Appendix G
Hydrology and flooding assessment

Jacobs

Memorandum

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Subject	**Clyde Stabling and Maintenance Facility Modification report**	**Project Name**	Metro West
Attention	Ari Stypel, Sydney Metro	**Project No.**	IA199800
From	Lih Chong		
Date	3 November 2021		
Copies to	Ryan Butler, Sydney Metro		

1. Introduction

1.1 Overview

Sydney Metro is Australia's biggest public transport program. The Sydney Metro West project is part of the broader Sydney Metro and includes a new 24-kilometre metro line that will connect Greater Parramatta with the Sydney CBD. Stations include Westmead, Parramatta, Sydney Olympic Park, North Strathfield, Burwood North, Five Dock, The Bays, Pyrmont and Hunter Street (Sydney CBD). This infrastructure investment will double the rail capacity of the Greater Parramatta to Sydney CBD corridor with a travel time target between the two centres of about 20 minutes.

The planning approval process for Sydney Metro West is being completed as a staged infrastructure application under section 5.20 of the *Environmental Planning and Assessment Act 1979* (EP&A Act).

1.2 The approved project

Planning approval Sydney Metro West Project Concept, from Westmead to the Sydney CBD, as well as station excavation and tunnelling between Westmead and The Bays (the approved project) was granted by the Minister for Planning and Public Spaces on 11 March 2020 (SSI-10038) and is described in the following documents:

- The Sydney Metro West Environmental Impact Statement – Westmead to The Bays and Sydney CBD (Sydney Metro, 2020a)
- The Sydney Metro West Westmead to The Bays and Sydney CBD Submissions Report (Concept and Stage 1) (Sydney Metro, 2020b)
- The Sydney Metro West Westmead to The Bays and Sydney CBD Amendment Report (Concept and Stage 1) (Sydney Metro, 2020c)
- Conditions of Approval for Sydney Metro West – Concept and Stage 1 Construction (SSI 10038) (Department of Planning and Environment, 2021)

1.3 The proposed modification

The proposed modification relates to the major civil construction work at the Clyde stabling and maintenance facility and would include:

- Rosehill dive structure relocation and extension

- Kay Street and Unwin Street realignment.

These changes to the design for the approved project would require:

- Additional land required for future planning applications brought forward
- Additional impact to heritage not assessed as part of the approved project
- Additional impact to biodiversity not assessed as part of the approved project

There would be no changes proposed to the Concept as described in Chapter 6 (Concept description) of the Environmental Impact Statement.

1.4 Project description

1.4.1 Rosehill dive structure

The Rosehill dive structure is required to provide for a future connection from the Clyde stabling and maintenance facility to the mainline tunnels. The proposed modification includes:

- Relocation east and extension of the Rosehill dive structure further north within the former T6 Carlingford Line
- Additional construction area, previously identified in the Environmental Impact Statement as required for future use, to allow for:
  - Enabling works as outlined in Section 9.4.1 of the Environmental Impact Statement
  - Removal of the Rosehill Railway Station Footbridge which is of local heritage significance, listed under the RailCorp Heritage and Conservation Register under Section 170 of the *Heritage Act 1977* (NSW), and provision for an alternative crossing of the former T6 Carlingford Line prior to removal of the footbridge
  - Removal of the platforms and station furniture at the former Rosehill Railway Station
- Minor realignment of the tunnel portal connecting the mainline tunnels to the revised Rosehill dive structure location.

The revised Rosehill dive structure is presented in **Figure 1**. Further investigation into temporary facilities to support additional access to the tunnels would be considered as part of detailed construction planning.

Figure 1 Clyde stabling and maintenance facility indicative construction site (proposed modification)

1.4.2 Kay Street and Unwin Street realignment

The realignment of Kay Street and Unwin Street is required to provide general traffic and B-double access around the Clyde stabling and maintenance facility construction site. The proposed modification includes the following changes to the Kay Street and Unwin Street realignment:

- A road bridge as opposed to an underpass to cross the future metro rail tracks
- Elevation of the Kay Street and Unwin Street realignment for about 250 metres
- Minor realignment of the Kay Street and Unwin Street route
- A shared path to accommodate pedestrians and cyclists on one side.

The revised Kay Street and Unwin Street realignment is presented in **Figure 2**.

The proposed modification does not include any changes to the culverts located at A'Becketts Creek and Duck Creek assessed as part of the approved project. These structures and the changes to A'Becketts Creek and Duck Creek as part of the approved project are subjective to ongoing design development to ensure project outcomes are met.

Figure 2 Kay Street and Unwin Street route realignment (proposed modification)

1.5 Purpose of this memo

This memo documents the review of the proposed modifications listed in Section 1 as they relate to hydrology and flooding. It provides the details on the assessment of potential hydrology and flooding impacts that may result due to those proposed modifications .

2. Changes to legislative and policy context

The legislative and policy context used to assess the hydrology and flooding impacts for the Concept and Stage 1 are discussed in Chapter 21 of the Environmental Impact Statement. The assessment was undertaken generally in accordance with the following key guidelines and design references as applicable:

- *NSW Floodplain Development Manual* (NSW Government, 2005), which incorporates the NSW Government's *Flood Prone Land Policy*
- Australian Rainfall and Runoff (ARR). ARR 1987 was adopted for hydrologic inputs into the flood modelling for consistency with adopted Council flood studies, while the flood risk management guidelines (such as flood hazard categorisation) from ARR 2019 were also referenced.

The provisions of the Flood Prone Land Policy were previously administered via the 2007 Planning Circular PS 07-003, which provided information on how to consider flooding in land use planning. New amendments came into effect on 14 July 2021 via Planning Circular PS 21-006: Considering flooding in land use planning: guidance and statutory requirements.

The new provisions have been introduced in connection with the NSW Government's new 'flood-prone land package' which aims to improve the management of flood risk in light of recent flooding events that have caused significant risk to life and damage to property, including up to and beyond the 1% annual exceedance probability (AEP) flood level. To achieve this, consent authorities will be able to consider the full range of flood behaviour, including up to the probable maximum flood (PMF) level.

These updates do not have direct or material impact to the assessment of the proposed modification, as the project is identified as State Significant Infrastructure which is not required to comply with the flood-prone land package requirements, and in any case, the potential flood impacts of the project were assessed for flood events up to and including the PMF with due consideration by the relevant planning authorities.

3. Impact assessment of proposed modification

3.1 Method

The assessment of the potential impacts of the proposed modifications on hydrology and flooding included:

- Review the nature of the proposed modification
- Identify where the proposed modification would be expected to result in a change to the previously identified flooding impacts for the approved project (see **Table 3-1**)
- Where the modification have the potential to impact on hydrology and flooding, undertake a desktop review of the nature and likely quantum of the impacts.

The proposed modification and expected impacts are outlined in **Table 3-1**. The assessment found that one aspect of the modification would have the potential to change the hydrology and flooding impacts from that as described in the amendment to the Environmental Impact Statement. Where impacts may change, the assessment is detailed in **Section 3.2**.

Table 3-1 Proposed modification hydrology and flooding impact screening*

	Proposed change	Comparison of potential impacts of proposed modification against approved project	Further detailed assessment required?
Clyde stabling and maintenance facility construction site			
1	Rosehill dive structure	The dive structure for the approved project would not be flood affected, and only affected by shallow, minor overland flow and drainage runoff. The revised dive structure would have similar exposure to flooding/runoff to the approved project. The former Rosehill train station and footbridge would not be affected by flooding. No impacts are expected	No
2	Kay Street and Unwin Street realignment	Construction of an overpass and related design refinements may have the potential to interact with flooding differently to the approved project.	Yes, refer to Section 3.2

* The screening of the proposed modification for potential flood impacts considers whether each modification change would impact flooding behaviour compared to the approved project.

3.2 Kay Street and Unwin Street realignment assessment

3.2.1 Description

The realignment of Kay Street and Unwin Street to include a road underpass, to cross the future Metro rail tracks, at the Clyde stabling and maintenance facility construction site for the approved project is proposed to be changed bridge for the proposed modification. As a result, the following design refinements would also be carried out which may change the flooding impacts:

- Removal of road dive structures and associated flood-proofing retaining walls surrounding the dives
- Introduction of bridge approach embankments on the floodplain (particularly north of A'Becketts Creek)
- Minor change in road alignment and embankment area.

The flood depths for the approved project are shown for the 1% AEP and probable maximum flood events on **Figure 3** and **Figure 4**, respectively. The Clyde stabling and maintenance facility filled embankment outline, as assessed for the approved project, is shown with a pink outline. The Kay Street and Unwin Street realignment is shown with a green line to illustrate its potential effect on the flood impacts. It is observed that the line of the proposed modification falls mainly within the approved project embankment and hence no substantial change to the embankment is proposed. The exception is the northern bridge approach, which represents an expansion of the embankment in that location, and a minor widening of the embankment on its western side due to the proposed B-double road embankment extending up to 10 metres outside the previously proposed embankment. Further design development which may include incorporation of retaining walls instead of sloped embankment sides to limit the expanded extent of the embankment could reduce the potential change in flood impacts.

The Clyde stabling and maintenance facility embankment is designed to be above the probable maximum flood for the approved project, and no changes to this design aspect are proposed.

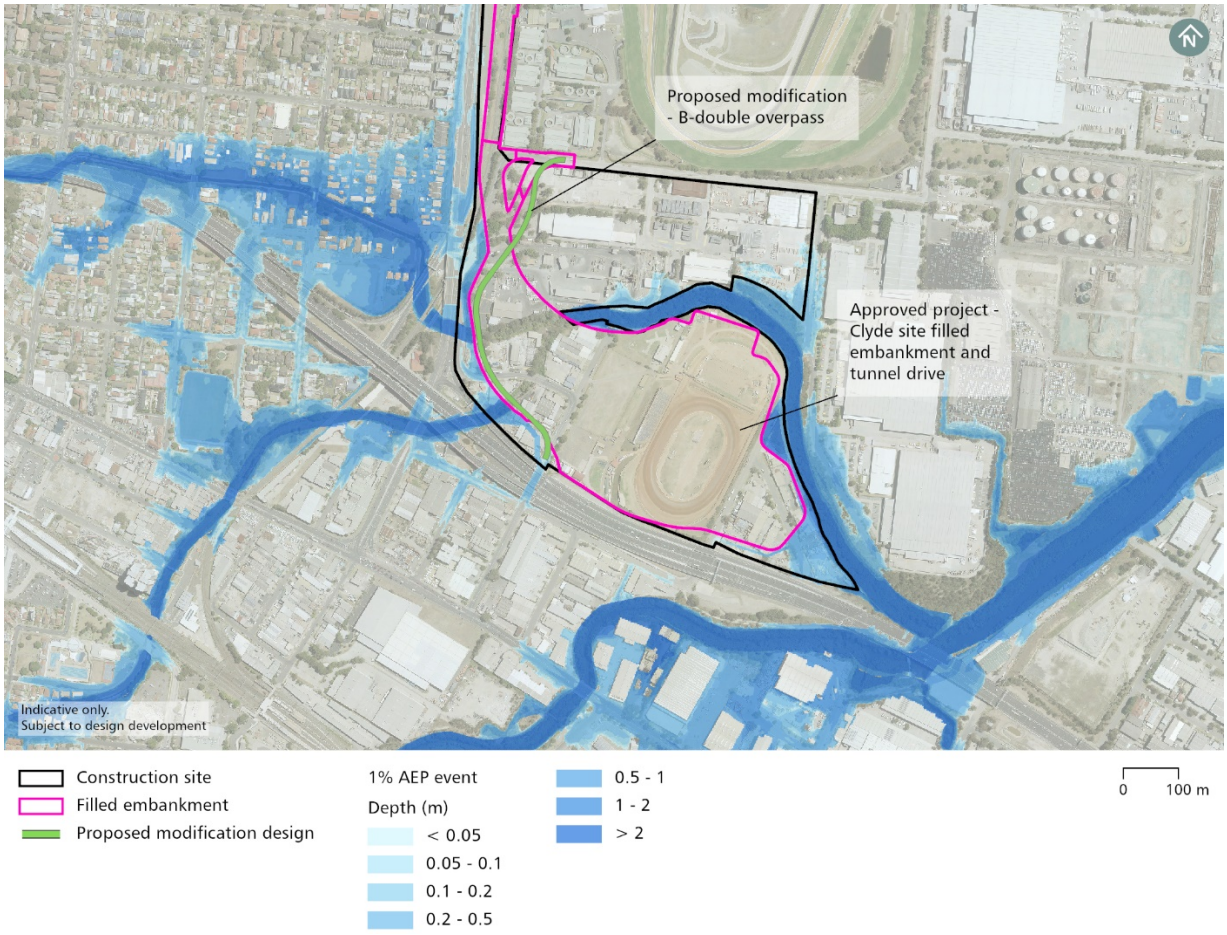

Figure 3: Flood depths for approved project (with revised Kay Street and Unwin Street alignment overlaid for assessment of change in flood impacts with the modification) – 1% AEP event

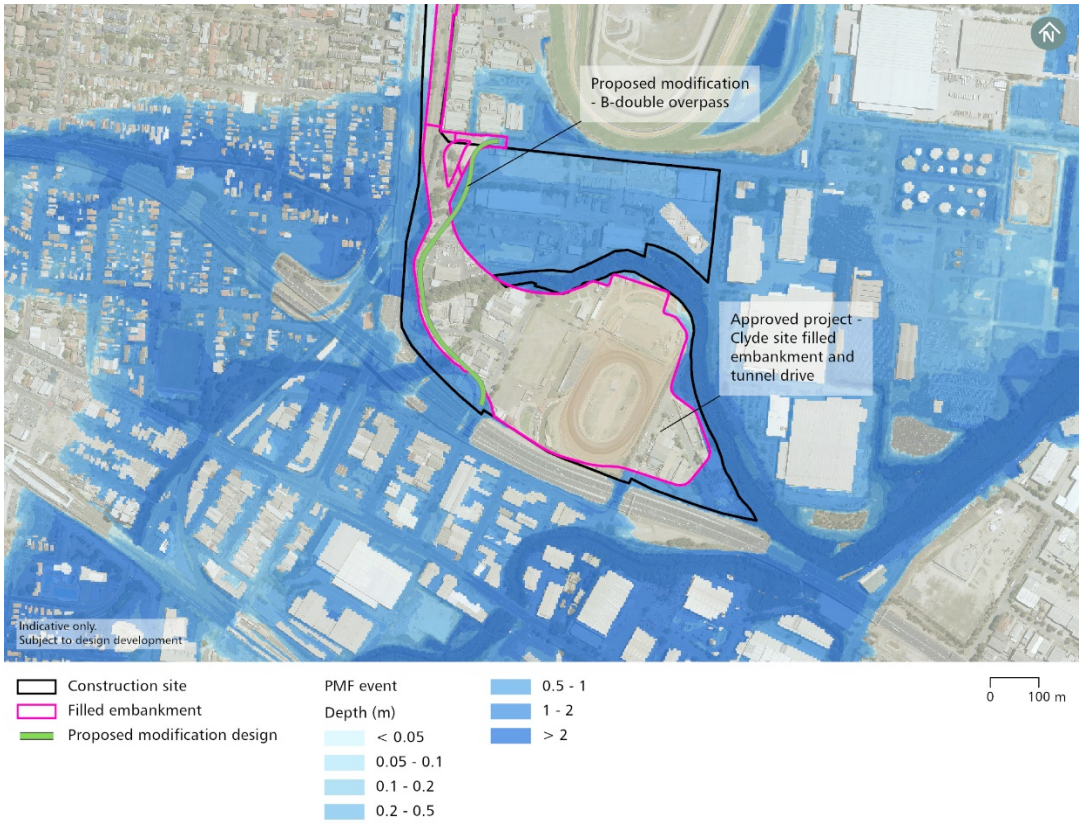

Figure 4: Flood depths for approved project (with revised Kay Street and Unwin Street alignment overlaid for assessment of change in flood impacts with the modification) – PMF event

3.2.2 Potential impacts on flood behaviour

A qualitative assessment of the proposed modification on flooding behaviour and flood impacts has been undertaken. The expected flooding impacts compared to existing conditions are described for the proposed modification and are summarised in **Table 3-2**. Where the impacts are changed from those with the approved project, these are shown in bold text in the second column. In general, the flood impacts (change from existing conditions), with the design modifications at Clyde stabling and maintenance facility construction site would be similar to the flood impacts for the approved project, for the one per cent annual exceedance probability (AEP) event and the probable maximum flood (PMF) event.

Table 3-2 Potential flooding impacts for the proposed modification – Clyde stabling and maintenance facility construction site

Potential impact	Description as per approved project (change in flood behaviour from existing)	Description with modification (change in flood behaviour from existing)	Change in impact (approved project to proposed modification)
Change in peak flooding levels	Potential reduction in peak flood levels on the Duck Creek floodplain of up to 0.3 metres during the five per cent and one per cent AEP event (upstream of the Clyde stabling and maintenance facility).	Potential reduction in peak flood levels on the Duck Creek floodplain of up to 0.3 metres during the five per cent and one per cent AEP event (upstream of the Clyde stabling and maintenance facility).	Negligible change in flood behaviour expected in relation to this flood impact. Minor widening (up to 4 metres widening) of embankment in Duck Creek floodplain upstream of the Clyde stabling and maintenance facility is not expected to significantly affect flood behaviour. No significant modifications to the Duck Creek culvert design is proposed.
	Potential reduction in peak flood levels on the A'Becketts Creek floodplain of up to 0.09 metres during the five per cent and one per cent AEP events (upstream of the Clyde stabling and maintenance facility).	Potential reduction in peak flood levels on the A'Becketts Creek floodplain of up to 0.09 metres during the five per cent and one per cent AEP events (upstream of the Clyde stabling and maintenance facility).	Negligible change in flood behaviour expected in relation to this flood impact. Minor widening (up to 10 metres widening) of western side of the Clyde stabling and maintenance facility embankment in A'Becketts Creek floodplain is not expected to significantly affect flood behaviour. No significant changes to the A'Becketts Creek Duck Creek culvert design is proposed.

Potential impact	Description as per approved project (change in flood behaviour from existing)	Description with modification (change in flood behaviour from existing)	Change in impact (approved project to proposed modification)
	Potential increase in peak flood levels in and adjacent to Duck Creek and Duck River of up to 0.03 metres during the five per cent and one per cent AEP events (downstream of the Clyde stabling and maintenance facility). Increases in flood levels in bunded ponding areas on Viva Energy site at the downstream end of Duck River of 0.1 to 0.14 metres in the one per cent AEP event, as a result of the minor increase in flood levels in Duck River. The volume of water overflowing to the bunded areas and the flood levels in the bunded is sensitive to the Duck River flood levels.	Potential increase in peak flood levels in and adjacent to Duck Creek and Duck River of up to 0.03 metres during the five per cent and one per cent AEP events (downstream of the Clyde stabling and maintenance facility). Increases in flood levels in bunded ponding areas on Viva Energy site at the downstream end of Duck River of 0.1 to 0.14 metres in the one per cent AEP event, as a result of the minor increase in flood levels in Duck River. The volume of water overflowing to the bunded areas and the flood levels in the bunded is sensitive to the Duck River flood levels.	No change in flood behaviour expected in relation to this flood impact. No significant changes to the A'Becketts Creek and Duck Creek culvert designs or filled embankment design, which would result in flood behaviour changes in this location, are proposed.
	Potential increase in peak flood levels in the PMF event (upstream and downstream of the Clyde stabling and maintenance facility) up to 0.09 metres in the A'Becketts Creek floodplain.	Potential increase in peak flood levels in the PMF event (upstream and downstream of the Clyde stabling and maintenance facility) up to 0.09 metres in the A'Becketts Creek floodplain.	Negligible change in flood behaviour expected in relation to this flood impact. Minor widening (up to 10 metres widening) of embankment in A'Becketts Creek floodplain upstream of the Clyde stabling and maintenance facility is not expected to significantly affect flood behaviour. No significant changes to the A'Becketts Creek Duck Creek culvert design is proposed.

Potential impact	Description as per approved project (change in flood behaviour from existing)	Description with modification (change in flood behaviour from existing)	Change in impact (approved project to proposed modification)
	Potential increase in peak flood levels in the PMF event (upstream and downstream of the Clyde stabling and maintenance facility) up to 0.15 metres in the Duck Creek floodplain upstream of the culvert crossing.	Potential increase in peak flood levels in the PMF event (upstream and downstream of the Clyde stabling and maintenance facility) up to 0.15 metres in the Duck Creek floodplain upstream of the culvert crossing.	Negligible change in flood behaviour expected in relation to this flood impact. Minor widening (up to 4 metres widening) of embankment in Duck Creek floodplain upstream of the Clyde stabling and maintenance facility is not expected to significantly affect flood behaviour. No significant changes to the A'Becketts Creek Duck Creek culvert design is proposed.
	Potential increase in peak flood levels in the PMF event (upstream and downstream of the Clyde stabling and maintenance facility) up to 0.08 metres in Duck Creek downstream of the culvert.	Potential increase in peak flood levels in the PMF event (upstream and downstream of the Clyde stabling and maintenance facility) **up to 0.09 metres in localised areas** in Duck Creek downstream of the culvert.	There is expected to be minor increases in PMF levels downstream of the Clyde stabling and maintenance facility, due to a loss in floodplain storage resulting from the modification's northern bridge approach. Increase in PMF level from approved project conditions is estimated to be less than 0.01 metres.
	Potential increase in peak flood levels in the PMF event (upstream and downstream of the Clyde stabling and maintenance facility) up to 0.1 metres in the Duck River floodplain (upstream of the M4 Motorway).	Potential increase in peak flood levels in the PMF event (upstream and downstream of the Clyde stabling and maintenance facility) up to 0.1 metres in the Duck River floodplain (upstream of the M4 Motorway).	No change in impact compared to the approved project.

Potential impact	Description as per approved project (change in flood behaviour from existing)	Description with modification (change in flood behaviour from existing)	Change in impact (approved project to proposed modification)
	Potential reduction in peak flood levels in the PMF event of up to 0.05 metres on the south-western section of Rosehill Gardens Racecourse grounds, and increases of up to 0.04 metres along the southern boundary of Rosehill Gardens Racecourse grounds.	Potential reduction in peak flood levels in the PMF event of up to **0.04 metres** on the south-western section of Rosehill Gardens Racecourse grounds, and increases of up to **0.05 metres** along the southern boundary of Rosehill Gardens Racecourse grounds.	Increase in PMF level from approved project conditions is estimated to be less than 0.01 metres due to a loss in floodplain storage resulting from the Kay Street and Unwin Street realignment northern bridge approach.
Change in flood extent	Potential minimal increases in the flood extent for all events up to the PMF.	Potential minimal increases in the flood extent for all events up to the PMF.	No consequential change compared to approved project.
	Potential maximum increases in the PMF extent of around 10 metres and typical increases of less than five metres.	Potential maximum increases in the PMF extent of around 10 metres and typical increases of less than five metres.	
Change in flood hazard	Potential minor increases in high flood hazard extent in the one per cent AEP and PMF events.	Potential minor increases in high flood hazard extent in the one per cent AEP and PMF events.	No consequential change compared to approved project.
	Some potential reductions in the high hazard extent on the Duck Creek and A'Becketts Creek floodplains upstream of the Clyde stabling and maintenance facility in the one per cent AEP event.	Some potential reductions in the high hazard extent on the Duck Creek and A'Becketts Creek floodplains upstream of the Clyde stabling and maintenance facility in the one per cent AEP event.	

Potential impact	Description as per approved project (change in flood behaviour from existing)	Description with modification (change in flood behaviour from existing)	Change in impact (approved project to proposed modification)
Change in duration of inundation	No significant increases in the duration of inundation.	No significant increases in the duration of inundation.	No change compared to approved project.
Property impacts	Potential minor increases in flood levels of 0.01 to 0.02 metres at industrial properties adjacent to Duck River in Auburn in the one per cent AEP events.		No change compared to approved project.
	Potential increases in flood levels of 0.03 metres at commercial and industrial properties near the Duck Creek and Duck River confluence in the one per cent AEP event.	Potential increases in flood levels of 0.03 metres at commercial and industrial properties near the Duck Creek and Duck River confluence in the one per cent AEP event.	No change compared to approved project.
	No newly-affected properties in the one per cent AEP event.	No newly-affected properties in the one per cent AEP event.	No change compared to approved project.
	Potential for five newly-affected properties in the PMF event.	Potential for five newly-affected properties in the PMF event.	No change expected compared to approved project. Negligible change in flood extent expected.
Critical infrastructure impacts	No significant impacts to critical infrastructure.	No significant impacts to critical infrastructure.	No change compared to approved project.
Climate change impacts	No increase in the flood protection level required to account for the effects of climate change on flooding.	No increase in the flood protection level required to account for the effects of climate change on flooding.	No change compared to approved project.

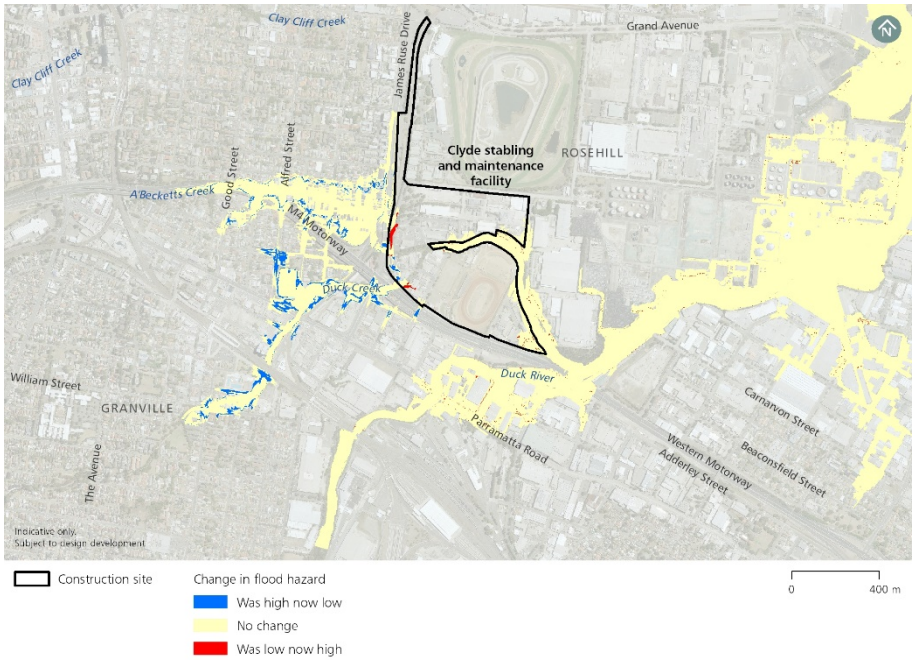

Figure 5: Potential change in flood hazard at the Clyde stabling and maintenance facility construction site – one per cent AEP event for the approved project compared to existing environment. Negligible changes are expected with the proposed modification.

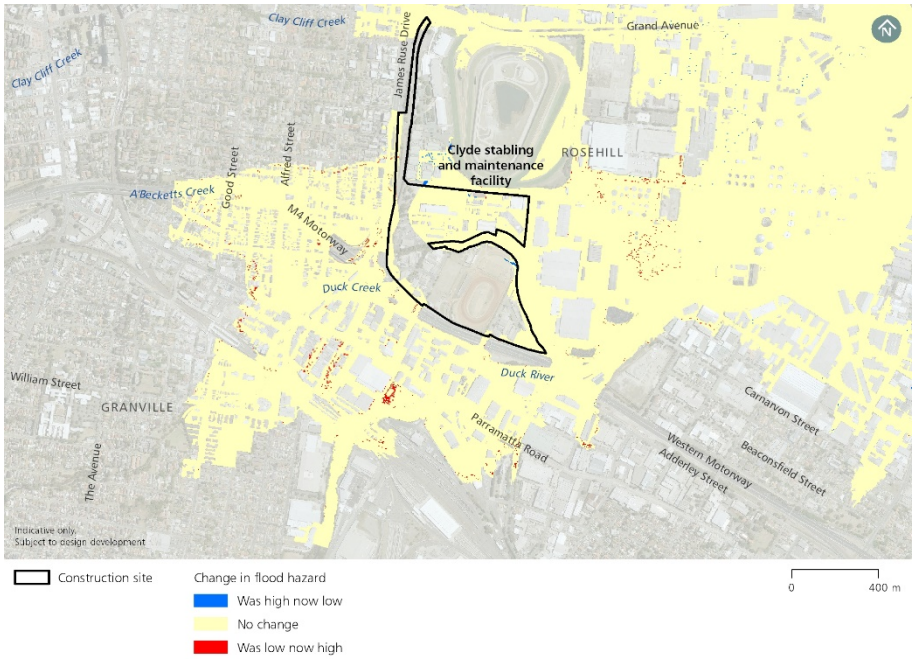

Figure 6: Potential change in flood hazard at the Clyde stabling and maintenance facility construction site – probable maximum flood event for the approved project compared to existing environment. Negligible changes are expected with the proposed modification.

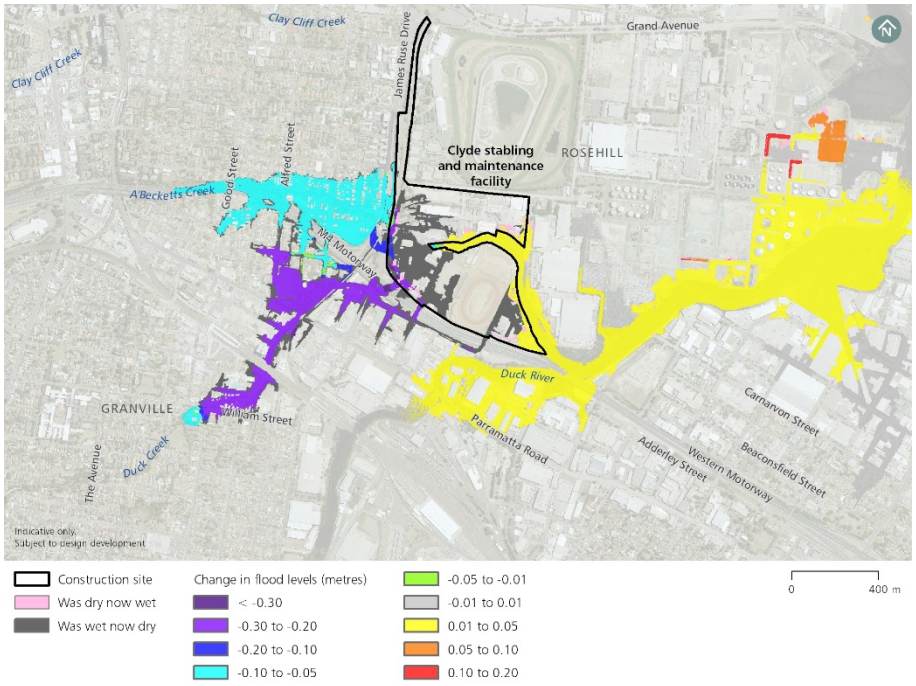

Figure 7: Potential change in flood levels at Clyde stabling and maintenance facility construction site – one per cent AEP event for the for the approved project compared to existing environment. Negligible changes are expected with the proposed modification.

3.2.3 Potential downstream velocity and scour impacts

No significant modifications to the A'Becketts Creek and Duck Creek culverts are proposed. The culverts may be extended by short lengths at their inlets to accommodate slightly wider filled embankment due to the modification of the B-double route design. This is not expected to significantly change the flows through the culverts or the culvert outlet velocities. Hence, no change to potential downstream velocity and scour impacts from the approved project are expected.

It is expected that the detailed design would appropriately consider the construction stage flow velocities at the culvert crossing outlets and in the downstream channel in the design of required scour protection works.

3.2.4 Floodplain risk management

As there are no adopted floodplain risk management plans or proposed/implemented measures in the vicinity of the Clyde stabling and maintenance facility construction site or the surrounding floodplain, there would be no impacts on floodplain risk management as a result of the proposed modifications.

3.2.5 Potential impacts to emergency management arrangements for flooding

The changes to potential impacts on emergency management arrangements as a result of the proposed modifications are summarised in **Table 3-3.**

Table 3-3 Changes to potential impacts to emergency management arrangements

Construction site	Identified emergency management routes, facilities and sensitive properties	Changes to potential impacts (modification from approved project)
Clyde stabling and maintenance facility	Unchanged from the approved project Emergency management routes: ▪ James Ruse Drive ▪ M4 Motorway ▪ Parramatta Road ▪ Sensitive properties: ▪ Rosehill Public School and Preschool ▪ Fun2learn Early Learning Centre ▪ Kinderoo ▪ Little Angels Kindergarten ▪ Rosehill Montessori Kindergarten.	No consequential change compared to the approved project which states: ▪ One per cent AEP flood event: potential impacts to emergency access routes, emergency facilities and sensitive properties as a result of the design amendments are not expected ▪ PMF event: potential impacts to emergency arrangements are unlikely as substantial flooding depths and high hazard is already present in the existing environment case. Parts of the Kinderoo property would potentially be affected by the PMF event with increases in flood depths of up to 0.03 metres.

3.2.6 Cumulative impacts

Negligible change in cumulative impacts is expected at the Clyde stabling and maintenance facility construction site from the approved project as a result of the proposed modification. There may be localised increases in flood levels of less than 0.01 metres on Duck Creek floodplain downstream of the Clyde stabling and maintenance facility construction site as a result of the proposed modification in the PMF event.

The proposed Camellia Town Centre redevelopment would result in potential flood impacts in the PMF event. Previous flood modelling carried out for the Clyde stabling and maintenance facility indicates the future development associated with the draft Camellia Town Centre Master Plan is not likely to impact on the Clyde stabling and maintenance facility construction site, hence there would not be cumulative impacts of the two developments in combination. The expected flood behaviour for the Clyde construction site design modification does not change this outcome.

4. Mitigation measures

The mitigation measures identified for the approved project would be applied to the proposed modification as summarised in **Table 4-1.** No changes or additional mitigation measures are required as a result of the proposed modification.

Table 4-1 Mitigation measures relevant to the Clyde stabling and maintenance facility modification (no changes from approved project)

Reference	Impact/ issue	Mitigation measure	Application location(s)[1]
HF3	Flooding behaviour impacts	Further design refinement at the Clyde stabling and maintenance facility construction site would occur during detailed design to mitigate the identified potential impacts including: ▪ The increases in flood levels of up to 0.03 metres in Duck Creek and adjacent properties in the one per cent AEP flood event ▪ Increases in flow velocities and the potential increased risk of scour at the proposed creek crossings and in the downstream channels ▪ The potential flooding impacts from filled features including the road overbridge approach.	CSMF

Note 1: CSMF: Clyde stabling and maintenance facility.

5. Conclusion

This technical memo has assessed the potential hydrology and flooding impacts resulting from the proposed modification. The potential changes, from the approved project, in flooding impacts at the Clyde stabling and maintenance facility construction site as a result of the proposed modification include:

- Negligible changes in the potential flooding impacts to properties which were previously identified in the approved project, for areas upstream of the Clyde stabling and maintenance facility construction site
- Minor increases in flood levels (up to 0.01 metres) in the PMF event downstream of the Clyde stabling and maintenance facility construction site when compared to the approved project. Some areas would experience an increase in flood levels compared to the existing case, while other areas would experience a reduction in flood levels compared to the existing case. This is a similar pattern of PMF flood impact to the approved project
- No changes expected to the identified potential flow velocity and scour impacts compared to the impacts identified for the approved project.
- Nil or negligible changes to number of properties impacted by flooding, when compared to the approved project
- Nil or no consequential changes to potential impacts to floodplain risk management plans, emergency management arrangements or cumulative flooding impacts.
- No changes to the proposed mitigation measure (HF3) identified as part of the approved project.