Appendix H

Flood Assessment
DRAINAGE AND FLOODING INVESTIGATION

MARSH STREET UPGRADE –
M5 EAST MOTORWAY TO COOKS RIVER

December 2014

DRAFT REPORT FOR CLIENT REVIEW
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5.1 Extent of Disturbed Areas

ABBREVIATIONS

AHD Australian Height Datum
ALS Airborne Laser Scanning (survey data)
ARI Average Recurrence Interval (years)
ARR Australian Rainfall and Runoff, 1998 Edition
DMR Department of Main Roads (now Roads and Maritime)
DRC Design Road Chainage
DTM Digital Terrain Model
GIS Geographic Information System
LESCA Local Erosion and Sediment Control Area
LGA Local Government Area
L&A Lyall & Associates
RCBC Reinforced Concrete Box Culvert
RCC Rockdale City Council
RCP Reinforced Concrete Pipe
RL Reduced Level
Roads and Maritime NSW Roads and Maritime Services
RTA Roads and Traffic Authority (now Roads and Maritime)
RUSLE Revised Universal Soil Loss Equation
SWMP Soil and Water Management Plan
S1 SUMMARY

S1.1 Background

An investigation was carried out by Lyall & Associates (L&A) to assess requirements for the control of stormwater runoff along the proposed upgrade of Marsh Street where it runs between the M5 East Motorway, Wolli Creek and the Cooks River, Arncliffe (Upgrade). An investigation was also carried out into the impact the Upgrade will have on main stream flooding patterns during storms which result in the Cooks River breaking its banks. This report also deals with issues relating to both the construction and operational phases of the proposed road upgrade.

The scope of the investigation comprised the following key tasks:

- Review and compilation of available drainage and flood related information.
- Development of a detailed DRAINS hydrologic / hydraulic model of the stormwater drainage system in Marsh Street (Marsh Street DRAINS Model).
- Assess the impact the Upgrade will have on main stream flooding patterns using the TUFLOW model that was developed by L&A in 2010 for the purpose of assessing upgrade requirements for the M5 East Motorway (Cooks River TUFLOW Model).
- Development of a concept drainage arrangement for the Upgrade which aims to maximise the hydrologic standard of stormwater drainage system.
- Assess requirements for an erosion and sediment control strategy which will need to be implemented during the construction phase of the Upgrade.

The extent of the catchment which is controlled by the existing stormwater drainage system in Marsh Street is shown on Figure 1.1, while Figure 2.1 shows the layout of the system, as well as other key features such pit type and pipe diameter.

S1.2 Key Features of the Existing Stormwater Drainage System

The key features of the existing stormwater drainage system are as follows:

i. Information on the stormwater drainage system which controls runoff from Marsh Street and the residentially developed area to its north is of a limited (and sometimes conflicting) nature. Appendices A to F of this report contain copies of drainage plans which were used in part to compile the Marsh Street DRAINS Model.¹

ii. Stormwater runoff is controlled by a series of pits and minor piped drainage lines which discharge to a single trunk drainage line that comprises circular, box and channel sections.

iii. The trunk drainage line runs diagonally across the eastbound and westbound lanes of Marsh Street over about a 430 m length.

iv. There is no direct access to the trunk drainage line where it runs beneath Marsh Street apart from a junction pit which is located in the westbound kerbside lane at its upstream end.

¹ Details of the existing stormwater drainage system incorporated in detailed ground survey undertaken by Roads and Maritime was also relied upon for the purpose of developing the Marsh Street DRAINS Model.
v. There is limited cover to the trunk drainage line where it runs beneath Marsh Street, reducing to a minimum of 150 mm beneath the westbound median lane (refer Figure 2.2, Sheets 1 and 2).

vi. The channel section of the trunk drainage line is unlined and populated by a mature stand of mangrove trees.

vii. The invert level of the downstream reach of the trunk drainage line lies below mean sea level (i.e. below RL 0.0 m AHD).

viii. A dysfunctional set of flood gates were observed on the outlet of the trunk drainage line where it discharges to the Cooks River.

ix. The gutter level at the location of the sag in the westbound lane of Marsh Street of RL 1.15 m AHD lies only 90 mm above High High Water Solstices Springs (HHWSS) level in the Cooks River of RL 1.06 m AHD and only 19 mm above the highest astronomical tide level which has been recorded over the period 1996 to 2010 of RL 1.131 m AHD (refer Section 2.3 for details of the tidal plane of the Cooks River).

x. The tidal plane of the Cooks River extends about 630 m along the trunk drainage line to the kerb inlet pit which is located in the eastbound lane of Marsh Street opposite Valda Street (refer pit EA4 on Figure 2.1).

xi. In the past 6 years a large amount of sediment has deposited along the trunk drainage line, extending into the minor drainage lines, as evidenced by comparison of ground survey of the channel section which was undertaken by Roads and Maritime in 2008 and 2014 (refer Figure 2.2, Sheet 2 of 2) and the plates contained in Appendix G of this report.

xii. The hydraulic capacity of the existing stormwater drainage system would be severely impacted by the presence of the sediment, which is as high as the overt level of the trunk drainage line at the downstream end of the box section (refer Figure 2.2, Sheet 2 of 2).

S1.3 Present Day Conditions Flooding and Drainage Patterns

S1.3.1 Main Stream Flooding Patterns

Figure 3.1 shows main stream flooding patterns in the vicinity of the Upgrade for the 100 year ARI envelope of flooding. The key features of flooding behaviour at the 100 year ARI level in the vicinity of the Upgrade are as follows:

i. Floodwater will flow around the eastern and western sides of the Mercure Sydney Airport Hotel where it will initially pond on the northern side of Marsh Street before quickly surcharging the central median of the road where it will discharge into the Kogarah Golf Course.

ii. There is a significant flood slope which forms as floodwater discharges around the Mercure Sydney Airport Hotel, with peak flood levels falling from about RL 2.4 m AHD on the northern side of the hotel site, to around RL 2.0 m AHD along the northern boundary of Marsh Street.

iii. Existing residential development which is located along the northern side of Marsh Street west of the Mercure Sydney Airport Hotel will be impacted by flooding at the 100 year ARI level.
iv. While floor level survey is not presently available, it is anticipated that several of the affected residential properties would experience above-floor inundation at the 100 year ARI level.

v. Marsh Street will be inundated over about a 220 m length, with depths of flow across the road reaching a maximum of between 600-700 mm in the westbound kerbside lane.

vi. The greater depths of inundation in the westbound kerbside lane are a result of flow being constricted by a series of earth mounds which are located in the Kogarah Golf Course along its northern boundary.

vii. A ridge of high ground running along the western (right) bank of the Cooks River south (downstream) of the Marsh Street bridge crossing prevents floodwater which is conveyed in the river channel from discharging directly into the Kogarah Golf Course. Rather, the southern portion of the golf course is inundated by backwater flooding which extends north from a low point in the river bank which is located adjacent to the Southern and Western Suburbs Ocean Outfall Sewer (SWSOOS).

viii. A ponding area forms in the northern portion of the golf course which is partially filled by floodwater which:

   a. discharges in a southerly direction across Marsh Street; and
   b. discharges in a northerly direction from the backwater which forms in the southern portion of the golf course.

ix. The magnitude of the inflows to the ponding area is insufficient for it to fill. As a result, the peak flood level in the ponding area is below that in the river. For example, the peak flood level in the river is about RL 2.1 m AHD, while in the ponding area it is about 0.5 m lower at about RL 1.6 m AHD.\(^2\)

S1.3.2 Local Drainage Patterns

Table 3.1 in Chapter 3 of the report gives peak flows along the stormwater drainage system for design storms of 2, 10 and 100 year ARI. The key findings of the investigation in regards local drainage patterns in the vicinity of the Upgrade were as follows:\(^3\)

i. The stormwater drainage system in Valda Avenue and Innesdale Road has a hydrologic standard of between 2 and 5 year average recurrence interval (ARI), while in Flora Street it is less than 2 year ARI.

ii. Major ponding will occur along the northern side of Marsh Street to the extent shown on Figure 2.1 during storms which surcharge the stormwater drainage system.

iii. In regards the three eastbound lanes of Marsh Street, only the kerbside lane is affected by stormwater which ponds along the northern side of the road corridor.

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\(^2\) Note that this finding is linked to a design storm of 2 hours duration which was found to be critical for maximising peak flows in the river. During a longer duration storm event, the volume of floodwater discharging to the golf course may be sufficient to fill the ponding area such that water levels equalise with those in the river.

\(^3\) Note that the analysis undertaken as part of the present investigation assumed that 100 per cent of the waterway of the stormwater drainage system was available for the conveyance of flow (i.e. it was assumed that the sediment which was observed in the stormwater drainage system is not present).
iv. A peak flow of about 0.8 m$^3$/s will discharge from Innesdale Road toward the ponding area which is located on the northern side of Marsh Street between the Mercure Sydney Airport Hotel and the Avion Apartments development at the 10 year ARI level, increasing to about 1.1 m$^3$/s at the 100 year ARI level.

v. Due to the relatively large volume of temporary flood storage which is available on the northern side of Marsh Street between the Mercure Sydney Airport Hotel and the Avion Apartments development, the peak flow discharging further east toward the Cooks River as overland flow reduces to about 0.4 m$^3$/s at the 10 year ARI level and about 0.6 m$^3$/s at the 100 year ARI level.

vi. On the southern side of Marsh Street, only the kerbside westbound lane is affected by stormwater which ponds at the location of the sag in the road.

vii. Widths of flow in the westbound kerbside lane are a maximum of 1.75 m at the 2 year ARI level, increasing to over 2 m at the 5 year ARI level.

**S1.4 Post-Upgrade Conditions – Operational Phase**

**S1.4.1 Road Geometry**

Initial runs of the Cooks River TUFLOW Model showed that the Roads and Maritime’s concept design for the Upgrade (Original Concept Design) would increase peak flood levels in several residential properties which are located on the northern (upstream) side the road corridor. The modelling showed that if the raised section of median opposite the proposed future extension of Gertrude Street were to be lowered to the level of the pavement (i.e. if the concept design reflected ultimate conditions), then peak 100 year ARI flood levels upstream of the road corridor would not be increased as a result of the Upgrade.

The present investigation also identified that the widening of Marsh Street along its southern side resulted in the gutter level at the location of the sag extending below the tidal plane of the Cooks River.

Based on these findings, Roads and Maritime updated the concept design for the Upgrade (Revised Concept Design) to:

a) remove a section of the raised median opposite the future Gertrude Street extension; and

b) lift the elevation of the sag on the southern side of Marsh Street above the tidal plane of the Cooks River.

Unless stated otherwise, the following discussion in regard the impact the Upgrade will have on both main stream flooding and local drainage patterns is based on the Revised Concept Design.

**S1.4.2 Impact of Upgrade on Main Stream Flooding Patterns**

Figure 5.1 shows main stream flooding patterns under post-Upgrade conditions, and Figure 5.2 the impact the Upgrade will have on the extent and depth of inundation, for the 100 year ARI envelope of flooding.$^4$

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$^4$ The impacts are represented as “afflux” in metres, whereby a positive value of afflux indicates an increase in peak flood levels will result from the Upgrade and conversely, a negative value of afflux indicates that a decrease in peak flood levels will result from the Upgrade.
The key findings of the investigation in regard the impact the Upgrade will have on main stream flooding patterns at the 100 year ARI level are as follows:

i. The Upgrade will result in a minor reduction in peak flood levels along the northern (upstream) side of the road corridor.

ii. There will be a minor reduction in the extent of inundation on the northern (upstream) side of road corridor west of Innesdale Road.

iii. There will be a 50 mm increase in the depth to which floodwater ponds in the northern portion of the Kogarah Golf Course.\(^5\)

iv. An increase of 50 mm in the depth of ponding in the northern portion of the Kogarah Golf Course does not translate into a significant increase in the extent of land which would be affected by flooding during an event with this ARI.

v. Sensitivity analyses were undertaken whereby the elevation of the high point along the centreline of the road was raised by between 20 to 50 mm in an attempt to remove the impacts in the golf course. Modelling showed that impacts within the golf course persist due to minor changes in the rate and volume of flow discharging across the road corridor resulting in a greater depth of ponding in the golf course.

vi. While it may be possible to develop a road profile which mimics present day flow conditions across the road corridor, the time and effort required to achieve this outcome is not justified given the minor nature of the impacts coupled with the existing land use in the affected area (i.e. a golf course).\(^6\)

### S1.4.3 Assessment of Stormwater Drainage Upgrade Options

Six options for upgrading the stormwater drainage system were assessed as part of the present investigation (Stormwater Drainage System Upgrade Options 1, 2, 3, 4, 5 and 6).\(^7\) \(\text{Table S1 at the end of the Summary} \) provides a brief description of each option, including its advantages and disadvantages, while Figures 4.3, 4.4, 4.5, 4.6, 4.7 and 4.8 show the key features of Stormwater Drainage System Upgrade Options 1, 2, 3, 4, 5 and 6, respectively.

**Tables 4.1, 4.2, 4.3, 4.4 and 4.5 in Chapter 4 of this report provide a comparison of peak flows in the existing and upgraded reaches of the stormwater drainage system as well as along the various overland flow paths for Stormwater Drainage System Upgrade Options 2, 3, 4, 5 and 6, respectively.**\(^8\)

\(^5\) Note that this finding is linked to a design storm of 2 hours duration which was found to be critical for maximising peak flows in the river. During a longer duration storm event, the volume of floodwater discharging to the golf course may be sufficient to fill the ponding area such that water levels equalise with those in the river. If this were to occur, then the Upgrade would have nil impact on main stream flooding patterns during such an event.

\(^6\) It is likely that a road profile that is found to mimic flow conditions across the road corridor at the 100 year ARI level will not match flow conditions for other ARI events. This is because of the different shape of the flood hydrographs and the impact features such as the raised earth mounds which are present in the golf course but which will be removed as part of the road widening works presently have on flood behaviour.

\(^7\) Note that Stormwater Drainage System Upgrade Options 1, 2, 3, 4 and 5 were developed using the Original Concept Design, while Stormwater Drainage System Upgrade Option 6 was developed using the Revised Concept Design.

\(^8\) Note that DRAINS modelling was not carried out for Stormwater Drainage System Upgrade Option 1 due to there being little or no available cover to several piped reaches rendering this option infeasible.
S1.5 Post-Upgrade Conditions – Construction Phase

**Figure 6.1** shows the extent of land which will be disturbed during the construction phase of the project (excluding areas of existing pavement) and identifies the receiving drainage lines to which runoff from these areas will discharge.

The assessment undertaken as part of the present investigation showed that large scale sediment retention basins do not necessarily need to form part of the Soil and Water Management Plan (or similar) for the road upgrade project in order to comply with the guidelines set out in “Soils and Construction – Managing Urban Stormwater” Volume 1 (Landcom, 2004) and Volume 2D (DECC, 2008). Rather, it is recommended that localised erosion and sediment control measures, including temporary sediment sumps where practicable, form the basis of the erosion and sediment control strategy that will need to be developed as part of final design and/or construction documentation for the road upgrade works.

It is recommended that a coffer dam be installed at the downstream end of the mangrove lined section of channel prior to commencing any drainage related works. This will prevent the influx of salt water to the stormwater drainage system during the construction period. The top of the coffer dam should be set at RL 0.7 m AHD, which will prevent:

a) the ingress of salt water to the works area up to MHWS level;\(^9\) and
b) major backwater flooding from occurring during storm events.

It will also be necessary to install a pump arrangement to dewater the works area below the level of the coffer dam following rainfall periods.

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\(^9\) Ignores the effects of wave action.
### TABLE S1
#### SUMMARY OF STORMWATER DRAINAGE SYSTEM UPGRADE OPTIONS

<table>
<thead>
<tr>
<th>Option</th>
<th>Description of Works</th>
<th>Hydrologic Standard</th>
<th>No. of New Pits</th>
<th>Length of New Stormwater Drainage Line</th>
<th>Advantages</th>
<th>Disadvantages</th>
</tr>
</thead>
</table>
| 1*     | ● Refer Figure 4.3.  
● Install new kerb inlet pits along southern side of Marsh Street, linked by 375 mm diameter pipes. 
● New piped drainage system to connect into existing stormwater drainage system at location of kerb inlet pits (which would need to be demolished and replaced with buried junction pits). 
● Remove mature stand of mangroves and construct 3 m wide vertically sided reinforced concrete channel between headwalls EA12 and EA13. | < 2year ARI | SF1 12 | 375 RCP | 129 | Least expensive option. 
Does not require trenching across existing carriageway. | Invert level of existing stormwater drainage system at location of kerb inlet pits is too high, resulting in pipes of less than 375 mm diameter needing to be adopted in order to provide cover to finished pavement levels. 
Adoption of pipes less than 375 mm in diameter is likely to result in future maintenance problems. 
Several lengths of the longitudinal piped drainage system would need to be concrete encased unless located beneath the southern footpath. 
The majority of the new transverse drainage lines would need to be concrete encased due to reduced cover. 
Would require sediment to be removed from existing stormwater drainage system in order for it to function correctly. 
Widths of gutter flow along southern side of Marsh Street would be wider than occurs presently. 
Increases the frequency and depth of ponding along northern side of road corridor. 
Increases the frequency and magnitude of stormwater surcharging the stormwater drainage system and discharging into the Kogarah Golf Course. |
| 2     | ● Refer Figure 4.4.  
● Install new kerb inlet pits along southern side of Marsh Street, linked by 375 mm diameter pipes. 
● New piped drainage system to connect into existing trunk drainage line located beneath westbound and eastbound lanes. 
● Remove mature stand of mangroves and construct 3 m wide vertically sided reinforced concrete channel between headwalls EA12 and EA13. | < 2year ARI | SF1 12 | 375 RCP | 129 | Second least expensive option.  
Extending across to the existing trunk drainage line generally allows new piped drainage system to be lowered sufficient to meet minimum cover requirements to top of concrete encasement. | Transverse drainage line linking pit PU7 with PT7 would need to be less than 375 mm in diameter in order to provide cover to finished pavement levels. 
Several lengths of the longitudinal piped drainage system would need to be concrete encased unless located beneath the southern footpath. 
The majority of the new transverse drainage lines would need to be concrete encased due to reduced cover. 
Would require sediment to be removed from existing stormwater drainage system in order for it to function correctly. 
Widths of gutter flow along southern side of Marsh Street would be wider than occurs presently. 
Frequency and depth of ponding along northern side of road corridor would be increased. 
Increases the frequency and magnitude of stormwater surcharging the stormwater drainage system and discharging into the Kogarah Golf Course. |

# Findings based on the results of modelling Option 2.

^ R.E. = Replace Existing 
^^ C.E. = Concrete Encased
## TABLE S1 (Cont’d)
### SUMMARY OF STORMWATER DRAINAGE SYSTEM UPGRADE OPTIONS

<table>
<thead>
<tr>
<th>Option</th>
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<th>Hydrologic Standard</th>
<th>No. of New Pits</th>
<th>Length of New Stormwater Drainage Line</th>
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<td>Type</td>
<td>Dimension (mm)</td>
<td>Type</td>
<td>Length (m)</td>
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<td>3</td>
<td>Refer Figure 4.5.</td>
<td>&lt; 2year ARI</td>
<td>SF1</td>
<td>12</td>
<td>375 RCP</td>
<td>172</td>
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<tr>
<td></td>
<td>Similar to Option 2, but would require existing transverse drainage line extending from pit PT7 to PA12 to be replaced, thereby allowing the drainage system to be lowered.</td>
<td></td>
<td>SA2</td>
<td>10</td>
<td>375 RCP (R.E)^</td>
<td>327</td>
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<td></td>
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<td></td>
<td>SA2(Special)</td>
<td>17</td>
<td>375 RCP (C.E)^^</td>
<td>74</td>
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<td></td>
<td></td>
<td>SAS</td>
<td>1</td>
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<td></td>
<td></td>
<td></td>
<td>Junction Pit (New)</td>
<td>1</td>
<td>Total</td>
<td>573</td>
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<td></td>
<td></td>
<td></td>
<td>Junction Pit (Adjusted)</td>
<td>7</td>
<td>Total</td>
<td>48</td>
</tr>
<tr>
<td>4</td>
<td>Refer Figure 4.6.</td>
<td>2 year ARI, except for at location of sag on southern side of road corridor##</td>
<td>SF1</td>
<td>12</td>
<td>375 RCP</td>
<td>128</td>
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<tr>
<td></td>
<td>Similar to Option 3 but install 2 off 450 mm diameter pipes running longitudinally along Marsh Street beneath southern footpath.</td>
<td></td>
<td>SA2</td>
<td>9</td>
<td>375 RCP (R.E)^</td>
<td>62</td>
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<tr>
<td></td>
<td>Remove mature stand of mangroves and construct 3 m wide vertically sided reinforced concrete channel between headwalls EA12 and EA13.</td>
<td></td>
<td>SA2(Special)</td>
<td>18</td>
<td>375 RCP (C.E)^^</td>
<td>67</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>SAS</td>
<td>1</td>
<td>450 RCP</td>
<td>120</td>
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<td></td>
<td></td>
<td>Junction Pit (New)</td>
<td>1</td>
<td>450 RCP (at 0.3% grade)</td>
<td>608</td>
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<td></td>
<td></td>
<td>Junction Pit (Adjusted)</td>
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<td>Total</td>
<td>985</td>
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<tr>
<td></td>
<td>Total</td>
<td></td>
<td>42</td>
<td>48</td>
<td>375 RCP</td>
<td>985</td>
</tr>
</tbody>
</table>

## While not assessed, lifting the elevation of the sag as per the Revised Concept Design may improve the hydrologic standard of the new drainage system at the location of the sag to 2 year ARI.##

^ R.E. = Replace Existing
^^ C.E. = Concrete Encased
TABLE S1 (Cont’d)
SUMMARY OF STORMWATER DRAINAGE SYSTEM UPGRADE OPTIONS

<table>
<thead>
<tr>
<th>Option</th>
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<th>Disadvantages</th>
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<td>Type / No.</td>
<td>Dimension (mm) / Type / Length (m)</td>
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<td></td>
</tr>
<tr>
<td>5</td>
<td>Refer Figure 4.7.</td>
<td>2-5 year ARI&lt;sup&gt;##&lt;/sup&gt;</td>
<td>SF1 12</td>
<td>375 RCP</td>
<td>Second most expensive option.</td>
<td>Requires the construction of special kerb inlet pits along southern side of Marsh Street where 1 off 1800 x 600 RCBC is located beneath footpath. [An alternative to this would be install standard kerb inlet pits linked with a series of concrete encased 375 mm diameter pipes and only connect into RCBC when capacity of pipe is exceeded].</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>SA2 10</td>
<td>375 RCP (R.E)&lt;sup&gt;^&lt;/sup&gt;</td>
<td>Reduces the length of existing trunk drainage line which would need to be cleaned out.</td>
<td>New transverse drainage lines would need to be concrete encased due to reduced cover.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>SA2(Special) 17</td>
<td>375 RCP (C.E)&lt;sup&gt;^^&lt;/sup&gt;</td>
<td>Improved hydrologic standard when compared to Option 4.</td>
<td>Would still require sediment to be removed from downstream reach of trunk drainage line in order for it to function correctly.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>SAS 1</td>
<td>450 RCP</td>
<td>Further reduces the frequency and depth of ponding along northern side of road corridor, when compared to Option 4.</td>
<td>Increases the frequency and magnitude of stormwater surcharging the stormwater drainage system and discharging into the Kogarah Golf Course.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Junction Pit (New) 1</td>
<td>450 RCP (C.E)&lt;sup&gt;^&lt;/sup&gt;</td>
<td>Widths of gutter flow along southern side of Marsh Street less than occurs presently.</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Junction Pit (Adjusted) 5</td>
<td>525 RCP (C.E)&lt;sup&gt;^&lt;/sup&gt;</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Total 46</td>
<td>Total 689</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Refer Figure 4.8.</td>
<td>10 year ARI&lt;sup&gt;##&lt;/sup&gt;</td>
<td>SF1 9</td>
<td>375 RCP</td>
<td>Most expensive option.</td>
<td>Requires new transverse drainage line to be installed across existing carriageway.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>SA2 10</td>
<td>375 RCP (R.E)&lt;sup&gt;^&lt;/sup&gt;</td>
<td>Removes the need to clean out existing trunk drainage line.</td>
<td>Requires the construction of special kerb inlet pits along southern side of Marsh Street where length of RCBC is located beneath footpath. [An alternative to this would be install standard kerb inlet pits linked with a series of concrete encased 375 mm diameter pipes and only connect into RCBC when capacity of pipe is exceeded].</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>SA2(Special) 16</td>
<td>450 RCP</td>
<td>Achieves Roads and Maritimes preferred minimum hydrologic standard of 10 year ARI&lt;sup&gt;^^&lt;/sup&gt;</td>
<td>May require more land to be acquired in Kogarah Golf Course in order to locate utilities beside new length of RCBC.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>SAS 1</td>
<td>450 RCP (C.E)&lt;sup&gt;^&lt;/sup&gt;</td>
<td>Significantly reduces the frequency and depth of ponding along northern side of road corridor.</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Junction Pit (New) 1</td>
<td>525 RCP (C.E)&lt;sup&gt;^&lt;/sup&gt;</td>
<td>Prevents surcharge of the stormwater drainage system into the Kogarah Golf Course up to the 100 year ARI level.</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Junction Pit (Adjusted) 4</td>
<td>750 RCP (C.E)&lt;sup&gt;^&lt;/sup&gt;</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Total 41</td>
<td>Total 773</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<sup>##</sup> Kerbside westbound lane and eastbound median lane only. Additional kerb inlet pits would be required in order to reduce the width of flow in the kerb side lane to no greater than 1.5 m and in the median lane to no greater than 1 m.

<sup>^</sup> R.E. = Replace Existing

<sup>^^</sup> C.E. = Concrete Encased
1 INTRODUCTION

1.1 Background

Marsh Street presently comprises a divided carriageway with three eastbound and two westbound lanes over the entire length of the proposed works. The Upgrade will involve widening of Marsh Street along its southern side to provide an additional westbound lane. The extent of the upgrade is shown on Figure 1.1. The Upgrade also incorporates provision for the future extension of Gertrude Street through to Marsh Street, whereby the central median has been configured to provide additional vehicle storage in the westbound right hand turning lane.

Catchment modelling was undertaken using the DRAINS rainfall-runoff software to assess the hydrologic standard of the existing stormwater drainage system and also requirements for its upgrade. Specific attention was given to mitigating the impact of the Upgrade on depths of inundation in a number of residential properties that are subject to local catchment flooding.

A previous study undertaken by L&A as part of the then proposed M5 East Motorway upgrade project (now known as WestConnex New M5) (L&A, 2010) found that the section of Marsh Street to be upgraded is subject to inundation by floodwater which surcharges the right (western) bank of the Cooks River north (upstream) of the road bridge. The hydraulic model developed as part of L&A, 2010 (i.e. the Cooks River TUFOLOW Model) was used to assess the impact the Upgrade will have on flooding patterns in the area.

1.2 Study Tasks

The study tasks were broadly as follows:

- Undertake a site inspection to ground-truth existing drainage arrangements, confirm additional survey requirements and identify relevant site constraints. A Survey Brief was subsequently prepared setting out additional requirements for Roads and Maritime’s surveyors to confirm details of various sections of existing piped and open channel drainage.

- Review of available drainage data and the concept design for the Upgrade.

- Liaise with RCC to obtain relevant drainage information upstream and along Marsh Street.

- Undertake an analysis to:
  - determine the hydraulic capacity of the existing stormwater drainage system which receives runoff from the road corridor; and
  - define patterns of overland flow along the road corridor.

- Reconfigure the hydraulic model developed as part of L&A, 2010 to include detailed ground survey along the road corridor and adjacent areas and then assess the impact of the Upgrade on flooding patterns.

- Develop a strategy aimed at:
  - improving as far as practicable the hydraulic capacity of the road drainage system; and
o mitigating the flooding and drainage related impacts of the Upgrade on existing residential development which is located along the northern side of the road corridor.

A concept layout which included both new and upgraded sections of the stormwater drainage system was developed to show the indicative location of inlet pits and piped drainage lines that will be required to capture and convey runoff from the upgraded length of Marsh Street to the outlet into the Cooks River.

➢ Develop a strategy to control erosion and sediment-laden runoff during construction of the Upgrade.

1.3 Outline of Report

Section 2 of this report provides a brief description of the catchment which presently contributes runoff to the existing stormwater drainage system which will be impacted by the Upgrade. A brief description of the affected drainage system is also provided.

Section 3 contains an overview of the methodology and findings of an investigation undertaken to assess drainage patterns along the road corridor and also the hydraulic capacity of the existing stormwater drainage system. The DRAINS software was used for this purpose. This section also describes the adjustments that were made to the hydraulic model which was developed as part of L&A, 2010 together with the resulting flooding patterns.

Section 4 presents six options which were assessed for managing runoff along the upgraded length of Marsh Street. This section also deals with the potential impacts of the Upgrade on drainage and flooding patterns.

Section 5 provides a summary of the approach to be adopted in developing an erosion and sediment control strategy for the construction phase of the Upgrade. This includes requirements for local erosion and sediment control measures along the length of the road corridor.

Section 6 contains a list of documents referred to in this report.

Appendices A to G contain drainage related information which was obtained from various sources over the course of the present investigation.

1.4 Available Data

The following data were made available by Roads and Maritime for this present investigation:

➢ Aerial photography and airborne laser scanning (ALS) survey data covering the study area.
➢ Detailed ground survey information along the route of the Upgrade.
➢ Detailed survey of the existing stormwater drainage system which is located both within and adjacent to the road corridor.
➢ Concept road design models for the Upgrade.
➢ Design drawings for previous upgrades and widening of Marsh Street.
➢ GIS datasets including property boundary information.
The following additional information was obtained from Rockdale City Council (RCC) to assist with the investigation:

- GIS datasets showing selected details of the existing stormwater drainage system along Marsh Street and in surrounding catchment areas to its north.

- Various information documenting the redevelopment of 20 Levey Street, Wolli Creek (Mercure Sydney Airport Hotel) including:
  - A report prepared by EWFW Pty Ltd entitled “Soil and Water Management for Proposed Development of 20 Levey Street, Wolli Creek” dated August 2012.
  - A plan showing the layout of the proposed drainage system internal to the property.
2 CATCHMENT AND DRAINAGE ARRANGEMENTS

2.1 Catchment Description

The existing stormwater drainage system which will be impacted by the Upgrade controls runoff from a 9.3 ha catchment, the extent and division of which is shown on Figure 2.1. Land use within the catchment is principally residential in nature, runoff from which generally discharges south as gutter flow toward the Marsh Street road corridor along the local roads of Valda Avenue, Flora Street and Innesdale Road.

Runoff from a portion of the Mercure Sydney Airport Hotel site which is located on the northern side of the road corridor east of the Innesdale Road intersection also contributes to flow in the affected stormwater drainage system. Roads and Maritime provided copies of several documents which deal with the stormwater related aspects of a planned redevelopment of the hotel site. A copy of a drainage plan prepared by EFWW Pty Ltd is contained in Appendix A of this report. A review of the drainage plan shows that the extent of the catchment contributing runoff to the stormwater drainage system which will be affected by the Upgrade will not change as a result of the planned redevelopment of the hotel.

2.2 Stormwater Drainage System

The existing stormwater drainage system which will be impacted by the Upgrade comprises a series of minor piped drainage lines which connect into a trunk drainage line that runs the length of Marsh Street. Details of the affected stormwater drainage system have been taken from available drainage plans and also detailed corridor survey which was undertaken by Roads and Maritime. Appendices B to F contain copies of the drainage plans and field survey which were used to compile Figures 2.1 and 2.2, the latter which is a long section of the trunk drainage line. The minor drainage lines generally control runoff which approaches the road corridor from the north (i.e. from the residentially developed area), while a series of kerb inlet pits control runoff along the southern kerbline of Marsh Street.

RCC’s stormwater asset database shows the presence of 600 mm diameter pipe running along the northern side of Marsh Street west of Valda Avenue (refer Line EY on Figure 2.1). The available data also suggests that this pipe drains in a westerly direction where it discharges to the south of Marsh Street. While several of the pits associated with this pipe were observed in the field, the relative ground levels on either side of Marsh Street, combined with the absence of any discernible outlet structure would indicate that the drainage line is redundant.

The aforementioned trunk drainage line comprises:

- a single 525 mm diameter pipe where it runs beneath the westbound kerbside lane of Marsh Street between Valda Avenue and Flora Street;
- a single 750 mm diameter pipe where it runs beneath the westbound kerbside lane of Marsh Street between Flora Street and Innesdale Road;
- a single 1200 mm wide by 900 mm high reinforced concrete box culvert (RCBC) which runs diagonally across both the eastbound and westbound lanes of Marsh Street between Innesdale Road and its point of discharge to an unlined section of channel;
- an unlined section of channel which is located on the northern side of Marsh Street, east of the Mercure Sydney Airport Hotel; and
- 3 off 900 mm diameter pipes which cross under Levey Street and discharge to the Cooks River on its right (western) bank.

Drainage plans provided by Roads and Maritime show that the invert of the trunk drainage line upstream of the unlined section of channel has a grade of less than 0.3 per cent. Cover to the 1200 x 900 RCBC is negligible in this area and is a minimum of about 150 mm (refer Figure 2.2). The invert level of the 1200 x 900 RCBC where it outlets to the unlined section of channel is shown on the drainage plans to be 0.11 m AHD.

A stand of mature mangrove trees presently line the unlined section of channel along its full length. The invert of the channel was observed to be set at the elevation equal to the obvert level of the 1200 x 900 RCBC (i.e. about RL 1.0 m AHD), a finding that was inconsistent with ground levels contained in the road corridor survey undertaken by Roads and Maritime in 2008. The earlier survey shows that the invert of the channel in 2008 was only slightly higher than that of the box culvert, indicating that a significant amount of sediment has deposited in the unlined section of channel over the intervening 6 year period.

The backwater imposed by the elevated bed level of the channel extends upstream along the enclosed section of the trunk drainage line into the minor drainage lines which control runoff in the local roads to the north of Marsh Street. The backwater imposed by the elevated bed level has also led to the deposition of sediment in the upstream reaches of the stormwater drainage system, as evidenced by the plates contained in Appendix G.

The invert level of both the inlet and outlet of the 3 off 900 mm diameter pipes which discharge to the Cooks River are located below mean sea level at RL -0.1 m AHD and RL -0.49 m AHD, respectively. A set of inoperable flood gates were also observed on the outlet of the 900 mm diameter pipes. A key feature of the stormwater drainage system is the presence of several trapped low points which are located along the northern side of the road corridor in the residentially developed area. Figure 2.1 shows the extent to which local catchment runoff will pond along the northern side of Marsh Street during storms which surcharge the stormwater drainage system.

Local catchment runoff which surcharges the stormwater drainage system in Valda Avenue and Flora Street flows in an easterly direction through several residential properties where it joins runoff ponding at the intersection of Innesdale Road and Marsh Street. During major storm events runoff ponding in this area discharges further east along the northern side of Marsh Street where it joins runoff ponding at a trapped low point which is located between the Mercure Sydney Airport Hotel and the Avion Apartments development. This ponding area is located adjacent to the sag in Marsh Street.

Rather than flow across Marsh Street at the location of the sag, stormwater ponding between the Mercure Sydney Airport Hotel and the Avion Apartments development will discharge in an easterly direction where it will combined with flow in the section of unlined channel adjacent to the inlet of the 3 off 900 mm diameter pipes.

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10 The flood gates on the outer two pipes were observed to be fixed in a partially open position, while the gate on the centrally located pipe is missing.
The sag in the westbound lanes is located opposite the Mercure Sydney Airport Hotel, adjacent to the Kogarah Golf Course. The elevation of the gutter at the location of the sag is RL 1.15 m AHD, which is only 90 mm above the HHWSS level of RL 1.06 m AHD in the Cooks River (refer Section 2.3 for details). During storms that exceed the capacity of the stormwater drainage system, runoff ponds to a depth of about 150 mm (i.e. to top of kerb level) at the location of the sag before discharging directly into the Kogarah Golf Course.

Another key feature of the stormwater drainage system is a series of brick-sided pits which were observed in the Kogarah Golf Course adjacent to the road corridor (refer adjacent plate). The location of these pits coincides with the kerb inlet pits that are located along the southern side of Marsh Street. The pits appear to allow runoff conveyed in the stormwater drainage system to discharge to the golf course, where it is probably used to replenish water stored in several of the golf course dams. The rate of flow discharging to the golf course is controlled by a series of uPVC pipes which have screw caps fitted to them.

2.3 Tidal Plane

Table 2.1 over page gives the average annual elevation of the various tidal planes near the mouth of the Cooks River. A review of the annual water level data presented in Table A170 of OEH, 2012 shows that the highest astronomical tide recorded over the period 1996 to 2010 occurred in 2000-2001 and reached an elevation of 1.131 m AHD (i.e. only 19 mm below the gutter level at the sag in Marsh Street), while a slightly lower level of 1.116 m AHD was reached in 2001-2002.
### TABLE 2.1
**COOKS RIVER TIDAL PLANES**\(^{(1,2)}\)

<table>
<thead>
<tr>
<th>Tidal Plane</th>
<th>Elevation (m AHD)</th>
<th>Upstream Limit of Tidal Influence in Marsh Street Drainage System</th>
</tr>
</thead>
<tbody>
<tr>
<td>High High Water Solstices Springs (HHWSS)</td>
<td>1.06</td>
<td>Kerb inlet pit on eastbound carriageway at southern end of Valda Street (pit EA4).</td>
</tr>
<tr>
<td>Mean High Water Springs (MHWS)</td>
<td>0.70</td>
<td>Kerb inlet pit on eastbound carriageway at southern end of Innesdale Road (pit EG4).</td>
</tr>
<tr>
<td>Mean High Water (MHW)</td>
<td>0.57</td>
<td>Kerb inlet pit on westbound carriageway opposite Innesdale Road (pit EA8).</td>
</tr>
<tr>
<td>Mean High Water Neap (MHWN)</td>
<td>0.45</td>
<td>Midway along centrally located trunk drainage line between pits EA8 and EA9.</td>
</tr>
<tr>
<td>Mean Sea Level (MSL)</td>
<td>0.06</td>
<td>Mangrove lined channel(^{(3)}).</td>
</tr>
<tr>
<td>Mean Low Water Neaps (MLWN)</td>
<td>-0.33</td>
<td>In 3 off 900 RCP’s where they cross Levey Street (i.e. between pits EA14 and EA15).</td>
</tr>
<tr>
<td>Mean Low Water (MLW)</td>
<td>-0.46</td>
<td>40 mm above invert level of 3 off 900 RCP’s at Cooks River outlet.</td>
</tr>
<tr>
<td>Mean Low Water Springs (MLWS)</td>
<td>-0.58</td>
<td>160 mm below invert level of 3 off 900 RCP’s at Cooks River outlet.</td>
</tr>
<tr>
<td>Indian Spring Low Water (ISLW)</td>
<td>-0.84</td>
<td>420 mm below invert level of 3 off 900 RCP’s at Cooks River outlet.</td>
</tr>
</tbody>
</table>

1. Source: Table A170 in OEH, 2012
2. Note that the high water levels at the Marsh Street bridge crossing will be slightly higher, and the low water levels slightly lower than the values given in the table.
3. Assumes invert of channel matches adjacent piped reaches of the drainage system.
3 PRESENT DAY DRAINAGE AND FLOODING PATTERNS

3.1 General

The DRAINS software was used to define local drainage patterns in the vicinity of the Upgrade and to assess the hydraulic capacity of the existing stormwater drainage system. DRAINS is a simulation program which converts rainfall patterns to stormwater runoff, and then routes flows through networks of piped drainage systems, culverts, storages and open channels. The software develops hydrographs and calculates hydraulic grade lines throughout the drainage network, enabling users to analyse the magnitude of overflows and stored water for established drainage systems.

As previously mentioned, the hydraulic model which was developed as part of L&A, 2010 was used to define main stream flooding patterns in the vicinity of the Upgrade. The TUFLOW software was used for this purpose. 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 software was used to define flooding patterns on the Cooks River floodplain for a range of design flood events. The findings of the investigation were used to assist in the development of road designs for the then proposed M5 East Motorway upgrade (now WestConnex New M5).

The following sections of the report contain a brief description of the DRAINS model development and the changes which were made to the structure of the TUFLOW model that was developed as part of L&A, 2010. Also presented is a discussion on the key findings of the analyses.

3.2 Background to Model Development

3.2.1 Cooks River TUFLOW Model

The digital terrain model which was used to develop the Cooks River TUFLOW Model was updated using the road corridor survey provided by Roads and Maritime. A ridgeline was also added to the model to improve the definition of the hydraulic control which is formed by the raised central median along Marsh Street.

The Cooks River TUFLOW Model was originally developed to assess the impact the installation of a large number of bridge piers would have on flooding behaviour, and hence incorporated a relatively small grid size of 2m. For the purpose of the present investigation the grid size was increased to 5 m to reduce model run times.

In accordance with OEH guidelines (DECCW, 2010), the derivation of flood levels in the tidal zone of the Cooks River required consideration of the interaction of catchment and ocean flooding for the following scenarios:

i. 20 year catchment flooding, with 1 in 100 year ocean flooding (peak water level of RL 1.7 m AHD) and coincident peaks.
ii. 100 year catchment flooding, with 1 in 20 year ocean flooding (peak water level of RL 1.4 m AHD) and coincident peaks.
iii. 100 year catchment flooding, with normal tidal cycle and coincident peaks.

For the purpose of the present investigation, only scenarios i) and ii) were used to define the envelope of 100 year ARI flooding since they are critical for maximising flood levels in the vicinity of Marsh Street.
3.2.2 Marsh Street DRAINS Model

The information contained in Appendices A to F was used in part to develop the Marsh Street DRAINS Model.\(^\text{11}\) For the purpose of assessing the hydraulic capacity of the stormwater drainage system it was assumed that:

a) the 600 mm diameter pipe located on the northern side of Marsh Street west of Valda Avenue is redundant and therefore does not convey flow;

b) the full waterway area of each conduit is available for the conveyance of flow (i.e. the sediment which was observed in the conduits during a recent inspection by Roads and Maritime (refer plates in Appendix G) is not present); and

c) the bed level of the unlined channel which is located on the northern side of Marsh Street east of the Mercure Sydney Airport Hotel site matches the adjacent enclosed sections of the stormwater drainage system (i.e. the bed level of the channel matches more closely the conditions which were present in 2008).

The depth to which water will pond and the volume of temporary storage which is present at the trapped low points located along the northern side of Marsh Street was estimated using the ALS survey data and incorporated into the Marsh Street DRAINS Model.

Adopted DRAINS model parameters comprised initial losses of 2 and 10 mm for paved and grassed areas, respectively. An antecedent moisture condition of 3 was adopted, reflecting rather wet conditions prior to the occurrence of storm events and the soil type was set equal to 3, which corresponds with a soil of comparatively high runoff potential.

Rainfall intensities for design storms ranging between 2 and 100 year ARI, and for storm durations ranging between 20 minutes and 2 hours, were derived using procedures outlined in Australian Rainfall and Runoff (ARR) (IEAust, 1998).

3.3 Model Results

Figure 3.1 shows main stream flooding patterns in the vicinity of the Upgrade for the 100 year ARI envelope of flooding, while Table 3.1 over page gives peak flows at several locations along the stormwater drainage system for design storms of 2, 10 and 100 year ARI.

The key findings of the investigation as they relate to main stream flooding and local catchment drainage patterns are presented respectively in Sections S1.3.1 and S1.3.2 of the Summary.

\(^{11}\) Details of the existing stormwater drainage system incorporated in detailed ground survey undertaken by Roads and Maritime was also relied upon for the purpose of developing the Marsh Street DRAINS Model.
TABLE 3.1
PEAK FLOWS IN STORMWATER DRAINAGE SYSTEM – PRESENT DAY CONDITIONS
(m³/s)

<table>
<thead>
<tr>
<th>Location</th>
<th>Peak Flow Location Identifier(1)</th>
<th>Piped</th>
<th>Overland</th>
</tr>
</thead>
<tbody>
<tr>
<td>Peak flow in 450 RCP crossing Marsh Street adjacent to Valda Avenue.</td>
<td>F1</td>
<td>0.221</td>
<td>0.26</td>
</tr>
<tr>
<td>Peak flow surcharging low point in Valda Avenue and discharging through residential properties to the east.</td>
<td>F2</td>
<td>0</td>
<td>0.037</td>
</tr>
<tr>
<td>Peak flow in 750 RCP crossing Marsh Street adjacent to Flora Street.</td>
<td>F3</td>
<td>0.286</td>
<td>0.303</td>
</tr>
<tr>
<td>Peak flow surcharging low point in Flora Street and discharging through residential properties to the east.</td>
<td>F4</td>
<td>0.161</td>
<td>0.794</td>
</tr>
<tr>
<td>Peak flow in 375 RCP crossing Marsh Street adjacent to Innesdale Road.</td>
<td>F5</td>
<td>0.137</td>
<td>0.14</td>
</tr>
<tr>
<td>Peak flow surcharging trapped low point immediately west of Innesdale Road.</td>
<td>F6</td>
<td>0</td>
<td>0.552</td>
</tr>
<tr>
<td>Peak flow in 375 RCP crossing immediately west of Mercure Sydney Airport Hotel.</td>
<td>F7</td>
<td>0.153</td>
<td>0.226</td>
</tr>
<tr>
<td>Peak flow surcharging trapped low point immediately west of Mercure Sydney Airport Hotel.</td>
<td>F8</td>
<td>0</td>
<td>0.046</td>
</tr>
<tr>
<td>Peak flow in 1200 x 900 RCBC at upstream end of unlined channel.</td>
<td>F9</td>
<td>0.874</td>
<td>1.11</td>
</tr>
<tr>
<td>Peak flow in 375 RCP draining sag in southern kerbline of Marsh Street.</td>
<td>F10</td>
<td>0.037</td>
<td>0.087</td>
</tr>
<tr>
<td>Peak flow surcharging sag in southern kerbline in Marsh Street.</td>
<td>F11</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Peak flow in unlined channel (upstream end)</td>
<td>F12</td>
<td>1.11</td>
<td>1.48</td>
</tr>
<tr>
<td>Peak flow discharging to Cooks River via 3 off 900 RCP’s(3)</td>
<td>F13</td>
<td>1.36</td>
<td>2.19</td>
</tr>
</tbody>
</table>

(1) Refer Figure 2.1 for reference to Location Identifier.
(2) Peak flows quoted to more than one decimal place for ease of comparison only between relatively small flows.
(3) Assumes flow surcharging at flow location F8 discharges to mangrove lined channel upstream of inlet to 3 off 900 RCP’s.
4 ASSESSMENT OF DRAINAGE AND FLOODING RELATED UPGRADE REQUIREMENTS

4.1 Road Geometry

4.1.1 Recommended Adjustments to the Concept Design

Review of the original concept design identified that the widening of Marsh Street on its southern side had the potential to result in the elevation of the sag in the road reducing to below RL 1.0 m AHD, which places it within the tidal plane of the Cooks River. The lowering of the southern kerbline of Marsh Street also led to an increase in the frequency and rate of surcharge of stormwater runoff into Kogarah Golf Course from the location of the sag in the road (refer Section 4.3 for further details). Based on these findings, the concept design was revised to incorporate a minimum gutter level of RL 1.17 m AHD, which lies above the highest astronomical tide recorded in the Cooks River over the period 1996 to 2010.

Preliminary runs of the Cooks River TUFLOW Model also showed that flooding behaviour along the northern side of the road corridor is sensitive to finished road levels, namely those along the raised concrete median which acts as the hydraulic control. Further modelling showed that peak flood levels on the northern side of the road corridor would not be impacted if the section of raised concrete median adjacent to the future Gertrude Road extension was removed from Roads and Maritime’s original concept design (i.e. the modelling showed that peak flood levels would not be increased if the ultimate median arrangement was incorporated in the concept design).

4.1.2 Impact of Upgrade on Main Stream Flooding Patterns

Figure 5.1 shows main stream flooding patterns under post-Upgrade conditions, and Figure 5.2 the impact the Upgrade will have on the extent and depth of inundation for the 100 year ARI envelope of flooding. The key findings of the investigation in regards the impact the Upgrade will have on main stream flooding patterns at the 100 year ARI level are presented in Section S1.4.2 of the Summary.

4.2 Stormwater Drainage Design Considerations

4.2.1 Hydrologic Standard of Upgraded Stormwater Drainage System

Due to the low lying nature of the road and limitations in the capacity of the stormwater drainage system, namely along the northern side of the road corridor, it is not feasible to upgrade the drainage system to achieve Roads and Maritimes preferred minimum hydrologic standard of 10 year ARI.

The recommended drainage strategy for the Upgrade is therefore aimed at maximising the hydraulic capacity of the stormwater drainage system as far as practicable while ensuring that widths of flow along the southern side of Marsh Street (i.e. along the widened section of carriageway) are no greater than occur under present day conditions.

12 The impacts are represented as “afflux” in metres, whereby a positive value of afflux indicates an increase in peak flood levels will result from the Upgrade and conversely, a negative value of afflux indicates that a decrease in peak flood levels will result from the Upgrade.
4.2.2 Maximum Allowable Widths of Flow

As mentioned above, the aim of the drainage strategy was to improve the hydraulic capacity of the stormwater drainage system and ensure that widths of flow along the widened section of carriageway will be no greater than occurs presently for storm events up to 5 year ARI.

4.2.3 Potential Blockage of the Road Drainage System

The following pit blocking factors were adopted for pit spacing purposes to account for the potential reduction in inlet capacity that may occur as a result of partial blockages due to litter and other debris:

- On-grade pits – 20% blockage
- Sag pits – 50% blockage

Note that these blockage factors were only applied to new kerb inlet pits which will be required along the southern side of the road (i.e. those new pits controlling runoff from the westbound lanes) and the new median inlet pits located opposite the Mercure Sydney Airport Hotel development (i.e. those new pits controlling runoff from a section of the eastbound lanes).

4.2.1 Future Development Upslope of the Road Corridor

In regards areas which lie outside the road corridor, it has been assumed that measures will be incorporated into any future development to control the rate of flow discharging to the stormwater drainage system to no larger than occurs under present day conditions.

4.2.2 Utilities

A CADD file was provided by Roads and Maritime at the commencement of the investigation which incorporated the plan location of existing utilities in the road reserve. An update version of the CADD file was provided by Roads and Maritime on 12 November 2014 which incorporated the plan location of several utilities which had not previously been identified along the southern side of the road corridor.

While the recommended strategy presented in this report is aimed at not greatly changing the invert levels or increasing the various elements of the stormwater drainage system where there is the potential for clashes with existing utilities to occur, it will be necessary to expose and level an existing high pressure gas line which crosses under the 1200 x 900 RCBC near its point of discharge to the unlined section of channel during detailed design.

4.3 Stormwater Drainage Upgrade Options

Table S1 in the Summary provides a brief description of each option, including its advantages and disadvantages, while Figures 4.3, 4.4, 4.5, 4.6, 4.7 and 4.8 show the key features of Stormwater Drainage System Upgrade Options 1, 2, 3, 4, 5 and 6, respectively.13

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13 Note that Stormwater Drainage System Upgrade Options 1, 2, 3, 4 and 5 were developed using finished road levels which were based on the original concept design for the Upgrade, while Stormwater Drainage System Upgrade Option 6 was developed using the latest road design model which incorporates the adjustments recommended in Section 4.1.1 of this report.
Tables 4.1, 4.2, 4.3, 4.4 and 4.5 over page therefore provide a comparison of peak flows in the existing and upgraded reaches of the stormwater drainage system, as well as along the various overland flow paths, for Stormwater Drainage System Upgrade Options 2, 3, 4, 5 and 6, respectively.¹⁴

¹⁴ Note that DRAINS modelling was not carried out for Stormwater Drainage System Upgrade Option 1 due to there being little or no available cover to several piped reaches rendering this option infeasible.
### TABLE 4.1
**IMPACT OF STORMWATER DRAINAGE SYSTEM UPGRADE OPTION 2 ON PEAK FLOWS**

(*m³/s*)

<table>
<thead>
<tr>
<th>Location</th>
<th>Location Identifier (2)</th>
<th>Post-Upgrade Peak Flows</th>
<th>Difference in Peak Flows (3, 4)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Piped</td>
<td>Overland</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2 year ARI</td>
<td>5 year ARI</td>
</tr>
<tr>
<td>Peak flow in 450 RCP crossing Marsh Street adjacent to Valda Avenue.</td>
<td>F1</td>
<td>0.217</td>
<td>0.256</td>
</tr>
<tr>
<td>Peak flow surcharging low point in Valda Avenue and discharging through residential properties to the east.</td>
<td>F2</td>
<td>0</td>
<td>0.06</td>
</tr>
<tr>
<td>Peak flow in 750 RCP crossing Marsh Street adjacent to Flora Street.</td>
<td>F3</td>
<td>0.289</td>
<td>0.263</td>
</tr>
<tr>
<td>Peak flow surcharging low point in Flora Street and discharging through residential properties to the east.</td>
<td>F4</td>
<td>0.17</td>
<td>0.589</td>
</tr>
<tr>
<td>Peak flow in 375 RCP crossing Marsh Street adjacent to Innesdale Road.</td>
<td>F5</td>
<td>0.142</td>
<td>0.146</td>
</tr>
<tr>
<td>Peak flow surcharging trapped low point immediately west of Innesdale Road.</td>
<td>F6</td>
<td>0</td>
<td>0.537</td>
</tr>
<tr>
<td>Peak flow in 375 RCP crossing immediately west of Mercure Sydney Airport Hotel.</td>
<td>F7</td>
<td>0.15</td>
<td>0.218</td>
</tr>
<tr>
<td>Peak flow surcharging trapped low point immediately west of Mercure Sydney Airport Hotel.</td>
<td>F8</td>
<td>0</td>
<td>0.05</td>
</tr>
<tr>
<td>Peak flow in 1200 x 900 RCBC at upstream end of unlined channel.</td>
<td>F9</td>
<td>0.967</td>
<td>1.03</td>
</tr>
<tr>
<td>Peak flow in 375 RCP draining sag in southern kerbline of Marsh Street.</td>
<td>F10</td>
<td>0.065</td>
<td>0.082</td>
</tr>
<tr>
<td>Peak flow surcharging sag in southern kerbline of Marsh Street.</td>
<td>F11</td>
<td>0.054</td>
<td>0.191</td>
</tr>
<tr>
<td>Peak flow in unlined channel (upstream end)</td>
<td>F12</td>
<td>1.27</td>
<td>1.37</td>
</tr>
<tr>
<td>Peak flow discharging to Cooks River via 3 off 900 RCP’s (3)</td>
<td>F13</td>
<td>1.52</td>
<td>1.86</td>
</tr>
</tbody>
</table>

(1) Peak flows have been quoted to more than one decimal place for comparative purposes only.

(2) Refer Figure 4.3 for reference to Location Identifier.

(3) Difference in peak flows derived by comparison with peak flows presented in Table 3.1.

(4) Note that a positive value represents an increase in peak flow when compared to present day conditions. Orange shading indicates an increase in peak flow as a result of the road upgrade, whilst green shading indicates a reduction (or no change) in peak flow.
## TABLE 4.2

**IMPACT OF STORMWATER DRAINAGE SYSTEM UPGRADE OPTION 3 ON PEAK FLOWS**(1)

(m³/s)

<table>
<thead>
<tr>
<th>Location</th>
<th>Location Identifier (2)</th>
<th>Post-Upgrade Peak Flows</th>
<th>Difference in Peak Flows(3,4)</th>
<th>Overland</th>
<th>Piped</th>
<th>Overland</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>2 year ARI</td>
<td>5 year ARI</td>
<td>10 year ARI</td>
<td>100 year ARI</td>
<td>2 year ARI</td>
</tr>
<tr>
<td>Peak flow in 450 RCP crossing Marsh Street adjacent to Valda Avenue.</td>
<td>F1</td>
<td>0.221</td>
<td>0.255</td>
<td>0.262</td>
<td>0.259</td>
<td>0</td>
</tr>
<tr>
<td>Peak flow surcharging low point in Valda Avenue and discharging through residential properties to the east.</td>
<td>F2</td>
<td>0</td>
<td>0.068</td>
<td>0.265</td>
<td>0.31</td>
<td>0</td>
</tr>
<tr>
<td>Peak flow in 750 RCP crossing Marsh Street adjacent to Flora Street.</td>
<td>F3</td>
<td>0.286</td>
<td>0.265</td>
<td>0.287</td>
<td>0.284</td>
<td>0</td>
</tr>
<tr>
<td>Peak flow surcharging low point in Flora Street and discharging through residential properties to the east.</td>
<td>F4</td>
<td>0.174</td>
<td>0.587</td>
<td>0.686</td>
<td>0.867</td>
<td>0.007</td>
</tr>
<tr>
<td>Peak flow in 375 RCP crossing Marsh Street adjacent to Innesdale Road.</td>
<td>F5</td>
<td>0.144</td>
<td>0.148</td>
<td>0.147</td>
<td>0.149</td>
<td>0</td>
</tr>
<tr>
<td>Peak flow surcharging trapped low point immediately west of Innesdale Road.</td>
<td>F6</td>
<td>0</td>
<td>0.529</td>
<td>0.703</td>
<td>0.93</td>
<td>-0.003</td>
</tr>
<tr>
<td>Peak flow in 375 RCP crossing immediately west of Mercure Sydney Airport Hotel.</td>
<td>F7</td>
<td>0.15</td>
<td>0.218</td>
<td>0.23</td>
<td>0.232</td>
<td>-0.003</td>
</tr>
<tr>
<td>Peak flow surcharging trapped low point immediately west of Mercure Sydney Airport Hotel.</td>
<td>F8</td>
<td>0</td>
<td>0.049</td>
<td>0.322</td>
<td>0.47</td>
<td>0</td>
</tr>
<tr>
<td>Peak flow in 1200 x 900 RCBC at upstream end of unlined channel.</td>
<td>F9</td>
<td>0.969</td>
<td>1.03</td>
<td>1.04</td>
<td>1.08</td>
<td>0.095</td>
</tr>
<tr>
<td>Peak flow in 375 RCP draining sag in southern kerbline of Marsh Street.</td>
<td>F10</td>
<td>0.053</td>
<td>0.075</td>
<td>0.077</td>
<td>0.075</td>
<td>0.016</td>
</tr>
<tr>
<td>Peak flow surcharging sag in southern kerbline of Marsh Street.</td>
<td>F11</td>
<td>0.04</td>
<td>0.179</td>
<td>0.247</td>
<td>0.443</td>
<td>0.04</td>
</tr>
<tr>
<td>Peak flow in unlined channel (upstream end)</td>
<td>F12</td>
<td>1.28</td>
<td>1.38</td>
<td>1.46</td>
<td>1.58</td>
<td>0.17</td>
</tr>
<tr>
<td>Peak flow discharging to Cooks River via 3 off 900 RCP's(5)</td>
<td>F13</td>
<td>1.53</td>
<td>1.85</td>
<td>1.95</td>
<td>2.07</td>
<td>0.17</td>
</tr>
</tbody>
</table>

---

(1) Peak flows have been quoted to more than one decimal place for comparative purposes only.
(2) Refer Figure 4.4 for reference to Location Identifier.
(3) Difference in peak flows derived by comparison with peak flows presented in Table 3.1.
(4) Note that a positive value represents an increase in peak flow when compared to present day conditions. Orange shading indicates an increase in peak flow as a result of the road upgrade, whilst green shading indicates a reduction (or no change) in peak flow.
### TABLE 4.3
IMPACT OF STORMWATER DRAINAGE SYSTEM UPGRADE OPTION 4 ON PEAK FLOWS(1)

<table>
<thead>
<tr>
<th>Location</th>
<th>Location Identifier (2)</th>
<th>Post-Upgrade Peak Flows</th>
<th>Difference in Peak Flows(3,4)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Piped</td>
<td>Overland</td>
</tr>
<tr>
<td>Peak flow in 450 RCP crossing Marsh Street adjacent to Valda Avenue.</td>
<td>F1</td>
<td>0.225</td>
<td>0.256</td>
</tr>
<tr>
<td>Peak flow surcharging low point in Valda Avenue and discharging through residential properties to the east.</td>
<td>F2</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Peak flow in 750 RCP crossing Marsh Street adjacent to Flora Street.</td>
<td>F3</td>
<td>0.337</td>
<td>0.346</td>
</tr>
<tr>
<td>Peak flow surcharging low point in Flora Street and discharging through residential properties to the east.</td>
<td>F4</td>
<td>0.063</td>
<td>0.492</td>
</tr>
<tr>
<td>Peak flow in 375 RCP crossing Marsh Street adjacent to Innesdale Road.</td>
<td>F5</td>
<td>0.125</td>
<td>0.151</td>
</tr>
<tr>
<td>Peak flow surcharging trapped low point immediately west of Innesdale Road.</td>
<td>F6</td>
<td>0</td>
<td>0.392</td>
</tr>
<tr>
<td>Peak flow in 375 RCP crossing immediately west of Mercure Sydney Airport Hotel.</td>
<td>F7</td>
<td>0.152</td>
<td>0.202</td>
</tr>
<tr>
<td>Peak flow surcharging trapped low point immediately west of Mercure Sydney Airport Hotel.</td>
<td>F8</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Peak flow in 1200 x 900 RCBC at upstream end of unlined channel.</td>
<td>F9</td>
<td>1.12</td>
<td>1.14</td>
</tr>
<tr>
<td>Peak flow in 375 RCP draining sag in southern kerbline of Marsh Street.</td>
<td>F10</td>
<td>0.066</td>
<td>0.077</td>
</tr>
<tr>
<td>Peak flow surcharging sag in southern kerbline of Marsh Street.</td>
<td>F11</td>
<td>0.084</td>
<td>0.344</td>
</tr>
<tr>
<td>Peak flow in unlined channel (upstream end)</td>
<td>F12</td>
<td>1.64</td>
<td>1.79</td>
</tr>
<tr>
<td>Peak flow discharging to Cooks River via 3 off 900 RCP’s(3)</td>
<td>F13</td>
<td>1.92</td>
<td>2.06</td>
</tr>
</tbody>
</table>

(1) Peak flows have been quoted to more than one decimal place for comparative purposes only.
(2) Refer Figure 4.5 for reference to Location Identifier.
(3) Difference in peak flows derived by comparison with peak flows presented in Table 3.1.
(4) Note that a positive value represents an increase in peak flow when compared to present day conditions. Orange shading indicates an increase in peak flow as a result of the road upgrade, whilst green shading indicates a reduction (or no change) in peak flow.
<table>
<thead>
<tr>
<th>Location</th>
<th>Location Identifier (2)</th>
<th>Post-Upgrade Peak Flows</th>
<th>Difference in Peak Flows (3,4)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Piped</td>
<td>Overland</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2 year ARI</td>
<td>5 year ARI</td>
</tr>
<tr>
<td>Peak flow in 450 RCP crossing Marsh Street adjacent to Valda Avenue.</td>
<td>F1</td>
<td>0.282</td>
<td>0.309</td>
</tr>
<tr>
<td>Peak flow surcharging low point in Valda Avenue and discharging through residential properties to the east.</td>
<td>F2</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Peak flow in 750 RCP crossing Marsh Street adjacent to Flora Street.</td>
<td>F3</td>
<td>0.412</td>
<td>0.432</td>
</tr>
<tr>
<td>Peak flow surcharging low point in Flora Street and discharging through residential properties to the east.</td>
<td>F4</td>
<td>0</td>
<td>0.419</td>
</tr>
<tr>
<td>Peak flow in 375 RCP crossing Marsh Street adjacent to Innesdale Road.</td>
<td>F5</td>
<td>0.128</td>
<td>0.138</td>
</tr>
<tr>
<td>Peak flow surcharging trapped low point immediately west of Innesdale Road.</td>
<td>F6</td>
<td>0</td>
<td>0.362</td>
</tr>
<tr>
<td>Peak flow in 375 RCP crossing immediately west of Mercure Sydney Airport Hotel.</td>
<td>F7</td>
<td>0.162</td>
<td>0.187</td>
</tr>
<tr>
<td>Peak flow surcharging trapped low point immediately west of Mercure Sydney Airport Hotel.</td>
<td>F8</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Peak flow in 1200 x 900 RCBC at upstream end of unlined channel.</td>
<td>F9</td>
<td>0.993</td>
<td>1.11</td>
</tr>
<tr>
<td>Peak flow in 375 RCP draining sag in southern kerbline of Marsh Street.</td>
<td>F10</td>
<td>0.066</td>
<td>0.084</td>
</tr>
<tr>
<td>Peak flow surcharging sag in southern kerbline of Marsh Street.</td>
<td>F11</td>
<td>0</td>
<td>0.264</td>
</tr>
<tr>
<td>Peak flow in unlined channel (upstream end)</td>
<td>F12</td>
<td>1.27</td>
<td>1.43</td>
</tr>
<tr>
<td>Peak flow discharging to Cooks River via 3 off 900 RCP’s (5)</td>
<td>F13</td>
<td>1.52</td>
<td>1.94</td>
</tr>
</tbody>
</table>

(1) Peak flows have been quoted to more than one decimal place for comparative purposes only.
(2) Refer Figure 4.6 for reference to Location Identifier.
(3) Difference in peak flows derived by comparison with peak flows presented in Table 3.1.
(4) Note that a positive value represents an increase in peak flow when compared to present day conditions. Orange shading indicates an increase in peak flow as a result of the road upgrade, whilst green shading indicates a reduction (or no change) in peak flow.
## TABLE 4.5
**IMPACT OF STORMWATER DRAINAGE SYSTEM UPGRADE OPTION 6 ON PEAK FLOWS**

(m³/s)

<table>
<thead>
<tr>
<th>Location</th>
<th>Location Identifier (2)</th>
<th>Post-Upgrade Peak Flows (1)</th>
<th>Difference in Peak Flows (3,4)</th>
<th>Overland</th>
<th>Piped</th>
<th>Overland</th>
<th>Piped</th>
<th>Overland</th>
<th>Piped</th>
<th>Overland</th>
<th>Piped</th>
<th>Overland</th>
<th>Piped</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>2 year ARI</td>
<td>5 year ARI</td>
<td>10 year ARI</td>
<td>100 year ARI</td>
<td>2 year ARI</td>
<td>5 year ARI</td>
<td>10 year ARI</td>
<td>100 year ARI</td>
<td>2 year ARI</td>
<td>5 year ARI</td>
<td>10 year ARI</td>
<td>100 year ARI</td>
</tr>
<tr>
<td>Peak flow in 450 RCP crossing Marsh Street adjacent to Valda Avenue.</td>
<td>F1</td>
<td>0.288</td>
<td>0.315</td>
<td>0.332</td>
<td>0.32</td>
<td>0.067</td>
<td>0.058</td>
<td>0.067</td>
<td>0.06</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Peak flow surcharging low point in Valda Avenue and discharging through residential properties to the east.</td>
<td>F2</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>-0.037</td>
<td>-0.303</td>
<td>-0.317</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Peak flow in 750 RCP crossing Marsh Street adjacent to Flora Street.</td>
<td>F3</td>
<td>0.432</td>
<td>0.451</td>
<td>0.458</td>
<td>0.48</td>
<td>0.146</td>
<td>0.188</td>
<td>0.187</td>
<td>0.219</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Peak flow surcharging low point in Flora Street and discharging through residential properties to the east.</td>
<td>F4</td>
<td>0</td>
<td>0.39</td>
<td>0.551</td>
<td>0.641</td>
<td>-0.161</td>
<td>-0.212</td>
<td>-0.243</td>
<td>-0.329</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Peak flow in 375 RCP crossing Marsh Street adjacent to Innesdale Road.</td>
<td>F5</td>
<td>0.129</td>
<td>0.148</td>
<td>0.148</td>
<td>0.149</td>
<td>0.008</td>
<td>0.006</td>
<td>0.008</td>
<td>0.009</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Peak flow surcharging trapped low point immediately west of Innesdale Road.</td>
<td>F6</td>
<td>0</td>
<td>0.262</td>
<td>0.533</td>
<td>0.672</td>
<td>0</td>
<td>-0.29</td>
<td>-0.262</td>
<td>-0.378</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Peak flow in 375 RCP crossing immediately west of Mercure Sydney Airport Hotel.</td>
<td>F7</td>
<td>0.182</td>
<td>0.187</td>
<td>0.223</td>
<td>0.233</td>
<td>0.029</td>
<td>-0.028</td>
<td>-0.003</td>
<td>0.003</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Peak flow surcharging trapped low point immediately west of Mercure Sydney Airport Hotel.</td>
<td>F8</td>
<td>0</td>
<td>0</td>
<td>0.104</td>
<td>0.094</td>
<td>0</td>
<td>-0.046</td>
<td>-0.269</td>
<td>-0.47</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Peak flow in new 3 off 1050 RCP's at upstream end of unlined channel.</td>
<td>F9</td>
<td>1.15</td>
<td>1.48</td>
<td>1.68</td>
<td>1.75</td>
<td>0.276</td>
<td>0.504</td>
<td>0.64</td>
<td>0.64</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Peak flow in 375 RCP draining sag in southern kerbline of Marsh Street.</td>
<td>F10</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Peak flow surcharging sag in southern kerbline of Marsh Street.</td>
<td>F11</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>-0.012</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Peak flow in unlined channel (upstream end)</td>
<td>F12</td>
<td>1.28</td>
<td>1.65</td>
<td>1.82</td>
<td>1.9</td>
<td>0.17</td>
<td>0.39</td>
<td>0.47</td>
<td>0.42</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Peak flow discharging to Cooks River via 3 off 900 RCP's (3)</td>
<td>F13</td>
<td>1.54</td>
<td>2.13</td>
<td>2.35</td>
<td>2.47</td>
<td>0.18</td>
<td>0.33</td>
<td>0.36</td>
<td>0.28</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

(1) Peak flows have been quoted to more than one decimal place for comparative purposes only.

(2) Refer Figure 4.7 for reference to Location Identifier.

(3) Difference in peak flows derived by comparison with peak flows presented in Table 3.1.

(4) Note that a positive value represents an increase in peak flow when compared to present day conditions. Orange shading indicates an increase in peak flow as a result of the road upgrade, whilst green shading indicates a reduction (or no change) in peak flow.
5 EROSION AND SEDIMENT CONTROL STRATEGY

5.1 General

A strategy aimed at mitigating the adverse impacts of the construction phase of the road upgrade on water quality in receiving drainage lines and watercourses was developed as part of this present investigation.

It is recommended that the strategy presented in this section of the report be used as a starting point for preparation of the Soil and Water Management Plan (SWMP) that will need to be developed as part of final design and/or construction documentation for the road upgrade works. However, it should be recognised that ultimate requirements for controlling erosion and sediment during construction will be dictated by final design of the road upgrade works, proposed construction methods, staging and site management practices, all of which are yet to be finalised.

The strategy has been developed based on the principles and design guidelines set out in the following documents:

- Soils and Construction – Managing Urban Stormwater series (herein referred to as the “Blue Book”), comprising:
  - Volume 1 (Landcom, 2004)
  - Volume 2D – Main Roads (DECC, 2008).

5.2 Key Elements of the Strategy

The primary principles for effective erosion and sediment control are firstly to minimise erosion, and then to capture sediment from disturbed areas where erosion cannot be prevented. While this present investigation deals primarily with the control of sediment, and the structural measures that will be required to capture “dirty” water (i.e. runoff generated on-site) and bypass “clean” water (i.e. runoff generated off-site) through the construction corridor, a range of erosion control principles will need to be incorporated into the future SWMP including:

- appropriate location and treatment of site access and stockpile sites;
- conservation of existing topsoil for later site rehabilitation;
- minimisation of disturbed areas, and stabilisation using batter blanketing, surface mulching or vegetation;
- scour protection along any temporary drainage lines through the site;
- separation of clean and dirty water wherever possible, and the diversion of clean water from upslope areas through the construction corridor;
- site maintenance requirements; and
- progressive site rehabilitation.
5.3 Local Erosion and Sediment Control Measures

The Blue Book allows for localised erosion and sediment control measures to be used in the absence of large scale sediment retention basins where the average annual soil loss from a disturbed area, as derived by application of the Revised Universal Soil Loss Equation (RUSLE)\(^\text{15}\), is less than 150 m\(^3\).

Figure 5.1 shows the extent of the 9,400 m\(^2\) (approx.) of land which will be disturbed during the construction phase of the project (excluding areas of existing pavement) and identifies the receiving drainage lines to which runoff from these areas will discharge. Table 5.1 summarises the parameters which are constant in the RUSLE for the site, noting that the Alluvial – Birrong (Albg) soil landscape group has been adopted for the purpose of estimating the average annual volume of soil which could be lost from disturbed areas.

### TABLE 5.1
CONSTANT PARAMETERS ADOPTED FOR APPLICATION TO THE RUSLE

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rainfall Intensity for 2 year ARI, 6 hour duration</td>
<td>12.5 mm/hr</td>
<td>For Arncliffe area.</td>
</tr>
<tr>
<td>design storm</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rainfall Erosivity Factor (R)</td>
<td>3371</td>
<td>Based on 2 year ARI, 6 hour duration design storm.</td>
</tr>
<tr>
<td>Soil Landscape</td>
<td>Albg [Alluvial</td>
<td>Localised high flooding and erosion hazard; saline subsoils, seasonal</td>
</tr>
<tr>
<td></td>
<td>- Birrong]</td>
<td>waterlogging, very low soil fertility</td>
</tr>
<tr>
<td>Soil Hydrologic Group</td>
<td>C</td>
<td>Moderate to high runoff potential, generally slow infiltration rates,</td>
</tr>
<tr>
<td></td>
<td></td>
<td>fine clayey texture with weak/moderate structure</td>
</tr>
<tr>
<td>Soil/Sediment Type</td>
<td>D</td>
<td>Based on Albg soil landscape group.</td>
</tr>
<tr>
<td>Soil Erodibility Factor (K)</td>
<td>Range 0.015 to</td>
<td>Taken from Table C20 in Appendix C of LC, 2004</td>
</tr>
<tr>
<td></td>
<td>0.047</td>
<td></td>
</tr>
<tr>
<td>Erosion Control Practice Factor (P)</td>
<td>1.3</td>
<td>Representative of compacted and smooth surface conditions on site.</td>
</tr>
<tr>
<td>Cover Factor (C)</td>
<td>1.0</td>
<td>Representative of bare earth conditions on site.</td>
</tr>
</tbody>
</table>

Application of the RUSLE results in an estimated average annual soil loss of less than 50 m\(^3\), indicating that large scale sediment retention basins are not justified. However, care will need to be taken in the control of sediment laden runoff given the close proximity of the Cooks River to the works area. The implementation of effective localised erosion and sediment control measures aimed at minimising the volume of sediment which is transported from disturbed areas will therefore be key to the control of sediment from disturbed areas. Measures would include use of the following practices and smaller scale elements:

\(^\text{15}\) For further details of the RUSLE, refer Appendix A of Landcom, 2004.
➢ staging of works to minimise the extent of disturbance at any one time;
➢ temporary stabilisation works to reduce the extent of disturbed surfaces;
➢ application of temporary surface treatments or blanketing on exposed earth surfaces;
➢ sediment barriers and sumps, in series where necessary;
➢ vegetative buffer strips; and
➢ stabilised drainage lines incorporating rock check dams at regular intervals.

Prior to commencing any drainage related works it is recommended that a coffer dam be installed upstream of the inlet to the 3 off 900 mm diameter pipes to prevent tidal movement within the channel during the construction period. The top of the coffer dam should be set at RL 0.7 m AHD, which will prevent:

➢ the ingress of salt water to the works area up to MHWS level;\(^\text{16}\) and
➢ major backwater flooding from occurring during storm events.

It will also be necessary to install a pump arrangement to dewater the works area below the level of the coffer dam following rainfall periods.

\(^{16}\) Ignores the effects of wave action.
6 REFERENCES


EWFW (2012a) “Soil and Water Management for Proposed Development of 20 Levey Street, Wolli Creek”.

EWFW (2012b) “Water Quality Management for Proposed Development of 20 Levey Street, Wolli Creek”


APPENDIX A

DRAINAGE PLAN
(EWFW, 2012)
APPENDIX B

DRAINAGE PLANS
(DMR, 1971)
APPENDIX C

AS-BUILT DRAINAGE PLAN
(HYDER, 2002)
APPENDIX D

DRAINAGE PLANS
(RTA, 2008)
GULLY PIT WITH PRECAST CONCRETE LINTEL

SECTION A - A

SCALE 1:20
APPENDIX E

MARSH STREET STORMWATER ASSETS
(RCC, 2013)
APPENDIX F

FIELD SURVEY DATA
(RMS, 2014)
***NOTE: Arrows indicate direction of flow.

***NOTE: RL's obtained in the field appear to contradict observed direction of flow in this system. Further investigation is required.

***NOTE: Diagram is to accompany survey model 'SURV MARSH DRAINAGE' from file 'Marsh St Drainage 08-05-2014'.
APPENDIX G

PLATES SHOWING CONDITION OF STORMWATER DRAINAGE SYSTEM
(RMS, 2014)
Marsh Street – existing drainage 8/07/14

**Junction pit opposite Valda Avenue at top of longitudinal trunk drain**

Junction pit in road pavement

450 mm RCP pipe inlet / 525 mm RCP outlet
525 mm invert RL = Surface RL 3.052 – approx 2.0 m depth = 1.052
5058.386.RC.2501 road plans show invert RL of 3.25’ = 0.991 m
525 mm RCP silted up

450 mm RCP silted up
Median pit upstream of outlet to open drain

Median pit 27  |  375 mm RCP longitudinal pipe inlet to pit on right hand side
Depth to water/silt level in pit = 0.85 m  |  depth of water/silt = 1.0 m
Depth to invert 1.85 / invert RL = 2.044 (top of median surface RL) – 1.85 = 0.194
5058.386.RC.2501 road plans show invert RL of 0.75’ = 0.229 m

Obvert of 375 mm cross pipe from golf course in silted up median pit (barely visible)
DRAINAGE AND FLOODING INVESTIGATION

MARSH STREET UPGRADE –
M5 EAST MOTORWAY TO COOKS RIVER

December 2014

DRAFT REPORT FOR CLIENT REVIEW