjoining floodplain users following construction of the proposed development. Council's interpretation of "no increase in flood levels" is no more than a 0.01 m increase in 1% AEP flood levels on adjoining lots. While 1D flooding assessments were undertaken of the sites previously these was unable to assess local flood impacts to Council's satisfaction. Consequently 1D/2D floodplain models of the local floodplains were assembled to define the spatial extent of flooding impacts of planned development. After multiple iterations modified concept layouts of proposed developments were formulated. The features of these layouts were assessed using 1D/2D model floodplain models. It is concluded that 1D/2D modelling of single lot re-development will be increasingly required in situations where Councils require that flood impacts of any planned re-development be no more than a 0.01 m increase in 1% AEP flood levels on adjoining lots.

1 INTRODUCTION

In the past local government flooding investigations in Australia have been typically based on the assembly of hydraulic models of all major watercourses and open channels but not routinely for overland flow paths. The challenge posed by the 2005 NSW Floodplain Development Manual [1] was to hydraulically model overland flow paths as well.

While historically 1D models have been adopted for flood studies the increasing collection of aerial laser scanning (ALS) across whole local government areas (LGAs) in Australia is providing detailed survey levels capable of supporting 2D terrain and hydrodynamic modelling and detailed floodplain mapping. Consequently the trend in the USA, Australia and elsewhere has been for the growing adoption of 2D models as the new benchmark for investigations of urban floodplains and assessment of flood mitigation schemes (Kuch et al, 2007 [2]).

This trend is evident in a number of case studies that have been previously presented. The application xpswmm2D have been previously outlined by Phillips et al, 2005 [3] and Phillips, Yu and Smith, 2006 [4] while a case study of the application of SOBEK has also been outlined by Thomson et al, 2010 [5].

In recent years the application of 1D/2D models has been focused on assessing the flooding impact of re-development at the lot scale. This is because 1D flooding assessments are increasingly unable to provide assessments which satisfy Council's planning requirements in relation to flooding and instead 1D/2D floodplain models of the local floodplains are being assembled to define the spatial extent of flooding impacts of planned development.

Two case studies which detail the complex hydraulic modelling which is being undertaken at the lot scale are outlined.

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2 8-10 ELVA STREET, STRATHFIELD

The flood impact assessment for 8-10 Elva St, Strathfield [6] is outlined as follows. The property is identified in Figure 1. The property is adjacent to a concrete-lined open section of Powells Creek.

Council has previously advised that this site is considered as being affected by the 1% AEP flood of 9.4 m AHD. The Probable Maximum Flood (PMF) level has not been estimated in any previous flood study.

2.1 Approach

Previously a 1D HEC-RAS flooding assessment was undertaken of Powells Creek including the section of open channel adjacent to 8-10 Elva St, Strathfield. To better define the spatial extent of any flooding impacts of planned development a local 1D/2D floodplain model of the Powells Creek floodplain was assembled. The concrete-lined channel and bridge crossings and the culverts are represented as 1 D elements and the floodplain is represented in the 2D domain.

The adopted grid size is 1 m x 1 m.

The upstream boundary conditions are the 1% AEP flood hydrographs obtained from the hydrological model of the catchment while the downstream boundary is a normal depth flow condition that matches the peak 1% AEP flood level from the HEC-RAS model flood level between the two railway crossings.

2.2 Benchmark Conditions

A local 1D/2D floodplain model was assembled based on the acquired data and was supplemented by survey of the subject property. The overall extent of the local 1D/2D model extends well south of Elva Street to ensure that the patterns of flow in the vicinity of 8-10 Elva Street are not influenced by boundary conditions.

Features of the model included:

- Inclusion of surveyed raised garden beds and/or walls within the subject property;
- Brick boundary walls represented as solid walls;
- Timber paling fences represented as walls which are 50% porous;
- Inclusion of the concrete/blockwork ring levee around the units on 4-6 Elva St, Strathfield;
- Inclusion of the flood storage in Raw Square and in the vicinity of the Raw Square / Leicester Ave / Everton Road roundabout; and
- Existing buildings are blocked out in the 2D domain.

The 1% AEP flood was assessed under Existing Conditions.

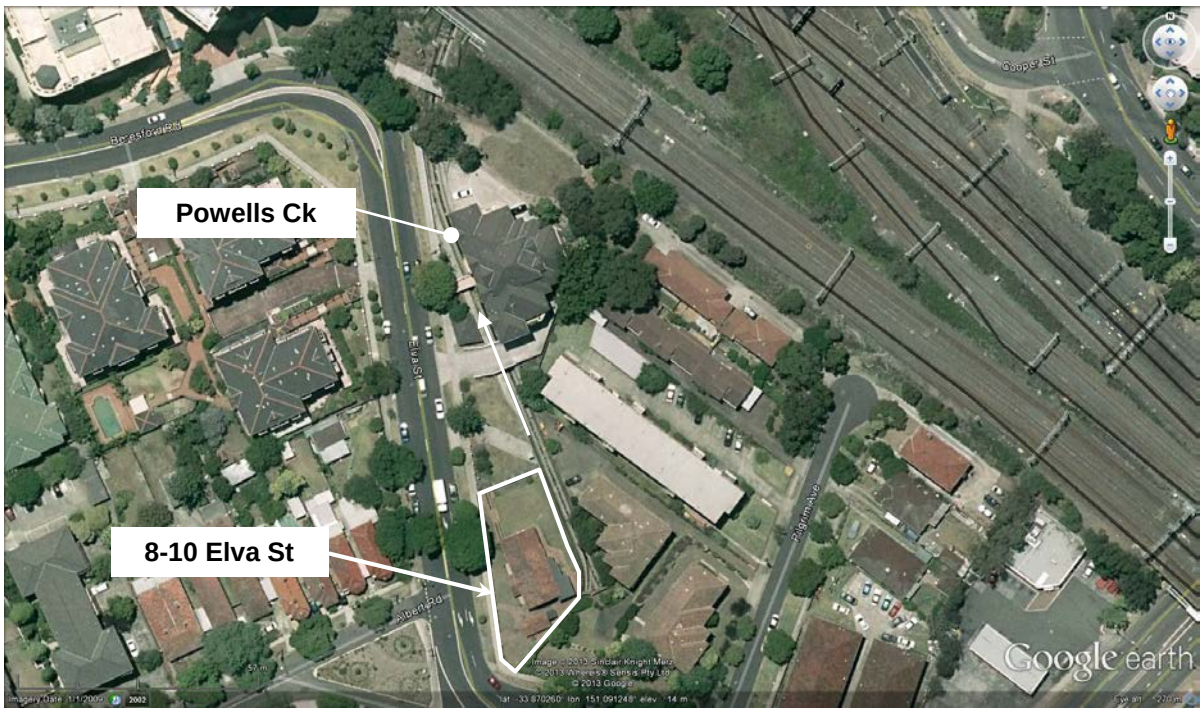

Figure 1 Location of 8-10 Elva St (Source: Google Earth, accessed 19 March 2013)

The assessment of benchmark conditions concluded that:

- The 1% AEP flood levels for flood planning purposes is 9.4 m AHD (which confirmed Council's previous advice);
- The 1% AEP flood levels in the concrete-lined channel are lower than the 1% AEP flood levels on the adjacent properties and in Elva Street;
- Overland flows down Elva Street and adjoining properties cascade back into the open channel as lateral inflow;
- The overland flow behaviour in the vicinity of Elva Street is highly two dimensional and differs significantly from the previous 1D modelling approach adopted by Council.

2.3 Flood Impact Assessment

Initially the original proposed development was assessed to determine if the detailed 1D/2D local floodplain model identified impacts on adjoining properties of greater than 1-2 cm. The assessment disclosed that the original Development Application (DA) configuration locally increases 1% AEP flood levels by up to 9 cm. These impacts far exceeded Council's benchmark of no more than 1-2 cm. Consequently the layout of the ground floor of the proposed development was adjusted iteratively to identify an optimal configuration that limits flood impacts on any adjoining property to no greater than 1-2 cm.

The features of the final amended layout included:

- The creation of an overland flowpath beneath the elevated ground floor;
- The inclusion of security bars to limit access under the building;
- Re-grading of the overland flowpath beneath the building to a level 8.5 m AHD to avoid any trapped low points (draining back towards Powells Creek);
- The inclusion of screening vegetation in front of the flowpath fronting Elva St; and
- Replacement of all boundary fences on the northern, eastern and southern boundaries with a mesh fence which is assumed to be 80% pervious, i.e. not a timber or colourbond fence.
- The surface of the subfloor area is concrete which is flat. If needed this subfloor area could be hosed down to flush any sediment and/or leaves to an anywhere they could be collected and removed for disposal.

The study area and roughness zones for the amended development TUFLOW model are given in Figure 2.

Figure 2 Roughness Zones – Amended Development

The estimated 1% AEP flood extent and depths, and velocities, velocity x depth and provisional flood hazard under post-development conditions are plotted in Figures 3 to 6 respectively. The results indicated that the amended development limits the impact on the 1% AEP flood level to no more than +1 cm outside the property depending on location. While the existing high velocities in the south-east corner of the property would extend beneath the proposed ground floor but that this area will be protected from scour by concrete.

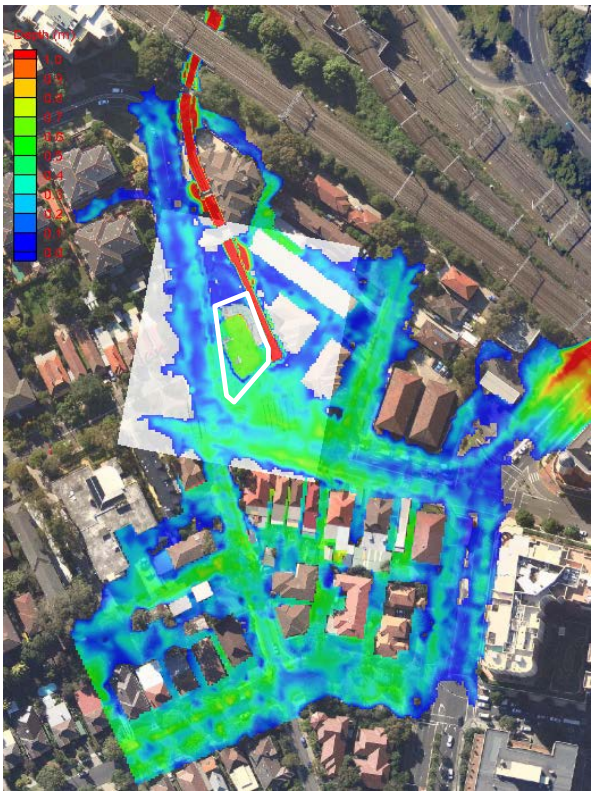

Figure 3 1% AEP Flood Depths (0 – 1 m)

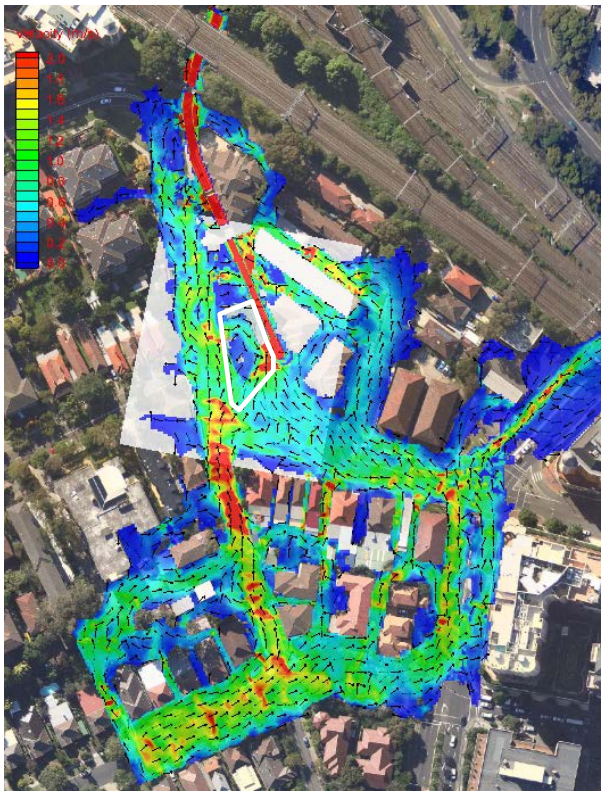

Figure 4 1% AEP Flood Velocities (0 – 2 m/s)

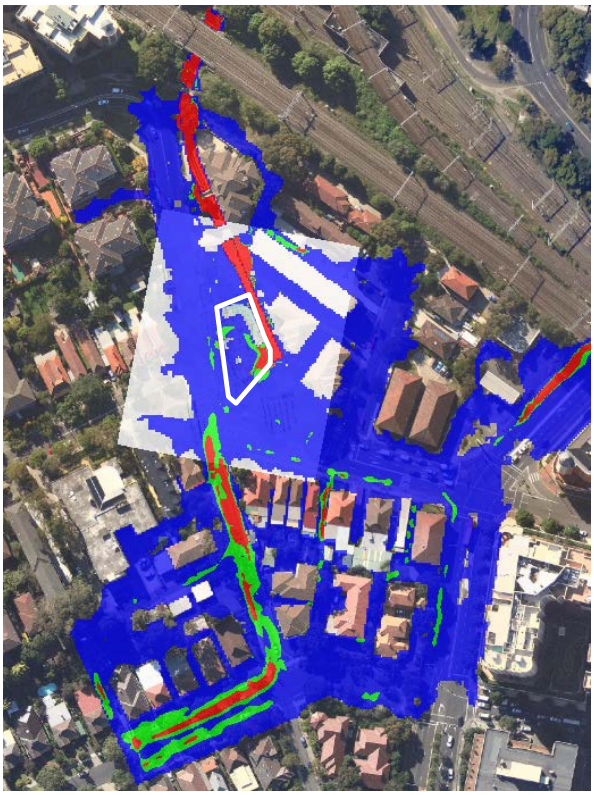

Figure 5 1% AEP Velocity x Depth

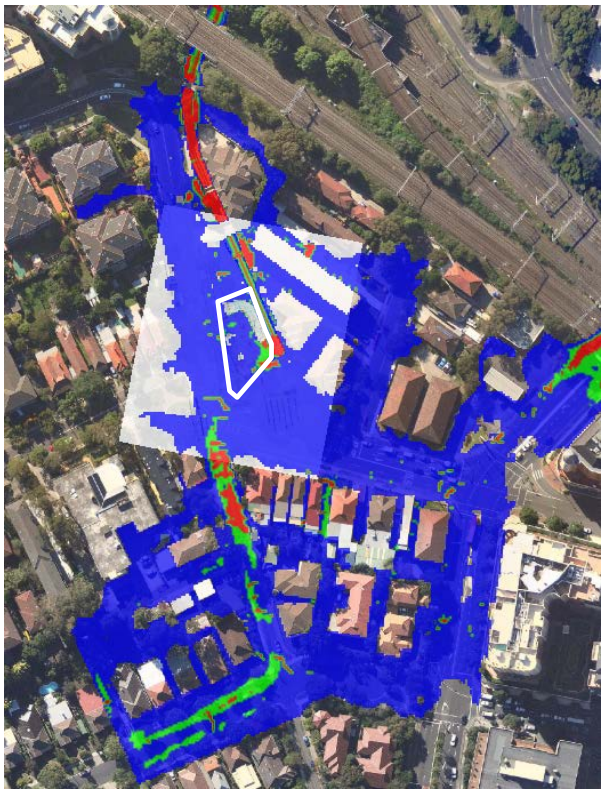

Figure 6 1% AEP Provisional Flood Hazard

3 21 MANDEMAR AVENUE, HOMEBUSH WEST

A Flood Impact Assessment report [7] details the flooding analysis of the proposed re-development of 21 Mandemar Avenue, Homebush West which is located in the upper reach of Boundary Creek. An assessment of the 1% AEP and Probable Maximum Flood (PMF) events under both pre-development and post-development conditions was undertaken.

A number of Addendum reports were also prepared. Addendum No. 4 was a re-assessment of Existing and Future Conditions. The results of these assessments are outlined as follows.

3.1 Previous Studies

A series of 1D flooding investigations have been previously completed for upper Boundary Creek as follows:

- The Boundary Creek Floodplain Management Study and Plan prepared in 1998;
- The Flood Assessment and Stormwater Drainage Concept Design for 21 Mandemar Avenue prepared in 2004;
- The study on Channel Widening and Culvert Upgrades at Telopea Avenue, Homebush West prepared in 2008; and
- A Flood Assessment of 21 Mandemar Avenue, Homebush West prepared in April 2014.

3.2 Hydrology and Hydraulics

The assessment of runoff 1% AEP and PMF events was undertaken by assembling a DRAINS model using a similar approach to the April 2014 study which estimated a 1% AEP peak flow at Mandemar Ave of 16.6 m^3/s in comparison with the peak flow of 13.8 m^3/s reported in 1998 and concluded it was within an acceptance level of agreement. The DRAINS model assembled for this study generated similar results to the April 2014 model. The critical duration estimated using the DRAINS model was 2 hours and 15 minutes for 100 year ARI and PMF events respectively.

The assessment of the impact of development on 21 Mandemar Ave was undertaken by assembling a 1D/2D TUFLOW floodplain model. The model incorporating fences on the north side of Mandemar Ave, bars or equivalent along the western boundary to prevent access to the proposed new channel, partial blockage of the Mandemar Ave and Telopea Ave culverts, removal of a section of the gutter beside the driveway and removal of the proposed inlet located within the site at the northern end of the gutter [8].

3.3 Existing Conditions

A comparison of 1% AEP flood profiles along Boundary Creek downstream of Mandemar Avenue calculated in the current study and previous studies is given in Figure 9. It was noted the flood profile calculated adjacent to the site using the 1D/2D TUFLOW model has a similar gradient to the 2008 flood profile albeit the current study gives flood levels which are higher than the 2008 flood levels but comparable to the 1998 flood levels except where there is an anomalous increase in the 1998 flood levels around 75 m downstream of Mandemar Ave. A comparison of PMF profiles was also undertaken. It was noted that the PMF levels estimated by the current study align with the PMF levels estimated by the 2008 and April 2014 studies except in the vicinity of Mandemar Avenue. This is attributed to the 1D/2D TUFLOW providing a more detailed representation of the 2D flooding behaviour at Mandemar Avenue.

3.4 Future Conditions

The modifications to the post-development TUFLOW model described in [7] included:

- Addition of various fences and/or bars across the floodplain and down the floodplain;
- Modification of the Mandemar Ave and Telopea Ave culvert crossings to include 20% blockage;
- A modified grated inlet and a footpath located on the eastern side of the driveway;
- The section of gutter north of the undercroft was deleted as was an internal drainage line which connected to the stormwater drainage pit on the eastern side of the site;
- The driveway crest level has been raised to a level above the estimated PMF level.

The adopted roughness zones in the study area were as plotted in Figure 8. These values were guided by the roughness values previously in other similar studies.

Figure 7 Site Location

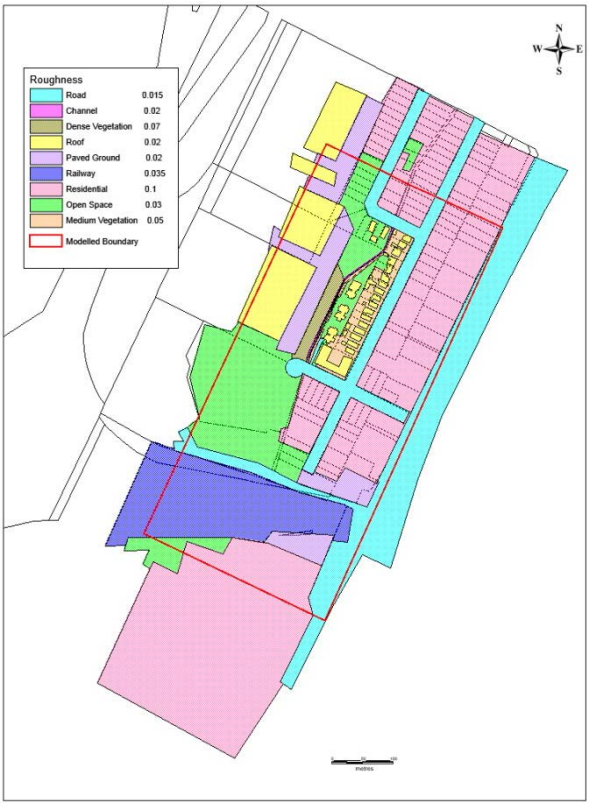

Figure 8 Future Roughness Zones

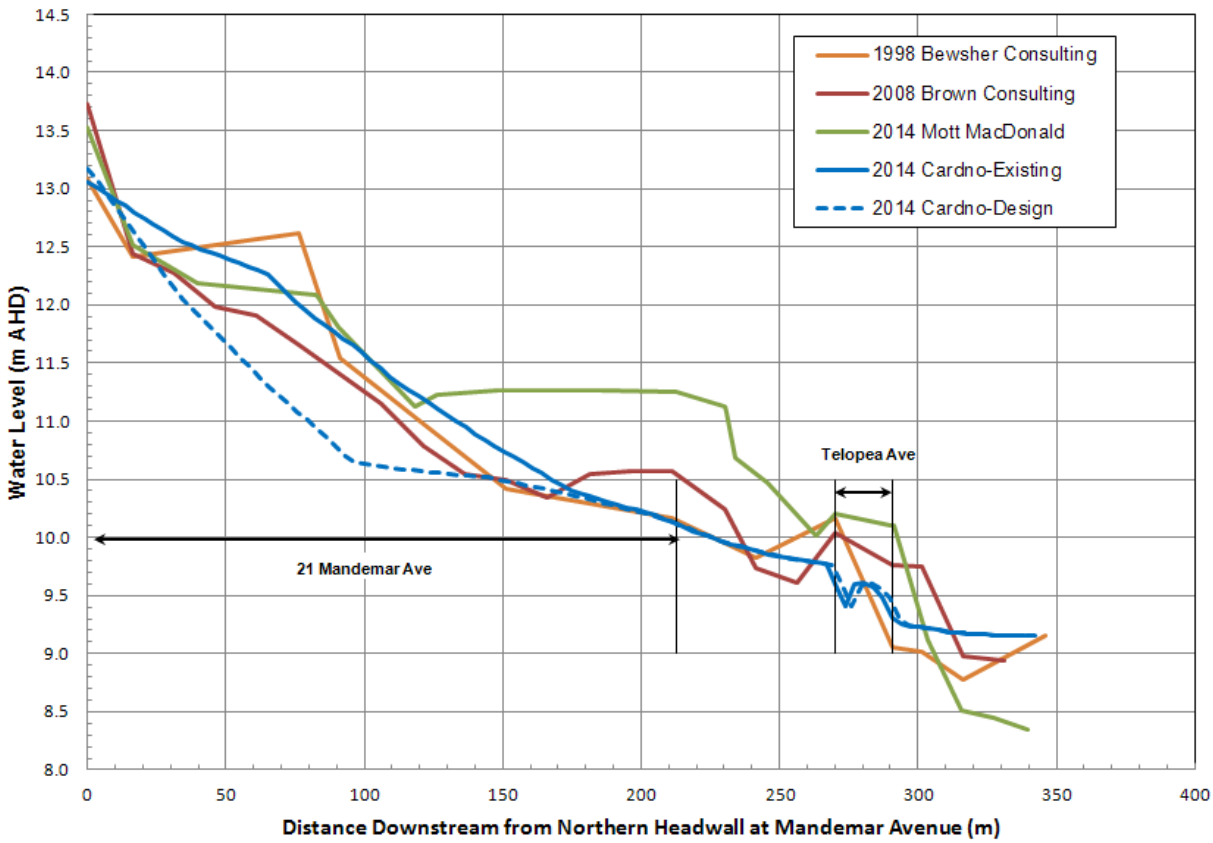

Figure 9 Comparison of 1% AEP Flood Profiles

The estimated 1% AEP flood depths, 1% AEP flood level differences, 1% AEP peak velocities and 1% AEP velocity x depth are plotted in Figures 10 to 13 respectively.

3.5 Flood Impact Assessment

In the 1% AEP event the proposed development reduces 1% AEP flood levels in Boundary Creek and within properties located along Courallie Avenue. These reductions in 1% AEP flood levels are attributed to the construction of an additional channel parallel to Boundary Creek with associated inlet works. This virtually eliminates overland flows through the site which discharged into the rear of properties located along Courallie Avenue in a 1% AEP event.

A very local adverse increase was also identified in the vicinity of the headwall of Boundary Creek on the northern side of Mandemar Ave. This does not adversely impact on any existing buildings.

In the PMF the proposed development lowers the PMF levels in Boundary Creek over a 100 m reach downstream of Mandemar Ave and reducing PMF levels in 10 properties located along Courallie Avenue. Further north the proposed development slightly raises the PMF levels in Boundary Creek and in seven properties located along Courallie Avenue.

It was concluded that the planned development has a negligible adverse impacts on 1% AEP flood levels and minor impacts on PMF levels adjacent to and north of Building C.

3.6 Vehicular Access to 21 Mandemar Ave during Floods

In the case of a 1% AEP event it was found that it would be unsafe for drivers of large vehicles to attempt to enter or depart 21 Mandemar Ave for 15 min (D > 0.3 m and VD > 0.6 m^2/s) – 25 mins (D > 0.2 m) depending on the safety criteria adopted while it would be unsafe for drivers of small vehicles to attempt to enter or depart 21 Mandemar Ave for around 30 min– 50 min (VD > 0.3 m^2/s). In a PMF it would be unsafe for drivers of small and large vehicles to attempt to enter or depart 21 Mandemar Ave for 25 min – 30 min depending on the safety criteria adopted.

4 CONCLUSIONS

In recent years the application of 1D/2D models has been focused on assessing the flooding impact of re-development at the lot scale. This is because 1D flooding assessments are increasingly unable to provide assessments which satisfy Council's planning requirements in relation to flooding and instead local 1D/2D floodplain models are being assembled to define the spatial extent of flooding impacts of planned development.

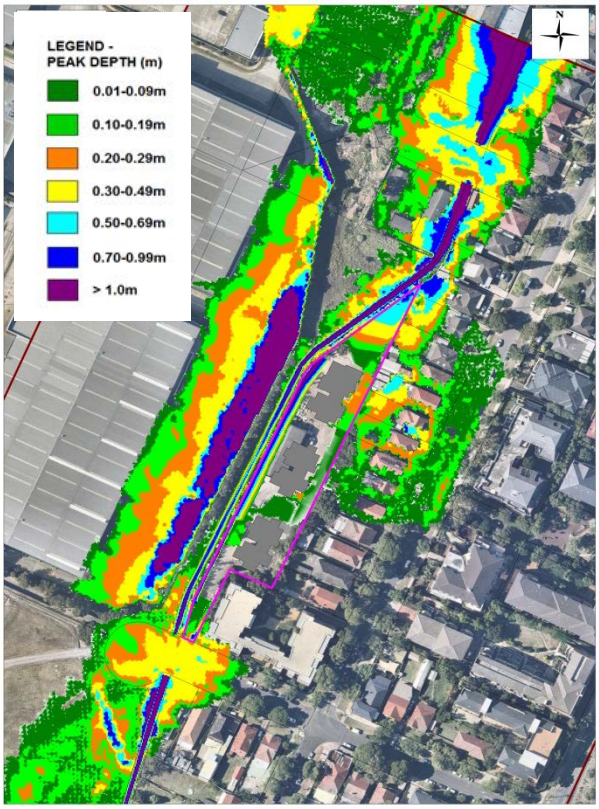

Figure 10 1% AEP Flood Depth

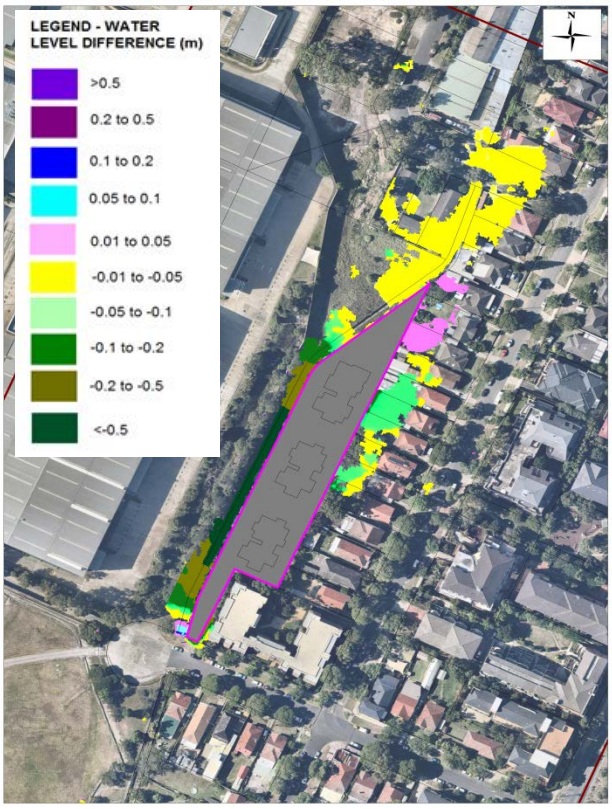

Figure 11 1% AEP Flood Level Differences

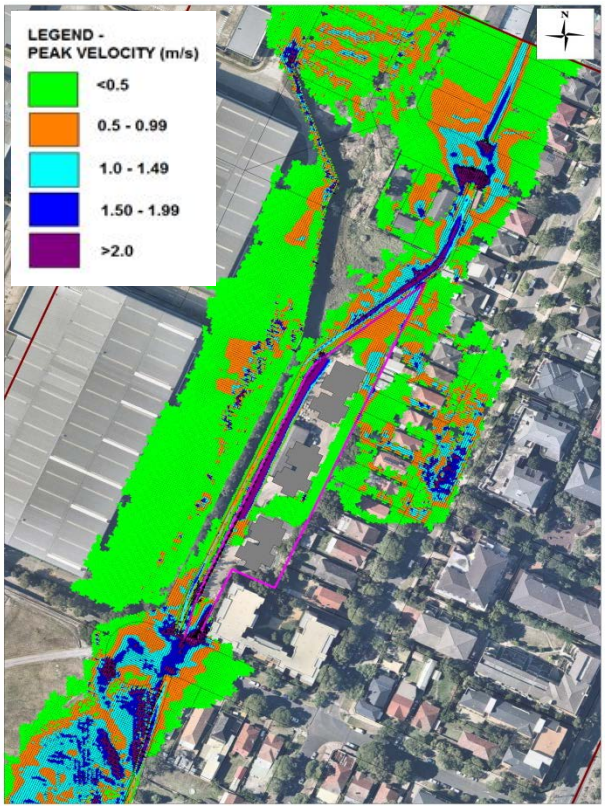

Figure 12 1% AEP Flood Velocities

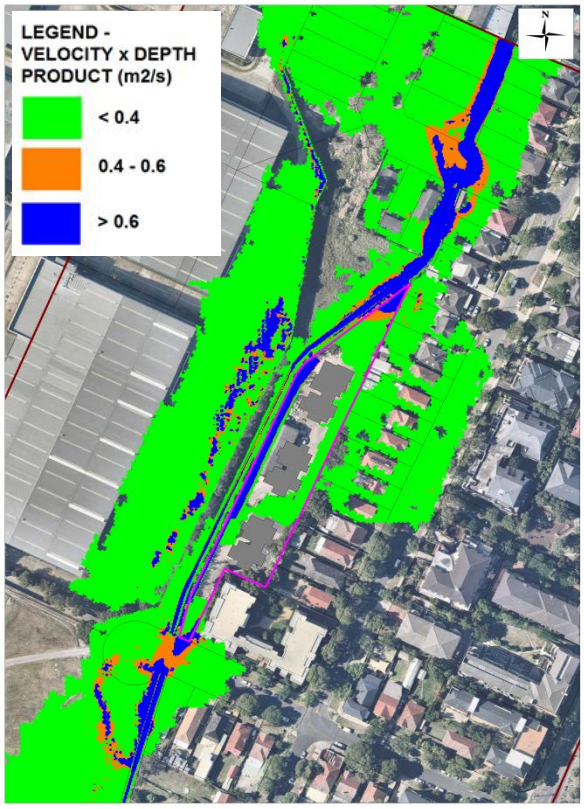

Figure 13 1% AEP Velocity x Depth

Two case studies which detail the complex hydraulic modelling which is being undertaken at the lot scale are outlined.

It is concluded that 1D/2D modelling of single lot re-development will be increasingly required in situations where Councils require that flood impacts of any planned re-development be no more than a 0.01 m increase in 1% AEP flood levels on adjoining lots.

5 REFERENCES

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