



Wednesday, 18 June 2008

Bovis Lend Lease
The Bond
30 Hickson Road
Millers Pont, Sydney, NSW, 2000

Attention: Mr Kim Goh

Dear Kim,

DARLING WALK FLOOD STUDY UPDATE

As requested following is an update of the Darling Walk Flood Study work undertaken to date.

Worley Parsons (*incorporating Patterson Britton & Partners*) have been engaged by Bovis Lend Lease (BLL) to undertake a detailed flood study for the development know as Darling Walk. This detailed flood study follows on from an earlier preliminary flood study also undertaken by Patterson Britton & Partners titled "*Darling Walk Redevelopment – Preliminary Flood Assessment*" 29 October, 2007.

The preliminary flood assessment was undertaken to ascertain potential flooding constraints for the development proposal, particularly in the 100yr ARI design storm event. However, it did not incorporate detailed flood modelling and as such a recommendation of this preliminary report was that a detailed assessment of flood behaviour and risk be undertaken to establish flood levels and hence appropriate floor levels and basement entry crest levels. Details of the preliminary flood assessment report can be found at **Appendix A** of this update letter.

Important findings of the preliminary assessment were as follows:

- There were three identified major potential sources of flooding for the site;
- Floor levels were recommended to be sited a minimum of 300mm above the preliminary estimated 100yr ARI flood levels;
- Protection of below ground basements from entry of 100yr ARI floodwaters was recommended; and
- Provision of an unobstructed overland flow path was recommended from Harbour Street through to the other side of the development (*ie between the two main buildings*).

Since the preliminary assessment much work has been undertaken by Worley Parsons (*incorporating Patterson Britton & Partners*) in defining the key sources of overland flow and modelling flood behaviour in the vicinity of the proposed development. Both existing and proposed cases have been assessed in detail to ascertain any impacts. Hydrological conditions have generally remained the same for both the existing and proposed cases, with differences in the overland flow paths/site levels being the main change.

The detailed flood study has identified five key sources of 100yr ARI overland flow that have the potential to affect the site as summarised below.

Flow Path	Description	Peak Flows (m3/s)
Overland flow 1 (OL1)	Flows from north of site and arriving at lmax depression	7.154



Flow Path	Description	Peak Flows (m3/s)
Overland flow 2 (OL2)	Flows from Sussex St and northbound along Harbor St	3.800
Overland flow 3 (OL3)	Internal site catchments & from Tumblelong Park	1.643 (combined)
Overland flow 4 (OL4)	Flows from Sussex St and southbound along Harbor St	0.264
Overland flow 5 (OL5)	Flows in Urban stream	50.151

METHODOLOGY

RAFTS has been used for modelling 100yr ARI catchment hydrology and generating calibrated design hydrographs. Flood flows have been based on a simplified catchment approach taking into consideration the effect of flow diversions due to streets and the vast array of interconnected pipe drainage. The adopted flows have been calibrated to hydrological information made available by Sydney Water as part of their capacity assessment for nearby trunk stormwater drainage systems.

A 2D TUFLOW model has been used to simulate the flood behaviour and the WaterRIDE program to import and review the results. TUFLOW is a commonly utilised hydrodynamic modelling tool used to model complex flood situations (refer to <http://www.tufLOW.com/>). WaterRIDE was developed by Patterson Britton & Partners to facilitate the display and interrogation of time-varying results from *any* hydraulic model (1D, 2D or 3D) in a live GIS environment. It facilitates sophisticated interrogation of the model results, across the *entire* time-series, whilst providing access to, and integration with, GIS datasets (refer to www.waterRIDE.net).

Since the preliminary flood assessment, new survey information has also been utilized to build the existing and proposed ground surfaces taking into account changes in surface roughness, obstructions and new flow paths defined by proposed development.

Three proposed case options have been investigated to date all of which model a flow path from Harbor St entering a pedestrian walkway between the two building towers and then turning north towards Cockle Bay along the same pedestrian walkway. The key difference between the options is related to the layout configuration and levels of the pedestrian walkway which depending on the option incorporates features such as water features, outdoor seating and landscaping.

Currently a fourth option is being developed as the preferred proposed case scenario. Modelling results for this option are not yet available but the aim is to incorporate sufficient floodway improvements to lower proposed case flood levels.

RESULTS

The results to date indicate that the critical duration 100 year ARI storm is 60 minutes. Only three of the five identified overland flow paths (OL2, OL4 & OL3) appear to directly impact the proposed development site. The effect of OL5 (*Urban Stream*) has effectively been eliminated by incorporating a flood levee in the proposed case and thereby preventing overflow from this source being directed towards the proposed buildings. The 100yr ARI water surface levels generated to date and the recommended building floor levels predicted by TUFLOW model at strategic points are tabulated below. A screenshot of the existing condition TUFLOW results is also contained at **Appendix B**.



Location	Existing	Option One (18.04.08)		Option Two (23.04.08)		Option Three (30.04.08)	
	Flood Level (RL)	Flood Level (RL)	Rec. Building Level (RL)	Flood Level (RL)	Rec. Building Level (RL)	Flood Level (RL)	Rec. Building Level (RL)
Southern extremity on Harbor St	3.99	3.99	4.3	3.99	4.3	3.99	4.3
Harbor St adjacent to the entry for pedestrian walkway between the two Towers	3.82	3.78	4.1	3.83	4.1	3.88	4.2
Exit from pedestrian walkway between the two Towers for north building side	0	3.68	4.0	3.68	4.0	3.47	3.8
Midway along the north building on pedestrian walkway	0	3.63	4.0	3.64	4.0	3.39	3.7
Northern extremity of the north building along the pedestrian walkway	(3.62)	3.63	4.0	3.60	3.9	3.34	3.7
Southern extremity of the south building along the pedestrian walkway	0	3.86	4.1	3.84	4.2	3.76	4.1

Note that a fourth preferred proposed scenario option is currently being developed, but the flood results are not yet available. The three options tabulated above generally represent the evolution of an acceptable proposed case solution.

CONCLUSIONS TO DATE

The detailed flood study is not yet complete hence final conclusions cannot be drawn, however we offer the following interim conclusions based on work completed to date.

- 100yr ARI overland flood flows will generally not pose a significant hazard to pedestrians in the immediate vicinity of the Darling Walk site;



- There appears to be minimal difference between the existing and proposed flood levels and velocities for adjoining sites (*ie minimal flood impact*);
- Adoption of a 300mm freeboard from proposed 100yr ARI flood levels to proposed ground floor levels appears reasonable in this instance due to the mode of flooding, proposed commercial use and because of the accurate model being used;
- Adoption of a 500mm freeboard from proposed 100yr ARI flood levels to below ground basement entry crests (*and any other openings leading to the basements*) coupled with an appropriate flood evacuation strategy appears reasonable in this instance to minimise the risk to basement occupants;
- The proposed building floor levels recommended to date are realistic in terms of constructability. However, architectural and landscaping details have evolved since the Option 1 to 3 modelling was undertaken and hence the above results do not reflect the current site surface levels and layout configuration (*ie this is the subject of our latest round of modelling*); and
- Overall it is not considered that flooding is a constraint to the proposed development subject to adoption of suitable floor levels, basement entry crest levels, unobstructed overland flow paths thru the site and appropriate freeboard.

We trust this interim information is satisfactory. Should you have any further enquiries, please do not hesitate to contact me on (02) 8456 7220.

Yours faithfully
WorleyParsons

Michael Shaw
BE (Civil) MIEAust NPER CPEng
Manager, Urban Infrastructure
Environment Group



WorleyParsons

resources & energy

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APPENDIX A

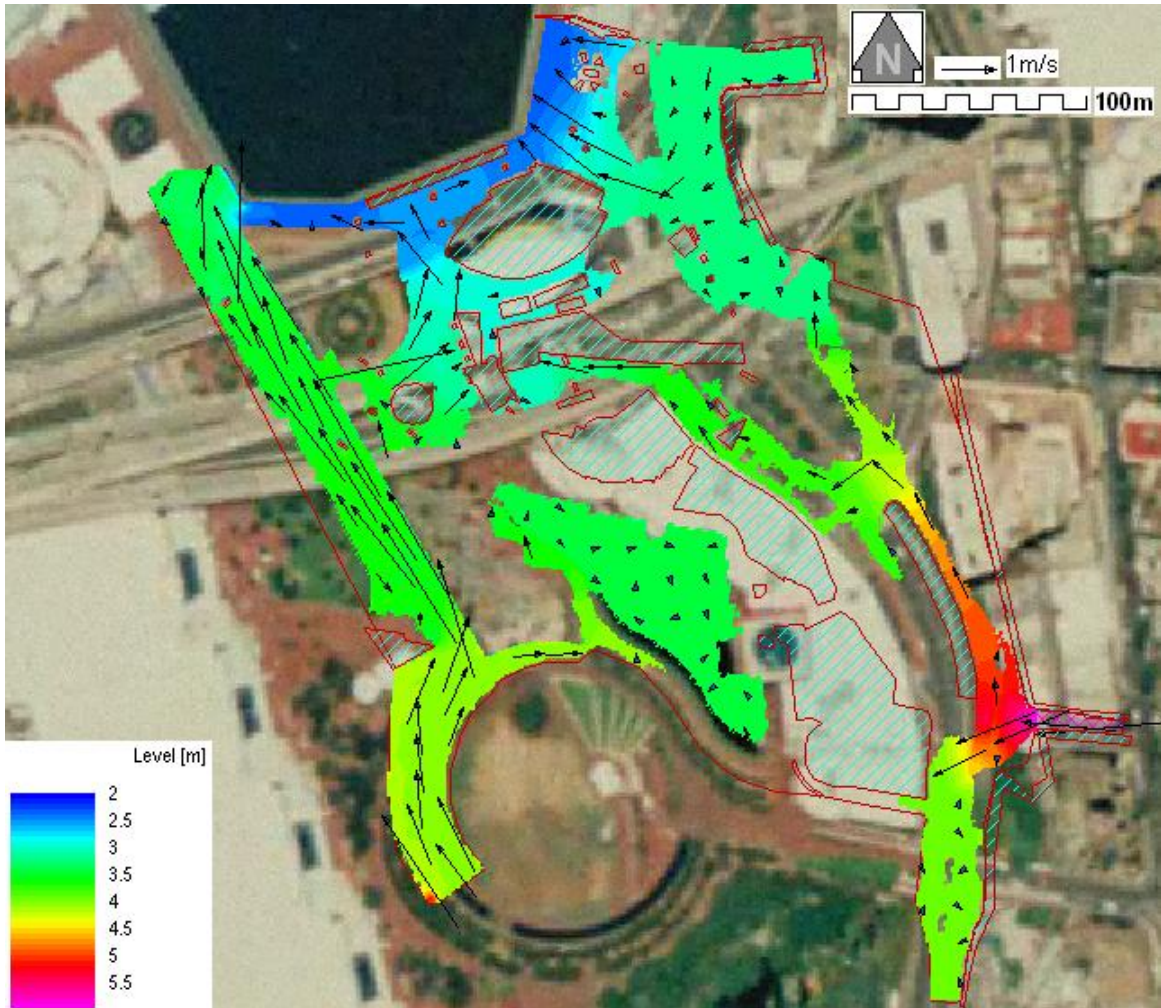


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APPENDIX B



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lr7190mjs071025-darling walk prelim flood assessment(final).doc

Bovis Lend Lease
30 The Bond
30 Hickson Road
Millers Point NSW 2000

Monday, 29 October 2007

Attention: Mr Kim Goh

Dear Sir

DARLING WALK REDEVELOPMENT – PRELIMINARY FLOOD ASSESSMENT

As requested following is a summary of the outcomes of our preliminary flood assessment for the proposed redevelopment of the Darling Walk site, Darling Harbour, Sydney.

1. Background

It is understood that the existing Sega World Darling Walk Precinct is to be redeveloped to accommodate a new mix of retail and commercial landuse, consisting of two new buildings, basement carparking facilities and surrounding landscape features (*refer to **Appendix A***).

Patterson Britton and Partners (*PBP*) have been engaged by Bovis Lend Lease (*BLL*) to undertake a preliminary flood assessment to ascertain any flooding constraints that may impact on the development proposal, particularly for the 100yr ARI design storm event.

It should be noted that this flood assessment is preliminary only and does not incorporate detailed flood modelling. It has been undertaken based on a review of existing background data, combined with a detailed site inspection and simplistic calculations only. A detailed assessment of flood behaviour and risk is required to establish flood levels and determine appropriate floor levels and basement driveway crest levels.

2. Existing Trunk Drainage Infrastructure and Major Flooding Sources

The majority of trunk stormwater drainage systems within proximity of the site are managed by Sydney Water Corporation (*SWC*), details of which are provided at **Appendix B** and illustrated in **Figure 1**.

Two of these systems have the potential to impact on overland flow and surface flooding in and around the proposed development site.



Principals

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Paul Harvey-Walker BE FIEAust David McConnell BSc MIEAust Joe Marson BE MEngSc FIEAust
Andrew Patterson BE FIEAust Christopher Thomas BE MEngSc MIEAust Mark Tooker BSc(Eng) MEngSc FIEAust CPEng
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Senior Associates

Steve Barrett Andrew Chitty BE MIEAust CPEng Paul Macinante BE MEnvEngSc Ben Patterson BE MIEAust
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Associates

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Alexandra Stone BE MIEAust



The first system is known as “SWC 30P”. This system drains a 32ha city catchment located directly to the east and south of the site. The two main branches of this system are the Liverpool Street/Hyde Park branch and the Lackey/Hay Street branch. The Liverpool Street/Hyde Park branch runs down Liverpool Street and into James Street before crossing Harbour Street and passing beneath the southern end of the proposed development site. The Lackey/Hay Street branch runs from Hay Street near Paddy’s Market, behind the Entertainment Centre down Lackey Street and then connects with the Liverpool Street Branch downstream of the site.

Because it serves a catchment located directly upstream of the site, the Liverpool Street/Hyde Park branch has been identified as the first potential contributor to overland flow and flooding for the proposed development. The approximate catchment area upstream of the site from this branch is estimated to be 17ha. The size of the line running beneath the site on this branch is firstly a 1350mm diameter pipe which expands to a 1520mm wide x 1290mm high Box Culvert (BC). This line then joins two large covered channels (*1No. 3070mm wide x 2210mm high and 1 No. 3900mm wide x 2210mm high*) downstream of the site which run beneath the northern end of the site and then discharge into Cockle Bay beneath the IMAX Theatre (*refer to Figure 1*).

The second system is known as “SWC 300”. This system drains a much larger 102ha catchment located to the south east of the site, which culminates in two large covered culverts (*2No. x 3000mm wide x 2400mm high*) that are located to the west of the site and discharge into Cockle Bay. Directly to the west of SWC300 is another large catchment and associated drainage system. Combined they result in 4 large covered culverts (*3No. x 3000mm wide x 2400mm high and 1No. 3500mm wide x 1600mm high*) that discharge at approximately the same point in Cockle Bay (*refer to Figure 1*). It is estimated that the combined catchment of these two large systems located to the west of the site is in the order of 200ha. Any overland flow in the lower reaches of these two systems will travel to the west of the subject site parallel to the Entertainment Centre along the walkway containing the “*Urban Stream*”. Because of its large catchment and relative proximity to the site, this has been identified as the second potential contributor to overland flow and flooding for the site.

Note that in total, six large trunk drainage lines discharge into Cockle Bay beneath or near the IMAX serving the above mentioned catchments (*refer to Figure 1*).

3. Preliminary Hydrology and Hydraulics

SWC have completed simplistic stormwater capacity assessments for the majority of trunk drainage lines in the vicinity of the site. In general, it can be said that unlike many other systems in Sydney, it appears that the majority of lines in the vicinity of the site have good to excellent capacity ratings of between 20yr ARI up to 100yr ARI. Although this may, as is the case with many drainage system in Sydney, be limited by restricted inlet capacity (*ie the full pipe capacity is unable to be realised due to the lack of inlet grates and/or blockage*). In addition, weak links have been identified in both systems which may also result in surcharge.

A summary of the SWC capacity assessment results and further simplified calculations undertaken by PBP for the two major sources of flooding identified in **Section 2** is contained in the following sections (*refer to Appendix B also*).

3.1 First Flooding Source - “SWC 30P” Liverpool Street/Hyde Park Branch at Harbour Street (Node D2 to D4)

- Pipe Dia. 1350mm;
- SWC Hydraulic capacity - 5.97m³/s;
- SWC Catchment Area - 16.9ha;
- SWC 5yr ARI runoff (*peak flow*) - 3.99m³/s; and
- SWC Assigned ARI Storm Event Capacity - 20-25yr ARI.

Note that all conduits downstream of link D2-D4 on this branch are rated with 100yr ARI event capacity. Hence, link D2-D4 is a potential weak link in the system and may generate overland flow for events greater than 20yr ARI frequency.

A 100yr ARI flow range generated by this same catchment based on a simplified RAFTS model calibrated to the SWC predicted 5yr ARI flow was calculated by PBP to be between 8.2m³/s and 10.7m³/s. Based on adoption of the SWC rated capacity for this link, the predicted 100yr ARI overland flow was then calculated to range from between 2.2m³/s to 4.7m³/s. Note this simplified assumption ignores timing affects but is likely to yield a conservative result.

Based on site inspection and the survey plan contained at **Figure 2**, it would appear that any overland flows generated by the catchment to the east of the site would be intercepted by Harbour Street and travel both to the north and south of a crest in Harbour Street located near its intersection with James Street. The overland flow path along Harbour Street to the north has been named OL1A, whilst the path to the south has been named OL1B.

Assuming this range of 100r ARI overland flows are split evenly to flow down Harbour Street both to the north and south of James Street, a range of flood depths was calculated using Mannings equation based on a typical cross section profile of Harbour Street. The range of 100yr ARI flow depths within Harbour Street along the frontage of the proposed development site was calculated to be between 250mm to 350mm above the western gutter invert level.

3.2 Second Flooding Source

1st Component - “SWC 30P” Hay/Lackey Street Branch (Node B-F)

This branch has been identified as a weak link in the system, potentially generating overland flows in events greater than the 20yr ARI. The predicted 100yr ARI overland flow generated by this source based on the existing SWC capacity assessment results and PBP’s preliminary RAFTS modelling results yielded an estimated overland flow of approximately 3m³/s from this source.

2nd Component - “SWC 300” (Node BC-F)

A weak link in the downstream reach of this system has been identified between nodes BC and F, which has the potential to generate overland flows in events greater than the 50yr ARI. The predicted 100yr ARI overland flow generated by this source based on the existing SWC capacity assessment results and PBP’s preliminary RAFTS modelling results yielded an estimated overland flow of approximately 4.8m³/s from this source.

3rd Component – catchment to west of “SWC 300”

The predicted 100yr ARI overland flow generated by this source based on PBP’s preliminary RAFTS modelling results yielded an estimated overland flow of approximately 5m³/s from this source.

Hence, the total quantity of 100yr ARI overland flow generated by this source is estimated to be approximately 12.8m³/s. For conservatism a value of 15m³/s was adopted in the subsequent hydraulic calculations. Note that the SWC lines serving the above sources are generally rated in the lower reaches as 100yr ARI capacity, with a combined total capacity predicted by SWC of some 65m³/s. Independent hydrological calculations undertaken by PBP estimate that the combined 100yr ARI flow generated by this large 200ha catchment is approximately 64m³/s, which confirms the results obtained by SWC. Based on this, overland flow is only likely to be generated by restricted inlet capacity, blockages and local sources. Note also that as a proportion of the total flow, the 100yr ARI overland flow is expected to be a relatively small component.

Based on site inspection and the survey plan contained at **Figure 2**, it would appear that the primary flow path that the above overland flows are likely to traverse in the vicinity of the site would be along the path of the “Urban Stream”. This route has been referred to as OL 2 (*refer to Figure 1*).

An estimated flood depth was calculated using Mannings equation based on a typical cross section profile of the lowered “Urban Stream” walkway. The estimated 100yr ARI flow depth in the vicinity of the site was calculated to be approximately 500mm. As the channel and topography to the east of this channel affords approximately 1000mm level difference to the site it can be concluded that this source of flooding is unlikely to impact on the proposed development site in the 100yr ARI event.

4. Minimum Recommended Ground Floor Levels

Based on adoption of a freeboard of 300mm (*City of Sydney policy*) and the flood depth results described in Section 3, minimum recommended ground floor levels have been derived as illustrated in **Figure 3**.

In addition, it is critical that any overland flow from both of the major sources of 100yr ARI flooding at this site are not able to enter the proposed car parking basements as this may introduce an extremely hazardous predicament for any person within the basement during a major storm event. Considering this, minimum recommended basement entry crest levels have been calculated and are also illustrated in **Figure 3**.

To ensure the passage of overland flows in events greater than the 100yr ARI event are not impeded as they travel through the site, finished surface levels are also recommended as illustrated in **Figure 3**. Note that the break between the two buildings aligned with Day Street provides an excellent opportunity for larger upstream flows (*ie greater than the 100yr ARI*) to travel from Harbour Street to the “Urban Stream” overland flow path (*ie amongst several other potential routes*).

5. Important Overland Flow/Hydraulic Features

Important features that need to be maintained to ensure the flooding regime is not altered in the vicinity of the site and also to improve the passage of floodwaters is summarised as follows:

1. The elevated topography of the existing playground between the “Urban Stream” and the subject site – The elevated levels in this area should be maintained as the mound that is created acts as a levee of sorts, buffering the subject site from the flooding impact of OL2;
2. A lowered area between the two main proposed buildings – This area will allow the passage of large flows to travel between the new structures and join with OL2;
3. Harbour Street entry to the Cross City Tunnel – It should be noted that any rare to extreme floodwaters generated by the catchments to the east of the site, are not likely to increase much beyond approximately RL 4.2, as this is the level at which floodwaters would begin to enter the Harbour Street entry of the cross city tunnel.

6. Qualifier

Patterson Britton and Partners advise that this flood assessment is preliminary only and does not incorporate detailed flood modelling. It has been undertaken based on a review of existing background data, combined with a detailed site inspection and simplistic calculations only. A range of possible 100yr ARI flood levels have been identified as part of this study, however they should be viewed as preliminary in nature only. Detailed flood modelling and flood risk assessment will need to be undertaken to establish flood levels, floor levels, basement driveway entry crest levels and flood risk management measures for the purposes of the proposed development.

We trust this information is satisfactory. Should you have any further enquiries, please do not hesitate to contact either Michael Shaw or myself on (02) 9957 1619.

Yours faithfully

PATTERSON BRITTON

Review / Verification by Date

Mark Tooker
Principal

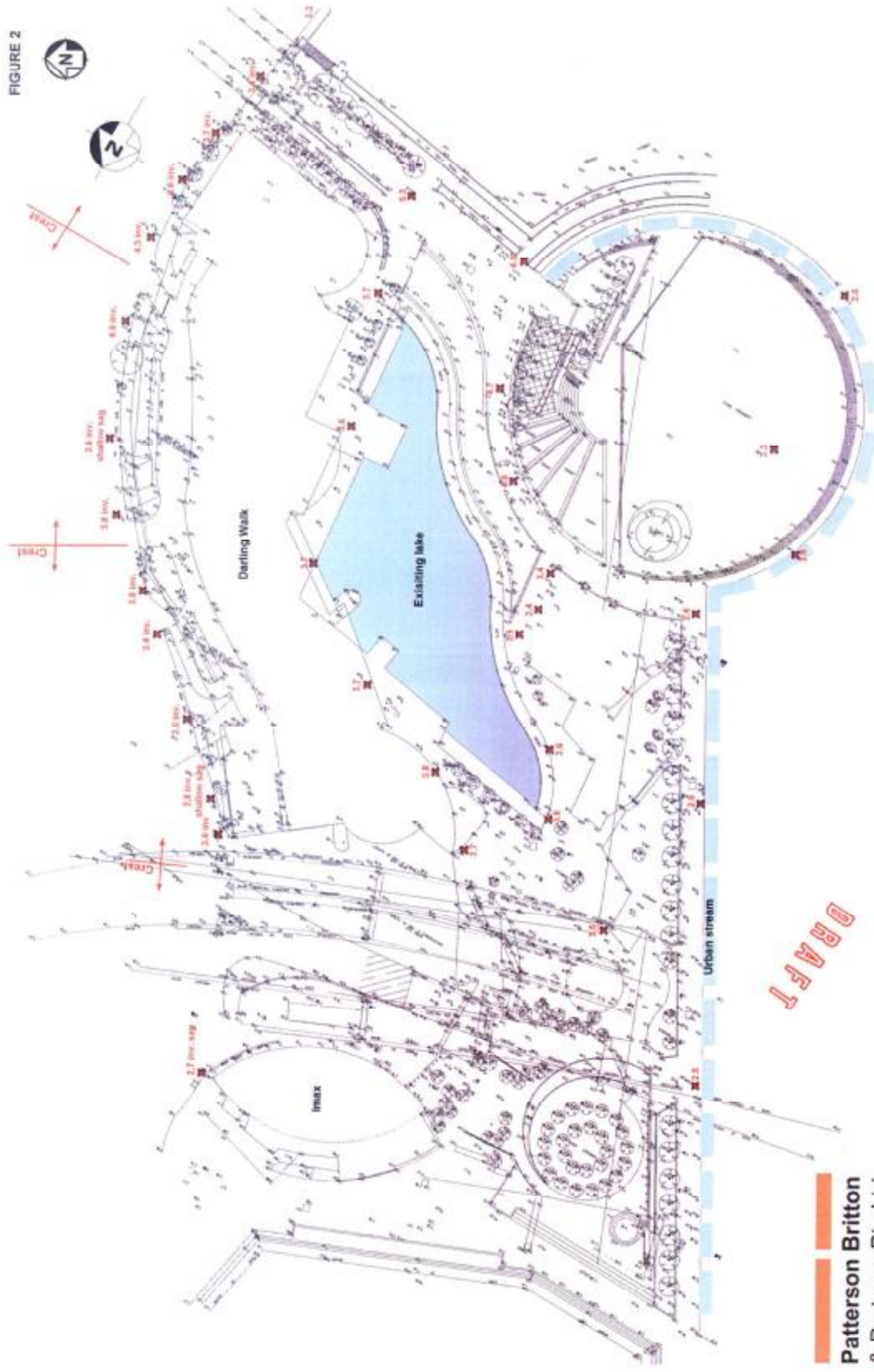
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FIGURES

FIGURE 1



FIGURE 2



DARLING WALK PRELIMINARY FLOOD ASSESSMENT
EXISTING SURFACE LEVELS

FIGURE 3



DARLING WALK PRELIMINARY FLOOD ASSESSMENT
RECOMMENDED MINIMUM GROUND FLOOR LEVELS

DRAFT

APPENDIX A

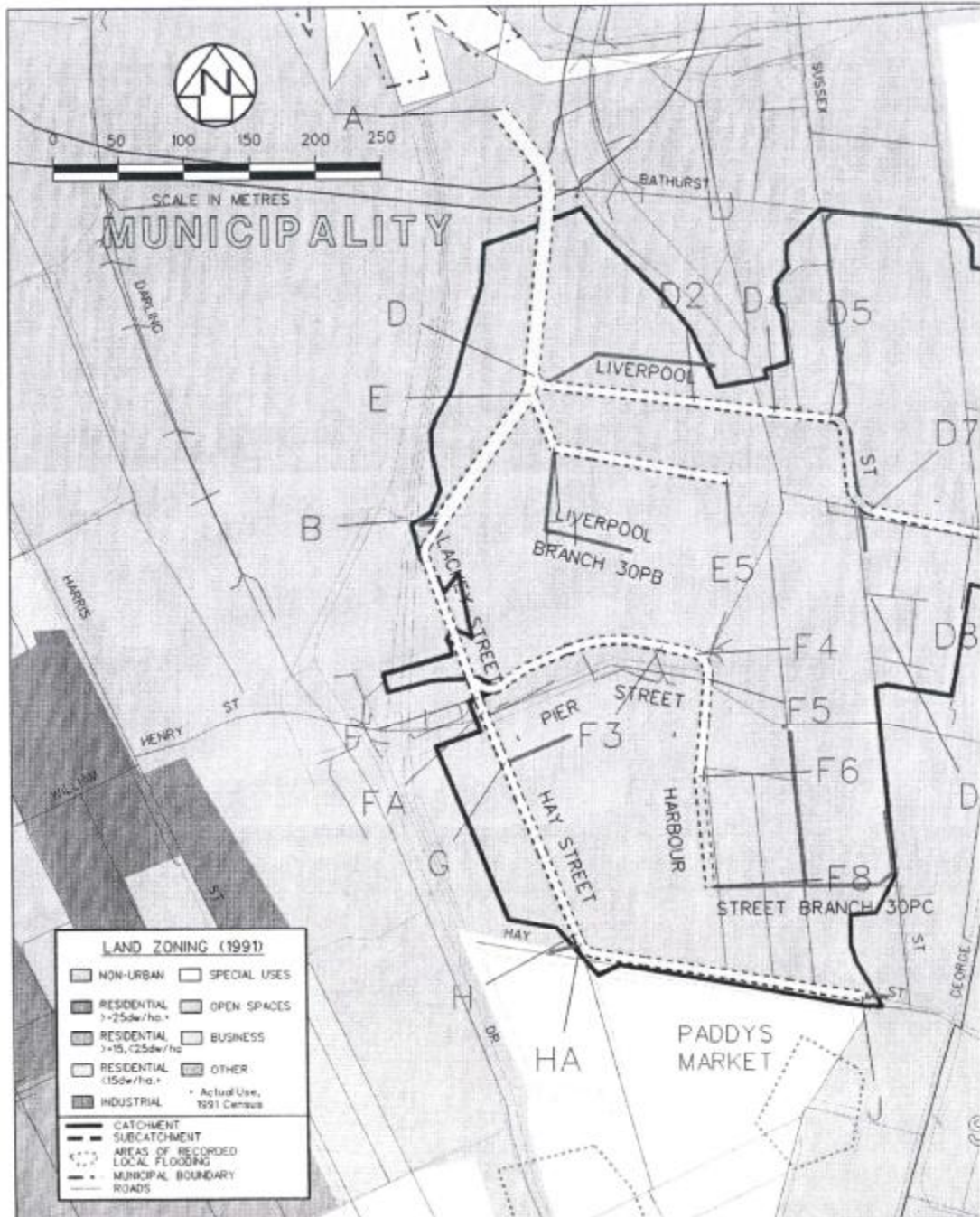


DARLING WALK
STAGE THREE DEVELOPMENT CONCEPT

GROUND FLOOR



APPENDIX B



Sydney
WATER

SIDNEY WATER CORPORATION LIMITED
ACN 063 779 645

UTILITIES PLANNING SERVICES

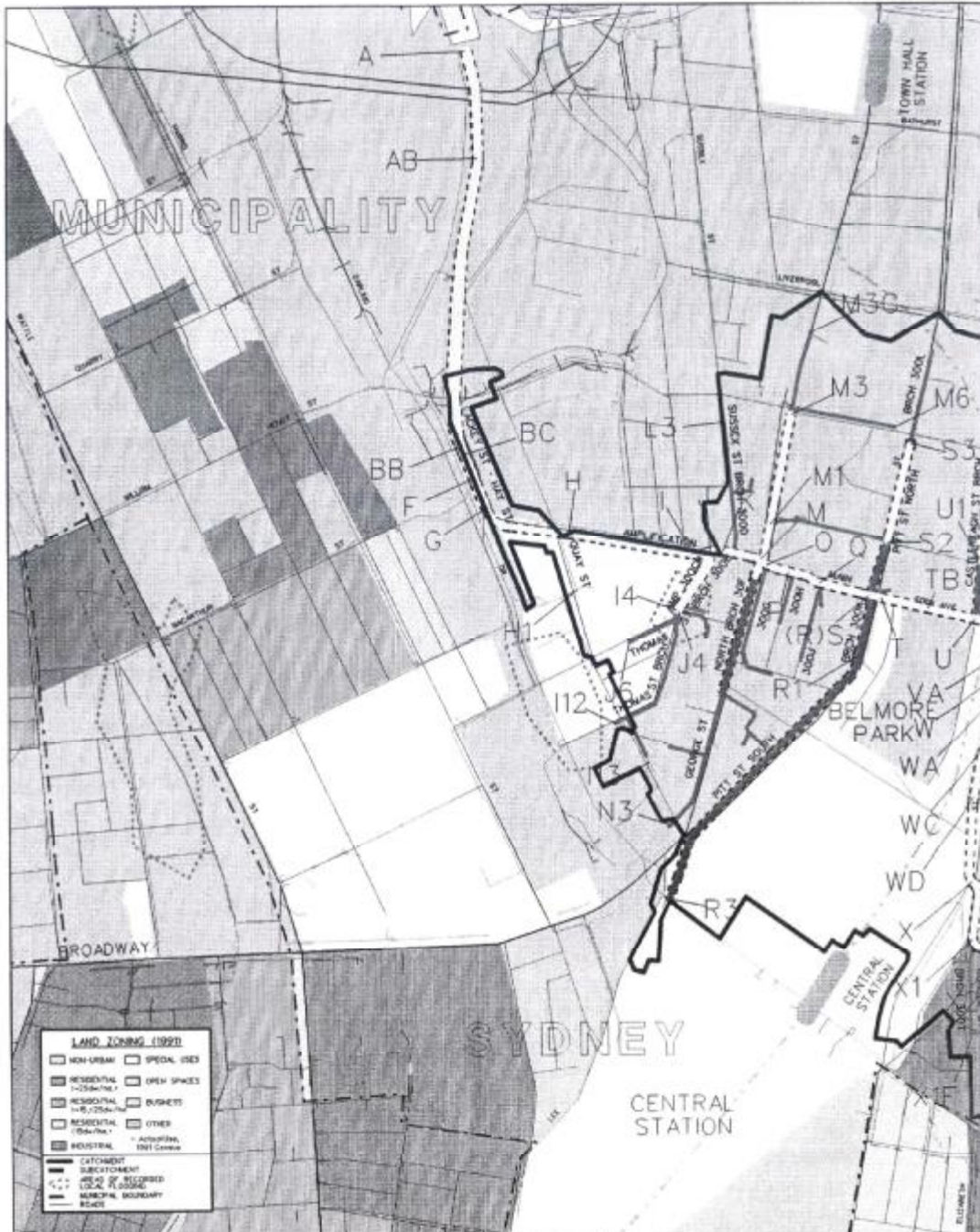
CITY DRA
CAPACIT

SWC 30P

Stormwater Capacity Assessment

TABLE 5-2. SUMMARY DETAILS FOR CITY AREA 30, LACKEY STREET-HAY STREET SWC 30P

No.	Name	MAIN DRAIN INCOMING BRANCH, SUB-BRANCH or BRANCH SIDELINE	Overhead Land Feature (City/Municipality 1995)	NODES according to: HSD URS & Region	SECTION (per REACH)			Distance From Outlet (m)	CROSS-SECTION	HYDRAULIC CAPACITY	CATCHMENT AREA (ha)	RUNOFF 9 yr ARI PeakFlow (m³/sec)	RATIO 9 yr ARI Capacity/9yr Peak	Ratio x Event (100-yr -C.F.)	ARI Storm Event Capacity (m³/sec)	Landuse Design ARI (years)	See Note	
					Node	Length (m)	Reach											Width (m)
				TOTALS	4,271.7	3,893.2	2,431.1	4,271.7										
30P1	MAIN CHANNEL (EAST)	30PA		A-D	190.75		190.75	190.75	B	C	0.0140	17.90	31.9		100	8+	20	
30P2	MAIN CHANNEL (WEST)	30PB	Dwelling	A	190.75	190.75	190.75	190.75	B	C	0.0140	12.80	31.0	12.63	2,431	100	8+	20
30P1	MAIN CHANNEL (EAST)	30PA		D-E	7.73	7.73	7.73	7.73	B	C	0.0140	17.90	12.9	9.13	3,364	100	8+	20
30P2	MAIN CHANNEL (WEST)	30PB	Dwelling		7.73	7.73	7.73	7.73	B	C	0.0140	12.80	12.9	9.13	3,364	100	8+	20
30P1	MAIN CHANNEL (EAST)	30PA		D-E	8.32	8.32	8.32	8.32	B	C	0.0140	16.70	12.9	9.14	3,277	100	8+	20
30P2	MAIN CHANNEL (WEST)	30PB	Dwelling		8.32	8.32	8.32	8.32	B	C	0.0140	12.80	12.9	9.14	3,277	100	8+	20
30P1	MAIN CHANNEL (EAST)	30PA		E-B	119.00		119.00	119.00	B	C	0.0140	16.70	11.0	8.76	3,368	100	8+	20
30P2	MAIN CHANNEL (WEST)	30PB	Dwelling	B	121.20	121.20	121.20	121.20	B	C	0.0140	12.80	11.0	8.76	3,368	100	8+	20
30P1	MAIN CHANNEL (EAST)	30PA		B-F	123.50	123.50	123.50	123.50	B	C	0.0140	12.80	8.9	8.55	1,496	80	20-25	20
30P2	MAIN CHANNEL (WEST)	30PB			123.50	123.50	123.50	123.50	B	C	0.0140	12.80	8.9	8.55	1,496	80	20-25	20
30P1	MAIN CHANNEL (EAST)	30PA	Play Pt	F-F	20.00	20.00	20.00	20.00	B	C	0.0140	12.80	3.4	7.46	1,716	817	25-50	20
30P2	MAIN CHANNEL (WEST)	30PB			20.00	20.00	20.00	20.00	B	C	0.0140	12.80	3.4	7.46	1,716	817	25-50	20
30P1	MAIN CHANNEL (EAST)	30PA	Entertainment Centre	F-A	40.23	40.23	40.23	40.23	B	C	0.0140	15.10	2.9	7.39	2,044	100	50-100	100
30P2	MAIN CHANNEL (WEST)	30PB			40.23	40.23	40.23	40.23	B	C	0.0140	15.10	2.9	7.46	2,044	100	50-100	100
30P1	MAIN CHANNEL (EAST)	30PA		F-A	11.25	11.25	11.25	11.25	B	C	0.0140	15.10	0.4	6.91	2,185	1115	100	100
30P2	MAIN CHANNEL (WEST)	30PB			11.25	11.25	11.25	11.25	B	C	0.0140	15.10	0.4	6.91	2,185	1115	100	100
30P1	MAIN CHANNEL (EAST)	30PA		G-H	139.83	139.83	139.83	139.83	B	C	0.0140	15.10	0.4	7.15	2,291	1146	100	100
30P2	MAIN CHANNEL (WEST)	30PB	Hay St		139.83	139.83	139.83	139.83	B	C	0.0140	15.10	0.4	7.15	2,291	1146	100	100
30P1	MAIN CHANNEL (EAST)	30PA		H-I	8.88	8.88	8.88	8.88	A	S	0.0190	16.10	0.4	7.16	2,248	1146	100	100
30P2	MAIN CHANNEL (WEST)	30PB			8.88	8.88	8.88	8.88	A	S	0.0190	16.10	0.4	7.16	2,248	1146	100	100
30P1	MAIN CHANNEL (EAST)	30PA		H-J	214.96	214.96	214.96	214.96	A	S	0.0190	16.10	0.4	4.13	1,795	902	25-50	20
30P2	MAIN CHANNEL (WEST)	30PB			214.96	214.96	214.96	214.96	A	S	0.0190	16.10	0.4	4.13	1,795	902	25-50	20
30PA	LIVERPOOL ST HYDE PARK BRCH	30PB	Hobhouse	D-DA	122.37	122.37	122.37	122.37	B	C	0.0130	5.97	16.9	3.99	1,496	816	20-25	20
30PB		30PC		DA-DB	62.09	62.09	62.09	62.09	B	C	0.0130	5.97	16.9	3.99	1,496	816	20-25	20
30PA		30PB	James St	DB-DI	41.56	41.56	41.56	41.56	B	C	0.0130	6.40	16.7	3.97	1,612	895	25-50	20
30PB		30PC		DI-D2	82.05	82.05	82.05	82.05	B	C	0.0130	4.68	14.1	3.32	1,498	772	15-20	100
30PA		30PB	St James St	D2-D2A	79.65	79.65	79.65	79.65	B	C	0.0130	5.74	13.4	3.17	1,810	946	25-50	100
30PB		30PC	Liverpool St	D2A-D3	34.12	34.12	34.12	34.12	B	C	0.0130	3.83	11.9	2.81	1,361	742	15-20	100
30PA		30PB		D3-D4	21.49	21.49	21.49	21.49	B	C	0.0140	13.30	11.9	2.82	4,712	2407	100	8+
30PB		30PC		D4-D5	9.85	9.85	9.85	9.85	B	C	0.0130	5.03	11.9	2.83	1,790	699	25-50	100
30PA		30PB		D5-D6	16.99	16.99	16.99	16.99	B	C	0.0130	5.03	8.3	1.91	2,632	1344	100	8+
30PB		30PC		D6-D7	89.06	89.06	89.06	89.06	B	C	0.0130	1.69	7.6	1.81	8,906	533	4-5	100
30PA		30PB		D7-D8	37.65	37.65	37.65	37.65	B	C	0.0130	1.69	7.6	1.75	9,907	571	4-5	100
30PB		30PC		D8-D9	24.78	24.78	24.78	24.78	B	C	0.0130	1.69	7.6	1.76	9,903	569	4-5	100
30PA		30PB		D9-D10	81.11	81.11	81.11	81.11	B	C	0.0130	1.78	5.6	1.26	14,100	774	15-20	100
30PB		30PC		D10-D11	77.84	77.84	77.84	77.84	B	C	0.0130	0.91	3.9	0.82	1,112	634	7-8	100
30PA		30PB	Elizabeth St	D11-D12	210.50	210.50	210.50	210.50	B	C	0.0130	0.26	0.4	0.10	2,814	1340	100	8+
30PB		30PC		D12-D13	183.00	183.00	183.00	183.00	B	C	0.0130	0.26	0.4	0.10	2,814	1340	100	8+
30PA		30PB		D13-D14	43.50	43.50	43.50	43.50	B	C	0.0130	0.26	0.4	0.10	2,814	1340	100	8+
30PB		30PC	Barthol St	D14-D15	106.70	106.70	106.70	106.70	B	C	0.0130	0.26	0.4	0.10	2,814	1340	100	8+
30PA		30PB		D15-D16	83.50	83.50	83.50	83.50	B	C	0.0130	0.26	0.4	0.10	2,814	1340	100	8+
30PB		30PC		D16-D17	36.00	36.00	36.00	36.00	B	C	0.0130	0.26	0.4	0.10	2,814	1340	100	8+
30PA		30PB		D17-D18	94.10	94.10	94.10	94.10	B	C	0.0130	0.26	0.4	0.10	2,814	1340	100	8+
30PB		30PC		D18-D19	13.06	13.06	13.06	13.06	B	C	0.0130	0.26	0.4	0.10	2,814	1340	100	8+
30PA		30PB	Georgie St	D19-D20	746.11	746.11	746.11	746.11	B	C	0.0130	0.26	0.4	0.10	2,814	1340	100	8+
30PB		30PC		D20-D21	13.06	13.06	13.06	13.06	B	C	0.0130	0.26	0.4	0.10	2,814	1340	100	8+
30PA		30PB		D21-D22	13.06	13.06	13.06	13.06	B	C	0.0130	0.26	0.4	0.10	2,814	1340	100	8+
30PB		30PC		D22-D23	13.06	13.06	13.06	13.06	B	C	0.0130	0.26	0.4	0.10	2,814	1340	100	8+
30PA		30PB	Georgie St	D23-D24	13.06	13.06	13.06	13.06	B	C	0.0130	0.26	0.4	0.10	2,814	1340	100	8+
30PB		30PC		D24-D25	13.06	13.06	13.06	13.06	B	C	0.0130	0.26	0.4	0.10	2,814	1340	100	8+
30PA		30PB		D25-D26	13.06	13.06	13.06	13.06	B	C	0.0130	0.26	0.4	0.10	2,814	1340	100	8+
30PB		30PC		D26-D27	13.06	13.06	13.06	13.06	B	C	0.0130	0.26	0.4	0.10	2,814	1340	100	8+
30PA		30PB		D27-D28	13.06	13.06	13.06	13.06	B	C	0.0130	0.26	0.4	0.10	2,814	1340	100	8+
30PB		30PC		D28-D29	13.06	13.06	13.06	13.06	B	C	0.0130	0.26	0.4	0.10	2,814	1340	100	8+
30PA		30PB		D29-D30	13.06	13.06	13.06	13.06	B	C	0.0130	0.26	0.4	0.10	2,814	1340	100	8+
30PB		30PC		D30-D31	13.06	13.06	13.06	13.06	B	C	0.0130	0.26	0.4	0.10	2,814	1340	100	8+
30PA		30PB		D31-D32	13.06	13.06	13.06	13.06	B	C	0.0130	0.26	0.4	0.10	2,814	1340	100	8+
30PB		30PC		D32-D33	13.06	13.06	13.06	13.06	B	C	0.0130	0.26	0.4	0.10	2,814	1340	100	8+
30PA		30PB		D33-D34	13.06	13.06	13.06	13.06	B	C	0.0130	0.26	0.4	0.10	2,814	1340	100	8+
30PB		30PC		D34-D35	13.06	13.06	13.06	13.06	B	C	0.0130	0.26	0.4	0.10	2,814	1340	100	8+
30PA		30PB		D35-D36	13.06	13.06	13.06	13.06	B	C	0.0130	0.26	0.4	0.10	2,814	1340	100	8+
30PB		30PC		D36-D37	13.06	13.06	13.06	13.06	B	C	0.0130	0.26	0.4	0.10	2,814	1340	100	8+
30PA		30PB		D37-D38	13.06	13.06	13.06	13.06	B	C	0.0130	0.26	0.4	0.10	2,814	1340	100	8+
30PB		30PC		D38-D39	13.06	13.06	13.06	13.06	B	C	0.0130	0.26	0.4	0.10	2,814	1340	100	8+
30PA		3																



**Sydney
WATER**

UTILITIES PLANNING SERVICES

SYDNEY WATER CORPORATION LIMITED
ACN 163 079 549

CITY DRAIN
CAPACITY

SWC 30-0"

Stormwater Capacity Assessment

TABLE 6-2. SUMMARY DETAILS FOR CITY AREA 30, LACKEY STREET-HAY STREET AMPLIFICATION SWC 300

No.	Name	MAIN DRAIN SUB-BRANCH or BRANCH	INCOMING BRANCH/Channel or SLOPE	SUB-BRANCH or BRANCH	SECTION (or REACH)	LENGTH (m)		Inlet from Outlet (m)	CROSS-SECTION		HYDRAULIC CAPACITY % Capacity Manning (Comment)	CATCHMENT AREA (ha)	RURFACE 6 yr AIR Penetration (Comment)	RATIO Capacity by Peak (Comment)	Ratio F.L. & Capacity (F.L. & Capacity)	AIR Storm Event Capacity (years)	Landscape Design AIR Note (years)
						UPR (Downm)	DOWN (Downm)		W	H							
					TOTALS	12,295.1	5,993.7	13,373.0									
300	MAIN CHANNEL (DRAIN)	BL	A-B	A-B	AC-ABOB	50.45	50.45	100.90	2	3000	3400	101.9	14.90	2.269	1197	100.8	20
300			A-B	ABOB-BBEB	AB-BB	412.26	412.26	824.52	50	2	3000	2400	15.03	2.279	1148	100.8	20
300			B-C	BBEB-BC/EC	BB-BC	15.84	10.59	21.16	483	2	3000	2400	16.25	2.166	1197	100.8	20
300			B-C	BC/EC-F	BC-F	34.17	34.17	68.34	473	2	5000	2400	16.20	2.100	1082	50.100	20
300			B-C	BC/EC-F	BC-F	101.51	101.51	203.02	607	2	3000	2400	16.21	2.073	1070	50.100	20
300			F-G	FC-GC	FC-G	7.02	7.02	14.04	608	1	2400	2400	16.54	2.146	1118	100.8	20
300			G-H	GC-HC	GC-H	108.00	108.00	216.00	618	1	4300	2400	16.56	2.144	1117	100.8	20
300			H-I	HC-IC	HC-I	198.43	198.43	396.86	724	1	4300	2400	16.45	2.159	1128	100.8	20
300			I-J	IC-JC	IC-J	3.00	3.00	6.00	622	1	4300	2400	16.36	2.170	1107	100.8	20
300			J-K	JC-KC	JC-K	7.97	7.97	15.94	620	1	4300	2400	16.01	2.214	1120	100.8	20
300			J-K	JC-KC	JC-K	7.97	7.97	15.94	620	1	4300	2400	16.01	2.214	1120	100.8	20
300			J-K	JC-KC	JC-K	7.97	7.97	15.94	620	1	4300	2400	16.01	2.214	1120	100.8	20
300			J-K	JC-KC	JC-K	7.97	7.97	15.94	620	1	4300	2400	16.01	2.214	1120	100.8	20
300			J-K	JC-KC	JC-K	7.97	7.97	15.94	620	1	4300	2400	16.01	2.214	1120	100.8	20
300			J-K	JC-KC	JC-K	7.97	7.97	15.94	620	1	4300	2400	16.01	2.214	1120	100.8	20
300			J-K	JC-KC	JC-K	7.97	7.97	15.94	620	1	4300	2400	16.01	2.214	1120	100.8	20
300			J-K	JC-KC	JC-K	7.97	7.97	15.94	620	1	4300	2400	16.01	2.214	1120	100.8	20
300			J-K	JC-KC	JC-K	7.97	7.97	15.94	620	1	4300	2400	16.01	2.214	1120	100.8	20
300			J-K	JC-KC	JC-K	7.97	7.97	15.94	620	1	4300	2400	16.01	2.214	1120	100.8	20
300			J-K	JC-KC	JC-K	7.97	7.97	15.94	620	1	4300	2400	16.01	2.214	1120	100.8	20
300			J-K	JC-KC	JC-K	7.97	7.97	15.94	620	1	4300	2400	16.01	2.214	1120	100.8	20
300			J-K	JC-KC	JC-K	7.97	7.97	15.94	620	1	4300	2400	16.01	2.214	1120	100.8	20
300			J-K	JC-KC	JC-K	7.97	7.97	15.94	620	1	4300	2400	16.01	2.214	1120	100.8	20
300			J-K	JC-KC	JC-K	7.97	7.97	15.94	620	1	4300	2400	16.01	2.214	1120	100.8	20
300			J-K	JC-KC	JC-K	7.97	7.97	15.94	620	1	4300	2400	16.01	2.214	1120	100.8	20
300			J-K	JC-KC	JC-K	7.97	7.97	15.94	620	1	4300	2400	16.01	2.214	1120	100.8	20
300			J-K	JC-KC	JC-K	7.97	7.97	15.94	620	1	4300	2400	16.01	2.214	1120	100.8	20
300			J-K	JC-KC	JC-K	7.97	7.97	15.94	620	1	4300	2400	16.01	2.214	1120	100.8	20
300			J-K	JC-KC	JC-K	7.97	7.97	15.94	620	1	4300	2400	16.01	2.214	1120	100.8	20
300			J-K	JC-KC	JC-K	7.97	7.97	15.94	620	1	4300	2400	16.01	2.214	1120	100.8	20
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300			J-K	JC-KC	JC-K	7.97	7.97	15.94	620	1	4300	2400	16.01	2.214	1120	100.8	20
300			J-K	JC-KC	JC-K	7.97	7.97	15.94	620	1	4300	2400	16.01	2.214	1120	100.8	20
300			J-K	JC-KC	JC-K	7.97	7.97	15.94	620	1	4300	2400	16.01	2.214	1120	100.8	20
300			J-K	JC-KC	JC-K	7.97	7.97	15.94	620	1	4300	2400	16.01	2.214	1120	100.8	20
300			J-K	JC-KC	JC-K	7.97	7.97	15.94	620	1	4300	2400	16.01	2.214	1120	100.8	20
300			J-K	JC-KC	JC-K	7.97	7.97	15.94	620	1	4300	2400	16.01	2.214	1120	100.8	20
300			J-K	JC-KC	JC-K	7.97	7.97	15.94	620	1	4300	2400	16.01	2.214	1120	100.8	20
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300			J-K	JC-KC	JC-K	7.97	7.97	15.94	620	1	4300	2400	16.01	2.214	1120	100.8	20
300			J-K	JC-KC	JC-K	7.97	7.97	15.94	620	1	4300	2400	16.01	2.214	1120	100.8	20
300			J-K	JC-KC	JC-K	7.97	7.97	15.94	620	1	4300	2400	16.01	2.214	1120	100.8	20
300			J-K	JC-KC	JC-K	7.97	7.97	15.94	620	1	4300	2400	16.01	2.214	1120	100.8	20
300			J-K	JC-KC	JC-K	7.97	7.97	15.94	620	1	4300	2400	16.01	2.214	1120	100.8	20
300			J-K	JC-KC	JC-K	7.97	7.97	15.94	620	1	4300	2400	16.01	2.214	1120	100.8	20
300			J-K	JC-KC	JC-K	7.97	7.97	15.94	620	1	4300	2400	16.01	2.214	1120	100.8	20
300			J-K	JC-KC	JC-K	7.97	7.97	15.94	620	1	4300	2400	16.01	2.214	1120	100.8	20
300			J-K	JC-KC	JC-K	7.97	7.97	15.94	620	1	4300	2400	16.01	2.214	1120	100.8	20
300			J-K	JC-KC	JC-K	7.97	7.97	15.94	620	1	4300	2400	16.01	2.214	1120	100.8	20
300			J-K	JC-KC	JC-K	7.97	7.97	15.94	620	1	4300	2400	16.01	2.214	1120	100.8	20
300			J-K	JC-KC	JC-K	7.97	7.97	15.94	620	1	4300	2400	16.01	2.214	1120	100.8	20
300			J-K	JC-KC	JC-K	7.97	7.97	15.94	620	1	4300	2400	16.01	2.214	1120	100.8	20
300			J-K	JC-KC	JC-K	7.97	7.97	15.94	620	1	4300	2400	16.01	2.214	1120	100.8	20
300			J-K	JC-KC	JC-K	7.97	7.97	15.94	620	1	4300	2400	16.01	2.214	1120	100.8	20
300			J-K	JC-KC	JC-K	7.97	7.97	15.94	620	1	4300	2400	16.01	2.214	1120	100.8	20
300			J-K	JC-KC	JC-K	7.97	7.97	15.94	620	1	4300	2400	16.01	2.214	1120	100.8	20
300			J-K	JC-KC	JC-K	7.97	7.97	15.94	620	1	4300	2400	16.01	2.214	1120	100.8	20
300			J-K	JC-KC	JC-K	7.97	7.97	15.94	620	1	4300	2400	16.01	2.214	1120	100.8	20
300			J-K	JC-KC	JC-K	7.97	7.97	15.94	620	1	4300	2400	16.01	2.214	1120	100.8	20
300			J-K	JC-KC	JC-K	7.97	7.97	15.94	620	1	4300	2400	16.01	2.214	1120	100.8	20
300			J-K	JC-KC	JC-K	7.97	7.97	15.94	620	1	4300	2400	16.01	2.214	1120	100.8	20
300			J-K	JC-KC	JC-K	7.97	7.97	15.94	620	1	4300	2400	16.01	2.214	1120	100.8	20
300			J-K	JC-KC	JC-K	7.97	7.97	15.94	620	1	4300	2400	16.01	2.214	1120	100.8	20
300			J-K	JC-KC	JC-K	7.97	7.97	15.94	620	1	4300	2400	16.01	2.214	1120	100.8	20
300			J-K	JC-KC	JC-K	7.97	7.97	15.94	620	1	4300	2400	16.01	2.214	1120	100.8	20
300			J-K	JC-KC	JC-K	7.97	7.97	15.94	620	1	4300	2400	16.01	2.214	1120	100.8	20
300			J-K	JC-KC	JC-K	7.97	7.97	15.94									



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ABN 61 001 279 812

Wednesday, 09 July 2008

Bovis Lend Lease
The Bond
30 Hickson Road
Millers Point, Sydney, NSW, 2000

Attention: Mr Kim Goh

Dear Kim,

DARLING WALK FLOOD STUDY – FREEBOARD REQUIREMENTS

Further to your recent request with regards to the freeboard adopted for the flood study, we confirm that the adopted values are 500mm for any underground basement entries and 300mm for the retail ground floor levels and lobbies.

The freeboard adopted for the flood study is based on our professional judgement and experience in flood modelling. At the commencement of the flood study City of Sydney Council advised that they would require a freeboard of 500mm for the Darling Walk site.

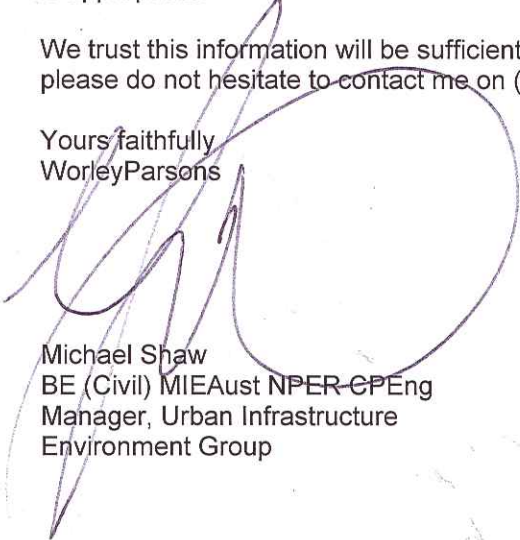
Based on the consideration of Council requirements and our professional judgement, we have nominated a minimum freeboard of 300mm for buildings floor levels and a higher overall freeboard of 500mm for underground basement due to increased risk of potential flood hazard in these areas.

Adoption of appropriate freeboard is guided not only by local authority requirements but also "The New South Wales Floodplain Development Manual". This planning document requires a merit based approach to be applied to flood planning levels for developments.

In this circumstance (particularly due to its proposed land use) we consider adoption of the above freeboard is appropriate.

We trust this information will be sufficient to clarify your concerns. Should you have any further enquiries, please do not hesitate to contact me on (02) 8456 7220.

Yours faithfully
WorleyParsons



Michael Shaw
BE (Civil) MIEAust NPER-CPEng
Manager, Urban Infrastructure
Environment Group



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Monday, 8 September 2008
Bovis Lend Lease
The Bond
30 Hickson Road
Millers Pont, Sydney, NSW, 2000

Attention: Mr Kim Goh

Dear Kim,

DARLING WALK FLOOD STUDY – IMPLICATIONS OF CLIMATE CHANGE (ADDENDUM NO. 1)

This addendum has been provided in relation to queries raised by the Department of Planning for the consideration of climate change implications on the recent Flood Study completed by Worley Parsons for the proposed building redevelopment by Bovis Land Lease on Harbour Street in Cockle Bay. Addendum 1 must be interpreted as part of the documentation and Report produced for the Flood Study and specifically making reference to the objectives of the Flood Study.

Climate change concerns raised by the Department of Planning specifically refer to making allowance for possible future increases in sea level and rainfall intensities. The following statement by Worley Parsons is intended to clarify the approach adopted for the flood study in relation to climate change.

This addendum has been prepared with reference to the DECC publication titled "Practical Considerations for Climate Change", Annexure 17(b) of Floodplain Risk Management Guideline and dated October 2007. This publication suggests that sea level rise on the NSW coast is expected to be in the range of 0.18m to 0.91m by between 2090 and 2100. In addition, the publication recommends that sensitivity analysis should be undertaken for between 10 to 30% increase in rainfall intensities.

Sea Level Rise

It is considered that any future sea level rise will not greatly impact on flood levels at site as the ground level (2.2 m AHD) adjacent to the water's edge in Cockle Bay is much higher than the predicted climate change affected Mean High Water Springs (MHWS) (1.61 m AHD). (Note MHWS today is 0.7 m AHD). This gives a height difference of 0.59m between the estimated ocean level and the ground level adjacent to water's edge.

It is highly improbable that MHWS combined with flooding in the Harbour (say in the 100 year ARI storm) would coincide with the peak flood discharge from site (i.e. the joint probability is remote and there are also considerable timing differences).

Increase in Rainfall Intensity

An increase in rainfall intensity of 20- 30% say as a result of climate change is unlikely to adversely impact the proposed development site. Hydraulic analysis of the Civic Connector flow path has shown that flood levels increase in depth by approximately 17% due to a 30% increase in rainfall intensities. This equates to



a flood depth increase of approximately 20 mm in the Civic Connector. Since the freeboard specified for ground floor levels is 300mm, an increase in flood level of 20 mm would not have any significant impact.

Section 8.1.1 in the Flood Study Report describes the assumptions made in determining catchment area for the flood study. By assuming a simplified approach we have adopted a conservative flood discharge for the development. In actual fact, the discharge directed towards the development would be less.

Section 8.1.4 of the Flood Study Report describes the conservative approach adopted for estimating the capacity of the existing pipe drainage system. This gives added protection to the development in the determination of building ground floor levels.

The simplified modelling assumptions described above provide a significant degree of protection in terms of mitigating for effects of future increases in rainfall intensities and flood levels in the vicinity of the development.

Additional Protection for Development

- Additional flood safety will be incorporated by preparing a Flood Evacuation Plan for the new development based on the PMF.
- Flood compatible building material will be specified for the ground level and underground premises to prevent and minimise flood damage in future.
- A higher 500mm freeboard has been adopted for the basement entries of the development.

We trust this information will be sufficient to clarify your concerns. Should you have any further enquiries, please do not hesitate to contact me on (02) 8456 7220.

Yours faithfully
WorleyParsons



Michael Shaw
BE (Civil) MIEAust NPER CPEng
Manager, Urban Infrastructure
Environment Group



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Thursday, 4 December 2008
Bovis Lend Lease
The Bond
30 Hickson Road
Millers Pont, Sydney, NSW, 2000

Attention: Ms Abbey Johnson

Dear Abbey,

DARLING WALK FLOOD STUDY PART 2.1 – IMPLICATIONS OF PERMITTING OVERFLOW FROM URBAN STREAM (ADDENDUM NO. 2) – OPTION 5

Addendum 2 has been prepared to assess flood behaviour due to overflow of floodwater from the Urban Stream combining with floodwater in Tumblelong Park. All information presented in *Addendum 2* is to be interpreted in conjunction with *Addendum 1* and the Original Flood Study Report of July 2008; now referred to as Darling Walk Flood Study Part 1.

In addition, a new layout has been adopted for Tumblelong Park and has been referred to as Option 5.

Addendum 2 makes reference to Darling Walk Flood Study- Part 2.1 and includes the options and scenarios described above.

Background

Modelling undertaken in Part 1 of the Flood Study was based on the assumption that proposed site ground levels would be sufficiently high enough to prevent the entry of floodwater from the Urban Stream and into Tumblelong Park from all locations.

Modelling approach applied for Part 2.1 of the Flood Study is based on the assumption that existing ground levels adjacent to the Urban Stream, which form a series of crests and dips, would be retained for visual reasons. As such, this scenario has required the consideration of the overflow of floodwater from the Urban Stream and into Tumblelong Park from all possible locations along the Urban Stream.

Part 2.1 has taken into account changes in layout and level required in Tumblelong Park. Minor variations in flow width and levels in the Civic Connector have been taken into consideration in flood modelling. A new floodway has been designed at the northern extremity of the Tumblelong Park to suit new levels required for landscaping and pedestrian safety.

Objective

The key objective of the assessment has been to establish the minimum building ground floor levels required for the proposed development (refer to details in the Flood Study Report of July 2008) under Part 2.1 conditions.



Limitations

Part 2.1 of the flood assessment has excluded the consideration of the existing flood conditions (as modelled in Part 1). As such, it has not been possible to assess the change in flood hazard or flood levels compared to existing conditions until such time as the existing conditions are remodelled to reflect the assumptions and simplifications of Part 2.1 of the Flood Study.

Addendum 2 has not attempted to provide a detailed analysis of flood behaviour but specifically report on the required building ground floor levels and provide relevant advice on potential scour areas and identify areas of high hazard due to flood current and flood depth.

Results

Flood modelling of Part 2.1 has confirmed that flood waters overflow the Urban Stream and enter Tumblelong Park from multiple locations such as show on **Figure 7 Part 2.1**. Floodwaters enter Tumblelong Park from all the dips in ground levels along the Urban Stream and from the southern side.

As expected, the overflow has decreased overall water levels in the Urban Stream but increased water levels in Tumblelong Park and the Civic Connector. Water levels in Tumblelong Park appear to be largely determined by water levels at the upper part of the Urban Stream at RP 8. However, floodwaters from OFP 2A2 (from Harbour Street) have caused slightly higher water levels in the southern portion of Tumblelong Park; thus confirming the influence of the direct overland flow (OFP 2A2) entering the site from Harbour Street.

The increase in water levels in the Civic Connector (between buildings) has been associated with higher downstream tail water levels in Tumblelong Park, due to overflow from the Urban Stream, combined with overall narrower flow path between buildings under Option 5.

Water levels at RP 16 and RP 3 have increased by 40mm due to higher overall downstream tail water levels.

Impact

The results discussed below make reference to water levels established for Part 1 of the Flood Study under Option 4. Refer to Flood Study Report (July 2008) for details. Refer to **Figure 7 Part 2.1** and **Revised Table 6 Part 2.1**, attached as part of **Addendum 2**, for a graphic and tabular representation of water levels established for Part 2.1 of the Flood Study.

The results indicate that flood water levels have increased adjacent to the proposed North building by approximately 270mm to a maximum of RL 3.78 (RP 29, 30, 31, 32).

Flood water levels in Tumblelong Park have increased by approximately 270mm to 400mm to a maximum of RL 3.80 (RP 22, 23, 24, 25, 26, 27, and 28).

In general, flood water levels have increased by approximately 200mm to a maximum of RL 3.82 in the Civic Connector (between buildings RP 20, 21).

As expected, flood water levels have increased at the northern extremity of the site adjacent to the IMAX Theatre by approximately 70mm to 100mm to a maximum of RL 3.06 (RP 12A and 13).

By contrast, flood water levels have decreased in the Urban Stream and have remained unchanged along Harbour Street.



Hazards

The velocity-depth product in Tumblelong Park and the downstream portion of the site has increased from below a safe value of $0.4 \text{ m}^2/\text{s}$ to $0.9 \text{ m}^2/\text{s}$; thereby increasing flood hazard. Refer to **Figure 9 Part 2.1** of **Addendum 2** for details.

The general flood depth in Tumblelong Park has increased from below the safe limit of 200mm to 1310mm; also increasing flood hazard. Refer to **Figure 10 Part 2.1** of **Addendum 2** for details.

Flood depth has increased in the Civic Connector from 110 mm to 280 mm at RP 20; thereby increasing flood hazard.

Flow velocity at the peak of storm was found to be less than 2 m/s (limit for scour) at all locations except adjacent to RP 8 where flow velocity was 2.3 m/s.

Mitigation Measures

Mitigation measures required for Part 2.1 of the Flood Study are identical to the Flood Study Part 1 Report (July 2008) which had adopted a minimum freeboard of 300mm for building ground floor levels and 500mm for underground vehicular entry.

No changes are required to the South Building in terms of ground floor levels and the underground vehicular entry ramp level except adjacent to the Civic Connector where the floor levels have increased by 100mm to RL 4.2. In addition, a minimum of 100mm level difference is recommended for building ground floor levels and the adjacent pavement levels at the south western extremity of the South Building that is otherwise not affected by floodwaters. Refer to **Figure 4 Part 2.1** of **Addendum 2** for additional details.

The North Building requires the minimum building ground floor level of RL 4.0; which is an increase of 200mm compared to Part 1 of the Flood Study (refer to **Figure 4 Part 2.1**). Additional increases of 100mm to 200mm building ground floor levels have been required along the western side of the North Building to new floor levels of RL 4.1 and RL 4.2. Nonetheless, the changes in building floor levels are within the scope of Option 5.

Building floor levels of the North Building along the Harbour Street side and the Civic Connector have increased by 100mm to RL 4.2. Underground entry level for the North Building has remained unchanged at RL 4.4.

As was the case for Part 1, a floodway will be required at the northern extremity of Tumblelong Park to increase the conveyance of floodwaters to downstream reaches as shown in **Figure 4 Part 2.1**.

Option 5 has resulted in an increase in flood hazard. This hazard must be addressed before a final solution can be adopted.

Scour protection is recommended for overflow from the Urban Stream and into Tumblelong Park at RP 8 such as shown on **Figure 4 Part 2.1**.

A comparison of increased risk to downstream properties could not be undertaken due to deferred modelling of existing conditions.



Conclusion

Addendum 2 presents an accurate assessment of flood behaviour due to Part 2.1 conditions but has not included the assessment of increased flood impact/hazard to downstream properties.

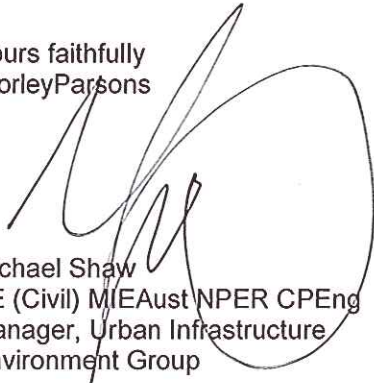
The Flood Study Part 2.1 shows that Option 5 produces significantly higher flood levels and flood hazard and it is recommended that further design evolution be undertaken.

Nonetheless, prevention of flood damage to buildings and compliance with freeboard requirements can be achieved by adopting the recommended building ground floor levels.

Scour and soil erosion can be prevented by applying suitable scour protection to protect from erosive flows.

We trust this information will be sufficient to assess flood behaviour due to Part 2.1 conditions. Should you have any further enquiries, please do not hesitate to contact Raj on (02) 8456 7219.

Yours faithfully
WorleyParsons



Michael Shaw
BE (Civil) MIEAust NPER CPEng
Manager, Urban Infrastructure
Environment Group

Revised Table 6 (Part 2.1) Pre Development and Post Development Water Surface Levels at Key Location (100 Year ARI)									
Reference Point	Pre Development WSL (RL)	Post Development WSL (OPT4) (RL)	Comment on WSL	Post Development WSL (OPT5) (RL)	Pre Development Discharge (m ³ /s)	Post Development Discharge (OPT 4) (m ³ /s)	Comment on Discharge	Description	Comments
1	3.33	3.26	Dec	3.36	5.26	5.85	Inc		
2	3.15	3.13	Dec	3.13	3.12	2.69	Dec		
3	3.87	3.88	Inc	3.88	0.51	0.49	Dec		
4	4.91	4.92	Inc	-	0.74	0.79	Inc		
5	4.11	4.11	Same	4.11	2.38	2.41	Inc		
6	3.99	3.99	Same	3.99	2.55	2.83	Inc		
7	4.01	4.06	Inc	3.81	46.67	46.34	Dec	Urban Stream	
8	3.99	4.05	Inc	3.75	45.65	45.74	Inc	Urban Stream	
9	3.06	3.02	Dec	-	0.28	0.14	Dec		
10 A	3.16	3.15	Dec	-	0.02	0.57	Inc		
10 B	3.10	3.16	Inc	-	0.05	0.06	Inc		
11 A	-	-	-	-	-	-	-		
11 B	3.53	3.55	Inc	3.45	1.46	1.92	Inc		
12 A	2.96	2.99	Inc	3.06	2.44	3.79	Inc		
12 B	2.69	2.71	Inc	-	2.83	3.24	Inc		
13	2.5	2.54	Inc	2.64	0.87	1.17	Inc		
14	3.4	3.44	Inc	3.28	31.27	34.81	Inc	Urban Stream	
15	3.41	-	-	-	2.18	-	-		
16	-	3.8	-	3.84	-	0.32	-		
17	3.77	-	-	-	0.25	-	-		
18	3.62	-	-	-	0.18	-	-		
19	3.12	-	-	-	0.19	-	-		
20	-	3.65	-	3.82	-	0.35	-	New overland flow path	
21	-	3.6	-	3.80	-	0.41	-	New overland flow path	
22	-	3.53	-	3.80	-	0.38	-	New overland flow path	
23	-	3.44	-	3.78	-	0.29	-	New overland flow path	
24	-	3.41	-	3.73	-	0.46	-	New overland flow path	
25	-	3.39	-	3.70	-	0.4	-	New overland flow path	
26	-	3.35	-	3.67	-	0.55	-	New overland flow path	
27	-	3.25	-	3.65	-	0.58	-	New overland flow path	
28	-	3.22	-	3.60	-	0.63	-	New overland flow path	
29	-	3.56	-	3.78	-	0.08	-	New overland flow path	
30	-	3.5	-	3.77	-	0.03	-	New overland flow path	
31	-	3.48	-	3.71	-	0.04	-	New overland flow path	
32	-	3.47	-	3.68	-	0.04	-	New overland flow path	

Note that Predevelopment water levels cannot be compared with Option 5 above as these refer to Part 1 conditions. Part 2 - Option 5 Predevelopment water surface levels have not been established.

FIGURE 4 PART 2.1 OPTION 5 LAYOUT DETAILS

DARLING WALK FLOOD STUDY

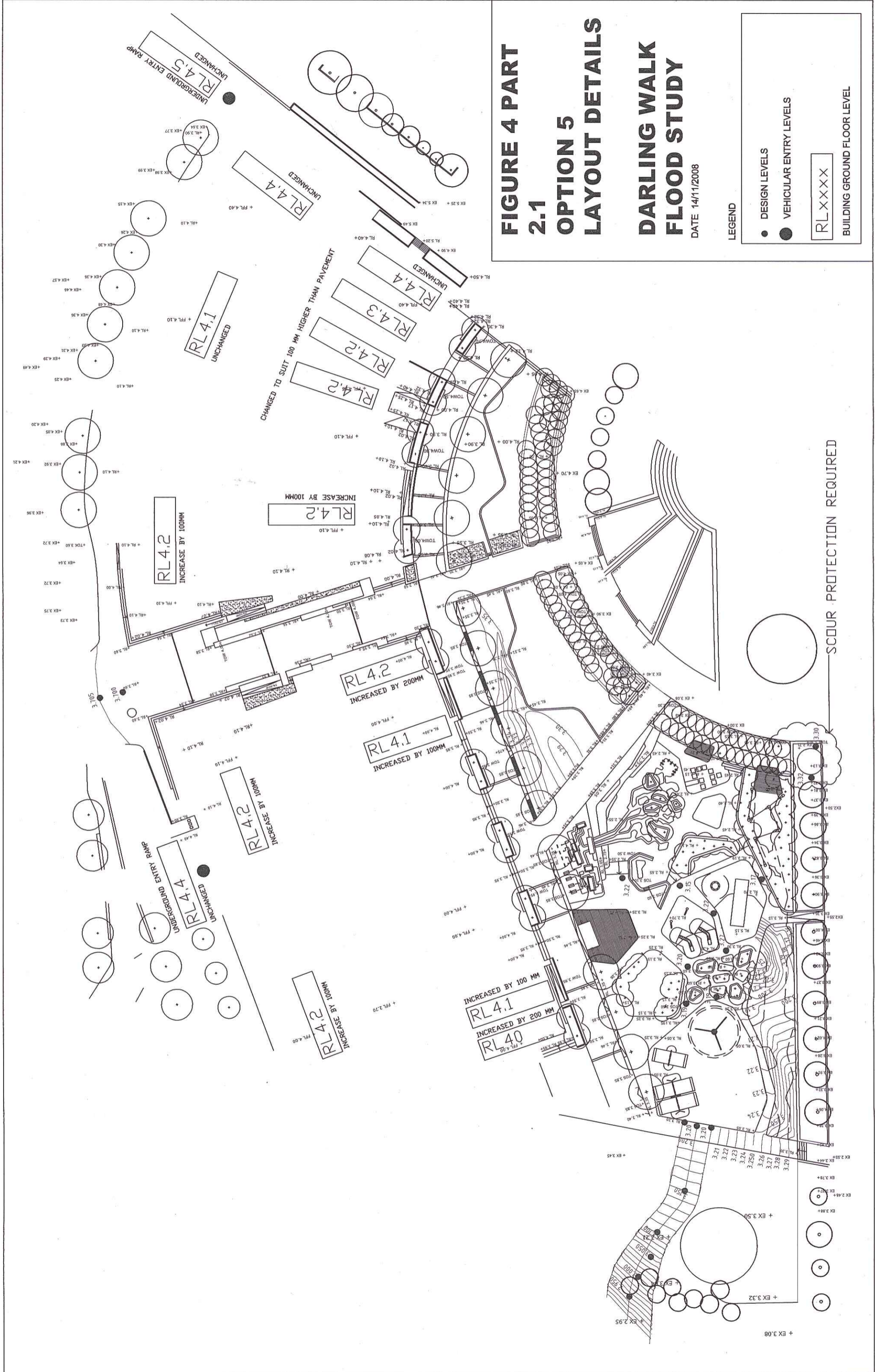
DATE 14/11/2008

LEGEND

- DESIGN LEVELS
- VEHICULAR ENTRY LEVELS

RLXXXX

BUILDING GROUND FLOOR LEVEL



SCOUR PROTECTION REQUIRED

**FIGURE 7 PART 2.1
OPTION 5**

**THEMATIC MAP
OF FLOOD LEVELS**

**POST
DEVELOPMENT
CONDITIONS WITH
OVERFLOW FROM
URBAN STREAM**

**100 ARI
60 MINUTE STORM**

**DARLING
WALK
FLOOD
STUDY**

DATE 18/11/2008

LEGEND

- **7 REFERENCE POINT**
- ◆ **FLOW POINT**
- **OVERLAND FLOW PATH**
- **PRE DEVELOPMENT OVERLAND FLOW PATH**
- **POST DEVELOPMENT OVERLAND FLOW PATH**

