



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](http://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**

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## APPENDIX A

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**WorleyParsons**

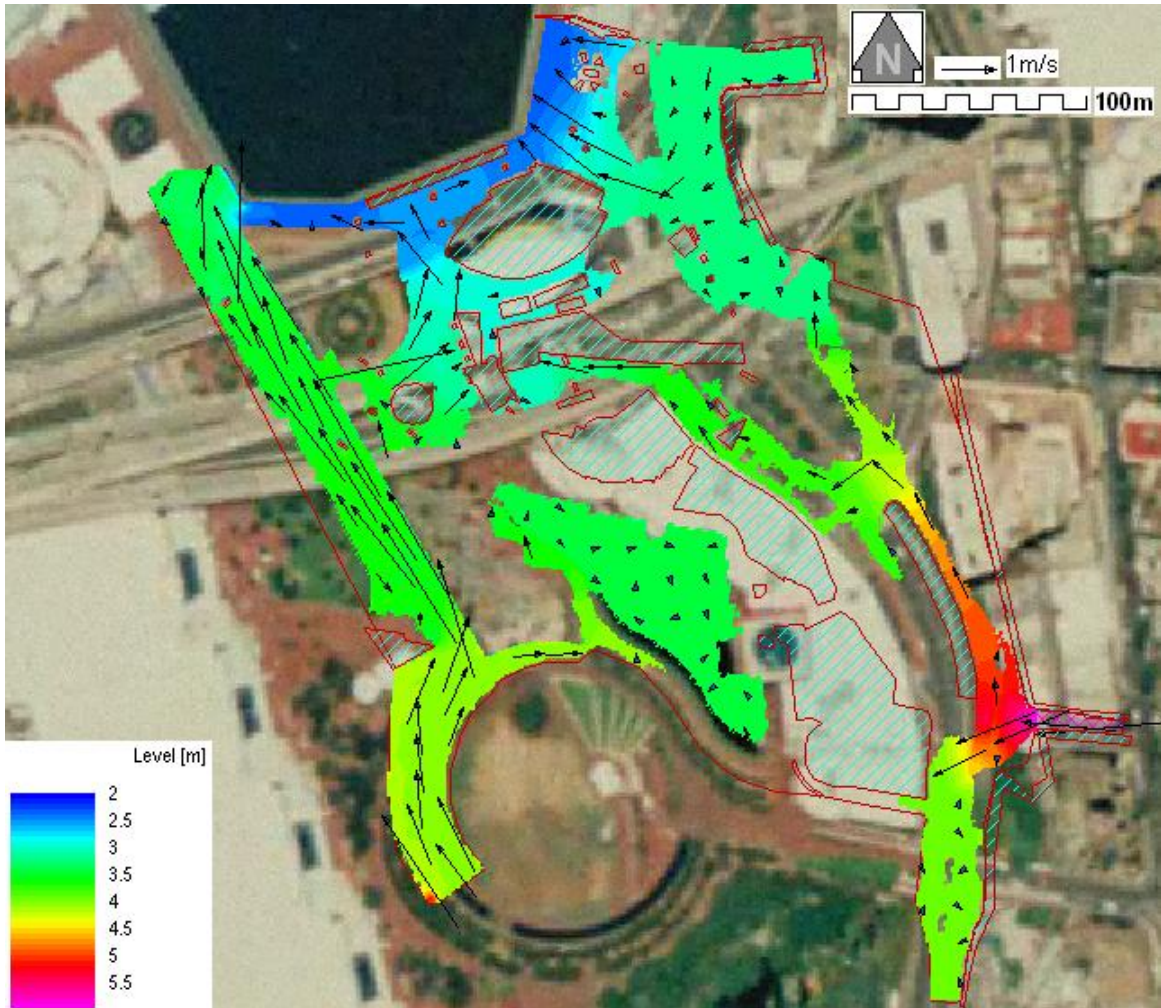
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## APPENDIX B

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consulting engineers

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  
Marc Roberts BE Michael Shaw BE MIEAust CPEng Michael Turner BE MIEAust

Associates

Stephen Aebi BE MIEAust Simon Batt BE MIEAust Scot Cranfield Tod Hall BA (Bio) MEM (Coastal)  
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 - 5.97m<sup>3</sup>/s;
- SWC Catchment Area - 16.9ha;
- SWC 5yr ARI runoff (*peak flow*) - 3.99m<sup>3</sup>/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 8.2m<sup>3</sup>/s and 10.7m<sup>3</sup>/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 2.2m<sup>3</sup>/s to 4.7m<sup>3</sup>/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 3m<sup>3</sup>/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 4.8m<sup>3</sup>/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 5m<sup>3</sup>/s from this source.

Hence, the total quantity of 100yr ARI overland flow generated by this source is estimated to be approximately 12.8m<sup>3</sup>/s. For conservatism a value of 15m<sup>3</sup>/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 65m<sup>3</sup>/s. Independent hydrological calculations undertaken by PBP estimate that the combined 100yr ARI flow generated by this large 200ha catchment is approximately 64m<sup>3</sup>/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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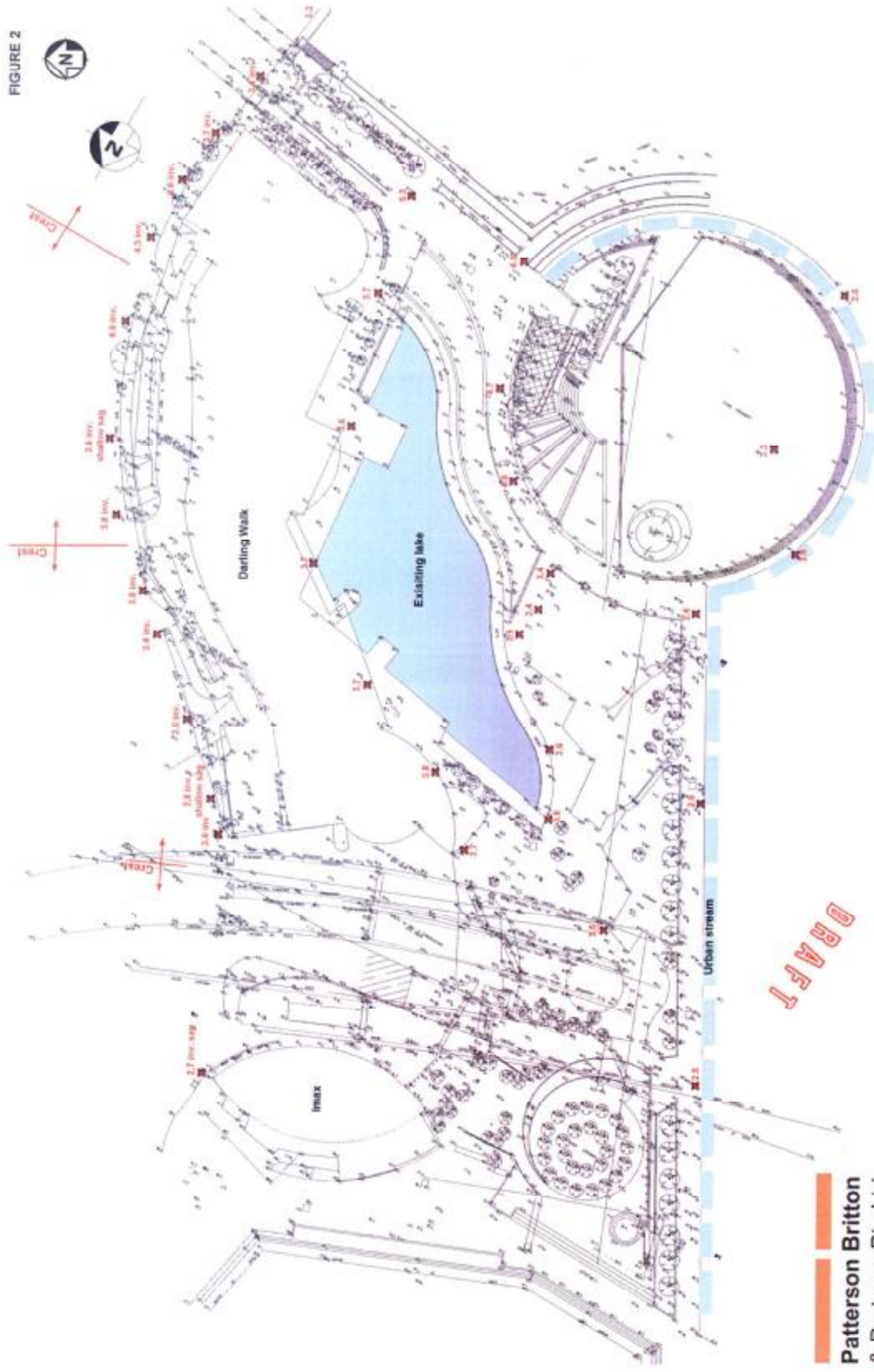
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## FIGURES

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FIGURE 2



DARLING WALK PRELIMINARY FLOOD ASSESSMENT  
EXISTING SURFACE LEVELS

FIGURE 3



DARLING WALK PRELIMINARY FLOOD ASSESSMENT  
RECOMMENDED MINIMUM GROUND FLOOR LEVELS

**DRAFT**

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## APPENDIX A

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**DARLING WALK**  
STAGE THREE DEVELOPMENT CONCEPT

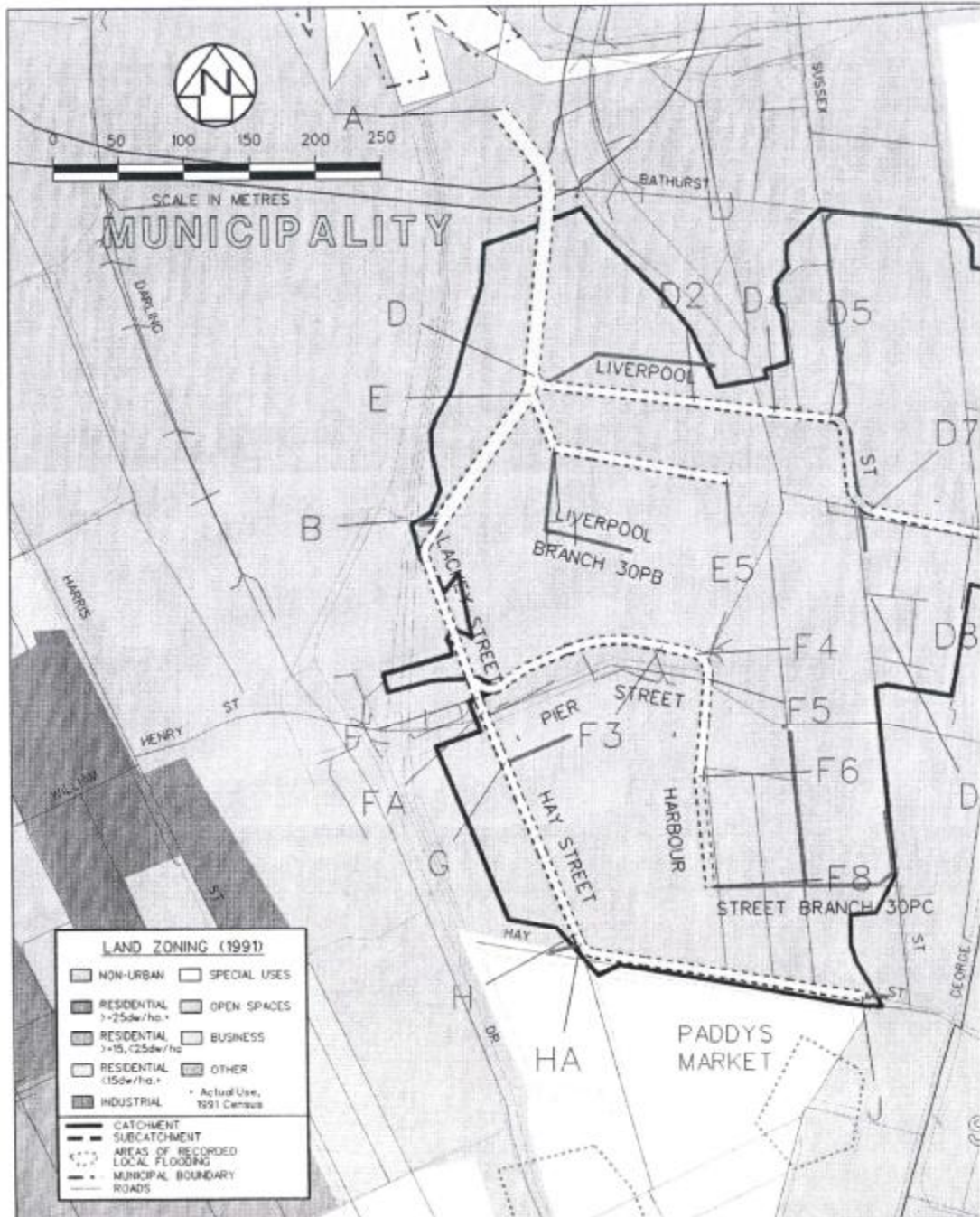
GROUND FLOOR



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## **APPENDIX B**

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Sydney  
**WATER**

SIDNEY WATER CORPORATION LIMITED  
ACN 063 779 645

UTILITIES PLANNING SERVICES

CITY DRA  
CAPACIT

SWC 30P

Stormwater Capacity Assessment

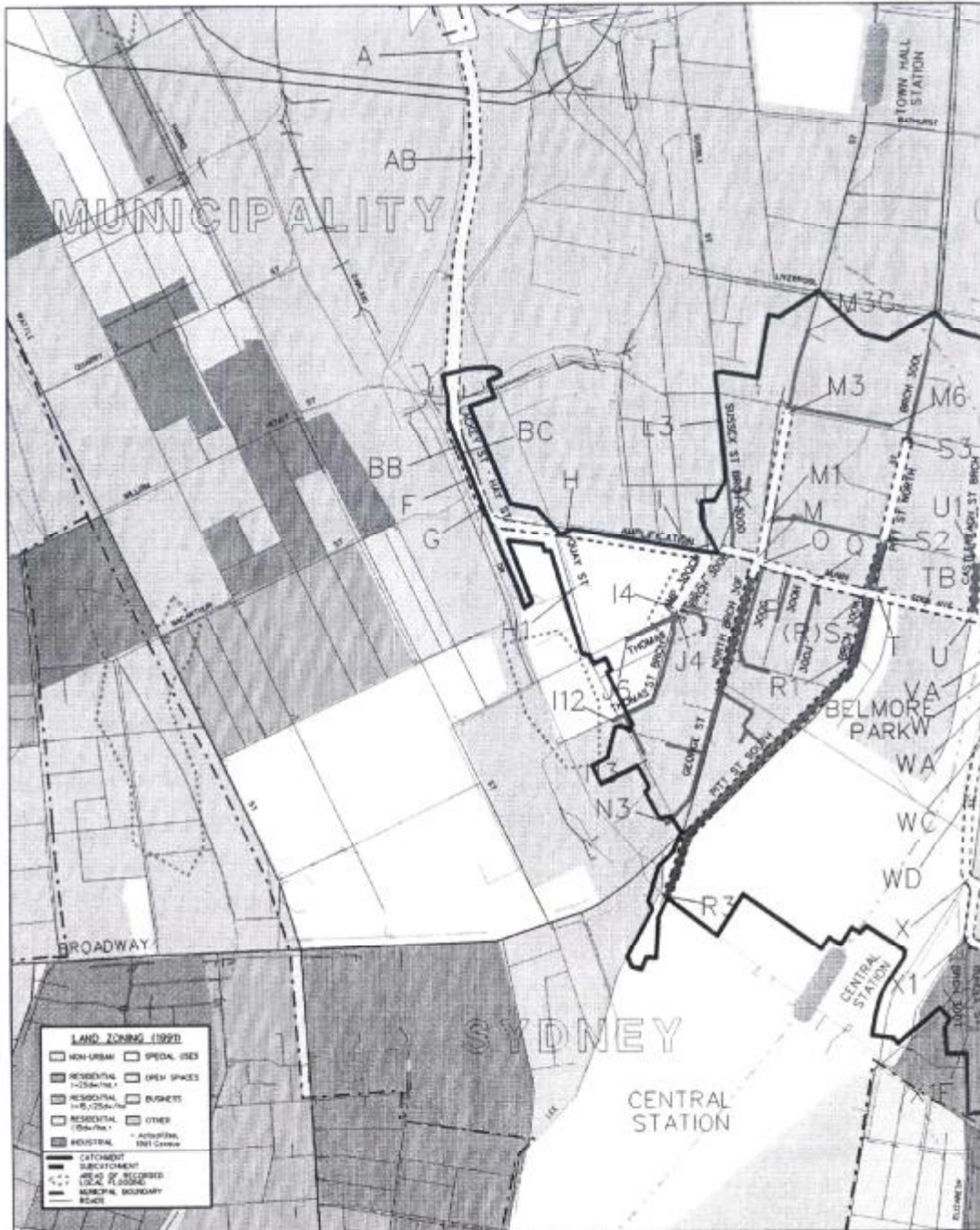
TABLE 5-2. SUMMARY DETAILS FOR CITY AREA 30, LACKEY STREET-HAY STREET SWC 30P

No.	Name	MAIN DRAIN	INCOMING BRANCH, SUB-BRANCH or SIDELINE	Overhead Land Feature	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 (l/s)	RATIO 9 yr ARI PeakFlow / 1 yr Peak	Ratio x Event Freq. (1/C-F)	ARI Storm Event Capacity (l/s)	Landuse Design ARI (years)	See Note			
						Node	Length (m)	Reach											Width (mm)	Height (mm)	Area (mm <sup>2</sup> )
			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	190.75	190.75	1	3910	2210	17.90	31.9			100 l/s	20				
30P2	MAIN CHANNEL (WEST)	30PA	A	190.75	190.75	190.75	190.75	190.75	1	3070	2210	12.80	31.0	12.63	2.431	100 l/s	20	2b			
30P1	MAIN CHANNEL (EAST)	30PB	D-E	7.73	7.73	7.73	7.73	7.73	200	3910	2210	17.90				100 l/s	20				
30P2	MAIN CHANNEL (WEST)	30PB	D-E	7.73	7.73	7.73	7.73	7.73	200	3070	2210	12.80				100 l/s	20	2b			
30P1	MAIN CHANNEL (EAST)	30PB	D-E	8.32	8.32	8.32	8.32	8.32	207	3710	2210	16.70				100 l/s	20				
30P2	MAIN CHANNEL (WEST)	30PB	D-E	8.32	8.32	8.32	8.32	8.32	207	3070	2210	12.80				100 l/s	20	2b			
30P1	MAIN CHANNEL (EAST)	30PC	E-B	119.00	119.00	119.00	119.00	119.00	216	3710	2210	16.70				100 l/s	20				
30P2	MAIN CHANNEL (WEST)	30PC	B	121.20	121.20	121.20	121.20	121.20	1	3070	2210	12.80				100 l/s	20	2b			
30P1	MAIN CHANNEL (EAST)	30PC	B-F	123.50	123.50	123.50	123.50	123.50	336	3710	2210	12.80				100 l/s	20	2b			
30P2	MAIN CHANNEL (WEST)	30PC	F-F	20.00	20.00	20.00	20.00	20.00	469	3710	2210	12.80				100 l/s	20	2b			
30P1	MAIN CHANNEL (EAST)	30PC	F-F	40.23	40.23	40.23	40.23	40.23	479	3430	2210	15.10				100 l/s	20	2b			
30P2	MAIN CHANNEL (WEST)	30PC	F-F	11.25	11.25	11.25	11.25	11.25	520	3070	2210	12.80				100 l/s	20	2b			
30P1	MAIN CHANNEL (EAST)	30PD	G-H	139.83	139.83	139.83	139.83	139.83	531	3430	2210	15.10				100 l/s	20	2b			
30P2	MAIN CHANNEL (WEST)	30PD	H-I	8.88	8.88	8.88	8.88	8.88	871	3050	2130	16.10				100 l/s	20	2b			
30P1	MAIN CHANNEL (EAST)	30PD	H-J	214.96	214.96	214.96	214.96	214.96	879	3050	1980	16.10				100 l/s	20	2b			
30PA	LIVERPOOL ST HYDE PARK BRCH	30PB	D-DA	122.37	122.37	122.37	122.37	122.37	200	1520	1290	7.42				17.9	4.13	1.795	902	25-50	20
30PA	DA-DB	30PB	D-DB	62.09	62.09	62.09	62.09	62.09	322	1350	1290	5.97				16.9	3.99	1.496	816	20-25	20
30PA	DB-DI	30PB	D-DB	41.56	41.56	41.56	41.56	41.56	364	1050	1290	6.40				16.7	3.97	1.612	895	25-50	20
30PA	DI-D2	30PB	D-DB	82.05	82.05	82.05	82.05	82.05	426	1050	1290	6.40				14.1	3.32	1.448	772	15-20	100
30PA	D2-D2A	30PB	D-DB	79.65	79.65	79.65	79.65	79.65	509	1050	1290	5.74				13.4	3.17	1.810	946	25-50	100
30PA	D2A-D2B	30PB	D-DB	34.12	34.12	34.12	34.12	34.12	587	850	1290	3.83				11.9	2.81	1.361	742	15-20	100
30PA	D2B-D2C	30PB	D-DB	21.49	21.49	21.49	21.49	21.49	651	1370	1220	13.30				11.9	2.82	4.712	2407	100 l/s	100
30PA	D2C-D2D	30PB	D-DB	9.85	9.85	9.85	9.85	9.85	653	800	1290	5.03				11.9	2.83	1.790	699	25-50	100
30PA	D2D-D2E	30PB	D-DB	16.99	16.99	16.99	16.99	16.99	653	800	1290	5.03				8.3	1.91	2.632	1344	100 l/s	100
30PA	D2E-D2F	30PB	D-DB	89.06	89.06	89.06	89.06	89.06	670	750	1290	1.69				7.6	1.81	0.906	533	4-5	100
30PA	D2F-D2G	30PB	D-DB	37.65	37.65	37.65	37.65	37.65	758	750	1290	1.69				7.6	1.75	0.907	571	4-5	100
30PA	D2G-D2H	30PB	D-DB	24.78	24.78	24.78	24.78	24.78	796	750	1290	1.69				7.6	1.76	0.903	569	4-5	100
30PA	D2H-D2I	30PB	D-DB	81.11	81.11	81.11	81.11	81.11	821	750	1290	1.78				5.6	1.25	1.410	774	15-20	100
30PA	D2I-D2J	30PB	D-DB	77.84	77.84	77.84	77.84	77.84	902	600	1290	0.91				3.9	0.82	1.112	634	7-8	100
30PA	D2J-D2K	30PB	D-DB	210.50	210.50	210.50	210.50	210.50	880	400	1290	0.26				0.4	0.10	2.814	1340	100 l/s	100
30PA	D2K-D2L	30PB	D-DB	183.00	183.00	183.00	183.00	183.00	426	400	1290	0.26				1.9	0.65			100	100
30PA	D2L-D2M	30PB	D-DB	43.50	43.50	43.50	43.50	43.50	809	300	1290	0.26				0.1	0.05			100	100
30PA	D2M-D2N	30PB	D-DB	106.70	106.70	106.70	106.70	106.70	426	300	1290	0.26				0.7	0.23			100	100
30PA	D2N-D2O	30PB	D-DB	83.50	83.50	83.50	83.50	83.50	653	400	1290	0.26				3.6	1.14			100	100
30PA	D2O-D2P	30PB	D-DB	36.00	36.00	36.00	36.00	36.00	740	400	1290	0.26				0.7	0.23			100	100
30PA	D2P-D2Q	30PB	D-DB	94.10	94.10	94.10	94.10	94.10	740	400	1290	0.26				7				100	100
30PA	D2Q-D2R	30PB	D-DB	13.06	13.06	13.06	13.06	13.06	740	300	1290	0.26				0.4	0.10	2.814	1340	100 l/s	100

Table 5-2 Sheet 1 of 2

Analysis, June 1996

URS \NSC30P.XLS, Print Date 24/09/96



**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 SIDLING	SUB-BRANCH or Land Features	SECTION (per REACH)		LENGTH (m)		Inlet from Culvert (m)	CROSS-SECTION			HYDRAULIC CAPACITY % Capacity Manning (Comment)	CATCHMENT AREA (ha)	RURFACE 6 yr AIR Penetration (Comment)	RATIO Capacity by Peak (C <sub>1</sub> -C <sub>2</sub> )	Ratio F.L. & Capacity (C <sub>1</sub> -C <sub>2</sub> )	AIR Storm Event Capacity (years)	Landscape Design AIR (years)	See Note				
					UPR (Downm <sup>2</sup> )	DOWNR (Downm <sup>2</sup> )	System	Rated (R <sub>1</sub> /R <sub>2</sub> )		Conduit (R <sub>1</sub> /R <sub>2</sub> )	W <sub>1</sub> (mm)	H (mm)									D (mm)	Typ/Rate		
			TOTALS		12,796.1	12,302.3	5,993.7	13,373.0																
300	MAIN CHANNEL (DRAIN)	BL	A-B	ASL-ABOR	50.45	50.45	100.00		2,300.0	3400			B C	0.0140	34.20	101.9	14.90	2.269	1197	100	20	20		
300			A-B	ALOR-BBEB	412.26	412.26	824.52		50	2,300.0	2400		B C	0.0140	34.20	101.9	15.03	2.273	1148	100	20	20		
300			B-C	BLUB-BCEC	10.58	10.58	21.16		463	2,300.0	2400		OC	0.0140	35.20	101.9	16.25	2.166	1197	100	20	20		
300			B-C	BCCEC-F	34.17	34.17	68.34		473	2,500.0	2400		B C	0.0140	34.20	101.9	16.20	2.100	1082	50	100	20	20	
300			B-C	FCFC	101.51	101.51	203.02		607	2,300.0	2400		B C	0.0140	35.00	101.1	16.21	2.073	1070	50	100	100	20	
300			F-G	FC-G	7.02	7.02	14.04		608	1	2400		CT	0.0140	35.00	101.1	16.34	2.146	1118	100	100	20	20	
300			G-H	G-H	108.00	108.00	216.00		618	1	4300	2400		B C	0.0140	35.50	101.1	16.36	2.144	1117	100	100	20	20
300			H-I	H-I	198.43	198.43	396.86		724	1	4300	2400		B C	0.0140	35.50	99.6	16.45	2.159	1198	100	100	20	20
300			I-J	I-J	3.00	3.00	6.00		622	1	4300	2400		B C	0.0140	35.90	87.3	16.36	2.170	1107	100	100	20	20
300			J-K	J-K	7.97	7.97	15.94		620	1	4300	2400		B C	0.0140	35.90	85.8	16.01	2.214	1132	100	100	20	20
300			J-K	J-K	13.15	13.15	26.30		623	1	3050	1980		A S	0.0140	16.10	79.46	7.26	4.190	2126	100	100	20	20
300	LACKEY STREET-HAY STREET AMPLIFICATION		J-K	J-K	18.85	18.85	37.70		647	1	3000	2100		CT	0.0140	37.00	95.8	23.20	4.190	2126	100	100	100	100
300	MAIN CHANNEL		K-L	K-L	36.60	36.60	73.20		643	1	3000	2100		B C	0.0140	47.50	94.6	23.34	2.050	1029	90	100	100	100
300			L-M	L-M	12.80	12.80	25.60		650	1	3000	2100		B C	0.0140	47.50	84.6	23.11	2.066	1074	90	100	100	100
300			M-O	M-O	35.20	35.20	70.40		651	1	3000	2100		B C	0.0140	47.50	86.9	21.19	2.242	1145	100	100	100	100
300			O-P	O-P	38.31	38.31	76.62		652	1	3000	2100		B C	0.0140	47.50	86.2	21.02	2.260	1164	100	100	100	100
300			P-Q	P-Q	67.36	67.36	134.72		653	1	3000	2100		B C	0.0140	47.50	85.5	20.91	2.272	1180	100	100	100	100
300			Q-S	Q-S	13.81	13.81	27.62		654	1	3000	2100		B C	0.0140	47.50	85.4	20.48	2.352	1186	100	100	100	100
300			S-T	S-T	62.84	62.84	125.68		655	1	3050	1980		B C	0.0140	54.90	71.6	17.68	3.108	1587	100	100	100	100
300			T-U	T-U	66.20	66.20	132.40		656	1	3050	1980		B C	0.0140	54.90	71.6	17.68	3.108	1587	100	100	100	100
300			U-V	U-V	31.20	31.20	62.40		657	1	3050	1980		A S	0.0140	29.50	63.7	17.16	1.717	820	25	50	20	20
300			V-W	V-W	50.00	50.00	100.00		658	1	1850	1980		TL	0.0140	11.00	29.4	7.40	1.967	842	25	50	20	20
300			W-X	W-X	28.79	28.79	57.58		659	1	1520	1980		B C	0.0140	12.80	20.8	5.26	2.428	1242	100	100	20	20
300			W-WA	W-WA	30.00	30.00	60.00		660	1	1520	1980		B C	0.0140	12.80	20.8	5.30	2.417	1208	100	100	20	20
300			W-WA	W-WA	4.00	4.00	8.00		661	1	1520	1980		CT	0.0140	12.80	20.8	5.30	2.417	1208	100	100	20	20
300			W-WB	W-WB	50.52	50.52	101.04		662	1	1520	1980		B C	0.0140	10.50	20.8	5.30	1.961	1098	50	100	20	20
300			W-WB	W-WB	35.93	35.93	71.86		663	1	1520	1980		B C	0.0140	22.60	20.8	5.30	4.228	2171	100	100	20	20
300			W-WB	W-WB	39.35	39.35	78.70		664	1	1520	1980		B C	0.0140	10.00	20.8	5.35	1.871	991	50	100	20	20
300			W-WB	W-WB	12.17	12.17	24.34		665	1	1520	1980		B C	0.0140	10.00	20.4	5.29	2.004	1051	50	100	20	20
300			W-WB	W-WB	111.26	111.26	222.52		666	1	1520	1750		TL	0.0140	10.00	20.4	5.29	2.004	1051	50	100	20	20
300			W-X	W-X	15.71	15.71	31.42		667	1	1000	1750		TL	0.0140	8.13	11.5	2.99	2.728	1367	100	100	20	20
300			X-XA	X-XA	35.61	35.61	71.22		668	1	1000	1750		TL	0.0140	8.13	11.5	2.99	2.728	1367	100	100	20	20
300			X-Y	X-Y	17.84	17.84	35.68		669	1	1000	1750		TL	0.0140	8.13	9.9	2.57	3.158	1621	100	100	20	20
300			Y-Z	Y-Z	66.83	66.83	133.66		670	1	1000	1750		TL	0.0140	4.20	9.1	2.37	1.774	984	25	50	20	20
300			Z-ZA	Z-ZA	73.51	73.51	147.02		671	1	1000	1750		TL	0.0140	4.48	7.9	2.07	2.181	1110	100	100	20	20
300			ZA-ZB	ZA-ZB	67.83	67.83	135.66		672	1	1000	1750		TL	0.0140	3.90	6.6	1.74	2.253	1156	100	100	20	20
300			ZB-ZC	ZB-ZC	34.36	34.36	68.72		673	1	1000	1750		TL	0.0140	2.44	5.6	1.50	1.800	879	25	50	20	20
300			ZC-ZD	ZC-ZD	11.86	11.86	23.72		674	1	1000	1750		TL	0.0140	1.76	4.5	1.20	1.480	805	20	25	20	20
300			ZD-ZE	ZD-ZE	11.86	11.86	23.72		675	1	1000	1750		TL	0.0140	1.76	4.5	1.20	1.480	805	20	25	20	20

Table 6-2 Sheet 1 of 7

Analysis, June 1996

LPR #152000.XLS, Print Date 24/06/96



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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.

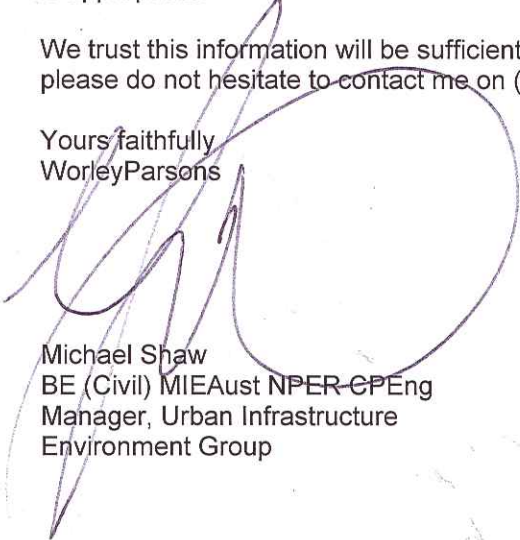
Based on the consideration of Council requirements and our professional judgement, we have nominated a minimum freeboard of 300mm for buildings floor levels and a higher overall freeboard of 500mm for underground basement due to increased risk of potential flood hazard in these areas.

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  
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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