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Cooks Cove Flood Impact Assessment

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			Name/Position	Signature
A	13 Sep 2016	Flood Impact Assessment	Joshua Atkinson	

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1.0 Introduction

The NSW Department of Planning and Environment is undertaking investigations regarding potential for mixed use development at Cooks Cove in Arncliffe. A range of development scenarios is to be considered, including a mixture of residential and commercial tower buildings, for the purposes of considering potential impact on flooding behaviour. As the site is located on the Cooks River floodplain, there is a risk that development of this nature may have an impact on flood behaviour. As such flood management must be incorporated into the design of the precinct.

The purpose of the present investigation was to undertake a high level assessment of main stream flood behaviour in the vicinity of the Cooks Cove site, as well as potential flooding impacts associated with its future development, to inform the development footprint established as part of the Cooks Cove Land Use and Infrastructure Strategy.

2.0 Existing Flood Characteristics at the Site

Development is proposed on the site of the present Kogarah Golf Club, which is on low lying land on the western bank of the Cooks River and to the north of the M5 East Freeway (refer **Figure 1**). The elevation of the site is generally between 0.7 and 2.0 m AHD, with some isolated high points that are in excess of 3.0 m AHD. An embankment with a crest elevation of between 2.0 and 2.5 m AHD runs along the western bank of the Cooks River, and acts to separate the site from the river.

The southern portion of the development area, located south of the M5 East Freeway, is approximately 800 m north west (upstream) of where the Cooks River enters Botany Bay (refer **Figure 1**). It is noted the present investigation does not consider potential flooding impacts or development requirements associated with future development of the portion of the site to the south of the M5 Freeway.

The river entrance is trained with rock revetments on both sides of the entrance, and a significant tidal signal is able to propagate up the river beyond Canterbury Road (MHL 2012), which is approximately 6.3 km upstream of the site. The confluence between the Cooks River and Alexandra Canal is located to the north of Marsh Street, which runs along the northern boundary of the site.

Figure 1 Cooks Cove Site

2.1 Flood Modelling Background

A number of previous flood studies and floodplain risk management studies have been prepared for the lower Cooks River. These studies include:

- Webb, McKeown and Associates (now WMAWater, 1994) *Cooks River Floodplain Management Study.*
- PB-MWH Joint Venture (2009), *Cooks River Flood Study* prepared for Sydney Water Corporation.
- WorleyParsons (2010), *Cook Cove – Stage 2 Open Space DA Flood Impact Assessment* prepared for Cook Cove Pty. Ltd.
- WMAWater (2016), *Bonnie Doon Flood Study,* prepared for Rockdale City Council.
- Lyall & Associates (2015) *Drainage and Flooding Investigation – Marsh Street Widening – M5 East Motorway to Giovanni Brunnetti Bridge* prepared for Roads and Maritime Services NSW.
- Lyall & Associates (2015), *WestConnex New M5 EIS - Technical Working Paper: Flooding.*

For this study the Sydney Water flood model (PB-MWH Joint Venture, 2009) has been used as the basis for flooding investigations, noting that this model has been adopted for floodplain management purposes on the lower Cooks River by various authorities including Rockdale City Council. The model uses an envelope approach for determining peak flood levels through consideration of both riverine and storm tide flooding mechanisms for a given flood frequency. For the 1% Annual Exceedance Probability (AEP) flood, the envelope is comprised of (1) High High Water Solstice Springs (HHWSS) tidal level of 1.1 m AHD combined with 1% AEP river flood, and (2) 1% AEP storm tide level of 1.7 m AHD combined with the 39% AEP (ie. 2 year Average Recurrence Interval) river flood. At the location of interest, the former combination leads to the higher peak flood levels.

2.2 Modifications to the Flood Model

The following modifications to the Sydney Water flood model were made to incorporate recent changes to the floodplain, as well as new information from more recent studies:

- Incorporating buildings and floodplain roughness definition from the Bonnie Doon flood model (WMAWater, 2016).
- Modifying the terrain along Marsh Street to reflect presently underway upgrades by Roads and Maritime Services.

2.3 Existing Case Flood Modelling Results

Peak flood depths and velocities for the 1% AEP Cooks River flood under existing case conditions are shown in **Figure 2**, while peak flood levels are shown in **Figure 3**. Significant ponding can be seen on the site, much of which is the result of water flowing across Marsh Street from the north. Peak flood levels in the Cooks River north of the Giovanni Bridge are approximately 2.0 m AHD, while along Marsh Street the maximum water elevation is approximately 1.8 m AHD, allowing water to flow from the Cooks River, towards Marsh Street where it can enter the site.

Peak flood levels and flood extents are generally comparable to the results documented in PB-MWH Joint Venture, 2009. **Table 1** gives a comparison of flood levels at key locations throughout the model for river flooding.

Table 1 1% AEP flood level comparisons between the *Cooks River Flood Study* (PB-MWH Joint Venture, 2009) and the present study

Location	*Cooks River Flood Study* (m AHD)	Present Study (m AHD)
General Holmes Drive	1.73	1.70
Marsh Street	2.00	2.00
Princes Highway	2.16	2.14
Tempe – Wolli Creek Railway	2.30	2.28

Similarly, **Figure 4** shows peak flood depths and velocities for the 0.5% AEP flood, while **Figure 5** shows peak flood levels for this event. As with the 1% AEP event, floodwater is able to enter the site from the north across Marsh Street. However it is also able to approach the site from the south, entering the site from the Cooks River by flowing over the elevated area adjacent to the river on the southern portion of the site.

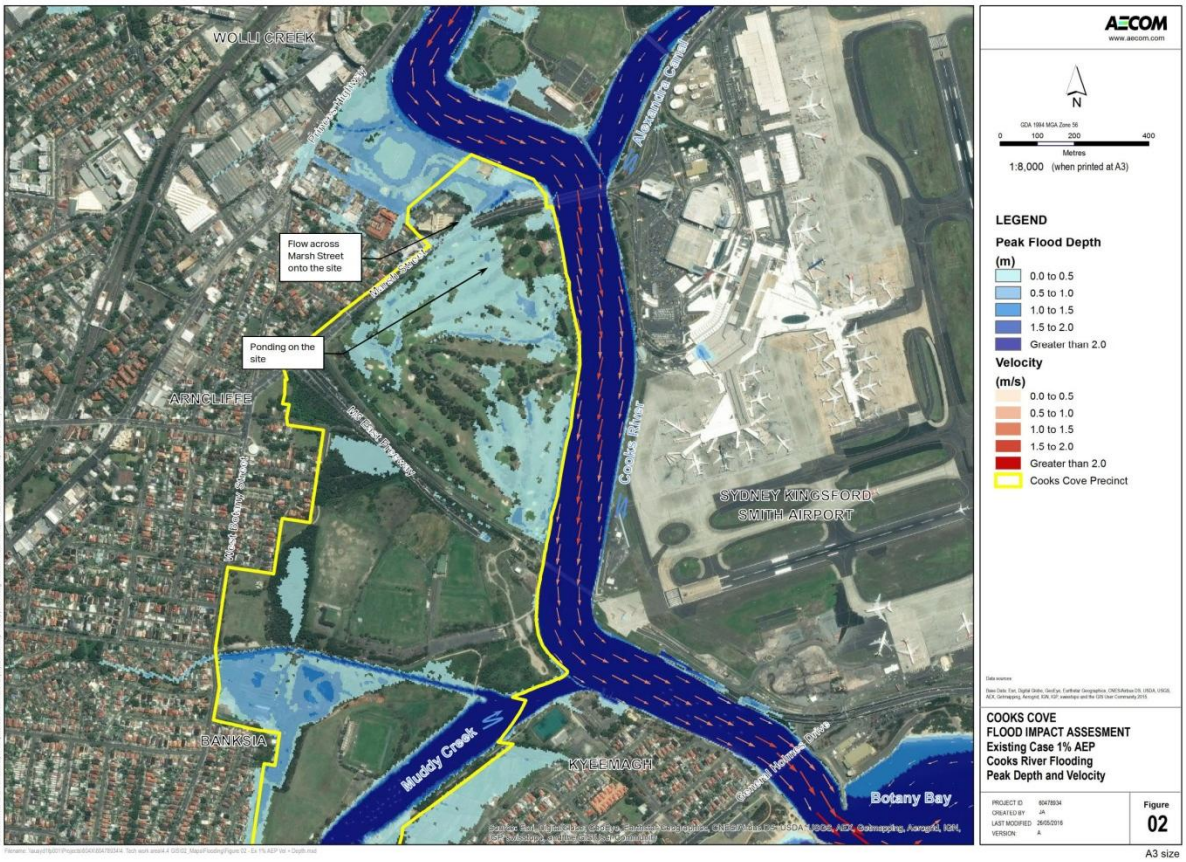

Figure 2 1% AEP Cooks River flood under existing case conditions

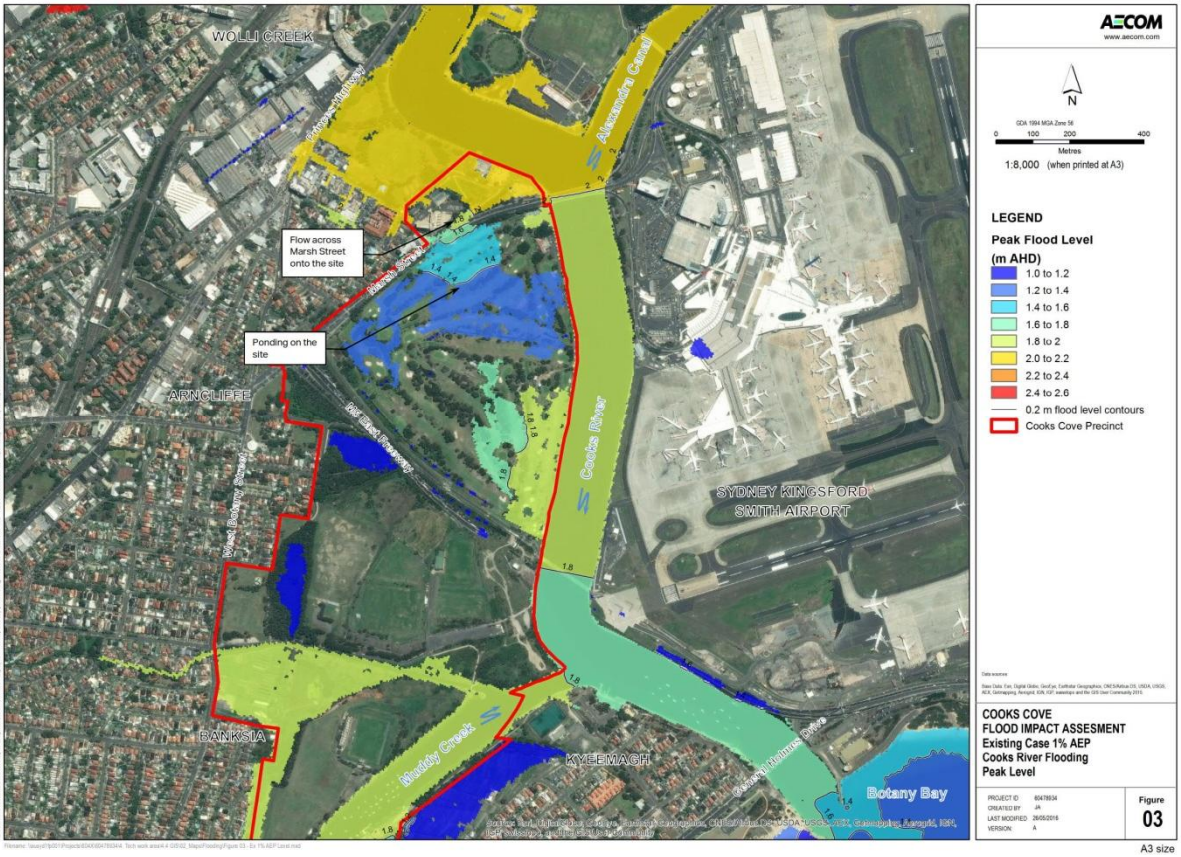

Figure 3 Peak flood levels

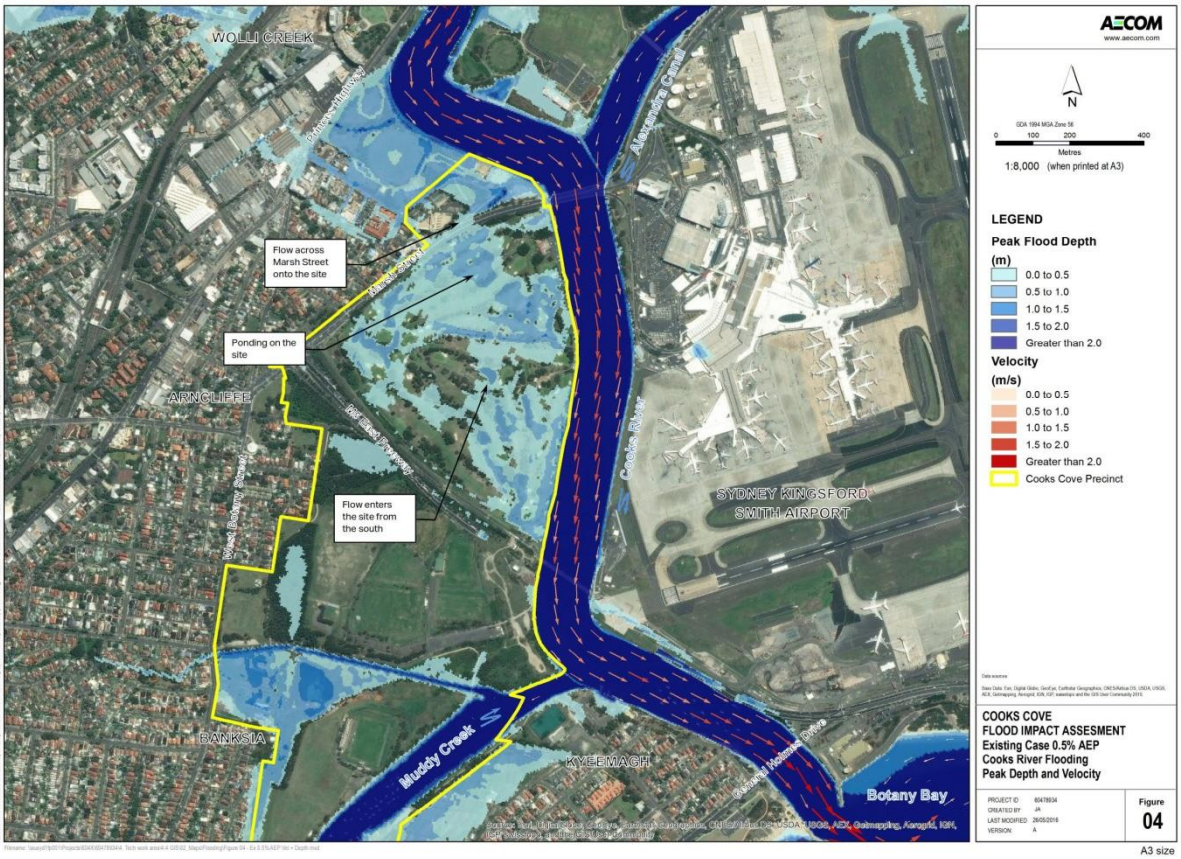

Figure 4 peak flood depths and velocities for the 0.5% AEP flood

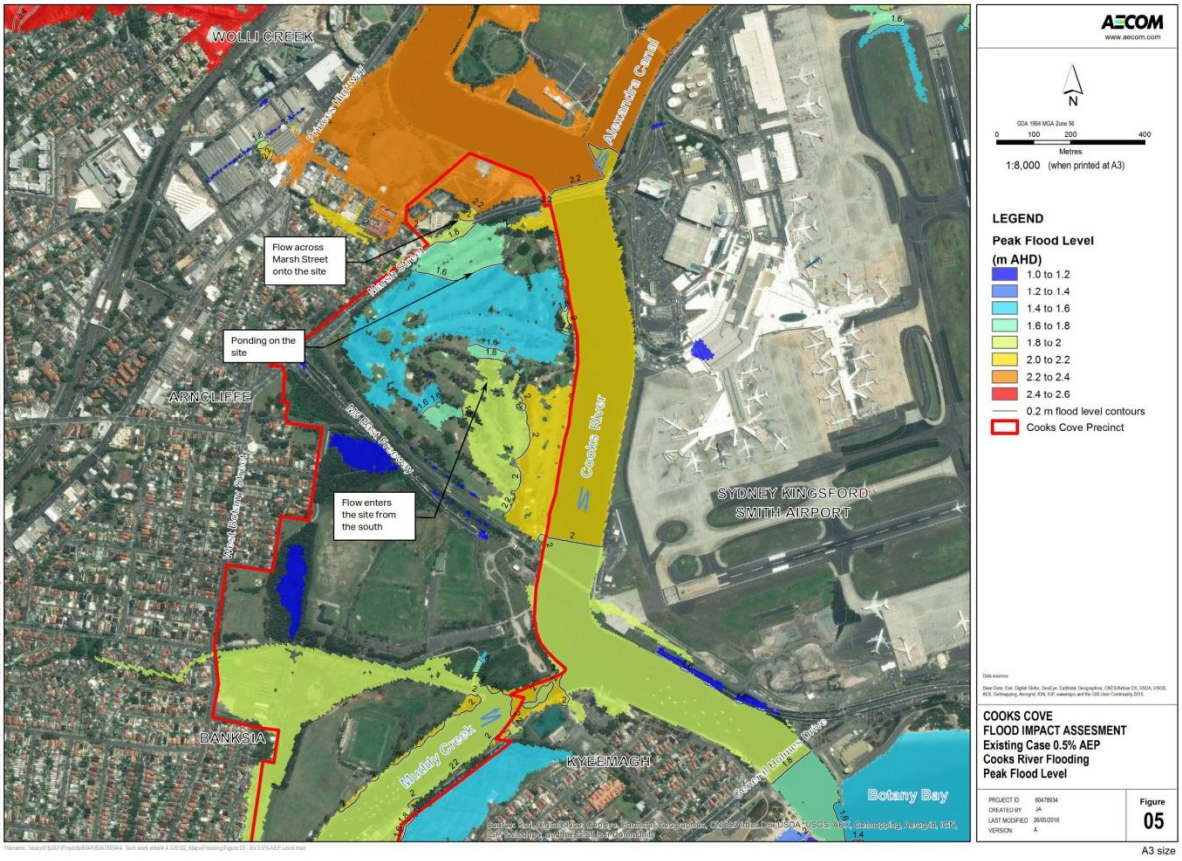

Figure 5 Peak flood levels for 0.5% flood event

3.0 Proposed Development Scenario

The extent of the proposed development is illustrated in **Figure 6**. A mixture of commercial and residential use buildings have been identified for the site. Due to the nature of the development, it is likely that area will also have to be set aside for community infrastructure, for example, a school.

Areas to be developed will be required to be elevated above the Flood Planning Level (FPL). It is understood that Rockdale City Council has set the FPL at 500 mm above the 0.5% AEP flood level. For the majority of the site, this will require that the development areas are elevated above 2.7 m AHD.

Development of the site will require that roads and open space are set aside to manage the flooding on the site. For events up to and including the 1% AEP, this flooding is predominantly a result of the flow entering the site from the north across Marsh Street. To manage flooding fro the Cooks River which flows over Marsh Street during the 1% AEP flood, a water body with a dry weather elevation of 0.7 m AHD is recommended in the mid portion of the site. An overland flow path with elevations of between 1.1 and 1.5 m AHD connecting Marsh Street to this water body is also recommended.

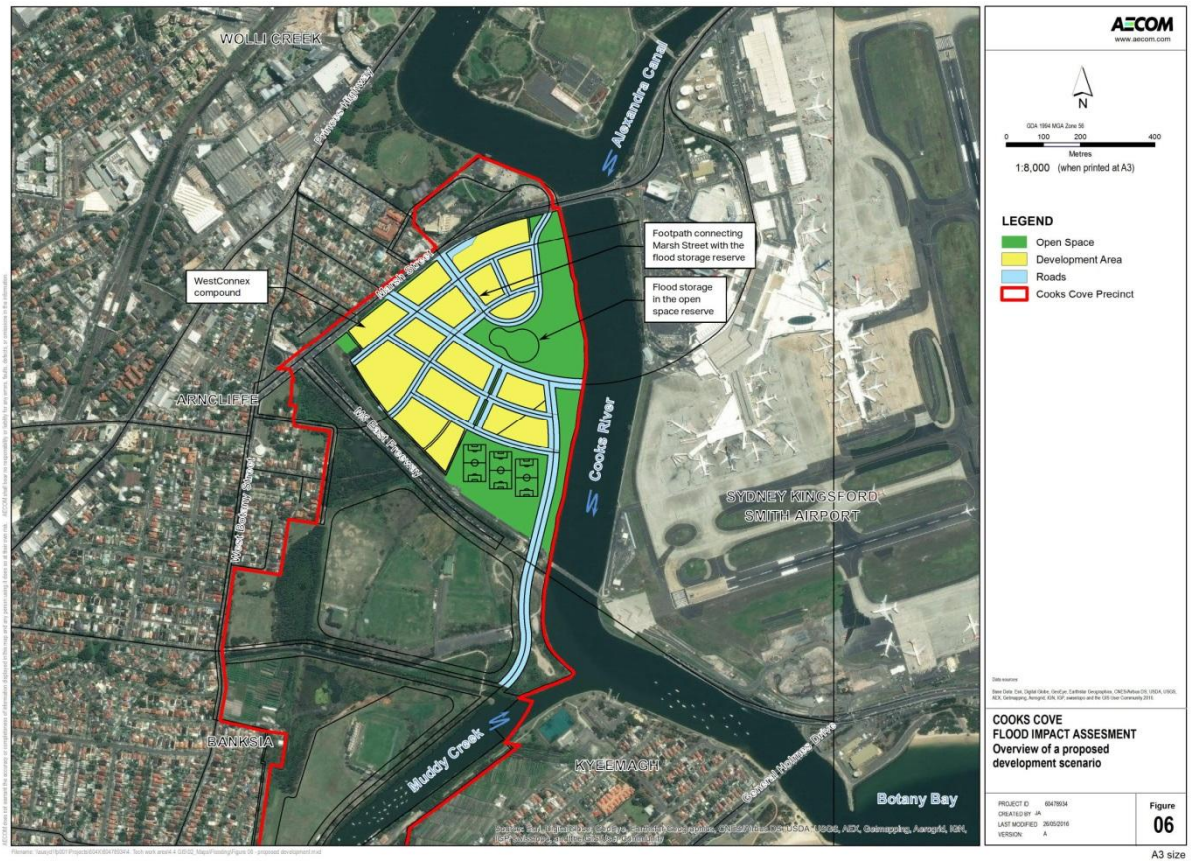

Figure 6 proposed development for Cooks Cove Site

4.0 Potential Impact of the Proposed Development Scenario on the 1% AEP Flood

Flood impacts for the 1% AEP Cooks River flood are shown in **Figure 7,** which shows that off-site impacts are negligible. During river flooding events, the majority of the floodwater is conveyed in the Cooks River channel, with the overbank areas having been blocked by previous development. The recommended roads and flood storage areas in the proposed Cooks Cove development area act to offset any impacts to properties north of Marsh Street.

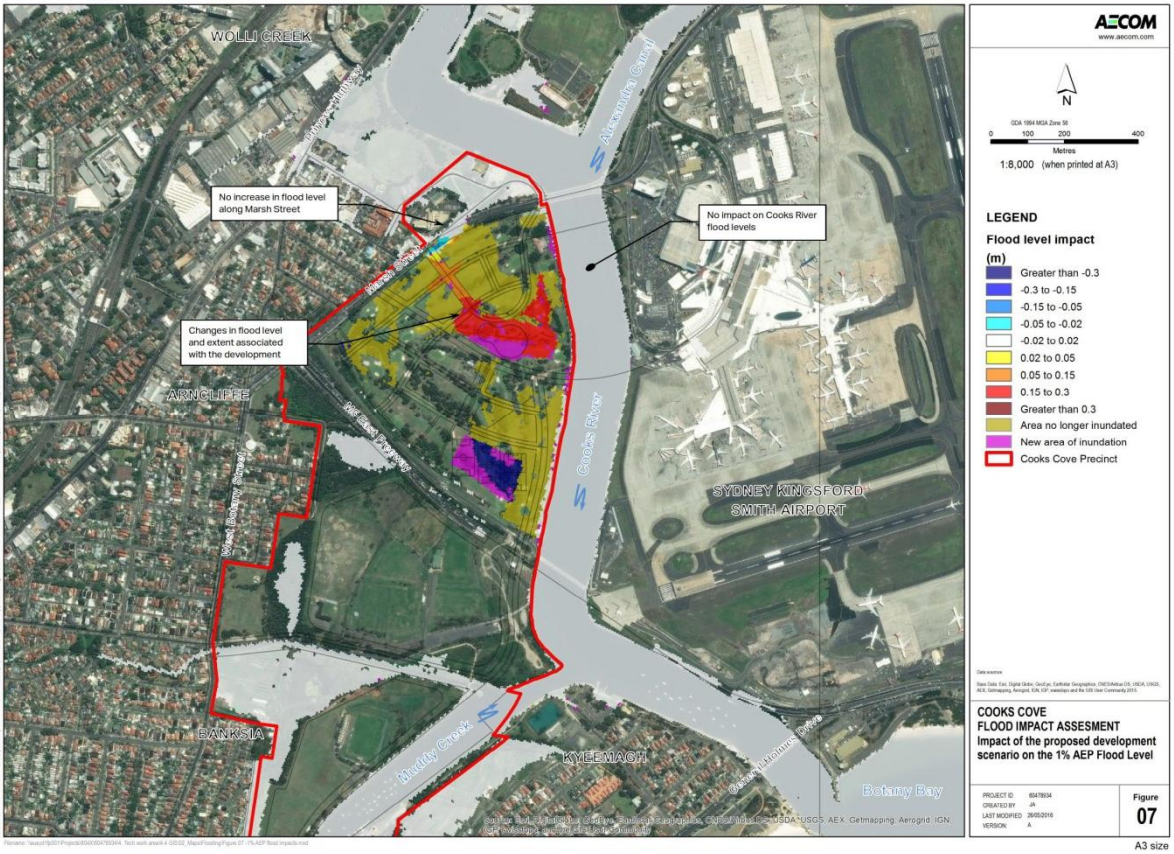

Figure 7 Flood impacts for the 1% AEP Cooks River flood

5.0 Sensitivity Analysis to Consider the Joint Effect of Elevated Water Levels in Botany Bay and River Flooding

As the site is located close to Botany Bay, elevated water levels in Botany Bay will have an influence on flooding at the site. To provide consistency with the *Floodplain Risk Management Guide: Modelling the Interaction of Catchment Flooding and Oceanic Inundation in Coastal Waterways* (OEH 2015), a scenario was developed to include an elevated water level of 1.7 m AHD for the 1% AEP tidal level, in combination with the 5% AEP river flood. This scenario incorporated the effects of:

- An elevated tidal level of 1.45 m AHD (1% AEP).
- Wind and wave setup of 0.25 m.

Offshore ocean levels were taken from the *Fort Denison Sea Level Rise Vulnerability Study* (Department of Environment and Climate Change, 2008). For this scenario which includes the effects of elevated water levels, the results presented are the envelope of the 1% AEP river flood with the HHWSS water level in Botany Bay, and the 1% AEP water level in Botany Bay with a 5% AEP river flood.

Figure 8 shows peak flood depths and velocities for the 1% AEP flood incorporating the joint effects of the above elevated water levels and river flooding. **Figure 9** shows the peak flood levels for the same event. In this scenario water can be seen to be entering the site from the north across Marsh Street, but also from the south. As such, flooding in the presence of elevated water levels in Botany Bay may be sensitive to variations in flood duration as longer duration events may fill the available flood storage on the site.

To manage inundation during the 1% AEP Cooks River flood when the joint effects of elevated tidal levels in Botany Bay and river flooding are considered in accordance with the most recent guidelines (OEH, 2015), the proposed recreation area to the south of the site has been set aside as a secondary flood storage area. Road levels lower than 1.6 m AHD are required to connect the two flood storage areas, while other roads within the development can be graded to facilitate drainage and to provide an appealing streetscape.

Figure 10 shows the potential flood level impacts of the development during the 1% AEP flood for the scenario incorporating the elevated water levels in Botany Bay. Off-site flooding impacts are generally negligible; however, some residual impacts of up to 90 mm are noted along the north side of Marsh Street. A larger flood storage area will likely be required to mitigate this remaining impact. This increase in levels does not alter the provisional flood hazard along Marsh Street, which remains low for all events.

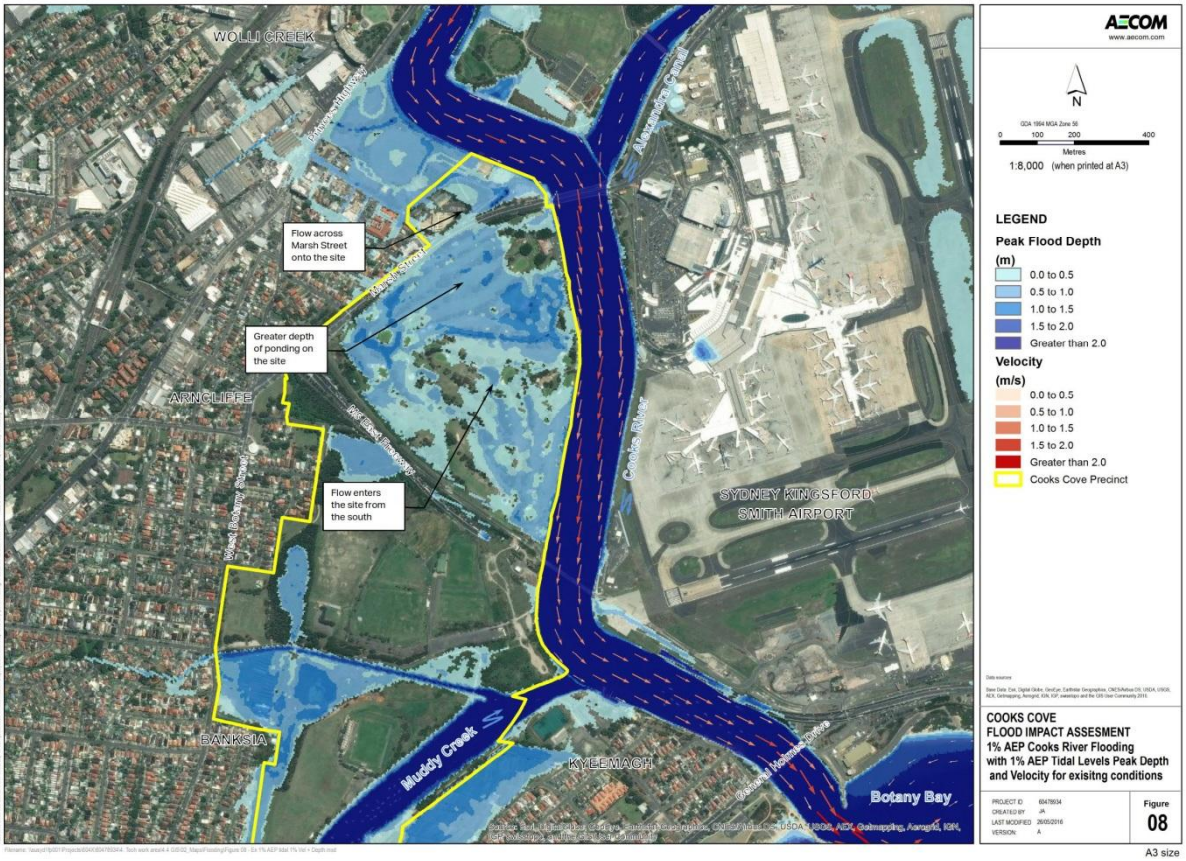

Figure 8 Peak flood depths and velocities for the 1% AEP flood

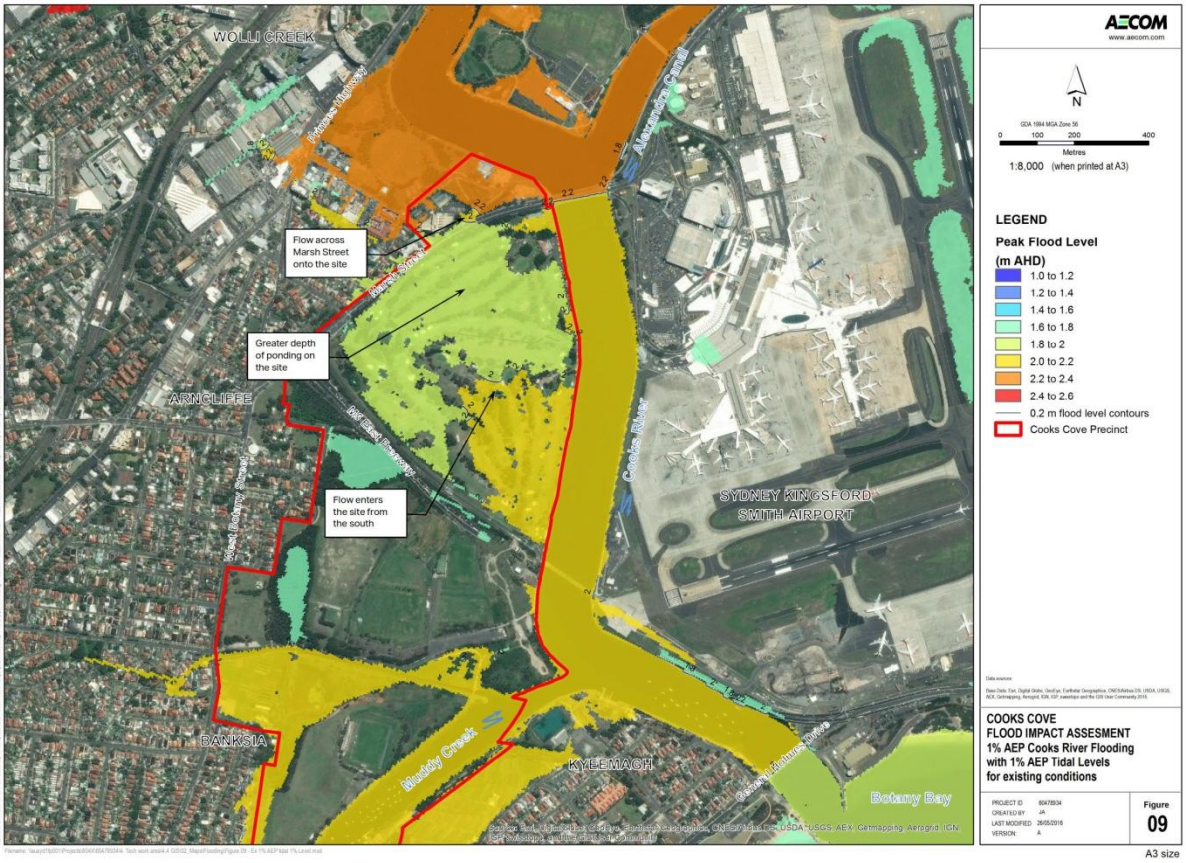

Figure 9 Peak flood levels for 1% AEP flood

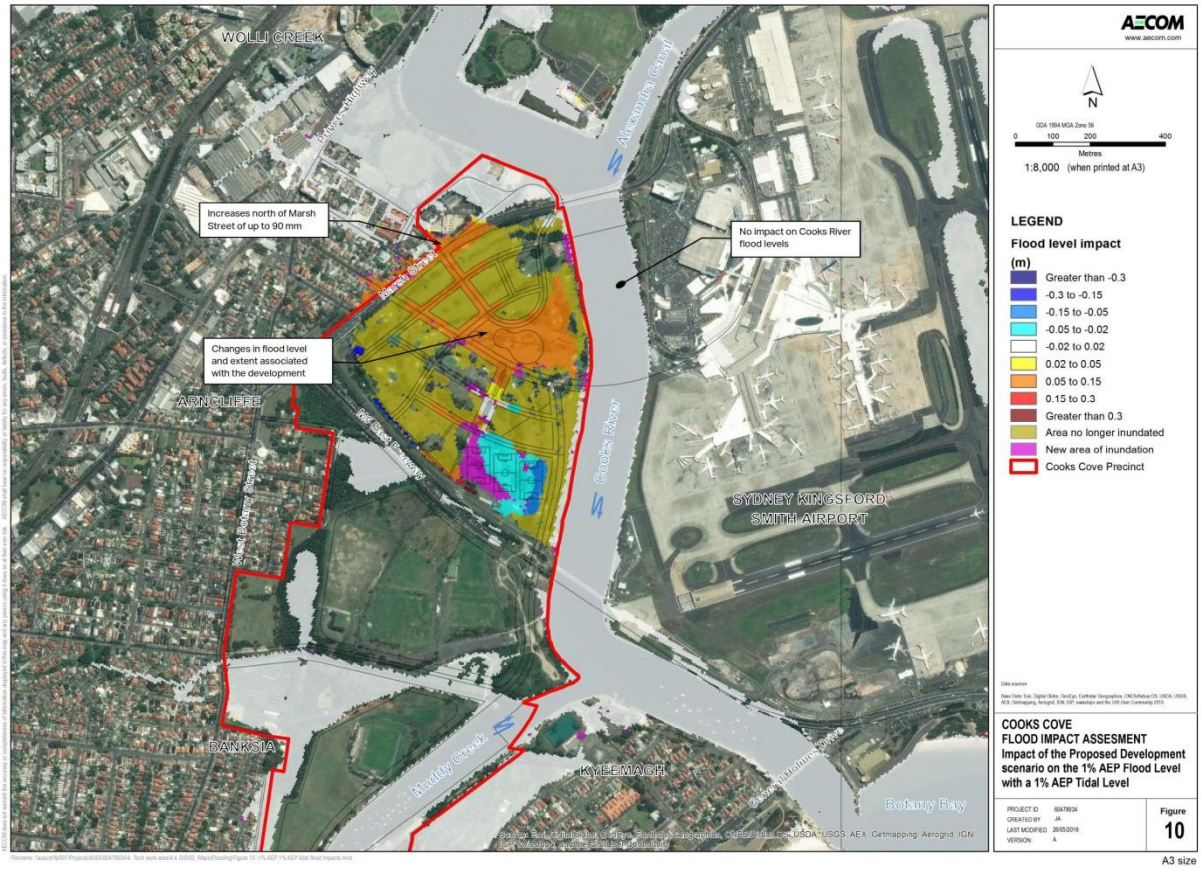

Figure 10 potential flood level impacts of the development during the 1% AEP flood for the development scenario

6.0 Conclusions

The proposed development scenario does not have broader impacts on Cooks River flooding during the 1% AEP flood as there are negligible changes in the water level both upstream and downstream of the site. There are also negligible impacts in the Cooks River when the 1% AEP water level in Botany Bay is also considered in conjunction with the 5% AEP river flood. The majority of the flood conveyance past the site takes place within the confines of the Cooks River, with the overbank conveyance having been blocked by previous developments.

However, as there is still a flow entering the site from the north by flowing across Marsh Street, and there is the potential that if this is blocked there will be residual impacts to the north of Marsh Street. These residual impacts can be managed in the 1% AEP Cooks River flood with the construction of a flood conveyance channel and flood storage area. These features will require integration with the final urban design once this is determined, and the final form of these features can be adapted to suit the adopted urban design masterplan.

For the events that incorporate the 1% AEP water level in Botany Bay coincident with the 5% AEP river flood, level impacts of up to 90 mm have been identified north of Marsh Street. Further work to identify the event duration that results in the maximum water level on the site should be undertaken for both the existing and proposed conditions, and this assessment should consider the effect of local catchment runoff and drainage, as well as the effectiveness of the embankment along the western bank of the Cooks River.

When the 1% AEP water level in Botany Bay is included in the model with the 5% AEP river flood, peak flood levels in the Cooks River are greater than defined in the *Cooks River Flood Study* (PB-MWH Joint Venture, 2009), the *Cook Cove – Stage 2 Open Space DA Flood impact Assessment* (WorleyParsons 2010), or the *Bonnie Doon Flood Study* (WMAWater, 2016). As such, the impacts shown in the 1% AEP, when it includes the effects of the 1% AEP water levels in Botany Bay coincident with a 5% AEP river flood, may be conservative when compared to the approach adopted as part of other studies.

Management of a flooding emergency will also require further consideration once the final form of the development has been determined. The *Cooks River Flood Study* (PB-MWH Joint Venture 2009) indicated that the peak level over the site during the PMF was between 3.0 and 3.2 m AHD. This flood level is significantly greater than the major roads surrounding the site, such as Marsh Street (approximately 1.4 m AHD at the low point), and during such an event it is likely that people on the site will be required to shelter in place. As the critical duration of the Cooks River is relatively short at 2 hours, and the area surrounding the development, including Wolli Creek, are relatively densely populated, it is unlikely that alternative response approaches are viable. However, emergency services including the SES should be consulted as part of developing the precinct masterplan for the development.

7.0 References

Department of Environment and Climate Change (2008) *Fort Denison Sea Level Rise Vulnerability Study*.

Department of Finance & Services: Manly Hydraulics Laboratory (2012), *OEH NSW Tidal Planes Analysis: 1990-2010 Harmonic Analysis,* prepared for NSW Office of Environment and Heritage.

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