ATTACHMENT 4

C&M
CONSULTING
ENGINEERS

SITE SPECIFIC FLOOD REPORT

AT

8-10 DUNLOP ST AND 7-33 WATER STREET

STRATHFIELD SOUTH

REPORT NO. R00373-F01

Revision 04

29 July 2009

C&M Consulting Engineers P/L
1/142 James Ruse Drive, Rosehill NSW 2142. P8209-3846 F9687-9393

PROJECT DETAILS

Property Address:	8-10 Dunlop St and 7-33 Water St, Strathfield South
Development Proposal:	Rezoning Application
For:	Westport Pty Ltd Hanson Construction Materials Pty Ltd Kell & Rigby Pty Ltd R J Green & Lloyd Pty Ltd

REPORT CERTIFICATION

Report prepared by:

EDWARD SHIN
Civil Engineer - Director
B.E.(Civil) , MIEAust, CPEng
NPER (Civil), RPEQ

Report reviewed by:

ANTHONY MANCONE
Civil Engineer - Director
B.E.(Civil),Hons., MIEAust, CPEng,
NPER (Civil), NPER (Building Services)

DISCLAIMER

C & M Consulting Engineers Pty Ltd should be consulted to ascertain the suitability of the information contained herein if any third party wishes to utilise this report. C & M Consulting Engineers Pty Ltd accepts no responsibility for the application of the contents of this report by other than the instructing party who has not verified the use of this report for their purposes.

DOCUMENT CONTROL

REVISION	ISSUE DATE	ISSUED TO	ISSUED FOR
Draft	24/03/09	Crown International	Draft
01	30/03/09	Crown International	Review
02	08/04/09	Crown International	Council Submission
03	02/06/09	Crown International	Review
04	29/07/09	Crown International	Council Submission

TABLE OF CONTENTS

1. INTRODUCTION

1.1 General

This Site Specific Flood Report has been prepared to supplement the application to Strathfield Council for the rezoning of the existing industrial lands at 8-10 Dunlop Street and 7-33 Water Street, Strathfield South.

The scope of this report is to estimate flood levels for the major storm events within the development site for planning purposes and to determine the likely impacts, if any, on the development, upstream and downstream properties.

From a site visit, it was revealed that the site is located on the northern side of Cooks River. Both Dunlop and Water Streets are the major overland flow paths for the local catchment for the major storm events. This flood investigation report will address the impacts on the development due to the flooding of Cooks River as well as recommend flood mitigation measures for the local overland flows.

The report addresses the site flooding in two (2) parts namely; (1) flooding of Cooks River, and (2) Local Flooding or overland flows.

The report however does not address the site drainage system other than flood relevant recommendations and any mitigation measures that may required to protect the development.

Figure 1 – Areal View of the site

Proposed Development

The rezoning application lodged to Council to rezone from the current Industrial 4 to Residential B to facilitate the construction of a multi-unit housing complex. The proposal consists of 14 building blocks ranging from 2 to 8 storeys totalling 388 dwelling units.

The development also involves softening of the site by providing a significant area for the landscaping.

A concept masterplan prepared by Alan Jack + Cottier is included in Appendix A.

1.2 Relevant Guidelines and Requirements

All development in Strathfield Council area must comply with the flood planning principles of the *Strathfield Council Stormwater Management Policy* and in particular the requirements of the Council's Stormwater Management Code dated 26 October 1994.

The main objectives of the policy are:

- To preserve and protect the amenity and property of residents, property owners and the community.
- To ensure the safety of residents and the community.
- To meet reasonable expectations and statutory requirements for the development of properties.
- To protect the physical environment and receiving waters of catchments.

The following elements of flood planning standards should be adhered to for the development within the Strathfield Council areas:

1. Provide minor and major stormwater systems with 20 year ARI piped system and a 100 year ARI overland flow system respectively for residential areas;
2. Provide a freeboard ranging from 0.3m to 0.5m to the floor levels against the 100 year peak flood level of channel, mainstream flows, or in areas where significant overland flow occurs;

For technical guidelines, "Australian Rainfall and Runoff" (AR&R) published by the Institution of Engineers, Australia (1987) has been used. AR&R is a technical guideline that specifies the acceptable methods of determining flows and flood levels in Australia.

1.3 The Site & Its Context

The description of the site and its context as well as current planning instruments are described in the Rezoning Application report prepared by Don Smith Planning. It is intended to not reiterate these items in this report; however issues related to flooding are addressed.

The character of the immediate locality is industrial surrounded by residential areas and is generally fully developed. The drainage system consists of a conventional system having regards to minor and major system principles.

The site is located on the northern side of Cooks River at the confluence with Cox's Creek. The site naturally falls and drains to Cooks River in a southerly direction. The section of Cooks River fronting the site is concrete lined channel.

Given that the site is not in its natural state, its natural ground level is not definite. However, the site is generally sloping in a southerly direction towards the Cooks River at an average gradient of 3%.

2. COOKS RIVER FLOODING

2.1 Currently Available Flood Study

Sydney Water Corporation has commissioned Parsons Brinckerhoff Pty Ltd (PB) to undertake a flood study of the Cooks River catchment to support the planning frame of the now degraded concrete lined channels and banks. The report is titled 'Cooks River Flood Study' and is dated February, 2009.

The main aim of the flood study is to investigate the effects of the proposed river wall rehabilitation works as outlined in the Cooks River Naturalisation Master Plan (2009) and Cooks River Strategic Plan (1997). The majority of the existing creek walls consist of concrete, masonry, or steel sheet pile walls, which are now deteriorating or require renewal.

Sydney Water is investigating the feasibility of naturalising those sections to improve aesthetics and environmental values.

2.2 Review of Cooks River Flood Study

The Cooks River catchment has an area of approximately 102km^2 draining into Botany Bay. It extends as far west as Lidcombe and has a number of major tributaries such as Wolli Creek and the Alexandra Canal.

The hydrological modelling of the Cooks River catchment was modelled using WBNM which is an event based hydrologic model originally developed by Professor Michael Boyd. WBNM is a very reputable model that simulates consistent results to recorded historical data.

The model has been semi-calibrated against previous models of the storms of November 1961 and March 1983. The current PB model shows a slight increase in peak flows but it may be due to higher imperviousness ratios adopted by PB in their more recent modelling.

The hydraulic modelling of the river and creeks were done using 2D TUFLOW linking with the 1D hydrodynamic modelling tool, ESTRY. The 1D model was used to simulate the channel flows and 2D model for the floodplains. For the boundary condition, the High Water Spring Solstice tide in Botany Bay together with allowances for storm related components and climate change were used. The hydraulic model has been calibrated against the storms of November 1961 and March 1983. However, the calibration was limited by comparing the flood levels observed by the public.

The study also investigated the effects of climate change, which is predicted to result in an increase in rainfall intensities and rise in sea levels. The *Floodplain Risk Management Guideline: Practical Consideration of Climate Change*, DECC 2007, recommends sensitivity analysis looking at rises in sea levels in combination with increase in rainfall intensities.

2.3 Cooks River Flood Levels

The development site is located on the upstream side of the Water Street bridge where Coxs Creek joins the river. From the PB Report, the peak flows at the confluence of the upper Cooks River and Coxs Creek are as follows:

LOCATION	2 Year ARI (m^3/s)	20 Year ARI (m^3/s)	100 Year ARI (m^3/s)	PMF (m^3/s)
Cooks River upper catchment	65.7	134.3	180.7	448.7
Coxs Creek - discharge to Cooks River	76.8	153.4	204.3	472.0

The hydraulic results show that the 100 year flood levels at the downstream of Water Street bridge reaches to RL9.74m AHD. However the flood level on the upstream, where the subject site is situated, reaches up to RL11m AHD due to the afflux at the Water Street bridge.

Climate change does not have much impact on flood levels upstream of the Water Street bridge. From the interpolation of the flood map, B-15 of the PB Report, the 100 year flood level for the site is approximately **11.2**m AHD which is approximately 2.6m above the 1991 Sydney Water Report of 8.6m AHD.

As a result of the increase in predicted flood level, it is now that the flood extends into the site as shown on Drawing SK04.

Figure 2 – Concrete Lined Cooks River

Proposed Flood Mitigation works
Based on the field surveyed information, the calculated flood displacement volume within the site is about 6,500m^3 with an average depth of inundation of below 0.5m. Given the shallow depth of inundation it can easily be mitigated by flood storage compensation.

As Sydney Water is planning to naturalise the degraded river walls, it would be ideal to carry out these works along the length of the development site in conjunction with the flood compensatory works.

Subject to further investigation, it is proposed to create a more distinctive flood plain along the river bank by excavating existing river banks and filling the site, similar to the one currently under construction in Marrickville.

Figure 3 – Example showing the River Edge Treatment

Drawing SK04 in Appendix shows the proposed works, which has been presented to Sydney Water, Sydney Metropolitan Catchment Management Authority (CMA) and Department of Water and Energy (DWE) at a meeting on 23 June, 2009.

The response from these Authorities was very supportive of the proposal and Sydney Water and the other Authorities need to be consulted during the development of the river rehabilitation works.

Letters from Sydney Water and CMA are attached in Appendix D.

3. LOCAL FLOODING

3.1 General

As mentioned in Section 1.1, this report addresses the flooding of the Cooks River as well as overland flows from the local catchment. This section of the report assesses the flow behaviours and any impacts of the overland flows.

3.2 Catchment Description

The catchment that flows to the proposed rezoning area encompasses an area of 35.1 hectares of fully developed residential and industrial areas. A catchment plan is included in Appendix A.

The catchment can be further subdivided into two (2) sub-catchments namely Dunlop Street catchment and Water Street catchment. The catchment generally falls in a southerly direction discharging into a concrete lined section of the Cooks River.

The drainage system for the catchment is of a conventional type having regards to principles of minor and major drainage systems. There is a network of piped road drains with some form of overland flow paths consisting of roadways, accesses, and depressions.

In hydraulic terms, the catchment can be classified as having moderate to flat terrain thereby making it hard to accurately define the general direction of the flows. It was revealed from the review of Council supplied pipe network plans and our site inspection, that the overland flow drainage does not necessarily follow the direction of the pipe drainage.

As mentioned above, the catchment has some form of overland flow paths, however, being an old urban area, these paths are not clearly defined. There are minor sag points in the roads that are otherwise flat. It is likely that the overland flows would spill over the road boundaries and spread out through the properties. For the purpose of this investigation, we have conservatively assumed the roadways are the overland flow paths.

The following elaborates each sub-catchment.

Dunlop Street Catchment:

This catchment has an area of 11.2 hectares covering Liverpool Road to the north, Barton Street to the east and Junction Street to the west. However, the area north of Dean Street, the minor drainage system runs along Dean Street and discharge to Cooks River via Dean Reserve. The overland flows from this area flow along Dunlop Street.

Further, there is a sag in Dunlop Street about 130m from the intersection with Dean Street. It is likely that the overland flow would pond in the sag before flows out along Dunlop Street.

The Concept Masterplan prepared by Allen Jack + Cottier shows a new entry road off Dunlop Street. This road should be the new overland flow path.

Water Street Catchment:

This catchment has an area of 23.9 hectares located to the east of the Dunlop Street catchment covering Liverpool Road to the north and Bennett Av and Everitt Place to the east. The catchment of Edward Street and Bennett Ave north of Dean Street, its overland flow portion flows along Dean Street in a westerly direction whereas piped minor storm flows along Maria Street.

3.3 Hydrological Modelling

This section of the report determines the peak flows derived at the critical location within and adjacent to the rezoning site.

3.3.1 RAFTS Runoff Routing Model

The hydrologic analysis of the catchment was undertaken using the rainfall runoff flood routing model RAFTS (Runoff and Flow Training Simulation) developed by XP Software.

All models for simulation of storms should be calibrated against historical records. In the absence of historic data, the calibration of the hydrologic model can be done by cross-checking the rural flow estimates using the Probabilistic Rational Method as set out in Australian Rainfall and Runoff, 1987.

The Probabilistic Rational Method[1] has been derived from more than 200 historic recorded data throughout Australia, and is, technically, the most accurately represented hydrological results available in Australia.

The following table summerises the calculation of the Probabilistic Rational Method for the catchment.

PARAMETERS	VALUES
Catchment	0.351 km2
FF100	1.34
C10	0.5
Tc	0.51 Hr
C100	0.67
100 year Intensity	112.4 mm/hr
Flowrate	**7.34 m3/s**

The parameters to be adjusted to best represent the similar peaks from the Probabilistic Rational Method are:

- BX factor
- Initial and Continuing Losses
- Manning's roughness coefficient, and
- Lag time

---

[1] AR&R Volume 1 : Chapter 5 – Estimation of Peak Flows for Small to Medium Sized Rural Catchments

In order to achieve the flowrate similar to 7.34m³/s, the rural model of the RAFTS model has to be adjusted to the following parameters for the pervious areas.

PARAMETERS	GRASSED
BX Factor	1.0
Initial Loss	13mm
Continuous Loss	3.5mm/hr
Mannings roughness	0.025

With these parameters, the calibrated RAFTS model estimated an undeveloped flowrate of 6.98m³/s.

3.3.2 Design Rainfall Intensities and Storm Bursts

For the purpose of this study, synthetic design storms made up of intensities supplied by the Bureau of Meteorology and temporal patterns as set out in Australian Rainfall and Runoff - 1987, have been applied to the standard model to simulate the behaviour of the catchment.

3.3.3 Imperviousness Ratio for the Urbanised Sub-catchments

The effects of urbanisation primarily involve the reduction in catchment storage due to a decrease in flow travel time and decrease in loss rate due to reduced infiltration. To model the urbanisation of a catchment, the primary modification is to change the physical characteristics of the catchment by the introduction of imperviousness ratios and loss parameters. These are the physical representation of the impervious surface areas such as roofs and paved areas, which are normally associated with urbanisation. These are defined in terms of the impervious area over the total sub-area.

For the purpose of this investigation the following imperviousness ratios were used:

Residential Area	60%
Commercial Area	90%

It is pertinent to note that Strathfield Council uses 65% imperviousness ratio for any developments where discharge controls (on-site detention) are not provided. Where the development exceeds imperviousness ratio of 65%, the site discharge is limited substantially resulting effective imperviousness of well below 65%.

The above imperviousness ratios are also identical to ones used for the Cooks River Flood Study by Parsons Brinckerhoff Pty Ltd. This would make our modelling consistent with the PB's model.

For loss parameters for the impervious areas are as follows:

Initial loss	1mm (accounts for wetting of surface)
Continuous loss	0mm/h

3.3.4 Modelling Assumptions

The topography of the catchment and our site inspection revealed that the overland flow paths do not exactly follow the direction of the pipe systems.

- Overland flows from Barton and Brooklyn streets will direct to Dean St thence to Dunlop Street.
- Overland flows from Bennett Av and Edward St will direct to Dean St thence to Water Street.

To model these correctly, an equivalent catchment area has been taken out that generates the same flowrate as the capacity of the pipe system.

Catchment Node	Pipe diameter (mm)	Pipe Slope (%)Note 1	Pipe Capacity (m3/s)	Equivalent Impervious Area (ha)	Receiving Node
A2	600	1	0.7	1.1	B1
E2	450	2	0.3	0.45	D1

Note 1 – we have assumed the pipe slope to be same as road grade.

3.3.5 Design Discharges

Discharge estimates were derived for storms of the 100 year ARI. A range of storm durations from 10 minutes to 6 hours were analysed to determine the critical storm duration.

The table below summarises the peak flows at the southern boundary.

Duration	100 Year ARI Peak flows (m^3/s)		
	Catchment 1 – B2 (Dunlop St)	Catchment 2 – F1 (William St)	Catchment 3 – D9 (Water St)
10	2.40	0.79	6.40
15	2.83	0.91	7.97
20	2.80	0.89	8.77
25	3.18	0.97	8.69
30	3.00	0.91	8.40
45	2.58	0.79	8.26
1 hr	3.19	0.94	9.00
1.5 hr	**3.34**	**0.99**	8.89
2 hr	3.19	0.95	**9.21**
3 hr	2.00	0.54	7.07
4.5 hr	1.76	0.48	6.20
6 hr	1.30	0.35	4.77

3.3.6 Pipe Flows

As discussed in Section 3.2 the drainage system in the catchment consists of a conventional pipe network system to convey minor storm events. In order to determine the total overland flow within the designated overland flow paths, the flows in the pipe system should be subtracted from the above total flows.

Catchment	Total Flowrate (m3/s)	Existing Pipe (mm)	Pipe Slope (%)	Pipe Flow (m3/s)	Overland Flow (m3/s)
Dunlop St	3.34	Note 1			3.34
Williams St	0.99	No pipe			0.99
Water St	9.21	900 & 375	2	3.05	6.16

Note 1 – There is a pipe drain with two (2) sag pits that collects the road runoff. We have assumed that these pits are completely blocked.

3.4 Hydraulic Analysis

The peak overland flows calculated above have been used for the hydraulic modelling to determine the flood levels.

The hydraulic analysis of the main overland flow paths (Dunlop and Water Streets) were undertaken using HECRAS River Analysis System developed by the U.S. Army Corps of Engineers. The sections for the analysis have been derived from the survey information.

In the modelling we have made an assumption that all runoff generated from the catchment becomes overland flows within the roadways. This is a very conservative assumption as the water generally spills over to the properties once the level reaches above the levels at the boundaries. This is the case for the overland flows flowing in Dean St.

The following nominal Manning's roughnesses based on the values provided in Table 14.17 of AR&R were used:

- 'n' for roadways = 0.015
- 'n' for overbanks (footpath) = 0.02 (concrete/grass)
- Contraction coefficient = 0.1
- Expansion coefficient = 0.3

3.4.1 Flood Level Estimates

The table below summarises the hydraulic analysis results.

Dunlop Street Catchment:

Station	100 year Overland Flow levels (m)	RL at Boundary (m AHD)	Water Depth at Boundary (m)	Remarks
70.78	12.81	13.25	0.44	Sag in the road
57.19	12.93	13.24	0.31	Block A1
45.65	13.01	13.23	0.22	New entry road
34.29	13.08	13.15	0.07	
16.93	12.97	13.01	0.04	
0	12.52	12.51	-0.01	

The above results show that the overland flow depth in Dunlop Street reaches up to 0.44m above the boundary level; this is at the sag in the road. As mentioned in Section 3.2, if the overland flows are diverted along the new entry road off Dunlop Street, the flow depth in this area would be vastly improved. The level difference between the sag area and the level at the new entry road is 0.12m. With good flood mitigation planning and design, the overall drainage system in this area can be improved with the proposed development.

Water Street Catchment:

Station	100 year Flood levels (m)	RL at Boundary (m AHD)	Water Depth at Boundary (m)	Remarks
167.5	12.01	11.94	0.07	Block C3
148.5	11.50	11.43	0.07	
114	11.43	11.09	0.34	New Entry Road
89.35	11.41	11.10	0.27	Block C6
62.91	11.30	11.14	0.16	Access to D1 and D2
34.87	11.07	10.94	0.13	Block D2
0	10.59	10.49	0.10	

The above results show that the flood levels in Water Street reach up to 0.34m above the boundary level. It is unlikely however that the flood level reaches this high. As mentioned in Section 3.2, the flood water would spread out to the adjacent properties.

Nonetheless, the proposed buildings along Water Street should be set a minimum of 0.3m above the estimated overland flow levels. This was based on Council's Stormwater Management Code that the freeboard should be ranging from 0.3m to 0.5m based on the risks associated with the flood depths. Given the nature of flooding is overland flow not associated with the adjacent floodplain of the Cooks River, a 0.3m freeboard we believe is appropriate.

These results should be used for planning purposes including site design and minimum finished floor levels as described in Section 4.

4. RECOMMENDATIONS

From this investigation, flood levels of Cooks River and the local overland flow on the existing roads adjacent to the rezoning area have been determined. These results will enable us to set the Flood Planning Levels for the development.

This also enable us to address the impacts of these flood levels on the proposed development and recommend habitable floor levels for each block. It also recommends flood mitigation measures for the development.

In accordance with Council requirement, the Flood Planning Level is higher of either the 500mm above the 100 year ARI Cooks River flood level or 300mm above the local overland flow depth. Since the Cooks River flood level of 11.2m AHD is the lowest flood levels, the minimum Flood Planning Level of the site is 11.7m AHD.

The finished floor levels shown on SK03 have been set based on the Flood Planning Levels. This will set the proposed FFL ranging from 0.3m to 1.2m above the road boundary levels. Given that each building will have a setback of 5m from the road boundaries, this increase in levels can be absorbed in the setback.

The overland flow management strategy should be set for the development considering the inherent constraints and integration with the external overland flows to make the development safe and preventative to flood damage to both existing and proposed properties. The following is a set of strategies that can be implemented in the planning and design of the site.

Strategies	Mitigations	Impacts
Water Street overland flows will be contained within the road reserve.	Two access roads should be set at minimum 150mm above the 100 year flood levels.	None. There is no change to the current situation.
Dunlop Street overland flows	The proposed access road off Dunlop Street should be one of the main overland flow paths for the Dunlop Street flows.	Relieves the current flooding in Dunlop Street.
William Street Overland flow	A designated overland flow path should be provided from the western end of William Street running along the eastern side of Blocks A3 and A5.	Relieves the current William Street overland flows.
Site Overland flows	The main overland flows within the site should be directed along the roads and designated overland flow paths.	Better overall improvement on flooding.

Typical sections for each overland flow path are included in sketch SK03 in Appendix A.

Based on the above strategies, the recommended FFL are set-out below. It should be noted that during the Development Application stage for any future development, more detailed investigations should be carried out based on the final planning and design.

Proposed Buildings	**Preliminary Finish Floor Level (FFL)**	**Remarks**
A1	14.9 m AHD	
A2	14.5	Note 1
A3	12.7	Note 1
A4	12.8	Note 1
A5	11.7	Note 1 &2
B1	11.7	Note 2 & 3
C1	11.7	Note 1 & 2
C2	11.7	Note 1 & 2
C3	12.3 (2ST) and 11.8 (3ST)	Split level to suit the road levels
C4	11.7	Note 2
C5	11.7	Note 2
C6	11.7	Note 2
D1	11.7	Note 2
D2	11.7	Note 2

Note 1 - The FFL of these buildings to be determined from the final site drainage investigation. Allow a minimum of 0.3m freeboard from the overland flow levels.

Note 2 - The FFL of these buildings to be determined from the final site drainage works and Cooks River Flood levels. A minimum of 0.3m Freeboard from the site overland flow and a minimum of 0.5m freeboard from the Cooks River flood level recommended.

Note 3 – The top of driveway ramp of B1 needs to be set at 0.3m above the overland flow level.

A sketch showing the proposed flood mitigation measures and minimum floor levels is included in Appendix A.

5. CONCLUSION

The report has been prepared to support the Rezoning Application for the existing Industrial lands in South Strathfield. Currently the lands are in zone 4 Industrial and it is proposed to rezone to Residential B and facilitating multi-unit housing complex.

The site is located directly north of Cooks River and Sydney Water Corporation commissioned Parsons Brinckerhoff to prepare the Cooks River Flood Study. The study indicated the site will be inundated for the 100 year flood with a maximum flood level of 11.2m AHD. The PB investigation indicates sudden rise in flood level on the upstream side of the Water Street bridge indicating flow afflux due to the bridge. This also indicates the inundation of the site is due to the backwater effect of the afflux. The total flood volume dispersed to the site is approximately 6,500m^3.

In order to maintain the same flood storage volume of 6,500m^3, we propose to remove a part of deteriorated concrete channel wall and excavate the blanks to create a secondary flood plain to contain the flood water without losing the storage volume. The secondary flood plain will be fully landscaped to be used as an active recreational area.

Local flood analysis indicates that the flood level may reach up to 0.34m above the road boundaries. However, the flood levels given in the report present a conservative approach to an otherwise very complex drainage system. The results however indicate that the recommended flood mitigation measures can be implemented for the proposed residential development.

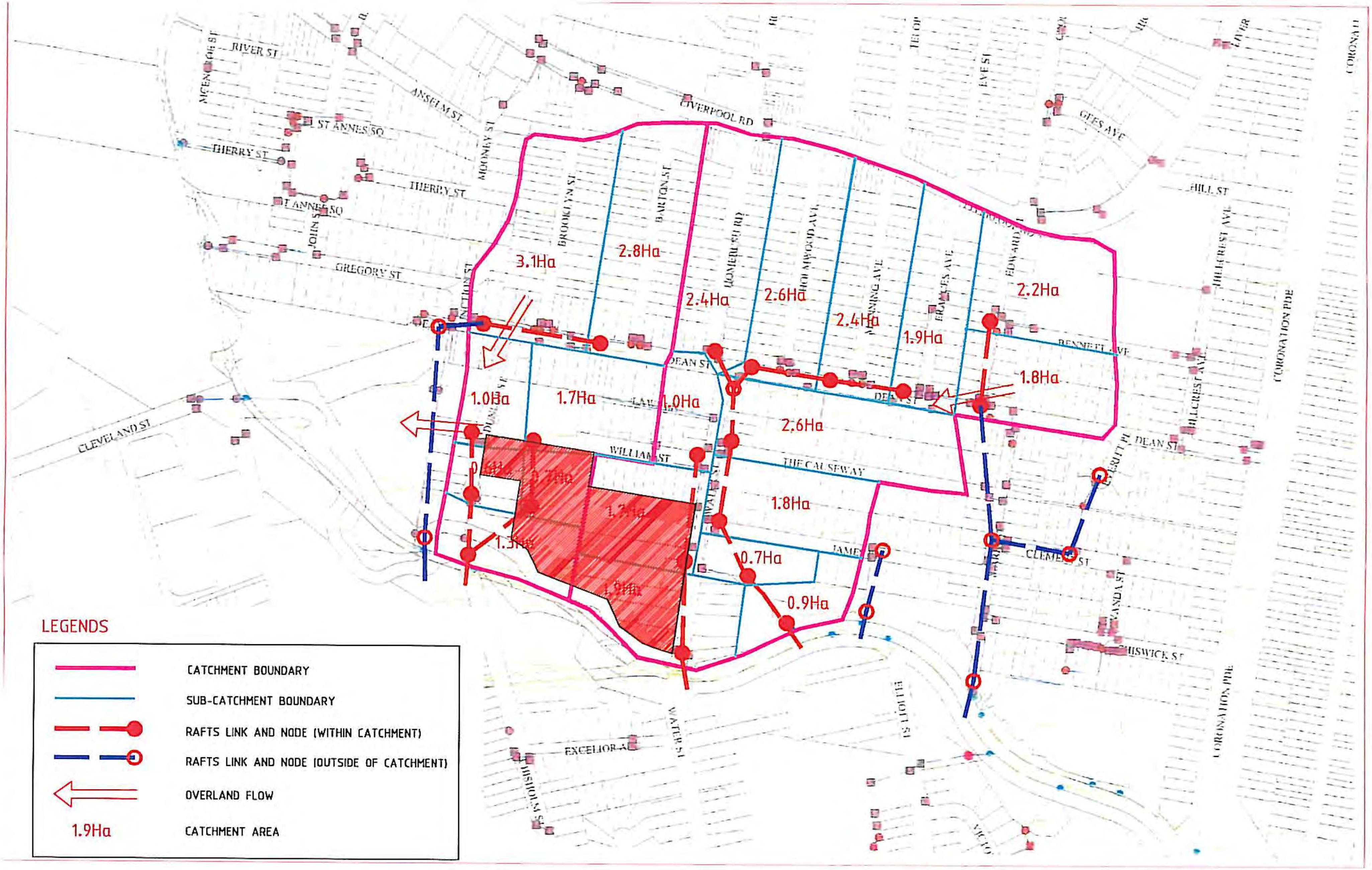
The results shown in this report indicate that the proposed development does not adversely impact on flooding within the development site and adjoining properties. It is therefore recommended that the proposals set out in this report be adopted.

REFERENCES

- Strathfield Council - *Stormwater Management Code*, 26 October 1994.
- Parsons Brinckerhoff Pty Ltd – *Cooks River Flood Study*, February 2009
- Institute of Engineers, Australia - *Australian Rainfall and Runoff*, 1987, 3rd edition.
- XP Software - RAFTS-XP Version 6.5 *Detailed Documentation and User Manual*
- U.S. Army Corps of Engineers - HEC-RAS, Version 4.0, *Program and User Manual*

APPENDIX A

FIGURES AND PLANS



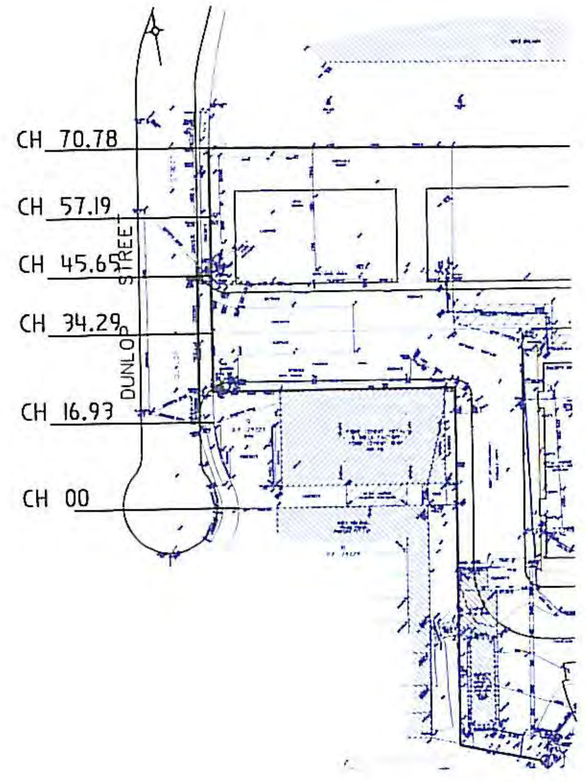
CONSULTING ENGINEERS

[illegible]

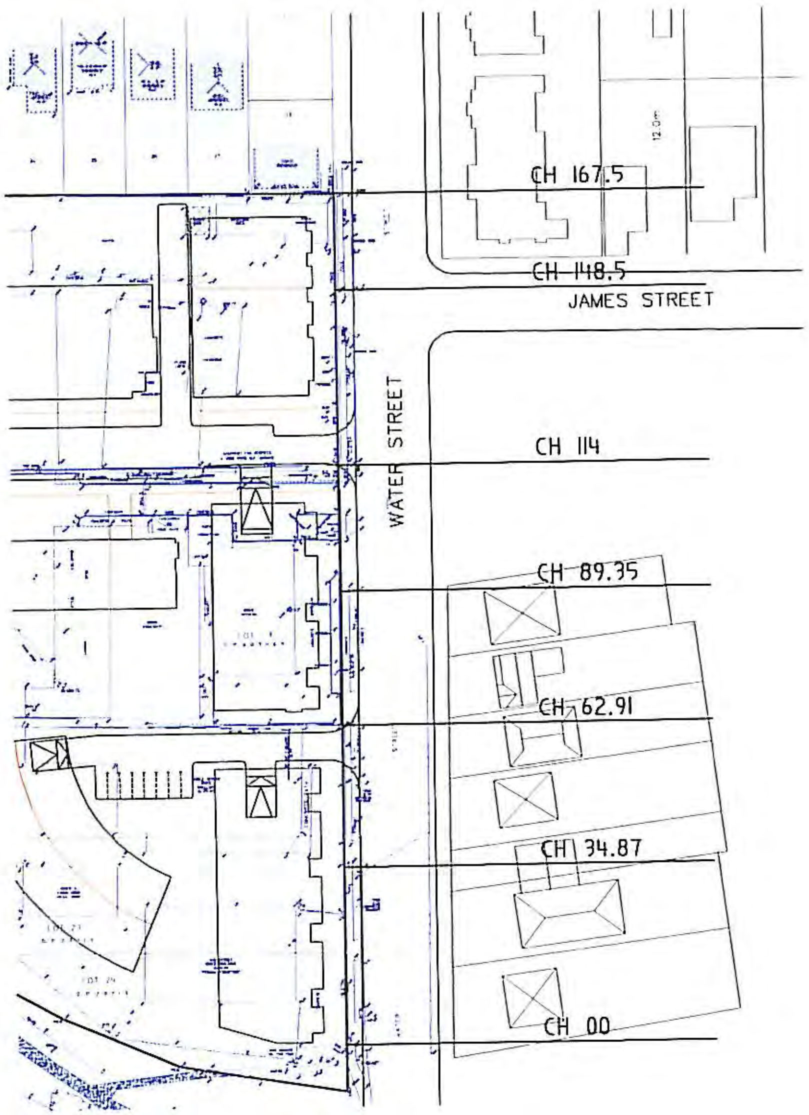
DUNLOP ST AND WATER ST, STRATHFIELD SOUTH

CATCHMENT PLAN

SCALE	DRAWING No
1:4000 @ A3	SK01



DUNLOP STREET CATCHMENT



WATER STREET CATCHMENT

CONSULTING ENGINEERS

CIVIL AND HYDRAULIC
ENGINEERING DESIGN AND
PROJECT MANAGEMENT

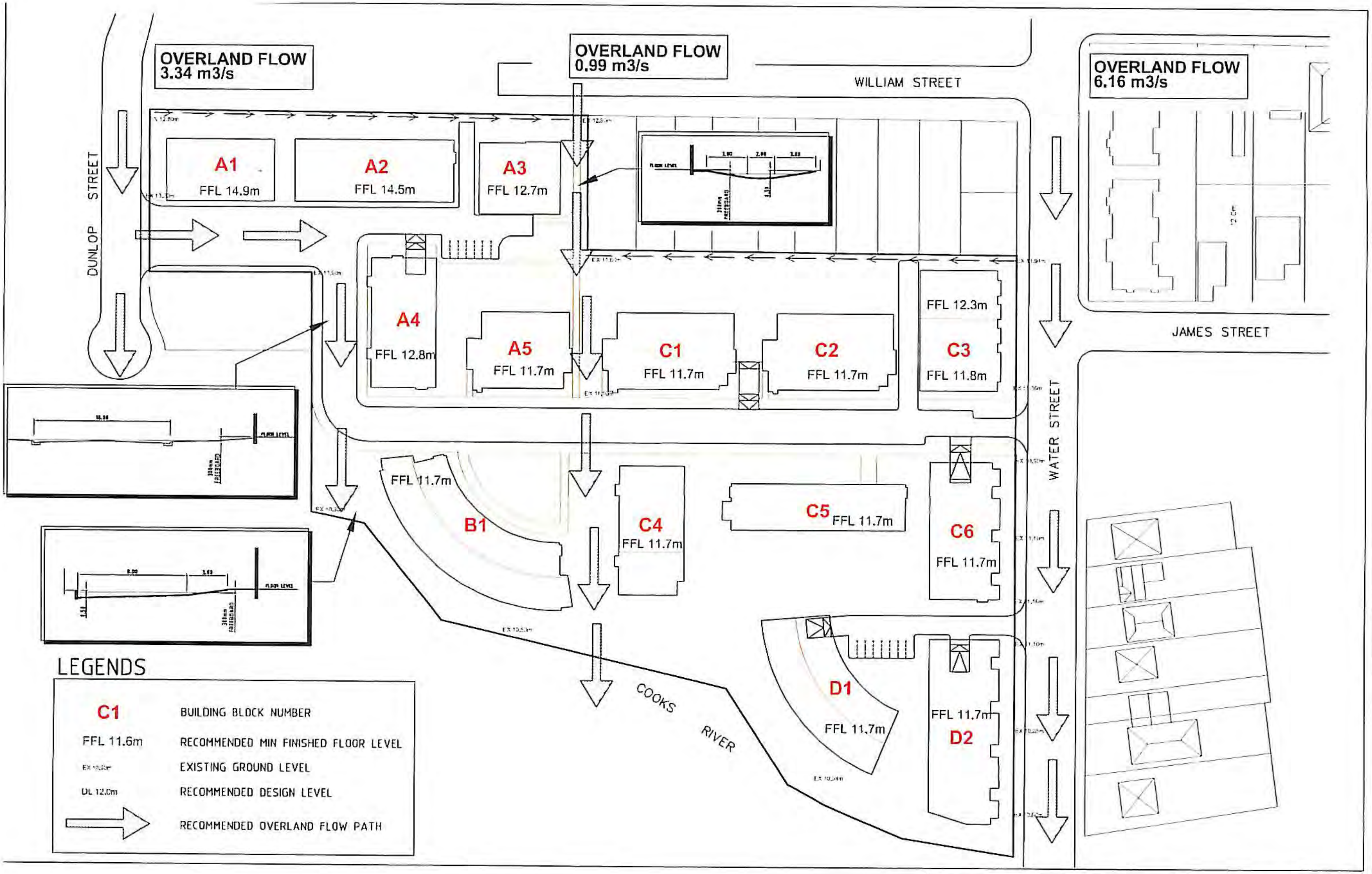
[illegible] JAMES RUSE DRIVE
ROSEHILL NSW 2142

PHONE: (02) [illegible] 3844
FAX: [illegible]
ABN [illegible]

DUNLOP ST AND WATER ST, STRATHFIELD SOUTH

HECRAS SECTIONS

SCALE:	DRAWING No
1:1000 @ A3	SK02



CM CONSULTING ENGINEERS

DUNLOP ST AND WATER ST, STRATHFIELD SOUTH

CONCEPT STORMWATER STATEGY

SCALE	DRAWING No
1:1000 @ A3	SK03

APPENDIX B

RAFTS OUTPUT RESULTS

```
#########################################################################################
                    RUNTIME        RESULTS
#########################################################################################

Max. no. of links allowed =  2000
Max. no. of routng increments allowed = 25000
Max. no. of rating curve points = 25000
Max. no. of storm temporal points = 25000
Max. no. of channel subreaches =    25
Max link stack level =    25
Input Version number =          650

 LINK D4-1             1.000

 ESTIMATED VOLUME (CU METRES*10**3) =          2.099
 ESTIMATED PEAK FLOW         (CUMECS) =      1.35
 ESTIMATED TIME TO PEAK         (MINS) =     30.00

 LINK E1             2.000

 ESTIMATED VOLUME (CU METRES*10**3) =          1.923
 ESTIMATED PEAK FLOW         (CUMECS) =      1.25
 ESTIMATED TIME TO PEAK         (MINS) =     30.00

 LINK E2             2.001

 ESTIMATED VOLUME (CU METRES*10**3) =          3.082
 ESTIMATED PEAK FLOW         (CUMECS) =      1.97
 ESTIMATED TIME TO PEAK         (MINS) =     30.00

 LINK D1             2.002

 ESTIMATED VOLUME (CU METRES*10**3) =          4.744
 ESTIMATED PEAK FLOW         (CUMECS) =      2.98
 ESTIMATED TIME TO PEAK         (MINS) =     30.00

 LINK D2             2.003

 ESTIMATED VOLUME (CU METRES*10**3) =          6.843
 ESTIMATED PEAK FLOW         (CUMECS) =      3.77
 ESTIMATED TIME TO PEAK         (MINS) =     30.00

 LINK D3             2.004

 ESTIMATED VOLUME (CU METRES*10**3) =          9.117
 ESTIMATED PEAK FLOW         (CUMECS) =      4.64
 ESTIMATED TIME TO PEAK         (MINS) =     31.00

 LINK D4-dummy          1.001

 ESTIMATED VOLUME (CU METRES*10**3) =          11.22
```

```
ESTIMATED PEAK FLOW        (CUMECS) =     5.96
ESTIMATED TIME TO PEAK       (MINS) =    31.00

LINK D5            1.002

ESTIMATED VOLUME (CU METRES*10**3) =          13.49
ESTIMATED PEAK FLOW        (CUMECS) =     6.78
ESTIMATED TIME TO PEAK       (MINS) =    31.00

LINK D6            1.003

ESTIMATED VOLUME (CU METRES*10**3) =          15.07
ESTIMATED PEAK FLOW        (CUMECS) =     7.22
ESTIMATED TIME TO PEAK       (MINS) =    33.00

LINK D7            1.004

ESTIMATED VOLUME (CU METRES*10**3) =          15.68
ESTIMATED PEAK FLOW        (CUMECS) =     7.39
ESTIMATED TIME TO PEAK       (MINS) =    34.00

LINK D8            1.005

ESTIMATED VOLUME (CU METRES*10**3) =          16.46
ESTIMATED PEAK FLOW        (CUMECS) =     7.57
ESTIMATED TIME TO PEAK       (MINS) =    36.00

LINK C1            3.000

ESTIMATED VOLUME (CU METRES*10**3) =         0.8746
ESTIMATED PEAK FLOW        (CUMECS) =     0.57
ESTIMATED TIME TO PEAK       (MINS) =    30.00

LINK C2            3.001

ESTIMATED VOLUME (CU METRES*10**3) =          2.360
ESTIMATED PEAK FLOW        (CUMECS) =     1.51
ESTIMATED TIME TO PEAK       (MINS) =    30.00

LINK C3            3.002

ESTIMATED VOLUME (CU METRES*10**3) =          4.021
ESTIMATED PEAK FLOW        (CUMECS) =     2.36
ESTIMATED TIME TO PEAK       (MINS) =    30.00

LINK D9-dummy          1.006

ESTIMATED VOLUME (CU METRES*10**3) =          20.48
ESTIMATED PEAK FLOW        (CUMECS) =     8.91
ESTIMATED TIME TO PEAK       (MINS) =    34.00
```

```
LINK A1          4.000

ESTIMATED VOLUME (CU METRES*10**3) =      2.449
ESTIMATED PEAK FLOW      (CUMECS) =    1.58
ESTIMATED TIME TO PEAK     (MINS) =   30.00

LINK A2          4.001

ESTIMATED VOLUME (CU METRES*10**3) =      4.148
ESTIMATED PEAK FLOW      (CUMECS) =    2.63
ESTIMATED TIME TO PEAK     (MINS) =   30.00

LINK B1          4.002

ESTIMATED VOLUME (CU METRES*10**3) =      5.022
ESTIMATED PEAK FLOW      (CUMECS) =    3.09
ESTIMATED TIME TO PEAK     (MINS) =   30.00

LINK B2          4.003

ESTIMATED VOLUME (CU METRES*10**3) =      5.556
ESTIMATED PEAK FLOW      (CUMECS) =    3.34
ESTIMATED TIME TO PEAK     (MINS) =   31.00

LINK F1          5.000

ESTIMATED VOLUME (CU METRES*10**3) =      1.513
ESTIMATED PEAK FLOW      (CUMECS) =    0.99
ESTIMATED TIME TO PEAK     (MINS) =   28.00

LINK F2          5.001

ESTIMATED VOLUME (CU METRES*10**3) =      2.125
ESTIMATED PEAK FLOW      (CUMECS) =    1.38
ESTIMATED TIME TO PEAK     (MINS) =   29.00

LINK B3          4.004

ESTIMATED VOLUME (CU METRES*10**3) =      8.813
ESTIMATED PEAK FLOW      (CUMECS) =    5.11
ESTIMATED TIME TO PEAK     (MINS) =   32.00

LINK OUTLET1        4.005

ESTIMATED VOLUME (CU METRES*10**3) =      8.813
ESTIMATED PEAK FLOW      (CUMECS) =    5.11
ESTIMATED TIME TO PEAK     (MINS) =   32.00

LINK OUTLET2        1.007

ESTIMATED VOLUME (CU METRES*10**3) =      29.30
```

```
ESTIMATED PEAK FLOW        (CUMECS) =    13.66
ESTIMATED TIME TO PEAK        (MINS) =    32.00

##########################################################################################
Results for period from  0: 0.0  1/ 1/1990 to 10: 0.0  1/ 1/1990
##########################################################################################

                    ROUTING INCREMENT (MINS) =      1.00
                    STORM DURATION (MINS)   =      90.
                    RETURN PERIOD (YRS)     =     100.
                    BX                  =    1.0000
                    TOTAL OF FIRST SUB-AREAS  (ha) =     10.33
                    TOTAL OF SECOND SUB-AREAS (ha) =     23.22
                    TOTAL OF ALL SUB-AREAS (ha)   =     33.55


  SUMMARY OF CATCHMENT AND RAINFALL DATA
 Link     Catch. Area     Slope   % Impervious     Pern       B      Link
 Label     #1     #2     #1    #2     #1   #2     #1    #2   #1   #2    No.
          (ha)          (%)          (%)
D4-1     0.7200  1.680  5.000 5.000  0.000 100.0  .025 .025  .0098 .0017  1.000
E1       0.6600  1.540  5.000 5.000  0.000 100.0  .025 .025  .0094 .0017  2.000
E2       0.5400 0.8100  5.000 5.000  0.000 100.0  .025 .025  .0085 .0012  2.001
D1       0.5700  1.330  5.000 5.000  0.000 100.0  .025 .025  .0087 .0015  2.002
D2       0.7200  1.680  5.000 5.000  0.000 100.0  .025 .025  .0098 .0017  2.003
D3       0.7800  1.820  4.000 4.000  0.000 100.0  .025 .025  .0114 .0020  2.004
D4-dummy  .00001  0.000  1.000 0.000  0.000 0.000  .025 0.00  0.000 0.000  1.001
D5       0.7800  1.820  3.000 3.000  0.000 100.0  .025 .025  .0132 .0024  1.002
D6       0.5400  1.260  2.000 2.000  0.000 100.0  .025 .025  .0133 .0024  1.003
D7       0.2100 0.4900  2.000 2.000  0.000 100.0  .025 .025  .0082 .0015  1.004
D8       0.2700 0.6300  2.000 2.000  0.000 100.0  .025 .025  .0093 .0017  1.005
C1       0.3000 0.7000  3.000 3.000  0.000 100.0  .025 .025  .0080 .0014  3.000
C2       0.5100  1.190  3.000 3.000  0.000 100.0  .025 .025  .0106 .0019  3.001
C3       0.5700  1.330  2.000 2.000  0.000 100.0  .025 .025  .0137 .0024  3.002
D9-dummy  .00001  0.000  1.000 0.000  0.000 0.000  .025 0.00  0.000 0.000  1.006
A1       0.8400  1.960  5.000 5.000  0.000 100.0  .025 .025  .0106 .0019  4.000
A2       0.9300  1.070  5.000 5.000  0.000 100.0  .025 .025  .0112 .0014  4.001
B1       0.3000 0.7000  3.000 3.000  0.000 100.0  .025 .025  .0080 .0014  4.002
B2       0.1200 0.4800  3.000 3.000  0.000 100.0  .025 .025  .0050 .0012  4.003
F1       0.3400  1.360  3.000 3.000  0.000 100.0  .025 .025  .0086 .0020  5.000
F2       0.2100 0.4900  3.000 3.000  0.000 100.0  .025 .025  .0067 .0012  5.001
B3       0.4200 0.8800  2.000 2.000  0.000 100.0  .025 .025  .0117 .0020  4.004
OUTLET1   .00001  0.000  1.000 0.000  0.000 0.000  .025 0.00  0.000 0.000  4.005
OUTLET2   .00001  0.000  1.000 0.000  0.000 0.000  .025 0.00  0.000 0.000  1.007


 Link   Average  Init. Loss  Cont. Loss   Excess Rain  Peak   Time  Link
 Label  Intensity  #1    #2    #1    #2     #1    #2   Inflow   to    Lag
       (mm/h)   ( mm )    (mm/h)      ( mm )    (m^3/s)  Peak  mins
D4-1     62.091 12.00 1.000  3.500 0.000  76.529 92.137   1.355  30.00 1.000
E1       62.091 12.00 1.000  3.500 0.000  76.529 92.137   1.246  30.00 2.000
```

```
E2       62.091 12.00 1.000  3.500 0.000  76.529 92.137   1.967  30.00 1.000
D1       62.091 12.00 1.000  3.500 0.000  76.529 92.137   2.982  30.00 1.500
D2       62.091 12.00 1.000  3.500 0.000  76.529 92.137   3.775  30.00 1.500
D3       62.091 12.00 1.000  3.500 0.000  76.529 92.137   4.645  31.00 1.000
D4-dummy  62.091  12.00 0.000  3.500 0.000  76.529  0.000   5.957  31.00 1.000
D5       62.091 12.00 1.000  3.500 0.000  76.529 92.137   6.778  31.00 2.000
D6       62.091 12.00 1.000  3.500 0.000  76.529 92.137   7.224  33.00 1.000
D7       62.091 12.00 1.000  3.500 0.000  76.529 92.137   7.389  34.00 2.000
D8       62.091 12.00 1.000  3.500 0.000  76.529 92.137   7.567  36.00 0.000
C1       62.091 12.00 1.000  3.500 0.000  76.529 92.137  0.5701  30.00 2.000
C2       62.091 12.00 1.000  3.500 0.000  76.529 92.137   1.507  30.00 2.000
C3       62.091 12.00 1.000  3.500 0.000  76.529 92.137   2.361  30.00 0.000
D9-dummy  62.091  12.00 0.000  3.500 0.000  76.529  0.000   8.912  34.00 0.000
A1       62.091 12.00 1.000  3.500 0.000  76.529 92.137   1.583  30.00 2.000
A2       62.091 12.00 1.000  3.500 0.000  76.529 92.137   2.633  30.00 1.000
B1       62.091 12.00 1.000  3.500 0.000  76.529 92.137   3.089  30.00 1.000
B2       62.091 12.00 1.000  3.500 0.000  76.529 92.137   3.344  31.00 1.000
F1       62.091 12.00 1.000  3.500 0.000  76.529 92.137  0.9900  28.00 1.000
F2       62.091 12.00 1.000  3.500 0.000  76.529 92.137   1.383  29.00 2.000
B3       62.091 12.00 1.000  3.500 0.000  76.529 92.137   5.110  32.00 0.000
OUTLET1   62.091 12.00 0.000  3.500 0.000  76.529  0.000   5.110  32.00 0.000
OUTLET2   62.091 12.00 0.000  3.500 0.000  76.529  0.000  13.663  32.00 0.000


 LINK D4-1          1.000

 ESTIMATED VOLUME (CU METRES*10**3) =         2.357
 ESTIMATED PEAK FLOW        (CUMECS) =     1.28
 ESTIMATED TIME TO PEAK        (MINS) =    35.00

 LINK E1          2.000

 ESTIMATED VOLUME (CU METRES*10**3) =         2.160
 ESTIMATED PEAK FLOW        (CUMECS) =     1.18
 ESTIMATED TIME TO PEAK        (MINS) =    35.00

 LINK E2          2.001

 ESTIMATED VOLUME (CU METRES*10**3) =         3.463
 ESTIMATED PEAK FLOW        (CUMECS) =     1.85
 ESTIMATED TIME TO PEAK        (MINS) =    35.00

 LINK D1          2.002

 ESTIMATED VOLUME (CU METRES*10**3) =         5.328
 ESTIMATED PEAK FLOW        (CUMECS) =     2.78
 ESTIMATED TIME TO PEAK        (MINS) =    35.00

 LINK D2          2.003

 ESTIMATED VOLUME (CU METRES*10**3) =         7.685
```

```
ESTIMATED PEAK FLOW        (CUMECS) =    3.79
ESTIMATED TIME TO PEAK       (MINS) =   38.00

LINK D3           2.004

ESTIMATED VOLUME (CU METRES*10**3) =         10.24
ESTIMATED PEAK FLOW        (CUMECS) =    4.89
ESTIMATED TIME TO PEAK       (MINS) =   40.00

LINK D4-dummy        1.001

ESTIMATED VOLUME (CU METRES*10**3) =         12.59
ESTIMATED PEAK FLOW        (CUMECS) =    5.92
ESTIMATED TIME TO PEAK       (MINS) =   40.00

LINK D5           1.002

ESTIMATED VOLUME (CU METRES*10**3) =         15.15
ESTIMATED PEAK FLOW        (CUMECS) =    6.85
ESTIMATED TIME TO PEAK       (MINS) =   41.00

LINK D6           1.003

ESTIMATED VOLUME (CU METRES*10**3) =         16.91
ESTIMATED PEAK FLOW        (CUMECS) =    7.29
ESTIMATED TIME TO PEAK       (MINS) =   43.00

LINK D7           1.004

ESTIMATED VOLUME (CU METRES*10**3) =         17.60
ESTIMATED PEAK FLOW        (CUMECS) =    7.47
ESTIMATED TIME TO PEAK       (MINS) =   41.00

LINK D8           1.005

ESTIMATED VOLUME (CU METRES*10**3) =         18.49
ESTIMATED PEAK FLOW        (CUMECS) =    7.66
ESTIMATED TIME TO PEAK       (MINS) =   43.00

LINK C1           3.000

ESTIMATED VOLUME (CU METRES*10**3) =        0.9813
ESTIMATED PEAK FLOW        (CUMECS) =    0.53
ESTIMATED TIME TO PEAK       (MINS) =   35.00

LINK C2           3.001

ESTIMATED VOLUME (CU METRES*10**3) =         2.650
ESTIMATED PEAK FLOW        (CUMECS) =    1.42
ESTIMATED TIME TO PEAK       (MINS) =   35.00
```

```
LINK C3          3.002

ESTIMATED VOLUME (CU METRES*10**3) =        4.516
ESTIMATED PEAK FLOW       (CUMECS) =     2.26
ESTIMATED TIME TO PEAK      (MINS) =    36.00

LINK D9-dummy        1.006

ESTIMATED VOLUME (CU METRES*10**3) =        23.00
ESTIMATED PEAK FLOW       (CUMECS) =     9.23
ESTIMATED TIME TO PEAK      (MINS) =    40.00

LINK A1          4.000

ESTIMATED VOLUME (CU METRES*10**3) =        2.749
ESTIMATED PEAK FLOW       (CUMECS) =     1.47
ESTIMATED TIME TO PEAK      (MINS) =    35.00

LINK A2          4.001

ESTIMATED VOLUME (CU METRES*10**3) =        4.654
ESTIMATED PEAK FLOW       (CUMECS) =     2.45
ESTIMATED TIME TO PEAK      (MINS) =    35.00

LINK B1          4.002

ESTIMATED VOLUME (CU METRES*10**3) =        5.636
ESTIMATED PEAK FLOW       (CUMECS) =     2.94
ESTIMATED TIME TO PEAK      (MINS) =    36.00

LINK B2          4.003

ESTIMATED VOLUME (CU METRES*10**3) =        6.235
ESTIMATED PEAK FLOW       (CUMECS) =     3.19
ESTIMATED TIME TO PEAK      (MINS) =    37.00

LINK F1          5.000

ESTIMATED VOLUME (CU METRES*10**3) =        1.697
ESTIMATED PEAK FLOW       (CUMECS) =     0.95
ESTIMATED TIME TO PEAK      (MINS) =    33.00

LINK F2          5.001

ESTIMATED VOLUME (CU METRES*10**3) =        2.385
ESTIMATED PEAK FLOW       (CUMECS) =     1.31
ESTIMATED TIME TO PEAK      (MINS) =    34.00

LINK B3          4.004

ESTIMATED VOLUME (CU METRES*10**3) =        9.891
```

```
 ESTIMATED PEAK FLOW         (CUMECS) =     5.01
 ESTIMATED TIME TO PEAK         (MINS) =    38.00

 LINK OUTLET1           4.005

 ESTIMATED VOLUME (CU METRES*10**3) =          9.891
 ESTIMATED PEAK FLOW         (CUMECS) =     5.01
 ESTIMATED TIME TO PEAK         (MINS) =    38.00

 LINK OUTLET2           1.007

 ESTIMATED VOLUME (CU METRES*10**3) =          32.89
 ESTIMATED PEAK FLOW         (CUMECS) =    13.79
 ESTIMATED TIME TO PEAK         (MINS) =    40.00


################################################################################
Results for period from  0: 0.0  1/ 1/1990  to 10: 0.0  1/ 1/1990
################################################################################


                    ROUTING INCREMENT (MINS) =       1.00
                    STORM DURATION (MINS)    =      120.
                    RETURN PERIOD (YRS)      =     100.
                    BX                   =    1.0000
                    TOTAL OF FIRST SUB-AREAS  (ha) =      10.33
                    TOTAL OF SECOND SUB-AREAS (ha) =      23.22
                    TOTAL OF ALL SUB-AREAS (ha)   =     33.55


   SUMMARY OF CATCHMENT AND RAINFALL DATA
 Link     Catch. Area     Slope   % Impervious     Pern      B     Link
 Label     #1     #2    #1    #2     #1   #2     #1    #2   #1   #2    No.
         (ha)          (%)         (%)
D4-1      0.7200  1.680  5.000 5.000  0.000 100.0  .025 .025  .0098 .0017  1.000
E1       0.6600  1.540  5.000 5.000  0.000 100.0  .025 .025  .0094 .0017  2.000
E2       0.5400 0.8100  5.000 5.000  0.000 100.0  .025 .025  .0085 .0012  2.001
D1       0.5700  1.330  5.000 5.000  0.000 100.0  .025 .025  .0087 .0015  2.002
D2       0.7200  1.680  5.000 5.000  0.000 100.0  .025 .025  .0098 .0017  2.003
D3       0.7800  1.820  4.000 4.000  0.000 100.0  .025 .025  .0114 .0020  2.004
D4-dummy  .00001  0.000  1.000 0.000  0.000 0.000  .025 0.00  0.000 0.000  1.001
D5       0.7800  1.820  3.000 3.000  0.000 100.0  .025 .025  .0132 .0024  1.002
D6       0.5400  1.260  2.000 2.000  0.000 100.0  .025 .025  .0133 .0024  1.003
D7       0.2100 0.4900  2.000 2.000  0.000 100.0  .025 .025  .0082 .0015  1.004
D8       0.2700 0.6300  2.000 2.000  0.000 100.0  .025 .025  .0093 .0017  1.005
C1       0.3000 0.7000  3.000 3.000  0.000 100.0  .025 .025  .0080 .0014  3.000
C2       0.5100  1.190  3.000 3.000  0.000 100.0  .025 .025  .0106 .0019  3.001
C3       0.5700  1.330  2.000 2.000  0.000 100.0  .025 .025  .0137 .0024  3.002
D9-dummy  .00001  0.000  1.000 0.000  0.000 0.000  .025 0.00  0.000 0.000  1.006
A1       0.8400  1.960  5.000 5.000  0.000 100.0  .025 .025  .0106 .0019  4.000
A2       0.9300  1.070  5.000 5.000  0.000 100.0  .025 .025  .0112 .0014  4.001
```

```
B1       0.3000 0.7000  3.000 3.000  0.000 100.0  .025 .025  .0080 .0014  4.002
B2       0.1200 0.4800  3.000 3.000  0.000 100.0  .025 .025  .0050 .0012  4.003
F1       0.3400  1.360  3.000 3.000  0.000 100.0  .025 .025  .0086 .0020  5.000
F2       0.2100 0.4900  3.000 3.000  0.000 100.0  .025 .025  .0067 .0012  5.001
B3       0.4200 0.8800  2.000 2.000  0.000 100.0  .025 .025  .0117 .0020  4.004
OUTLET1  .00001  0.000  1.000 0.000  0.000 0.000  .025 0.00  0.000 0.000  4.005
OUTLET2  .00001  0.000  1.000 0.000  0.000 0.000  .025 0.00  0.000 0.000  1.007


 Link   Average  Init. Loss  Cont. Loss   Excess Rain   Peak    Time   Link
 Label Intensity #1    #2    #1    #2     #1    #2    Inflow   to     Lag
        (mm/h)    ( mm )     (mm/h)       ( mm )      (m^3/s)  Peak  mins
D4-1      52.164 12.00 1.000  3.500 0.000  86.202 103.33   1.276  35.00 1.000
E1       52.164 12.00 1.000  3.500 0.000  86.202 103.33   1.178  35.00 2.000
E2       52.164 12.00 1.000  3.500 0.000  86.202 103.33   1.852  35.00 1.000
D1       52.164 12.00 1.000  3.500 0.000  86.202 103.33   2.776  35.00 1.500
D2       52.164 12.00 1.000  3.500 0.000  86.202 103.33   3.791  38.00 1.500
D3       52.164 12.00 1.000  3.500 0.000  86.202 103.33   4.893  40.00 1.000
D4-dummy  52.164 12.00 0.000  3.500 0.000  86.202  0.000   5.918  40.00 1.000
D5       52.164 12.00 1.000  3.500 0.000  86.202 103.33   6.847  41.00 2.000
D6       52.164 12.00 1.000  3.500 0.000  86.202 103.33   7.290  43.00 1.000
D7       52.164 12.00 1.000  3.500 0.000  86.202 103.33   7.474  41.00 2.000
D8       52.164 12.00 1.000  3.500 0.000  86.202 103.33   7.661  43.00 0.000
C1       52.164 12.00 1.000  3.500 0.000  86.202 103.33  0.5333  35.00 2.000
C2       52.164 12.00 1.000  3.500 0.000  86.202 103.33   1.418  35.00 2.000
C3       52.164 12.00 1.000  3.500 0.000  86.202 103.33   2.258  36.00 0.000
D9-dummy  52.164 12.00 0.000  3.500 0.000  86.202  0.000   9.230  40.00 0.000
A1       52.164 12.00 1.000  3.500 0.000  86.202 103.33   1.472  35.00 2.000
A2       52.164 12.00 1.000  3.500 0.000  86.202 103.33   2.447  35.00 1.000
B1       52.164 12.00 1.000  3.500 0.000  86.202 103.33   2.939  36.00 1.000
B2       52.164 12.00 1.000  3.500 0.000  86.202 103.33   3.191  37.00 1.000
F1       52.164 12.00 1.000  3.500 0.000  86.202 103.33  0.9465  33.00 1.000
F2       52.164 12.00 1.000  3.500 0.000  86.202 103.33   1.308  34.00 2.000
B3       52.164 12.00 1.000  3.500 0.000  86.202 103.33   5.009  38.00 0.000
OUTLET1   52.164 12.00 0.000  3.500 0.000  86.202  0.000   5.009  38.00 0.000
OUTLET2   52.164 12.00 0.000  3.500 0.000  86.202  0.000  13.792  40.00 0.000
```

APPENDIX C

HECRAS OUTPUT RESULTS

WATER STREET OVERLAND FLOW

Reach	River Sta	Profile	Q Total (m3/s)	Min Ch El (m)	W.S. Elev (m)	Crit W.S. (m)	E.G. Elev (m)	E.G. Slope (m/m)	Vel Chnl (m/s)	Flow Area (m2)	Top Width (m)	Froude # Chl
Water St	167.5	PF 1	6.16	11.66	12.01	12.01	12.12	0.003492	1.5	4.59	22.32	0.98
Water St	148.5	PF 1	6.16	11.26	11.5	11.61	11.93	0.029971	2.96	2.24	20.33	2.6
Water St	114	PF 1	6.16	10.8	11.43	11.15	11.45	0.000222	0.64	10.87	22.33	0.28
Water St	89.35	PF 1	6.16	10.89	11.41		11.44	0.000517	0.82	8.37	22.32	0.41
Water St	62.91	PF 1	6.16	10.95	11.3	11.3	11.41	0.00349	1.5	4.59	22.32	0.98
Water St	34.87	PF 1	6.16	10.77	11.07	11.12	11.25	0.008132	1.96	3.49	22.32	1.44
Water St	0	PF 1	6.16	10.32	10.59	10.67	10.87	0.015076	2.39	2.83	21.91	1.9

DUNLOP STREET OVERLAND FLOW

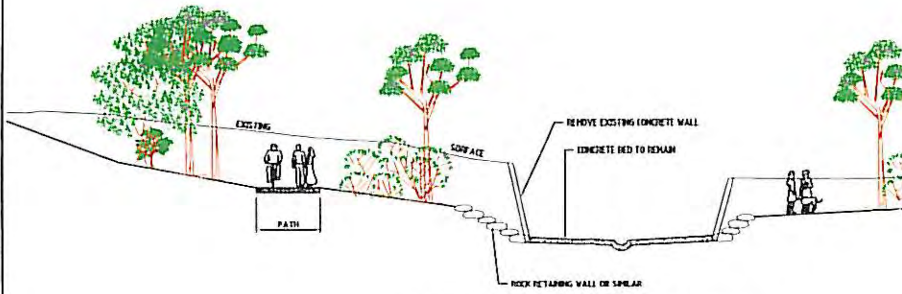
Reach	River Sta	Profile	Q Total (m3/s)	Min Ch El (m)	W.S. Elev (m)	Crit W.S. (m)	E.G. Elev (m)	E.G. Slope (m/m)	Vel Chnl (m/s)	Flow Area (m2)	Top Width (m)	Froude # Chl
Dunlop St	70.78	PF 1	3.34	12.57	13.25	12.91	13.26	0.000121	0.48	7.97	15.2	0.21
Dunlop St	57.19	PF 1	3.34	12.69	13.24		13.26	0.000247	0.61	6.33	15.2	0.29
Dunlop St	45.65	PF 1	3.34	12.77	13.23		13.26	0.000449	0.74	5.2	15.2	0.38
Dunlop St	34.29	PF 1	3.34	12.84	13.15	13.15	13.24	0.003421	1.41	2.73	15.2	0.95
Dunlop St	16.93	PF 1	3.34	12.73	13.01	13.05	13.15	0.00693	1.75	2.19	15.2	1.31
Dunlop St	0	PF 1	3.34	12.28	12.51	12.61	12.9	0.033562	2.87	1.31	14.77	2.67

APPENDIX D

LETTERS FROM SYDNEY WATER AND CMA

A1

FLOOD EXTENTS
SCALE 1:500



TYPICAL SECTION OF PROPOSED RIVER SECTION
SCALE 1:100

A	W.M.	30/06/09	E.S.	31/06/09	FOR APPROVAL
REV.	DES.	DATE	VER.	DATE	DESCRIPTION

CONSULTING ENGINEERS
CIVIL AND HYDRAULIC ENGINEERING DESIGN AND PROJECT MANAGEMENT

DESIGNED	W.MARTIN	DATE	
VERIFIED	E.SHIN	DATE	
DRAWN	W.MARTIN	SCALE @ A1	AS NOTED

WATER ST, SOUTH STRATHFIELD

PLAN SHOWING EXTENT OF FLOODING AND TYPICAL SECTION OF RIVER BANK WORK

STATUS	PRELIMINARY	DRAWING No.	00373_SK04	REVISION	A

Sydney
WATER

8/7/09

Edward Shin
C & M Consulting Engineers Pty Ltd
1/142 James Ruse Drive
Rosehill, NSW 2142

Dear Edward

Proposed works on the Cooks River near Water St, Strathfield

I am writing in reference to our meeting on 23 June regarding the proposed widening and naturalisation works upstream of Water St on the Cooks River. We understand that the proposed works include removal of the existing concrete channel walls and laying back the banks to provide compensatory flood storage capacity. The new river banks will then be stabilised using sandstone and native plants.

As the owner of the concrete channel in this area, Sydney Water provides in principle support for this proposal.

The proposal is similar to Sydney Water's planned naturalisation renewals (currently in concept design) at Second Avenue, Flockhart Park and Cup and Saucer Creek on the Cooks River. The proposal is also in line with the recently completed Cooks River Naturalisation Master Plan (2009) and Cooks River Strategic Plan (1997).

Sydney Water will need to be consulted on concept and detailed designs for the treatment of the banks of the Cooks River, and provide approval at various stages throughout the project. Agreement will also need to be reached on ownership and/or easement arrangements for the modified sections of the Cooks River.

We anticipate that as part of any development consent, the Council will require the developer to seek a Section 73 Certificate under the Sydney Water Act for the development as a whole. Application for the s.73 certificate should be made through an authorised water servicing coordinator. Please refer to the Sydney Water website for more information on this process http://www.sydneywater.com.au/BuildingDeveloping/ .

I would strongly suggest that your client selects a water servicing coordinator with experience in riparian restoration works, stormwater management and flood modelling given the nature of the works proposed.

As discussed I will provide copies of all relevant plans and documents that may assist the development of the naturalisation designs. Please feel free to contact me at daniel.cunningham@sydneywater.com.au or 88494325.

Yours sincerely

Daniel Cunningham
Natural Asset Manager

CMA
Sydney Metropolitan
CATCHMENT MANAGEMENT AUTHORITY

ABN 93695453413

Ground Floor, Macquarie Tower,
10 Valentine Ave, Parramatta. NSW 2150
PO Box 3720, Parramatta. NSW 2124.
Tel: 02 9895 7898 Fax: 02 9895 7330
Internet: www.cma.nsw.gov.au

File Ref: CMA00741
Letter No: 0604031
Contact: Phillip Birtles
Phone: 02 9895 6219
Email: phillip.birtles@cma.nsw.gov.au

14 July 2009

C&M Consulting Engineers Pty Ltd
1/42 James Ruse Drive
ROSEHILL NSW 2124

Att: Edward Shin

Dear Mr Shin,

Re: Proposed re-zoning, Water Street, Strathfield South

Thank you for your letter 2 July 2009 regarding the above mentioned development. The Sydney Metropolitan Catchment Management Authority (SMCMA) understands that the intention is to modify the banks of the Cooks River as part of the re-zoning of this site.

The SMCMA supports the removal of the existing concrete, replacement with a river bank design guided by soft engineering principles and the restoration of an appropriately vegetated riparian area. Such a project would augment the naturalisation projects currently being undertaken by Sydney Water Corporation (SWC) in the vicinity and improve the environmental quality of the Cooks River.

Consistent with the strategic intent of the SMCMA's Catchment Action Plan (CAP), it is recommended that any design allow for:

- an appropriate width of riparian area planted with fully structured, local native vegetation (trees, shrubs & ground covers) to afford long-term riverbank stability and improve biodiversity,
- removal of hard infrastructure (such as pathways) outside this riparian area,
- long term bank stability afforded by the planting of deep rooted native vegetation and, if necessary, augmented by rock work,
- opportunities to improve the hydraulic variability of the stream flow by construction of large woody debris structures etc,
- consideration of any continuing maintenance requirements of SWC; and
- the drainage infrastructure design for the development site to be based on the principles of Water Sensitive Urban Design.

The SMCMA would welcome being consulted further on such a design and is able to provide limited environmental restoration advice.

Any correspondence should be with Phillip Birtles, Catchment Officer (SMCMA) on 02 9895 6219, alternatively I can be contacted on 02 9895 7512 (direct).

Yours sincerely,

Owen Graham
Place Manager Botany Bay and Catchment