

APPENDIX A

HISTORIC FLOODS

Extract from Sydney Morning Herald, Saturday 12 May 1860, p.10

ANOTHER DESTRUCTIVE FLOOD

SYDNEY has not been visited with such heavy rain for many years, as that which fell from Wednesday, the 25th April, to the following Sunday. Scarcely have we rallied from the effects of the disastrous inundations recorded in our last summary, ere another visitation, but this time not attended with so great a loss of life, sweeps once more the Western and Southern districts, making 1860, indeed, a memorable year. In the metropolis there was little destruction to property, but in the suburbs the people were not so fortunate.

The market gardeners at Rushcutters and Double Bay have suffered severely, all their little plots having been under water, which, draining off, has left behind a bed of sand. These poor people had but just recovered from the last flood, and had only repaired the damage then inflicted, a short time before the rain set in. Their plots of barley, and their beds of vegetables, and feed for cattle, are all destroyed by the sand and water, and their prospects for the winter therefore are bleak enough. The new South Head Road was literally worn out by this last rain.

Extract from Sydney Morning Herald, Saturday 13 April 1867, p.5

THE RAIN AND ITS EFFECTS

After several weeks of changeable weather, embracing frequent showers and several rather heavy rainfalls, we have at last had a regular downpour, and the effects in some parts of the city and suburbs have been disastrous. Shortly before midnight of Thursday the heavy masses of clouds that had been gathering up from the southward overspread the sky, and the rain began to fall in heavy showers. Not very long after the first shower the rain came down in torrents, and continued to descend as one sheet of water all night long. We hear the same statements from all parts of the city and suburbs, that no one can remember such incessant heavy rain for so many hours. The effects, in the sweeping away of metal from the streets, the breaking up of culverts, and the displacement of guttering, are sufficiently evident in all parts of the city.

At Double Bay, the destruction caused by the terrific rush of water, was also very great. A large portion of Mr. Guilfoyle's exotic nursery was submerged, and the destruction among the flowers and tender plants was very great. The market gardens on both sides of the Old South Head Road suffered similarly to those at Rushcutters Bay, but not, apparently, to the same extent. A large portion of these gardens was covered at one time, but the water subsided without causing much damage, except as regards the culvert under the main road, which is in a dangerous state, and if not speedily re-paired, will render the road impassable. Lower down in the bay a bridge over the main watercourse suffered severely. A large portion of the road close to this bridge was washed away, leaving an immense hole, into which a horse fell in the course of the morning; and it was with great difficulty that he was got out alive. Many of the houses in Double Bay were, for a time, ankle deep, and some of them knee-deep in water.

Extract from Sydney Morning Herald, Saturday 20 May 1933, p.13

FIERCE STORM ON COAST WITH TORRENTIAL RAIN
Floodings in City and Suburbs

A fierce cyclonic storm swept Sydney and the central coast late yesterday afternoon.

At Sydney, 3½ inches of rain fell, more than 2 inches of which was registered between 5 and 6.30 o'clock.

Low lying areas in Rose Bay, Double Bay and Rushcutters Bay were inundated.

Extract from Sydney Morning Herald, Friday 15 November 1940, p.9

RAIN IN CITY
Heavy Fall This Morning

Heavy rain began about 1.45 a.m. today and continued steadily for about an hour. Then it eased slightly, but the outlook for further falls was promising.

Roads in the city were flooded shortly after 2am. In New South Head Road, Double Bay, the water was a foot deep opposite Hoyts theatre, and a tram was held up for some time waiting for the water to recede. Several motor cars were also halted by the floodwater.

Extract from Sydney Morning Herald, Monday 24 July 1950, p.1

RAIN CHAOS IN SYDNEY AND SUBURBS
Families Flooded Out of Homes

Torrential rain in Sydney and suburbs yesterday temporarily drove scores of people from their homes, disrupted rail and air traffic, and swamped road bridges.

Between 9 a.m. and 8 p.m., 429 points fell in the city, making the total so far this year greater than the whole of last year's.

Some of the worst floodings were in Glebe; Manning Road, Double Bay; Curlew Street, Bondi; Epping Road, Epping; Moore Park Road, Centennial Park; sections of Kingsford, Daceyville, Maroubra, Kingsford, Mortdale, and Bankstown.

APPENDIX B

COMMUNITY CONSULTATION MATERIAL

- Letter to Residents**
- Information Sheet No. 1 (introduction to study)**
- Community Questionnaire**
- Agency Questionnaire**
- Information Sheet No. 2 (with public exhibition)**

Council Ref: 1037.G (AR:AR)
Your Ref:

11 September 2009

[Name]
[Address 1]
[Address 2]

Dear [Name],

Double Bay Catchment Floodplain Risk Management Study & Plan

Woollahra Municipal Council has commissioned Bewsher Consulting to undertake a floodplain risk management study for the Double Bay catchment. The study will examine flooding problems within the Double Bay catchment and investigate solutions to these problems.

The included community information sheet gives you valuable information on the flood plain management process. If you could take a few minutes to read it and complete the attached community survey it would be greatly appreciated. When complete the survey will be used to ensure that all the flood related issues in the catchment have been covered and that all residents' concerns have been adequately addressed. A pre-paid addressed envelope is included for your convenience.

Should you require any further information on this matter, please contact Mr Michael Casteleyn, Drainage Engineer, on 9391 7131 during business hours.

Yours Sincerely

Alan Opera
Manager – Engineering Services



Double Bay Catchment Floodplain Risk Management Study & Plan

Community Information Sheet 1

September 2009

Introduction

Woollahra Council has appointed Bewsher Consulting Pty Ltd (floodplain management specialists) to prepare a Floodplain Risk Management Study & Plan for the Double Bay Catchment.

Storms are known to have generated flooding problems near New South Head Road in 1943, 1951, 1983 and 1988. Some residents reported houses flooded above floor level in the November 1984 event. Some shops were flooded and the northern part of Kiaora Road was completely inundated in the April 2007 event (Figure 1).

The Study will assess the potential impact of flooding on the community and evaluate options for addressing flooding problems.

It is being funded under the NSW Government's Floodplain Management Program.

The study area

The Double Bay catchment has an area of about 2.8 km² which drains to Sydney Harbour (Figure 2). It includes Double Bay and parts of Edgecliff, Woollahra and Bellevue Hill. Of the total area, 0.3 km² represents the West Double Bay portion of the catchment which has separate pipelines conveying local runoff to the harbour.

The upper section of the catchment comprises urban development, commercial and retail premises and limited areas of open space apart from Cooper Park. Stormwater within this section is carried within the underground piped network, or when this is exceeded, along roads or through private property.

The lower section comprises the area where stormwater collects into the open channel downstream of Lough Park and the receiving covered channel which passes under the Double Bay retail area. Sydney Water owns and maintains the major open and covered channels between Lough Park and the harbour, while Council owns and maintains the stormwater pipe systems.



Glendon Road, April 1988
Figure 1: Historical flooding



New South Head Road, April 2007

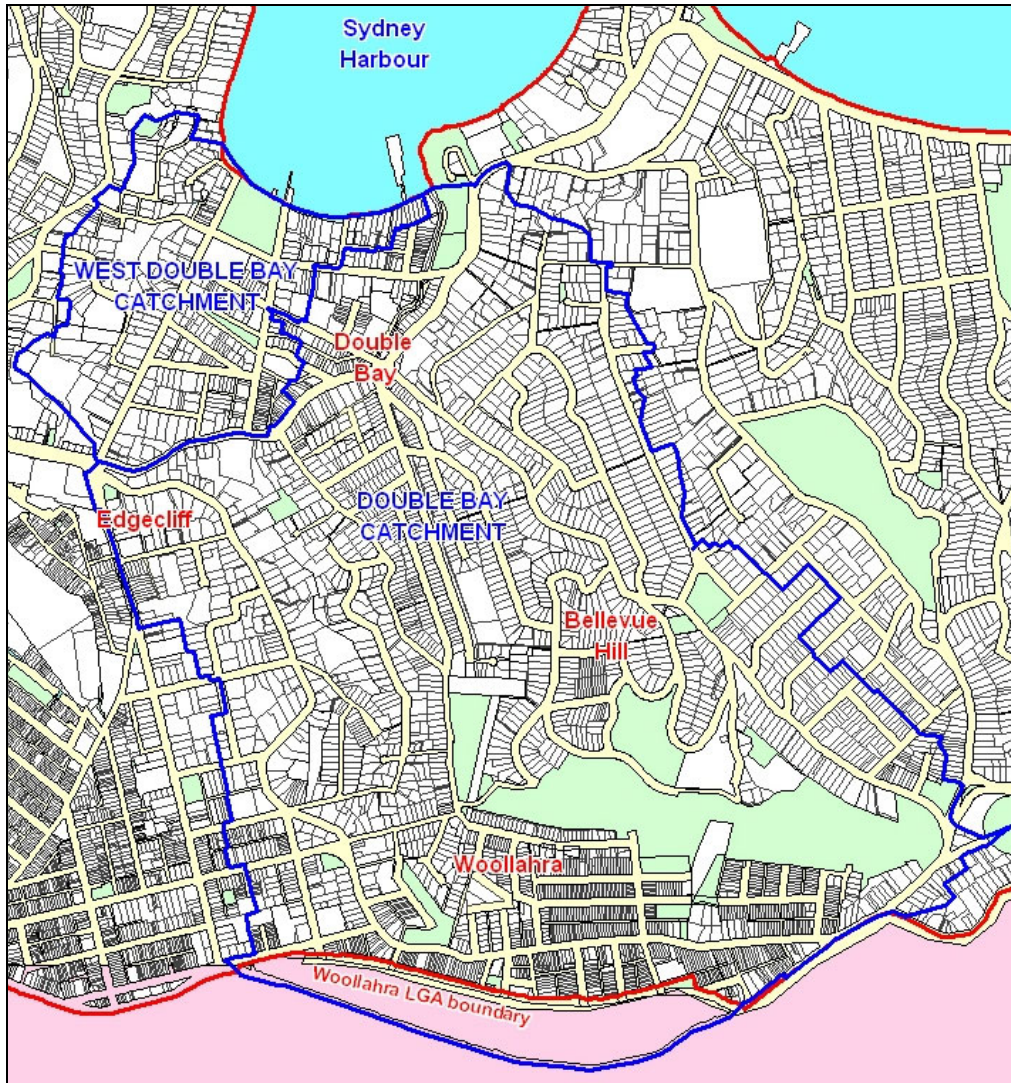


Figure 2: Catchment Map

Floodplain management process

The first step in the floodplain management process depicted in Figure 3—preparation of the Flood Study—has been completed. Council formally adopted the Double Bay Catchment Flood Study in December 2007.

The current investigation represents the second and third steps in the process. Preparation of the Floodplain Risk Management Study involves evaluating a range of floodplain management measures to address the areas of concern. The Floodplain Risk Management Plan is a recommended management plan for addressing the flood problem, following public exhibition and consideration of community feedback. After formal adoption by Council, the Plan will be implemented as resources permit.

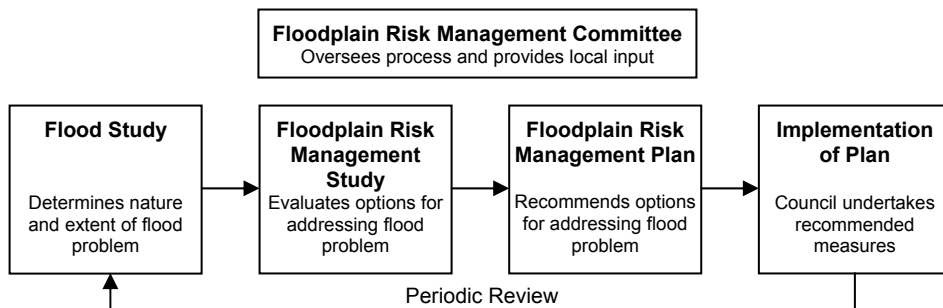


Figure 3: The Floodplain Risk Management Process

Management measures

The Floodplain Risk Management Study will consider various options that may be able to reduce the damages caused by floods. This evaluation takes into account local residents' views, as well as environmental, social, economic and engineering factors. Among the options that could be considered are:

Measures that modify the way a flood behaves

- ▶ Constructing detention basins
- ▶ Enlarging the capacity of drainage infrastructure
- ▶ Reducing the potential for culvert blockage
- ▶ Constructing permanent levees

Measures that modify property

- ▶ Applying appropriate planning controls on new buildings (e.g. minimum floor levels)
- ▶ 'Flood-proofing' properties (e.g. using shutters)
- ▶ Council offering to purchase the most severely flood affected properties
- ▶ Raising houses above the 100 year flood level

Measures that modify people's response to flooding

- ▶ Improving flood warning systems and evacuation plans
- ▶ Promoting community flood awareness

The overall objective is to reduce the flood risk to life and damage to property.



Figure 4: The Double Bay Catchment FRMS will assess the potential impacts of climate change on flood behaviour.



Figure 5: Open channel next to Kiaora Road. The FRMS will consider the propensity for drains to block and measures to avert blockage.



Figure 6: One option could be to 'uncover' the Sydney Water underground channel and provide some 'naturalisation' of the trunk drainage system.

How can you be involved?

Community input to the Double Bay Floodplain Risk Management Study is essential. Several opportunities to let your voice be heard are available.

1) Questionnaire

Accompanying this information sheet is a questionnaire that seeks your ideas about how flooding issues should be managed and disclosed. In order to evaluate the economic merit of various floodplain management options, we are also seeking information about the average value of property contents. (Obviously, all questionnaire responses are confidential).

2) Public display

Once all the floodplain management options have been identified and evaluated and tentative recommendations have been formulated and agreed with the Floodplain Management Committee, a public display will be held providing a further opportunity to comment.

3) Public exhibition

Public exhibition of the draft *Double Bay Catchment Floodplain Risk Management Study & Plan* will provide a further opportunity to comment.

4) Speak to a member of the Floodplain Management Committee

Clr Chris Howe, Double Bay Ward, Woollahra Council
Tel: 9328 1198

Mr Tony Gregory, Double Bay Residents Association
Tel: 0414 609898 or 9327 1782

Mr Bart Foley, Dept Environment, Climate Change and Water

Ms Kim Edwards, Waverley-Woollahra SES

Mr Ray Parsell, Sydney Water

Property Survey

In order to identify properties, houses and businesses potentially exposed to flood risks, Council has engaged Turner Surveying to survey buildings over September - October. This will require access onto private property (but not inside houses). The survey will extend from Cooper Park to the Double Bay retail area and nearby residential areas. We are grateful for your assistance in facilitating this work.



Who can you contact for more information?

For more information about the Double Bay Catchment Floodplain Risk Management Study & Plan, please contact:

Woollahra Municipal Council

Michael Casteleyn
Phone: 9391-7131
E-mail: Michael.Casteleyn@woollahra.nsw.gov.au

Bewsher Consulting Pty Ltd

Stephen Yeo
Phone: 9868-1966
E-mail: syeo@bewsher.com.au

Thank you for being part of this study



Department of
Environment, Climate Change and Water NSW




Bewsher



Double Bay Catchment Floodplain Risk Management Study Community Questionnaire, September 2009

Please complete this questionnaire for the property within the Double Bay Catchment study area, in which you have an interest. (Refer to the map over page).

The information provided from this questionnaire will help us to identify and evaluate potential measures for addressing any flood problems.

All information provided will be treated as confidential and will be used only for this study. No names or addresses will be included in any published material.

Type of development	Address	Name of business (if applicable)
<input type="checkbox"/> Residence		
<input type="checkbox"/> Business		

1. Are there any particular flood issues that you are aware of in the Double Bay study area that warrant attention?

2. Do you have any suggestions that would help reduce flooding problems in the study area ?

3. Do you have any other suggestions about what the Study should cover?

4. In order to assist us in estimating the economic merit of potential floodplain management options, could you please complete this table for your residence or business?

Approximate internal ground floor area (m ²)	Value of contents that would be destroyed or damaged if 30cm of muddy water entered your ground floor. (Include in your estimate floor coverings, items stored in a garage or shed below the same level, landscaping etc. Exclude from your estimate motor vehicles.)
	<input type="checkbox"/> below \$20,000, <input type="checkbox"/> \$20,000-\$40,000, <input type="checkbox"/> \$40,000-\$60,000, <input type="checkbox"/> \$60,000-\$80,000, <input type="checkbox"/> \$80,000-\$100,000, <input type="checkbox"/> \$100,000-\$120,000, <input type="checkbox"/> above \$120,000

5. How do you think information about the risks of flooding should be provided to the local community?
(Indicate with a ✓)

	Yes	No	Neutral/ unsure
Council should have flood maps available on its web site.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Council should have flood maps available for inspection at its office.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Council should issue flood level certificates to property owners on request.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Council should issue flood level certificates to prospective purchasers on request.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Council should issue flood level certificates to property owners regularly.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Council should provide no advice about flooding.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

6. Contact details (optional):

Name: _____

Address: _____

Phone number: _____

Email: _____

Please return the completed questionnaire by 9 October 2009 to Bewsher Consulting:

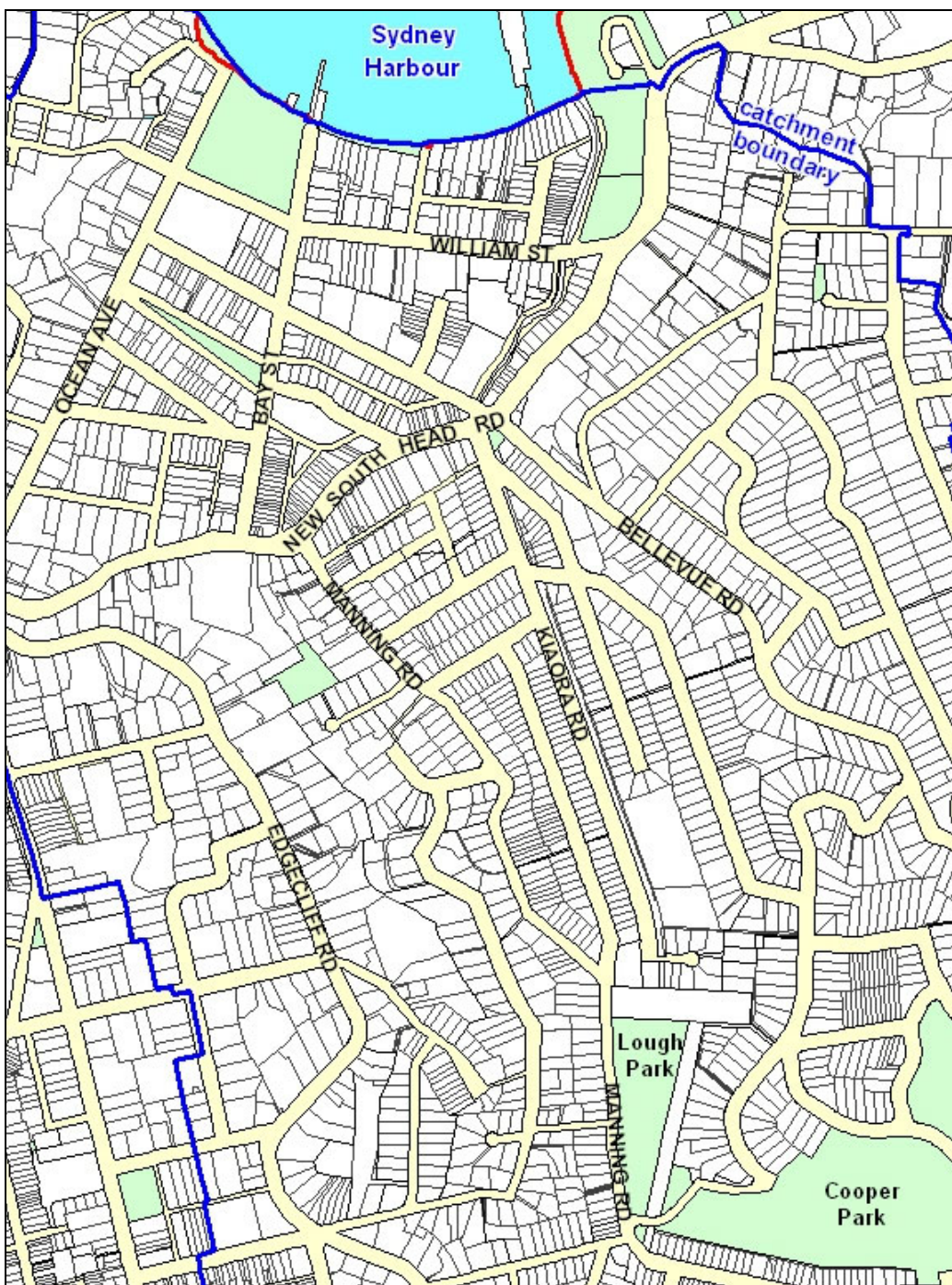


1) Using the reply-paid envelope provided

Bewsher Consulting
Reply Paid No. 352
EPPING NSW 1710



2) Faxing your questionnaire to 9868-5759



Please mark any flood problem areas on the map.

Thank you for your assistance.

DOUBLE BAY CATCHMENT FLOODPLAIN RISK MANAGEMENT STUDY & PLAN

**STAKEHOLDER SURVEY
FOR AGENCIES, AUTHORITIES AND INTEREST GROUPS
SEPTEMBER 2009**

PART A: CONTACT DETAILS

Name of Organisation:	
Contact Name:	
Position of Contact Person:	
Postal Address:	
Contact phone number:	
Contact fax number:	
Contact e-mail:	

PART B: RELEVANT REPORTS, STUDIES AND DESIGNS

Are you aware of any reports, studies or design drawings that have been carried out within the study area? These may or may not be related to flooding or the floodplain.

Author	Date	Title of report or drawing	Prepared for	Published by	Does your office have a copy we could borrow if required?

PART C: POTENTIAL FLOOD DAMAGE TO PROPERTY, ASSETS OR SERVICES

We are interested in your views relating to the potential damage that *could* occur to your property, assets or services if they were inundated by floodwaters. Items that could be damaged by floodwaters through inundation or be damaged if undermined by erosion during a flood might include buildings, road surfaces, pumps, pumping stations, electricity substations, traffic signals, other electrical equipment, equipment and/or stock piles at depots, monitoring equipment as well as cables, conduits or pipes.

Please complete the following table using the examples as a guide.

Please describe the property/asset/service that could be damaged by floodwaters.	Please provide the location of the property/asset/service.	Please describe the type of damage that could be sustained if inundated by floodwaters.	Please estimate the approximate cost of damage that could be sustained.	Approximately, how long would it take to repair the damage.	How critical would the property/asset/service be to the community if it were damaged by floodwaters?	Could potential damage be reduced if flood mitigation works were constructed or if warnings were issued? Please give details.
Road surface	Brown Street	Damage to road surface if inundated for > about 3-6 hrs	\$100 per m ² of affected pavement	About 2 weeks	About 5000 vehicles/day would have to find alternative routes for up to 2 weeks	Damage may be reduced if Brown Street bridge was enlarged.
Sewer Pumping Station	Corner Smith and Jones Streets	Pumps would fail if inundated by more than 300 mm of water	\$50,000	About 1 week	There would be no sewer to about 400 homes for up to 5 days	Pumps may be protected with at least 2 hours warning.

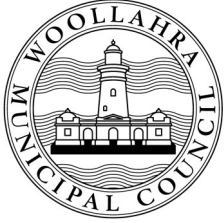
PART D: POSSIBLE FUTURE WORKS IN STUDY AREA

Does your organisation have any planned future works within the Double Bay Catchment Study Area that could be affected by flooding, or could have an impact on possible floodplain management options?

Floodplain management options could include constructing detention basins in Cooper Park and/or the Lough Playing Fields, enlarging the capacity of drainage infrastructure, reducing the potential for culvert blockage, constructing permanent levees, etc.

Please complete the following table using the example as a guide. Please attach a separate sheet if required.

Proposed Work	Location (attach map if required)	Approximate Cost	Indicative Time Frame
600 mm dia sewer rising main	Crosses the river upstream of the William Long bridge	\$10 million (2006 estimate)	Within next 5–10 years



Double Bay Catchment Floodplain Risk Management Study & Plan

Community Information Sheet 2

May 2011

Introduction

Commencing in 2009, and with financial assistance from the Department of Environment, Climate Change and Water (DECCW), Woollahra Council has been working to prepare a Floodplain Risk Management Study & Plan for the Double Bay catchment. Floodplain management specialists Bewsher Consulting, overseen by Council's Flood Risk Management Committee, have completed a draft report, which is now on public exhibition. In broad terms, the report investigates what can be done to minimise the effects of flooding in the Double Bay catchment and has recommended a strategy in the form of a draft Plan. ***We invite you to take this opportunity to inspect the draft report and welcome your comments.***

Floodplain management process

The first step in the floodplain management process depicted below—preparation of the Flood Study—has been completed. Council formally adopted the Double Bay Catchment Flood Study in December 2007.

The current investigation represents the second and third steps in the process. Preparation of the Floodplain Risk Management Study involves evaluating a range of floodplain management measures to address the areas of concern. The Floodplain Risk Management Plan is a recommended management plan for addressing the flood problem, following public exhibition and consideration of community feedback. After formal adoption by Council, the Plan will be implemented as resources permit.

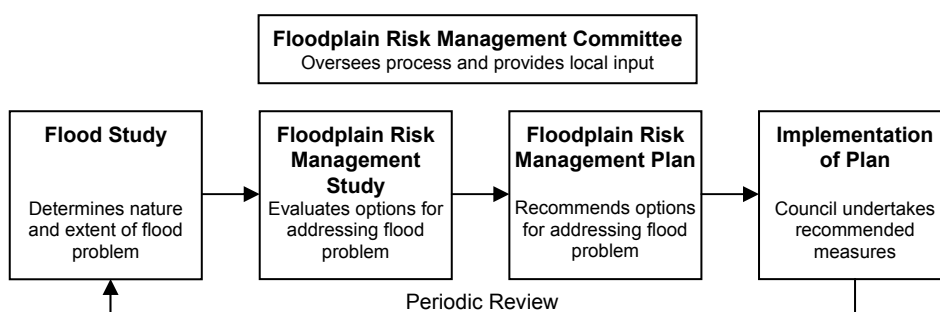
The study area

The Double Bay catchment has an area of about 2.8 km² which drains to Sydney Harbour. It includes Double Bay and parts of Edgecliff, Woollahra and Bellevue Hill (see page 3).

Principal outcomes

The principal outcomes of the study include:

- ▶ A summary of flood behaviour (including updated modelling), and an assessment of the sensitivity of flood behaviour to the potential impacts of climate change;
- ▶ An assessment of potential flood damages in the Double Bay catchment – an estimated 62 dwellings and 142 businesses would be flooded above floor level in the 100 year flood; the average annual damage of flooding is estimated to cost \$3.7 million;
- ▶ An evaluation of potential floodplain management measures to reduce flood damages; and
- ▶ A recommended draft Double Bay catchment Floodplain Risk Management Plan.



Draft Floodplain Risk Management Plan

A draft Floodplain Risk Management Plan showing the preferred floodplain risk management measures for the Double Bay catchment study area is presented below and in the figure opposite. The recommended measures have been selected from a range of measures considered in the study, after an assessment of each measure's impact on flood risk, as well as consideration of environmental, social, and economic factors.

The principal components of the Plan are presented below according to priority, which is assessed on the basis of how easily (quickly) each measure can be implemented and on value for money. The timing of the proposed works will depend on Council's overall budgetary commitments, and the availability of funds from other sources.

High priority measures include:

- ▶ Install secure fencing adjacent to the Sydney Water channel from the Lough Playing Fields to New South Head Road, to prevent objects entering the drain and potentially blocking culverts;



Open channel next to Kiaora Road. One recommendation is to replace the existing fencing next to the channel with structurally designed safety fencing, to reduce the potential for large objects—including motor vehicles—from blocking critical culverts during flooding.

- ▶ Amend the flood risk management provisions in the Development Control Plan in accordance with best practice and to incorporate climate change flood risk considerations;

- ▶ Improve emergency management planning by preparing a Local Flood Plan for Woollahra Local Government Area (SES);
- ▶ Improve public flood readiness by:
 - 1) preparing a Double Bay Commercial District flood-proofing brochure,
 - 2) preparing a Double Bay Commercial District flood emergency response plan template,
 - 3) conducting a Business FloodSafe breakfast (SES), and
 - 4) installing safety signage at Lough Playing Fields and Manning Road;
- ▶ Prepare a questionnaire and institute processes to facilitate the rapid capture of flood data following future flooding in Woollahra LGA.

Medium priority measures include:

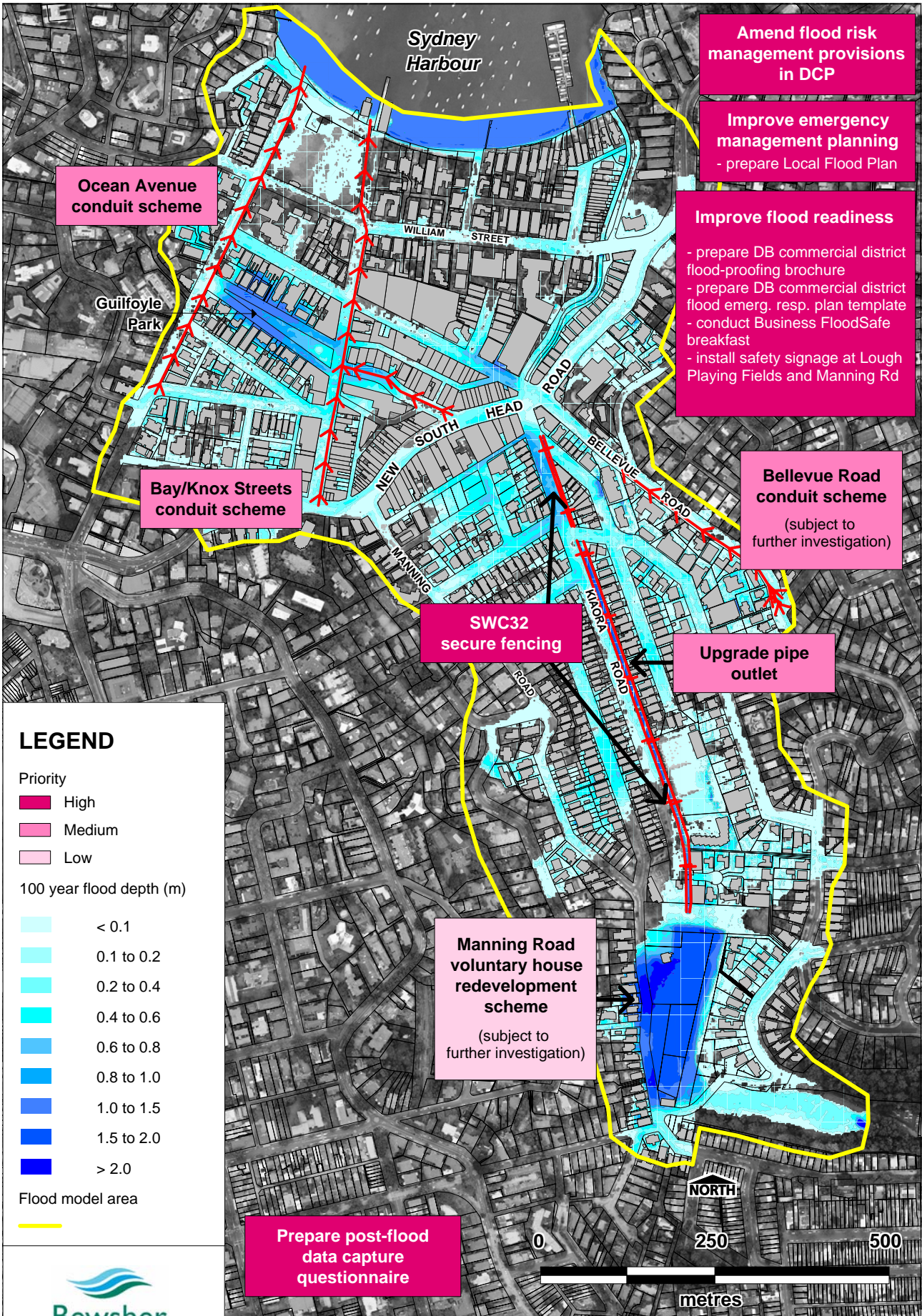
- ▶ Further investigate and if feasible implement the Bellevue Road conduit scheme (see Figure 6.3 in draft report);
- ▶ Implement the Bay Street/Knox Street conduit scheme (see Figure 6.4 in draft report);
- ▶ Implement the Ocean Avenue conduit scheme (see Figure 6.4 in draft report);
- ▶ Carry out minor outlet works for the pipe joining the Sydney Water channel near Nos. 24-26 Glendon Road.

Low priority measures include:

- ▶ Further investigate (including consultation) and if practical invite owners of six Manning Road properties to join a voluntary house redevelopment scheme, which would offer a partial subsidy to landowners to redevelop buildings in a flood-compatible manner.

Funding

The total capital cost of implementing the draft Plan is estimated to be \$13.0-14.5M.



File: J1806_FRMP.WOR
 Job No.: J1806
 Date: 17 Mar 2011


Recommended Measures

Public exhibition

A previous opportunity for the community to provide input to the Double Bay Floodplain Risk Management Study was through completing a questionnaire issued in September 2009. Now that the draft report has been prepared, we encourage you to inspect the report during public exhibition, and welcome your comments. Details about the public exhibition are contained in the attached letter.


Now on public exhibition

**Double Bay Catchment
Floodplain Risk Management
Study & Plan**



Double Bay, April 1988 flood (source: Mr. Tony Gregory)

Draft Report for Public Exhibition
March 2011
Report of Woollahra Municipal Council's Floodplain Management Committee,
prepared by



History corner

For the history buffs, here's a report of a historical inundation at Double Bay:

THE RAIN AND ITS EFFECTS

After several weeks of changeable weather, embracing frequent showers and several rather heavy rainfalls, we have at last had a regular downpour, and the effects in some parts of the city and suburbs have been disastrous. Shortly before midnight of Thursday the heavy masses of clouds that had been gathering up from the southward overspread the sky, and the rain began to fall in heavy showers. Not very long after the first shower the rain came down in torrents, and continued to descend as one sheet of water all night long. We hear the same statements from all parts of the city and suburbs, that no one can remember such incessant heavy rain for so many hours. The effects, in the sweeping away of metal from the streets, the breaking up of culverts, and the displacement of guttering, are sufficiently evident in all parts of the city.

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Sydney Morning Herald, Saturday 13 April 1867, p.5

Who can you contact for more information?

For more information about the Double Bay Catchment Floodplain Risk Management Study & Plan, please contact:

Woollahra Municipal Council

Michael Casteleyn
Phone: 9391-7131
E-mail: Michael.Casteleyn@woollahra.nsw.gov.au

Bewsher Consulting Pty Ltd

Stephen Yeo
Phone: 9868-1966
E-mail: syeo@bewsher.com.au



APPENDIX C

FLOOD DAMAGES ASSESSMENT INPUTS

- Inputs for Deriving Residential Sector Stage-Damage data**
- Residential Sector Stage-Damage data**
- Commercial Sector Stage-Damage data**
- Distribution of Businesses by Value Class**

SITE SPECIFIC INFORMATION FOR RESIDENTIAL DAMAGE CURVE DEVELOPMENT					
Version 3.00 October 2007			Queries to duncan.mcluckie@dnr.nsw.gov.au		
PROJECT	DETAILS		DATE	JOB No.	
Double Bay Floodplain Risk Management Study & Plan			Apr-10	J1806	
BUILDINGS					
Regional Cost Variation Factor	1.00		From Rawlinsons		
Post late 2001 adjustments	1.42		Changes in AWE see AWE Stats Worksheet		
Post Flood Inflation Factor	1.40		1.0 to 1.5		
	<i>Multiply overall structural costs by this factor</i>		<i>Judgement to be used. Some suggestions below</i>		
	Regional City		Regional Town		
	Houses Affected	Factor	Houses Affected	Factor	
<i>Small scale impact</i>	< 50	1.00	< 10	1.00	
<i>Medium scale impacts in Regional City</i>	100	1.20	30	1.30	
<i>Large scale impacts in Regional City</i>	> 150	1.40	> 50	1.50	
Typical Duration of Immersion	2 hours				
Building Damage Repair Limitation Factor	0.85		due to no insurance short duration long duration		
			Suggested range 0.85 to 1.00		
Typical House Size	190 m ²		240 m ² is Base		
Building Size Adjustment	0.8				
Total Building Adjustment Factor	1.34				
CONTENTS					
Average Contents Relevant to Site	\$ 95,000		Base for 240 m ² house		\$ 60,000
Post late 2001 adjustments	1.42		From above		
Contents Damage Repair Limitation Factor	0.75		due to no insurance short duration long duration		
Sub-Total Adjustment Factor	1.07		Suggested range 0.75 to 0.90		
Level of Flood Awareness	low		low or high only. Low default unless otherwise justifiable.		
Effective Warning Time	0 hour				
Interpolated DRF adjustment (Awareness/Time)	0.99		IDRF = Interpolated Damage Reduction Factor		
Typical Table/Bench Height (TTBH)	0.90		0.9m is typical height. If typical is 2 storey house use 2.6m.		
Total Contents Adjustment Factor AFD <= TTBH	1.06		AFD = Above Floor Depth		
Total Contents Adjustment Factor AFD > TTBH	1.07				
Most recent advice from Victorian Rapid Assessment Method					
<i>Low level of awareness is expected norm (long term average) any deviation needs to be justified.</i>					
Basic contents damages are based upon a DRF of	0.9				
Effective Warning time (hours)	0	3	6	12	24
RAM Average IDRF Inexperienced (Low awareness)	0.90	0.80	0.80	0.80	0.70
DRF (ARF/0.9)	1.00	0.89	0.89	0.89	0.78
RAM AIDF Experienced (High awareness)	0.80	0.80	0.60	0.40	0.40
DRF (ARF/0.9)	0.89	0.89	0.67	0.44	0.44
Site Specific DRF (DRF/0.9) for Awareness level for iteration	1.00	0.89	0.89	0.89	0.78
Effective Warning time (hours)	0	3	0		
Site Specific iterations	1.00	0.89	0.99		
ADDITIONAL FACTORS					
Post late 2001 adjustments	1.42		From above		
External Damage	\$ 6,700	\$6,700 recommended without justification			
Clean Up Costs	\$ 4,000	\$4,000 recommended without justification			
Likely Time in Alternate Accommodation	2 weeks				
Additional accommodation costs /Loss of Rent	\$ 220	\$220 per week recommended without justification			
TWO STOREY HOUSE BUILDING & CONTENTS FACTORS					
Up to Second Floor Level, less than	2.6 m		70% Single Storey Slab on Ground		
From Second Storey up, greater than	2.6 m		110% Single Storey Slab on Ground		
Base Curves					
AFD = Above Floor Depth					
Single Storey Slab/Low Set	13164	+	4871	x	AFD in metres
Structure with GST	AFD	greater than	0.0	m	
Validity Limits	AFD	less than or equal to	6	m	
Single Storey High Set	16586	+	7454	x	AFD
Structure with GST	AFD	greater than	-1.50	m	
Validity Limits	AFD	less than or equal to	6	m	
Contents	20000	+	20000	x	AFD
Contents with GST	AFD	greater than	0		
Validity Limits	AFD	less than or equal to	2		

Floodplain Specific Damage Curves for Individual Residences

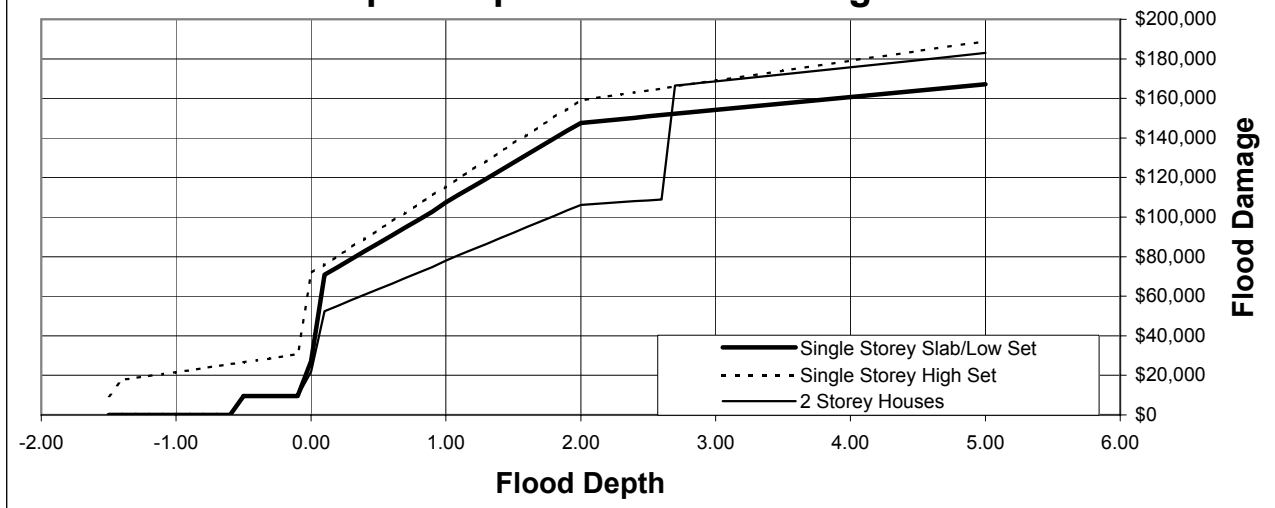
Steps in Curve

0.1

m

Type	Single Storey High Set	Single Storey Slab/Low Set	2 Storey Houses
	1	2	3
AFD from Modelling	Damage	Damage	Damage
-5.00	\$0	\$0	\$0
-1.50	\$9,514	\$0	\$0
-1.40	\$17,742	\$0	\$0
-1.30	\$18,739	\$0	\$0
-1.20	\$19,736	\$0	\$0
-1.10	\$20,734	\$0	\$0
-1.00	\$21,731	\$0	\$0
-0.90	\$22,728	\$0	\$0
-0.80	\$23,725	\$0	\$0
-0.70	\$24,722	\$0	\$0
-0.60	\$25,719	\$0	\$0
-0.50	\$26,716	\$9,514	\$9,514
-0.40	\$27,713	\$9,514	\$9,514
-0.30	\$28,710	\$9,514	\$9,514
-0.20	\$29,708	\$9,514	\$9,514
-0.10	\$30,705	\$9,514	\$9,514
0.00	\$71,732	\$27,124	\$21,841
0.10	\$76,101	\$70,834	\$52,438
0.20	\$80,471	\$74,827	\$55,233
0.30	\$84,840	\$78,820	\$58,028
0.40	\$89,210	\$82,813	\$60,823
0.50	\$93,580	\$86,806	\$63,618
0.60	\$97,949	\$90,799	\$66,413
0.70	\$102,319	\$94,791	\$69,208
0.80	\$106,688	\$98,784	\$72,003
0.90	\$111,058	\$102,777	\$74,798
1.00	\$115,428	\$107,395	\$78,030
1.10	\$119,797	\$111,419	\$80,847
1.20	\$124,167	\$115,443	\$83,664
1.30	\$128,537	\$119,467	\$86,481
1.40	\$132,906	\$123,491	\$89,298
1.50	\$137,276	\$127,515	\$92,115
1.60	\$141,645	\$131,539	\$94,932
1.70	\$146,015	\$135,563	\$97,748
1.80	\$150,385	\$139,587	\$100,565
1.90	\$154,754	\$143,611	\$103,382
2.00	\$159,124	\$147,636	\$106,199
2.10	\$160,121	\$148,287	\$106,655
2.20	\$161,118	\$148,939	\$107,111
2.30	\$162,115	\$149,590	\$107,567
2.40	\$163,112	\$150,242	\$108,024
2.50	\$164,109	\$150,894	\$108,480
2.60	\$165,106	\$151,545	\$108,936
2.70	\$166,104	\$152,197	\$166,465
2.80	\$167,101	\$152,848	\$167,182
2.90	\$168,098	\$153,500	\$167,899
3.00	\$169,095	\$154,152	\$168,615
3.50	\$174,080	\$157,409	\$172,199
4.00	\$179,066	\$160,667	\$175,783
4.50	\$184,052	\$163,925	\$179,367
5.00	\$189,037	\$167,183	\$182,950

Floodplain Specific Flood Damage Curves



COMMERCIAL SECTOR STAGE-DAMAGE DATA, DOUBLE BAY CATCHMENT (Nov 2009 dollars)

Depth (m)	Small commercial properties (<186m ²)					Medium commercial properties (186-650m ²)					Large commercial properties (>650m ²)*				
	Value class					Value class					Value class				
	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0
0.01	\$350	\$710	\$1,400	\$2,800	\$5,700	\$1,100	\$2,200	\$4,500	\$9,000	\$17,900	\$1	\$2	\$5	\$10	\$20
0.05	\$710	\$1,400	\$2,800	\$5,700	\$11,300	\$2,200	\$4,500	\$9,000	\$17,900	\$35,800	\$2	\$5	\$10	\$20	\$39
0.10	\$1,400	\$2,800	\$5,700	\$11,300	\$22,600	\$4,500	\$9,000	\$17,900	\$35,800	\$71,600	\$5	\$9	\$20	\$39	\$79
0.20	\$2,800	\$5,700	\$11,300	\$22,600	\$45,300	\$9,000	\$17,900	\$35,800	\$71,600	\$143,300	\$10	\$19	\$41	\$79	\$157
0.25	\$3,500	\$7,100	\$14,100	\$28,300	\$56,600	\$11,200	\$22,400	\$44,800	\$89,600	\$179,100	\$12	\$24	\$51	\$98	\$196
0.30	\$4,100	\$8,100	\$16,300	\$32,500	\$65,000	\$12,800	\$25,600	\$51,100	\$102,300	\$204,600	\$17	\$34	\$71	\$138	\$276
0.40	\$5,100	\$10,300	\$20,500	\$41,000	\$82,000	\$16,000	\$31,900	\$63,900	\$127,700	\$255,500	\$27	\$54	\$110	\$217	\$436
0.50	\$6,200	\$12,400	\$24,700	\$49,500	\$99,000	\$19,100	\$38,300	\$76,600	\$153,200	\$306,400	\$37	\$75	\$149	\$297	\$595
0.60	\$7,200	\$14,500	\$29,000	\$58,000	\$116,000	\$22,300	\$44,700	\$89,300	\$178,600	\$357,300	\$48	\$95	\$189	\$376	\$755
0.70	\$8,300	\$16,600	\$33,200	\$66,500	\$132,900	\$25,500	\$51,000	\$102,100	\$204,100	\$408,200	\$58	\$115	\$228	\$455	\$914
0.75	\$8,800	\$17,700	\$35,400	\$70,700	\$141,400	\$27,100	\$54,200	\$108,400	\$216,800	\$433,700	\$63	\$126	\$248	\$495	\$994
0.80	\$9,300	\$18,600	\$37,100	\$74,200	\$148,500	\$28,500	\$57,000	\$114,100	\$228,100	\$456,300	\$70	\$139	\$275	\$550	\$1,103
0.90	\$10,200	\$20,300	\$40,700	\$81,300	\$162,600	\$31,300	\$62,700	\$125,400	\$250,800	\$501,500	\$83	\$166	\$330	\$659	\$1,320
1.00	\$11,000	\$22,100	\$44,200	\$88,400	\$176,800	\$34,200	\$68,300	\$136,700	\$273,400	\$546,800	\$96	\$192	\$385	\$768	\$1,538
1.10	\$11,900	\$23,900	\$47,700	\$95,500	\$190,900	\$37,000	\$74,000	\$148,000	\$296,000	\$592,000	\$110	\$219	\$440	\$877	\$1,755
1.20	\$12,800	\$25,600	\$51,300	\$102,500	\$205,000	\$39,800	\$79,700	\$159,300	\$318,600	\$637,300	\$123	\$246	\$495	\$986	\$1,973
1.25	\$13,300	\$26,500	\$53,000	\$106,100	\$212,100	\$41,200	\$82,500	\$165,000	\$330,000	\$659,900	\$130	\$259	\$523	\$1,041	\$2,082
1.30	\$13,400	\$26,800	\$53,600	\$107,200	\$214,500	\$41,700	\$83,400	\$166,700	\$333,500	\$667,000	\$138	\$276	\$556	\$1,108	\$2,215
1.40	\$13,700	\$27,400	\$54,800	\$109,600	\$219,200	\$42,600	\$85,100	\$170,300	\$340,600	\$681,100	\$154	\$310	\$623	\$1,241	\$2,483
1.50	\$14,000	\$28,000	\$56,000	\$111,900	\$223,900	\$43,500	\$86,900	\$173,800	\$347,600	\$695,300	\$171	\$344	\$689	\$1,375	\$2,750
1.75	\$14,700	\$29,500	\$58,900	\$117,800	\$235,700	\$45,700	\$91,300	\$182,700	\$365,300	\$730,600	\$212	\$428	\$856	\$1,709	\$3,417
2.00	\$15,600	\$31,200	\$62,500	\$124,900	\$249,800	\$48,600	\$95,200	\$194,400	\$388,900	\$777,800	\$255	\$511	\$1,021	\$2,043	\$4,085
3.00	\$15,600	\$31,200	\$62,500	\$124,900	\$249,800	\$48,600	\$95,200	\$194,400	\$388,900	\$777,800	\$255	\$511	\$1,021	\$2,043	\$4,085

* units of \$/m²

COMMERCIAL SECTOR VALUE CLASSES, DOUBLE BAY CATCHMENT

Value class				
1	2	3	4	5
Betting agency Mechanic Public toilets Pumping station Vacant shops	Café Church Florist Office (general) Pet shop School	Bakery Bank Beauty parlour Chocolates Club Deli Dry cleaners Fruit/veg Hairdresser Marina Medical/dental/ optical surgery Nail salon Real estate Restaurant Shoe repair Supermarket (small) Tailor Tanning salon Tobacconist Travel agent	Bookstore Bottle shop DVD rental Motel Newsagency Post office Stationary Supermarket (large)	Accessories (e.g. leather) Art gallery Bedding Boutique furniture Camera/ photography Chemist Clothing Electrical Electrical sub- station Fashion Giftware Glass/silverware Homeware Jewellery Shoes Wedding dresses


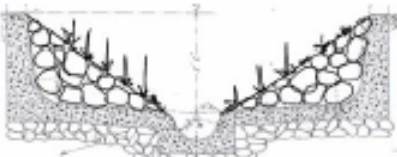
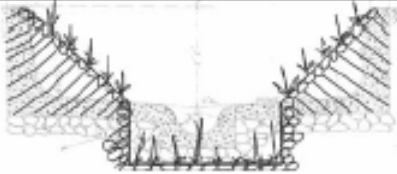
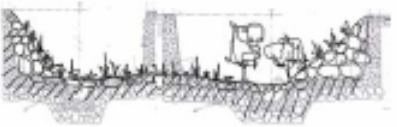
APPENDIX D

EXTRACTS FROM SWC REPORT REVIEWING FEASIBILITY OF STORMWATER CHANNEL RESTORATION (4SITE NATURAL SOLUTIONS, 2003)

Overview of rehabilitation options

Option	Description	Main advantages	Main disadvantages
1. Baseline. Repair unstable channel	<ul style="list-style-type: none"> Remove and replace cover of channel 	<ul style="list-style-type: none"> Conceptually simple Low risk Minimal maintenance 	<ul style="list-style-type: none"> No improvement in ecology, water quality, landscape or recreation
2. Naturalise channel banks within existing channel	<ul style="list-style-type: none"> Remove cover and retain existing channel Place large rock banks at 1:2 slope down to invert (width and depth of channel dictates slope) Fence both sides of channel (for safety, given steepness of banks) Construct pedestrian bridge at Castra place 	<ul style="list-style-type: none"> No excavation required Limited improvement in habitat value May improve landscape value (subjective) 	<ul style="list-style-type: none"> Substantially reduced hydraulic capacity Removes access for residents on w side
3. Naturalise channel banks and bed; lower invert level	<ul style="list-style-type: none"> As per Option 1, but bed excavated to provide additional hydraulic capacity Vegetate lower banks with salt tolerant plants, other than mangroves; Fence both sides of channel (for safety, given steepness of banks) Construct pedestrian bridge at Castra place 	<ul style="list-style-type: none"> Provides permanent estuarine habitat 	<ul style="list-style-type: none"> Reduced hydraulic capacity Removes access for residents on w side Scour of benthic habitat may occur in high flows Substantial excavation of concrete invert may cause scouring and undermining of property
4. Naturalise bed and banks of both channels	<ul style="list-style-type: none"> Remove covers from both channels Remove the adjacent (inner) walls of both channels structure and reinstate a stable bed (this will create a single channel of varying width) Large rock linings on both banks at 1:2 slope on both banks Vegetate lower banks with salt tolerant plants, other than mangroves; Pedestrian bridge at Castra place Walkway and fence adjacent to properties on w. side 	<ul style="list-style-type: none"> Provides tidal habitat Maintains hydraulic capacity May provides for some recreational access on e. side Provides for access from properties on western side 	<ul style="list-style-type: none"> Scour of benthic habitat may occur in high flows Significant potential exists for impacts on adjacent properties (western boundary) e.g. slumping. Major works with significant costs May require realignment of Sherbrooke Avenue and relocation of private garage, both of which appear to be constructed over the channel.
5. Replace the cover (as per option 1) and landscape the channel corridor	<ul style="list-style-type: none"> As per option 1 Formalise the landscaping with areas of grass, groundcover and small trees Provide recreational opportunities such as a paved pathway and viewing point to Double Bay 	<ul style="list-style-type: none"> Improved landscape and recreational opportunities 	<ul style="list-style-type: none"> No open water or improvement in aquatic ecology Landscaping may be at risk in major flood events and require reinstatement

Analysis of channel options

Option	Profile	Hydraulic Capacity
<p>Option 1 Repair Unstable Channel</p>		<p>Cross-sectional area = approx 10.80 m² Depth of channel = 1.65m Width of channel = 5.85m</p>
<p>Option 2 Naturalise channel banks within existing channel</p>		<p>Bank slope = 1:2 Depth of channel=1.65m Cross-sectional area = approx 7.50m² This option reduces cross sectional by 30%.</p>
<p>Option 3 Naturalise channel banks and bed; lower invert level</p>		<p>Bank slope = 2:1 Depth of channel=1.65m Depth of invert =3.15m Cross-sectional area = 10.755 m² This option retains a similar cross-sectional area to current, however the invert will be tidal and hydraulic capacity is likely to be reduced.</p>
<p>Option 4 Naturalise bed and banks of both channels</p>		<p>Existing total channel capacity = 15.945 m² Depth of naturalised channel = 1.85m Width of naturalised channel = 10.755m Cross-sectional area =12.772 m² This option provides for removal of the eastern channel and naturalisation of the entire channel width. This option results in significant increase in cross sectional area but may result adverse impacts on adjacent properties. The costs of this option may be restrictive.</p>
<p>Option 5 Replace the cover (as per option 1) and landscape the channel corridor</p>	