BUCKTON LYSENKO
CONSULTING ENGINEERS

Construction and Use of Warehouse and Distribution Complex Templar Road, Erskine Park, NSW – SITE E

Civil Engineering Report for Development Application

10th* April 2008

*

BUCKTON LYSENKO

in association with
planning workshop australia

Construction and use of Warehouse and Distribution Complex Templar Road, Erskine Park, NSW – SITE E

Civil Engineering Report for Development Application

10th April 2008

BUCKTON LYSENKO
284 Great North Road, PO Box W79, Five Dock 2046
Tel +61 2 9712 1511 Fax +61 2 9712 1910
www.bucktonlysenko.com

Job number 25067

Buckton Lysenko BRN T4432216, a partnership of
Boris Lysenko Pty Ltd ACN 002 536 647
Mark Consulting Pty Ltd ACN 002 536 503

Document Verification

Page 1 of 1

BUCKTON LYSENKO
CONSULTING ENGINEERS

Job title	Construction and use of Warehouse and Distribution Complex Templar Road, Erskine Park NSW – SITE E	Job number	25067
Document title	Civil Engineering Report for Development Application	File reference	080410 DA report
Document ref			

Revision	Date				
Issue A	02/02/03	Filename	080410 DA report_issue A.doc		
		Description	First draft		
			Prepared by	Checked by	Approved by
		Name	Graham Morton BE, Grad Dip LGE, MIEAust	Graham Morton BE, Grad Dip LGE, MIEAust	Boris Lysenko BSc (Civil)
		Signature			
Issue B		Filename	25067 DA report_Issue B.doc		
		Description	Issue for Development Application		
			Prepared by	Checked by	Approved by
		Name	Graham Morton BE, Grad Dip LGE, MIEAust	Graham Morton BE, Grad Dip LGE, MIEAust	Boris Lysenko BSc (Civil)
		Signature			
		Filename			
		Description			
			Prepared by	Checked by	Approved by
		Name			
		Signature			

Issue Document Verification with Document ✓

This report takes into account the particular instructions and requirements of our Client. It is not intended for and should not be relied upon by any third party and no responsibility is undertaken to any third party.

CONTENTS **PAGE**

1 EXECUTIVE SUMMARY

General Property Trust (GPT) is proposing to develop the parcel of land, known as Site E, located at the south eastern corner of Templar and Lockwood Roads, Erskine Park. Goodman Fielder will occupy the site under a separate tenancy agreement with GPT. The site is located within the Penrith City Council local government area. Please refer to **Appendix A** for the locality plan. The development application will be assessed under Part 3A of the Environmental Planning and Assessment Act 1979 (EP&A Act) by the NSW Government Department of Planning.

The stormwater drainage system for the site will be designed in accordance with the Department of Planning requirements and the Part 3A of the EP&A Act.

All civil works including road and stormwater drainage works have been designed in accordance with the Department of Planning requirements, Australian Standards AS2890 and with Penrith City Council's relevant standards.

2 INTRODUCTION

The developer for the project is GPT Group. GPT is proposing to develop Site E located at the south eastern corner of Templar and Lockwood Roads, Erskine Park NSW. Goodman Fielder will occupy the site under a separate tenancy agreement with GPT.

Hansen Yuncken has commissioned Buckton Lysenko to prepare a civil engineering report for the proposed works as shown on the drawings prepared by Hansen Yuncken and listed in Section 10 of this report. This report will be lodged to the Department of Planning and will form part of the Develop Application (DA).

The advice as outlined in this report and documented on Bucken Lysenko drawings 25067C01 to 25067C06 addresses the following engineering components:

- Existing and proposed site levels;
- Erosion and sediment control plan;
- Pavement designs;
- Road designs; and
- Stormwater drainage layout and pipe sizes.
- Authority infrastructure requirements

3 PROJECT DESCRIPTION

The site is located at the south eastern corner of Templar and Lockwood Roads and is within the Erskine Park Employment Area, Erskine Park. The site is within the Penrith City Council local government area.

The site covers a total site area of 5.39 Ha and comprises the construction of a production facility with amenities and office areas covering a total area of 40,015 m^2. The building area covers an area of approximately 1.4 Ha. An engineering workshop and ground floor office located on the north western section of the building cover areas of approximately 300 m^2 and 900 m^2 respectively. Oil storage and mixing, along with trade waste facilities are located adjacent to the southern boundary of the site. The following layouts and areas are proposed for the site:-

Factory	
Building area	13,990 m^2
Office area	1,200 m^2
No. of carparking spaces	125 spaces

Table 3.1 – Proposed Factory, Offices, Maintenance Areas and Carparking Spaces

A total of 125 carparking spaces, including 15 visitor carparking spaces and 2 disabled carparking spaces are proposed for the site. Access to and from the site will be available from Templar Road which is located on the western side of the site. The truck entries and exits are also available from Templar Road and these truck entries and exits are independent to the car entry and exits.

The development application will be assessed under Part 3A of the Environmental Planning and Assessment Act 1979 (EP&A Act) by the NSW Government Department of Planning.

4 EROSION AND SEDIMENT CONTROL

Prior to any earthworks commencing on the site, erosion and sediment control measures will be put in place generally in accordance with Penrith City Council's requirements and Managing Urban Stormwater: Soils and Construction 4th Edition, March 2004. These measures include:-

- Installation of a 1.8 metre high chain wire fence covered with Hessian, to the perimeter of the work site area, where required;
- The construction of a silt fence on the low side of all site areas to be disturbed;
- The provision of a sediment basin or basins as required to the perimeter of the site which stormwater will be channelled. The sediment basins will be located as required to suit the staging of the road and drainage works; and
- The provisions of a temporary truck wash down facility to service vehicles exiting the site during the construction stage.

4.1 SEDIMENT BASIN

Sediment basins are proposed to be constructed as part of the enabling works package.

The sediment basins have been designed to cater for the catchment being approximately 5.39 hectares. The calculated required capacity is 881 m^3 (refer to **Appendix B** for calculations). The calculated required capacity of 881 m^3 is the minimum volume required to collect the sediment generated during the construction works. The excavation will be graded towards the southern section of the site.

The sediment basin will be maintained on site throughout the excavation works ensuring that it operates effectively in accordance with Council's requirements and Managing Urban Stormwater: Soils and Construction 4th Edition, March 2004. The water in the sediment basin shall be lowered periodically to maintain the minimum storage volume at the lower level of the settling zone identified by pegs to clearly show the level at which design storage capacity is available.

Water from the basin will be utilised where possible for dust control. The excess water from the sediment basin will be discharged to Council's existing stormwater system to the perimeter of the site. Prior to any off site discharge from the basin, water will be tested to ensure that it complies with the above standards.

5 STORMWATER MANAGEMENT

5.1 GENERAL

The stormwater management systems for the site will comply with Council's Urban Drainage Design Manual, On Site Stormwater Detention Policy and the conditions imposed under Schedule 2 Part 3A of the Environmental Planning and Assessment Act 1979. Council's policy and the conditions in the Minister's approval of the concept plan and stage 1 proposal require improved water quality and no increase in the stormwater discharge from the developed site prior to discharging into the public stormwater drainage infrastructure.

Council also requires the removal of target pollutants from the site during the construction phase as vehicles that may enter or exit could generate various pollutants such as oil and grease. These target pollutants can be identified into five (5) major groups of stormwater pollutants:-

- Gross pollutants;
- Coarse, medium and fine sediments;
- Nutrients;
- Heavy metals; and
- Oil and grease.

Guidelines for the removal and treatment of the above pollutants will be required by Gross Pollutant Traps, which will be provided generally as noted below.

5.2 GROSS POLLUTANT TRAPS (GPTs)

Council's policy and the Minister's approval of the concept plan and stage 1 proposal allows the stormwater collected from the roofed areas to be discharged from the site to the creeks without treatment. Stormwater that discharges directly from the roofed areas is considered to be 'clean' water and will drain directly to a roof water reservoir or storage tank via a combination pit and pipe system.

The stormwater flows collected from the carparking and truck parking areas will drain to a gross pollutant trap. A Humegard Model HG 35A is proposed as the gross pollutant trap and the stormwater collected within the gross pollutant trap will be treated before discharge to an underground detention tank. Refer to **Appendix C** for the information on Humes Humeguard Model 35A GPT.

5.3 STORMWATER DRAINAGE STANDARDS

The stormwater drainage has been designed to comply with the following guidelines:-

- Australian Rainfall and Runoff 2000;
- The NSW Government Department of Planning, "*Concept Plan (06_0216 and Stage 1 (06_0208) Approval*", 1 March 2007;
- Penrith City Council, "*Development Control Plan 2006*", adopted 21 August 2006; and
- "*Managing Urban Stormwater: Soils and Contruction*", Volume 1 4th Edition, March 2004.

Penrith City Council's stormwater policy requires that the rainfall intensity values for Erskine Park be generated using the procedures outlined in chapter 2 of Australian Rainfall and Runoff 2000 (Refer to **Appendix D** for rainfall intensity values for Erskine Park).

5.4 STORMWATER PIPE DRAINAGE SYSTEM

In accordance with the Minister's approval of the concept plan and stage 1 proposal, the inground stormwater piped drainage system has been designed for a 1 in 20 year Average Recurrence Interval (ARI) event, with designated overland flow paths for the 1 in 100 year ARI event. Refer to Buckton Lysenko drawings C01 for details.

The pipe sizing and pit spacing generally complies with Council's policy for overland flow widths and depth x velocity product. A minimum pipe size diameter of 375mm is Penrith City Council's criteria for roads. A minimum pipe size diameter of 225 mm has been adopted for drainage of the internal carparking areas to avoid potential blockage due to litter and gross pollutants.

5.5 STORMWATER DETENTION

Council's Development Control Plan (DCP) for the Erskine Park Employment Area requires that on site stormwater detention (OSD) is to be provided at the site. The OSD system will reduce the developed peak flows off the developed site and ensure no increase in the flows downstream of the site.

All runoff from non roof areas, truck parking and carparking areas, will drain to an OSD tank via a Humeguard GPT. The OSD tank has been calculated to have a volume of 400 m^3. The OSD tank will be located in the south western corner of the site near the truck turning area and the tank will discharge to the creek system which is adjacent to the southern boundary of the site.

Brown Consulting "*Pad 4 Stormwater Concept Plan Eastern Lands Erskine Park*", July 2006 have determined the site pre development characteristics as having a 5% fraction impervious with Mannings roughness "n = 0.035". The post development characteristics have been determined as having a minimum 90% fraction impervious with Mannings roughness "n = 0.015". Refer to Appendix D for a copy of the Brown's report is and the results of the hydraulic modelling. Refer to **Appendix E** for the pre development calculations. The pre development flow rates were calculated using the RAFTS hydraulic model.

5.6 RAINWATER TANKS AND HARVESTING

Council's Development Control Plan (DCP) for the Erskine Park Employment Area allows the water collected from the roof areas to be discharged to a creek without treatment.

The Minister's approval of the concept plan and stage 1 proposal, however, requires that all roof hardstand areas to be collected and stored in a roof water reservoir or storage tank(s). The storages are tabled below. The storage tanks will be located in the ground. The water from the storage tank will then discharge by way of a pumped rising main to supplement approximately 40kL / day of Goodman Fielder's water requirements any excess can be made available to the regional rainwater harvesting infrastructure.

SCHEDULE OF ROOF AREAS & HARVESTING VOLUMES (440kL /Ha of Roof)

STAGE	AREA sqm	STORAGE VOL cum
1	16,560	729
Future Buiding	2,320	102
Future Expansion	8,670	381
TOTAL	**27,550**	**1,212**

Refer to **Appendix F** for a copy of the *DRAINS* model and relevant plans.
Refer to **Appendix G** for a copy of the report Brown Consulting completed in July 2006.

6 ROADWORKS

6.1 GENERAL

The site will be accessed from the Templar Road adjacent to the western boundary of the site.

Roadworks within the site and any required within Council's road reserves are proposed to be constructed by the developer.

6.1.1 Road Types

Templar Road is adjacent to the western boundary of the site and is under the authority of Council.

The entry and exit roads to and from the site, internal carparks and truck parking areas are under the authority of the developer. Road configurations and widths have been designed in accordance with Council's Development Control Plan 2006 and the Minister's approval of the concept plan and stage 1 proposal.

6.2 VERTICAL AND HORIZONTAL GEOMETRY

The entry and exit roads to and from the site, internal carparks and truck parking areas have been designed to comply with Council's requirements and Austroads design standards, including 26 metre semi trailer vehicles in accordance with Australian Standards AS 2890.2 (2002).

6.3 PAVEMENT DESIGN

The internal entry and exit roads, carparks and truck parking areas will be designed in accordance with Council's and AUSTROADS standards. The subgrade strength will be determined by the Geotechnical Engineer and the subgrade strength will form the basis of the pavement design.

7 SERVICES

7.1 SEWER

The site is serviced from the existing 375 mm diameter sewer main located at the western boundary of the site. Goodman Fielder's discharge to Sydney Waters sewer will be an average of 150kL / day with a maximum of 620kL/day on the odd occasion. The trade waste component of their discharge is an average of 140kL / day with a maximum of 610kL/day.These flows equate to a continuous discharges of 2L/s average and 7L/s on a maximum day. The sewer capacity is in the order of 250L/s.

Goodman Fielder has a current agreement to discharge trade waste with Sydney Water for their premises in Mascot and Sydney Water has agreed in principal to transfer this agreement to this site.

7.2 WATER

The site will be serviced from the existing 200 mm water main constructed in Templar Road. Goodman Fielder's water demands are estimated to be an average of 200kL / day with a maximum of 500kL/day. Approximately 40kL/day of this demand dose not require town water and it is anticipated that this can be supplied from the roof water harvesting system. The net load on Sydney Waters system should be an average of 160kL / day with a maximum of 460kL/day.These flows equate to a continuous demand of 2L/s average and 5.3L/s on a maximum day. The sewer capacity is in the order of 250L/s. The town main capacity in Templar Road is in the order of 70L/s of which approximately 25L/s is available for fire protection.

Goodman Fielder's water demands for fire protection are in the order of 100L/s this water will be supplied from on site tanks.

.

7.3 ELECTRICITY

Electrical conduits from the local zone substation and have been laid in Templar Road.

7.4 GAS

Goodman Fielder's gas requirements are estimated to be an average of 154GJ / day with a maximum of 262GJ / day. The 150mm gas main in Templar Road will meet this requirement..

7.5 TELECOMMUNICATIONS

Telecommunications conduits have been laid in Templar Road.

8 CONCLUSION

The following conclusions are drawn:-

- Erosion and sediment control is to be provided in accordance with Penrith City Council requirements, the Minister's approval of the concept plan and stage 1 proposal dated 1 March 2007 and Managing Urban Stormwater: Soils and Construction 4th Edition, March 2004;
- Stormwater Management is to be provided in accordance with Penrith City Council Development Control Plan adopted 21 August 2006 and the Minister's approval of the concept plan and stage 1 proposal dated 1 March 2007;
- On site stormwater detention and rain water harvesting is to be provided in accordance with Penrith City Council Development Control Plan adopted 21 August 2006 and the Minister's approval of the concept plan and stage 1 proposal dated 1 March 2007;
- Road adjustments that may be required to the Access Road along the eastern boundary of the site and internal carparking and truck parking areas are to be designed to Penrith City Council's Standards and in accordance with AUSTROADS – 2004 "Pavement Design – A Guide to the Structural Design of Road Pavement" as a granular pavement with thin bituminous surfacing and concrete rigid pavements respectively;
- The connection to the sewer and water mains in the vicinity of the site will be determined by Sydney Water when a Section 73 Certificate application is lodged and conditions received; and
- The connection of electrical conduits, gas mains and telecommunications cables is carried out with the relevant authority's requirements.

9 REFERENCES

1. Landcom, 2004, "*Managing Urban Stormwater: Soils and Construction*", Volume 1 4th Edition, March 2004;
2. AS/NZS 2890.1: 2004 Parking facilities Part 1: Off-street car parking;
3. The Institution of Engineers, 2001 "*Urban Stormwater Management in Australian Rainfall and Runoff – A guide to flood estimation*", Book VIII, Barton;
4. AUSTROADS 2004, "*Pavement Design – A Guide to the Structural Design of Road Pavement*".
5. Penrith City Council, "*Development Control Plan 2006*", adopted 21 August 2006;
6. Brown Consulting, "*Pad 4 Stormwater Concept Plan Eastern Lands Erskine Park*", July 2006;
7. Brown Consulting, "*South Eastern Creek Realignment – Hydrology and Hydraulics, CSR Eastern Lands Erskine Park*", 2006; and
8. Brown Consulting, "*Stormwater Concept Plan, Eastern Lands Erskine Park*", 2006.

10 REFERENCE DRAWINGS

The following architectural drawings have been referenced:-

Development Application - Site Plan	SPPACE	GF-TE-DA-001	25 March 2008
Development Application – Roof Plan	SPPACE	GF-TE-DA-120	25 March 2008

APPENDIX A – LOCATION PLAN OF LENORE LANE, ERSKINE PARK

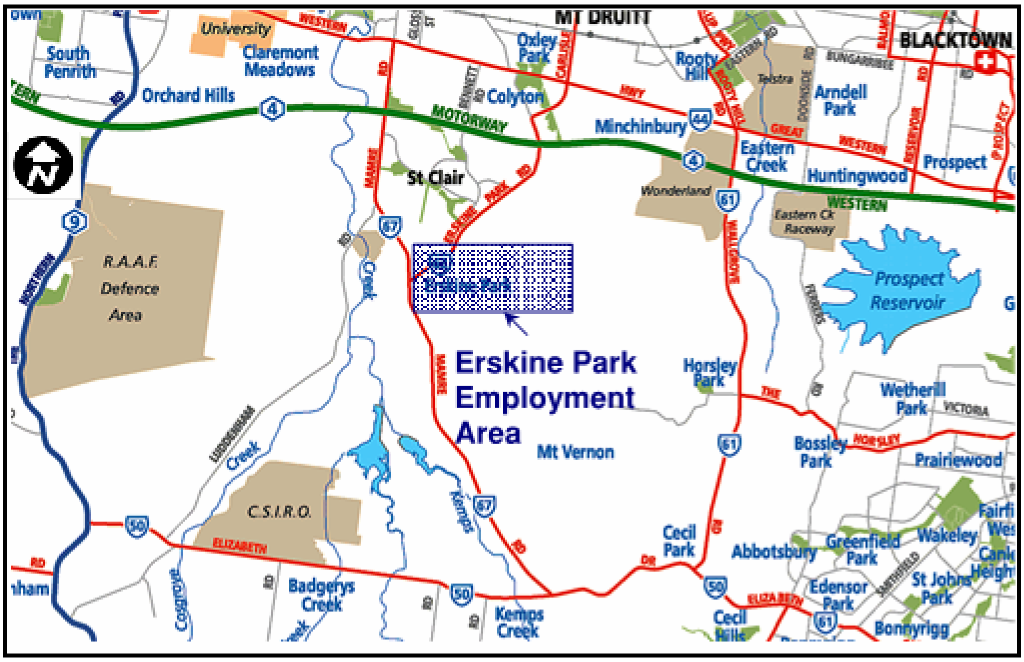


Figure A1 – Erskine Park Employment Area
Brown Consulting "Pad 4 Stormwater Concept Plan Eastern Lands Erskine Park", July 2006

APPENDIX B – SEDIMENT BASIN CALCULATIONS

SWMP Commentary, Standard Calculation

Note: These "Standard Calculation" spreadsheets relate only to low erosion hazard lands as identified in figure 4.6 where the designer chooses to not use the RUSLE to size sediment basins. The more "Detailed Calculation" spreadsheets should be used on high erosion hazard lands as identified by figure 4.6 or where the designer chooses to run the RUSLE in calculations.

1. Site Data Sheet

Site name: SITE E ERSKINE PARK

Site location: CORNER OF TEMPLAR AND LOCKWOOD ROADS

Precinct: PENRITH CITY COUNCIL

Description of site:

Site area	Site						Remarks
	Site E						
Total catchment area (ha)	5.39						
Disturbed catchment area (ha)	5.39						

Soil analysis

Soil landscape							DIPNR mapping (if relevant)
Soil Texture Group	F						Sections 6.3.3(c), (d) and (e)

Rainfall data

Design rainfall depth (days)	5						See Sections 6.3.4 (d) and (e)
Design rainfall depth (percentile)	75						See Sections 6.3.4 (f) and (g)
x-day, y-percentile rainfall event	21.8						See Section 6.3.4 (h)
Rainfall intensity: 2-year, 6-hour storm	10.19						See IFD chart for the site
Rainfall erosivity (R-factor)	2290						Automatic calculation from above data

Comments:

080305 sediment basin.xls 1

SWMP Commentary, Standard Calculation

2. Storm Flow Calculations

Peak flow is given by the Rational Formula:

$$Qy = 0.00278 \times C_{10} \times F_Y \times I_{y,tc} \times A$$

where:

- Q_y is peak flow rate (m^3/sec) of average recurrence interval (ARI) of "Y" years
- C_{10} is the runoff coefficient (dimensionless) for ARI of 10 years. Rural runoff coefficients are given in Volume 2, figure 5 of Pilgrim (1998), while urban runoff coefficients are given in Volume 1, Book VIII, figure 1.13 of Pilgrim (1998) and construction runoff coefficients are given in Appendix F
- F_y is a frequency factor for "Y" years. Rural values are given in Volume 1, Book IV, Table 1.1 of Pilgrim (1998) while urban coefficients are given in Volume 1, Book VIII, Table 1.6 of Pilgrim (1998)
- A is the catchment area in hectares (ha)
- $I_{y,tc}$ is the average rainfall intensity (mm/hr) for an ARI of "Y" years and a design duration of "tc" (minutes or hours)

Time of concentration (t_c) = $0.76 \times (A/100)^{0.38}$ hrs (Volume 1, Book IV of Pilgrim, 1998)

Note: For urban catchments the time of concentration should be determined by more precise calculations or reduced by a factor of 50 per cent.

Peak flow calculations, 1

Site	A (ha)	tc (mins)	Rainfall intensity, I, mm/hr						C_{10}
			$1_{yr,tc}$	$5_{yr,tc}$	$10_{yr,tc}$	$20_{yr,tc}$	$50_{yr,tc}$	$100_{yr,tc}$	
Site E	5.39	15	46.38	76.88	86.83	99.96	117.13	130.2	0.35

Peak flow calculations, 2

ARI yrs	Frequency factor (F_y)	Peak flows						Comment
		Site E						
		(m^3/s)	(m^3/s)	(m^3/s)	(m^3/s)	(m^3/s)	(m3/s)	
$1_{yr,tc}$	0.8	0.195						
$5_{yr,tc}$	0.95	0.383						
$10_{yr,tc}$	1	0.455						
$20_{yr,tc}$	1.05	0.550						
$50_{yr,tc}$	1.15	0.706						
$100_{yr,tc}$	1.2	0.819						

080305 sediment basin.xls 1

SWMP Commentary, Standard Calculation

4. Volume of Sediment Basins, *Type D* and *Type F* Soils

Basin volume = settling zone volume + sediment storage zone volume

Settling Zone Volume

The settling zone volume for *Type F* and *Type D* soils is calculated to provide capacity to contain all runoff expected from up to the y-percentile rainfall event. The volume of the basin's settling zone (V) can be determined as a function of the basin's surface area and depth to allow for particles to settle and can be determined by the following equation:

$$V = 10 \times C_v \times A \times R_{y\text{-%ile, x-day}} \ (m^3)$$

where:

10 = a unit conversion factor

C_v = the volumetric runoff coefficient defined as that portion of rainfall that runs off as stormwater over the x-day period

R = is the x-day total rainfall depth (mm) that is not exceeded in y percent of rainfall events. (See Sections 6.3.4(d), (e), (f), (g) and (h)).

A = total catchment area (ha)

Sediment Storage Zone Volume

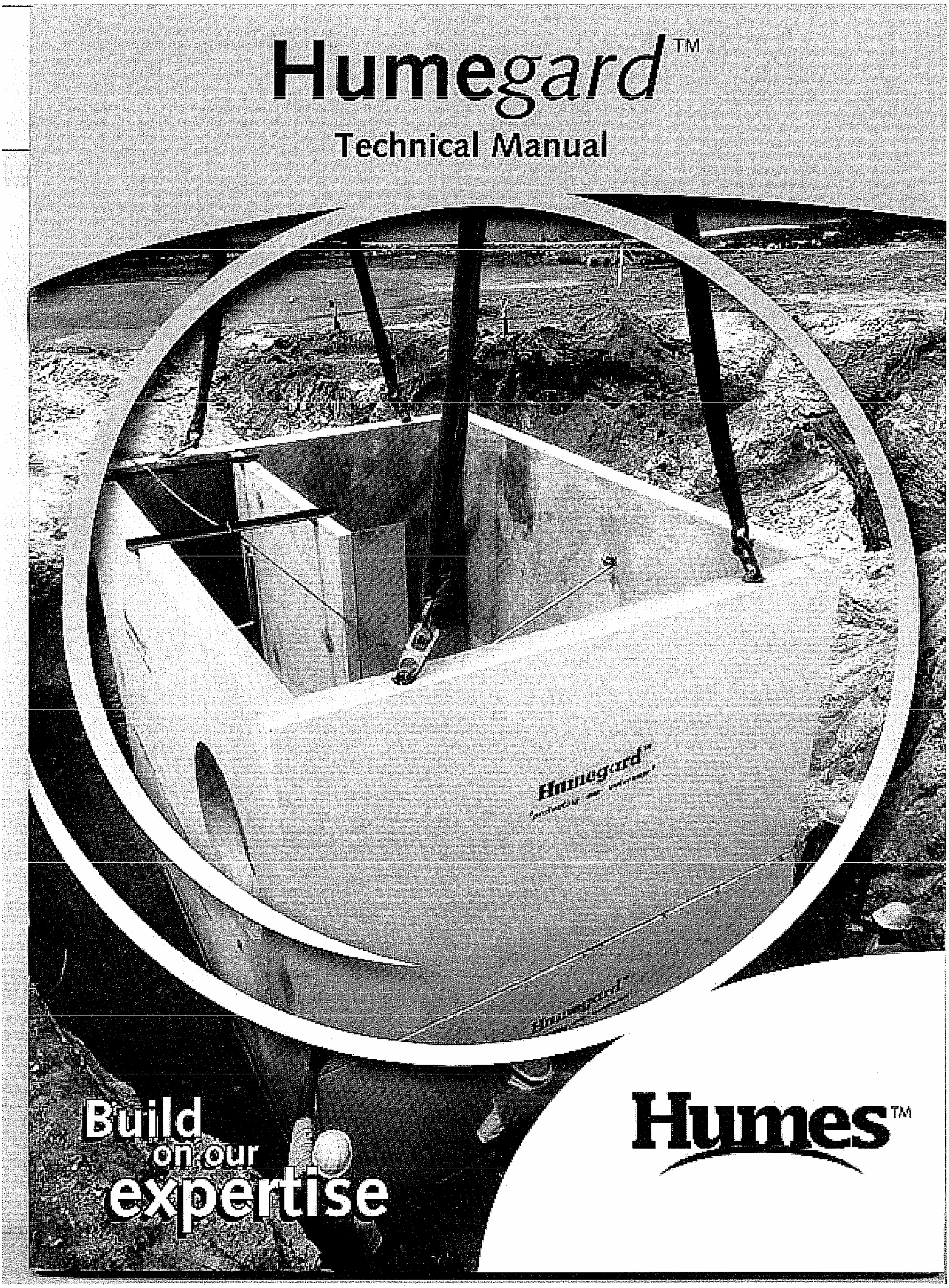
In the standard calculation, the sediment storage zone is 50 percent of the setting zone. However, designers can work to capture the 2-month soil loss as calculated by the RUSLE (Section 6.3.4(i)(ii)), in which case the "Detailed Calculation" spreadsheets should be used.

Total Basin Volume

Site	C_v	R x-day y-%ile	Total catchment area (ha)	Settling zone volume (m^3)	Sediment storage volume (m^3)	Total basin volume (m^3)
Site E	0.50	21.8	5.39	587.51	294	881.265

080305 sediment basin.xls 1

APPENDIX C – HUMES MODEL 35A GROSS POLLUTANT TRAP


Humegard™
Technical Manual
Build on our expertise
Humes™

Humes

The field test program trapping efficiencies for the targeted litter items at O'Grady Street and Lonsdale Street are detailed in Tables 1 to 4.

Table 1. Litter Capture Efficiencies, O'Grady St., Humegard™ (8 ha catchment)

Month of Litter Drop	Capture Efficiency percent for each category of litter				
	Plastic Bottles	Metal Cans	Waxed Paper Cartons	Polystyrene Cups	Corks
Feb 98	95	70	70	100	100
Mar 98	75	80	90	60	70
Jun 98	90	90	60	100	85
Aug 98	90	70	80	100	93.3
Oct 98	70	100	70	95	100
Progressive	83.8	82	76	94	93

Table 2. Gross Pollutants Recovered from O'Grady St., Humegard™

Date of Pump out	Gross Pollutants					
	Plastic Bottles (Items)	Metal Cans (Items)	Plastic Bags (Items)	Polystyrene (Items)	Corks (Items)	Organic/ Inorganic Sediments (kg)
16/3/98	3	2	2	23	11	*N/A
3/6/98	7	12	0	39	1	3000
29/7/98	4	2	8	60	5	**4000
8/9/98	4	0	1	2	1	3000
27/10/98	6	6	9	30	9	4400
Totals	30	22	20	144	27	14,400

*Sump not pumped out **Sump not completely pumped out

Table 3. Litter Capture Efficiencies, Lonsdale St., Humegard™

Month of Litter Drop	Capture Efficiency percent for each category of litter				
	Plastic Bottles	Metal Cans	Waxed Paper Cartons	Polystyrene Cups	Corks
Aug 98	96.7	100	100	95	96.7
Oct 98	78.4	90	90	100	96.7
Progressive	86.7	95	95	97.5	96.7

Table 4. Gross Pollutants Recovered from Lonsdale St., Humegard™

Date of Pump out	Gross Pollutants					
	Plastic Bottles (Items)	Metal Cans (Items)	Plastic Bags (Items)	Polystyrene (Items)	Corks (Items)	Organic/ Inorganic Sediments (kg)
23/9/98	22	24	6	26	1	1300
6/11/98	24	7	28	33	0	1800
Totals	46	31	34	59	1	3,100

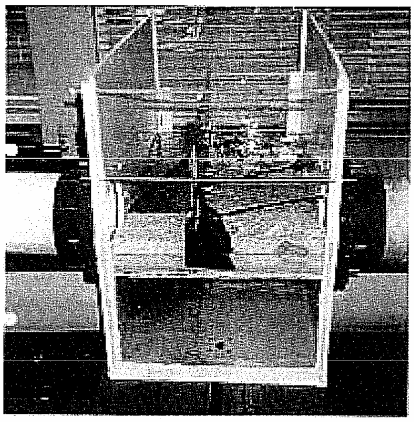
*Sump not pumped out **Sump not completely pumped out

Laboratory and field testing has proven capture rates up to 100% for gross pollutants prior to by-pass and up to 85% on an annualised basis, allowing for periods of high flow by-pass. The smallest positively targeted litter item in the field study was 12mm in diameter (syringes), however, many items smaller than the targeted items were captured.

Whilst sediment capture was not the focus of this test program, a substantial volume of organic and inorganic sediment was collected within the storage chamber during the field testing, indicating high removal rates of at least organic and coarse grained sediments.

Laboratory tests to establish the sediment capture efficiency of Humegard™ were conducted in Melbourne, Australia by Swinburne University of Technology, School of Civil Engineering during August 2000.

Laboratory testing has proven capture rates up to 99% for sediments ≥ 150 micron with a specific gravity of 2.65, prior to by-pass and up to 85% on an estimated annualised basis, allowing for periods of high flow by-pass.



Humegard™ model testing under laboratory conditions.

1.5 Patent Issues

The Humegard™ System apparatus is protected by Australian Patent No. 704777. A true Humegard™ System apparatus must be purchased from an organisation licensed by Humes limited in Australia.

If engineers and designers specify equipment "equivalent" to the Humegard™ System apparatus, and that apparatus is truly an "equivalent", it will infringe the Humegard™ System patent, if literally then under a tenet well-established in the patent law and known as the "doctrine of pith and marrow".

Humes and Swinburne University of Technology have made significant investment in time and money preparing technical design information, laboratory testing, and field studies in order to prove the efficacy of the Humegard™ system apparatus. In situations where there is a question of whether a competitive product is outside the scope of the doctrine of pith and marrow and whether it will perform as well as Humegard™ equipment, a prospective purchaser or reviewer is advised to ask for laboratory and field testing data from the supplier of the competitive product, or contact the nearest Humes' Sales Office.

5

Humes™

2.0 Design Information

The design of Humegard™ involves reviewing the configuration of the stormwater system, the location and purpose of other stormwater management controls for the proposed development, impervious area, pipeline diameter and assessment of the local rainfall data relative to regional rainfall sizing guidelines for residential and commercial areas.

2.1 Configuration of the Stormwater System

The configuration of the stormwater system is important as Humegard™ works efficiently from small through to medium/large catchment areas, depending on local rainfall characteristics, and one influent pipe.

Inlet Pipe

Humes recommends that a one inlet pipe - one outlet pipe arrangement be used. Junction pits upstream of the in-line separator may be required to provide this arrangement. Inlet and outlet pipes can be either in line with each other or at a 90 degree angle depending on pipe size (see Figure 3). Other angles may also be accommodated, contact Humes for advice. The storage/treatment chamber can be located either side of the drainage pipeline to suit site conditions.

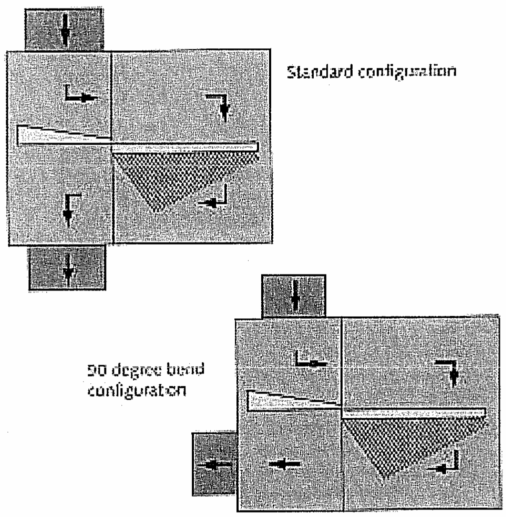


Figure3. Typical Humegard™ configurations

By-Pass Chamber

The bypass chamber is sized to suit the inlet/outlet pipe diameter. Table 5 indicates the Humegard™ model and associated pipe diameters accommodated. The largest pipe that can be currently accommodated in a standard Humegard™ is 1350mm diameter reinforced concrete pipe. For pipe diameters larger than 1350mm or box culvert applications we recommend you contact your nearest Humes Sales Office.

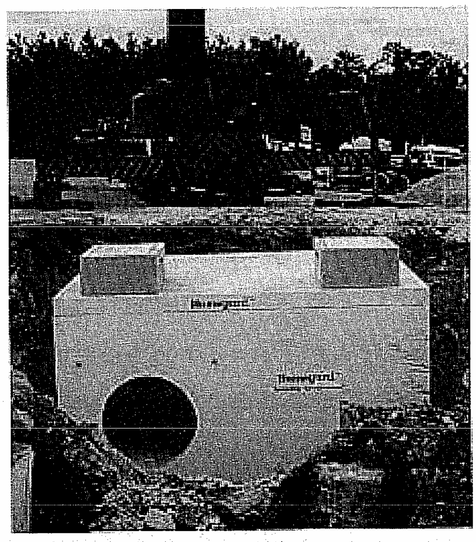
Table 5. Inlet and Outlet Pipe diameters (Concrete)

Humegard™ model	One Inlet and one Outlet Pipe apart
HG	Pipe Diameter (mm)
18	<=600
24	600
27	750
30	750
30A	900
35	900
40	900
35A	1050
40A	1050
40B	1200
45	1200
45A	1350

Location in the Stormwater System

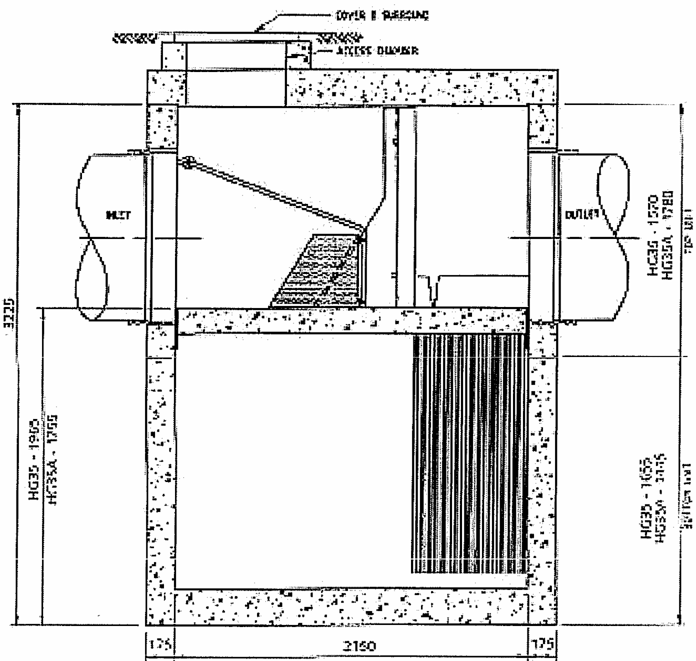
Humegard™ is designed to accommodate low to peak discharge flows. The frequency of the magnitude of the flow rate is dependant upon the upstream drainage area and the level on imperviousness of that drainage area.

The sizing guidelines (Section 2.4) provide limits for the amount of drainage area that can be accommodated for Residential and Commercial situations by each Humegard™ model, currently being manufactured.

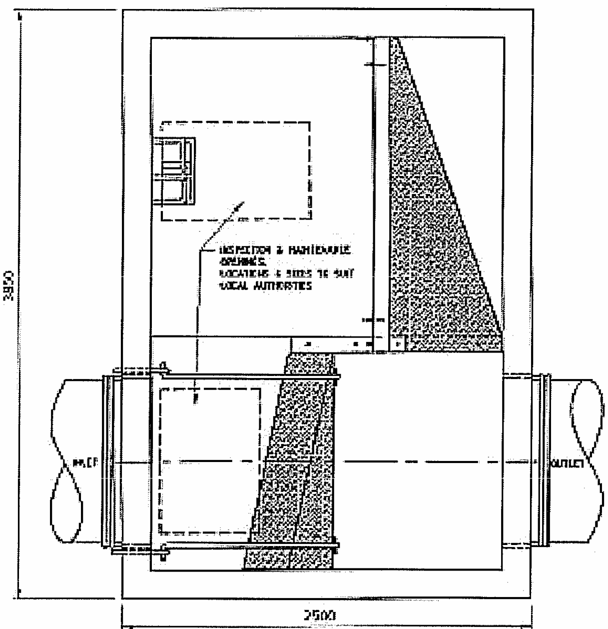


Located in the stormwater drainage system - Humegard™ does not require difference in elevation between the inlet and outlet invert of the pipeline.

Humes



SECTION THROUGH CHAMBER



PLAN (LID REMOVED)

Humegard™
Model HG35A
11.0m³ Holding Capacity

NOTES:

1. Typical assembly drawing only - refer to project drawing for actual requirements.
2. Dimensions included are standard.
3. Storage Volumes:
   Total = 11m³
4. Component Masses:
   Chamber Mass - Top Unit = 10.2 tonnes
   Chamber Mass - BTM Unit = 12.2 tonnes
   Chamber Lid = 4.5 tonnes
5. Refer to installation guide for recommended installation procedure.
6. Swiftlift Lifting Anchors provided for lifting all components. The following Swiftlift Knuckles will be required:
   For Chamber - BTM Unit - 4No. 10 tonne
   For Chamber - Top Unit - 4No. 5 tonne
   For Lid 4No. - 5 tonne
7. Pipe Diameter accommodated on Model HG35A is ≤ 1050mm.
8. Step Irons, Inspection and Maintenance Openings to be as per Plan View.

Humegard™
Model HG35
12.0m³ Holding Capacity

NOTES.

1. Typical assembly drawing only - refer to project drawing for actual requirements.
2. Dimensions included are standard.
3. Storage Volumes:
   Total = 12m³
4. Component Masses:
   Chamber Mass - Top Unit = 9.2 tonnes
   Chamber Mass - BTM Unit = 13.2 tonnes
   Chamber Lid = 4.5 tonnes
5. Refer to installation guide for recommended installation procedure.
6. Swiftlift Lifting Anchors provided for lifting all components. The following Swiftlift Knuckles will be required:
   For Chamber - BTM Unit - 4No. 10 tonne
   For Chamber - Top Unit - 4No. 5 tonne
   For Lid 4No. - 5 tonne
7. Pipe Diameter accommodated on Model HG35 is ≤ 900mm.
8. Step Irons, Inspection and Maintenance Openings to be as per Plan View.

14

APPENDIX D – RAINFALL INTENSITY ERSKINE PARK

RAINFALL INTENSITIES IN MM/HOUR

TITLE: ERSKINE PARK DATE: 20/02/08
UBD Map ref: 59AH 6

Site data : 2I1= 30.5 2I12= 6.66 2I72= 1.86 50I1= 59.2 50I12= 13.1
50I72= 4.22 REGSKEW=0.004 F2=4.295 F50=15.80 C10=0.45

Duration	Average Storm Recurrence Interval (years)						
	1	2	5	10	20	50	100
2min	102.29	131.91	170.33	192.71	222.17	260.76	290.17
3	90.90	117.19	151.26	171.08	197.20	231.40	257.45
4	82.96	106.95	137.98	156.03	179.82	210.97	234.69
5	76.91	99.13	127.86	144.56	166.58	195.40	217.35
6	72.10	92.92	119.81	135.45	156.06	183.03	203.58
7	68.04	87.68	113.03	127.76	147.19	172.61	191.97
8	64.57	83.20	107.23	121.20	139.61	163.71	182.05
9	61.55	79.31	102.19	115.48	133.02	155.96	173.43
10	58.93	75.93	97.82	110.53	127.31	149.25	165.96
11	56.62	72.94	93.95	106.16	122.25	143.32	159.35
12	54.45	70.14	90.34	102.06	117.53	137.77	153.18
13	52.54	67.68	87.16	98.46	113.38	132.89	147.74
14	50.82	65.46	84.28	95.20	109.62	128.47	142.83
15	49.20	63.37	81.58	92.15	106.10	124.34	138.23
16	47.74	61.49	79.15	89.40	102.92	120.61	134.08
17	46.38	59.73	76.88	86.83	99.96	117.13	130.20
18	45.16	58.15	74.84	84.52	97.29	114.00	126.72
20	42.85	55.18	71.00	80.17	92.28	108.12	120.17
25	38.29	49.30	63.40	71.58	82.37	96.49	107.22
30	34.79	44.79	57.58	64.99	74.78	87.57	97.31
35	32.04	41.24	53.00	59.80	68.80	80.56	89.51
40	29.77	38.31	49.22	55.53	63.88	74.79	83.08
45	27.88	35.87	46.07	51.97	59.78	69.98	77.73
50	26.28	33.81	43.41	48.97	56.32	65.92	73.22
60	23.66	30.45	39.07	44.06	50.67	59.29	65.85
90	18.58	23.91	30.70	34.64	39.84	46.63	51.80
2hrs	15.60	20.08	25.79	29.10	33.48	39.20	43.54
3	12.15	15.65	20.11	22.70	26.12	30.60	34.00
4	10.17	13.10	16.85	19.02	21.89	25.64	28.49
4.5	9.46	12.18	15.66	17.69	20.36	23.85	26.50
6	7.91	10.19	13.12	14.81	17.05	19.98	22.21
9	6.17	7.94	10.23	11.56	13.31	15.60	17.34
12	5.17	6.66	8.58	9.70	11.17	13.09	14.56
14	4.65	6.01	7.77	8.81	10.17	11.95	13.30
16	4.25	5.49	7.14	8.11	9.37	11.04	12.31
18	3.92	5.07	6.62	7.53	8.72	10.29	11.49
20	3.65	4.73	6.19	7.06	8.18	9.67	10.81
22	3.41	4.43	5.82	6.64	7.71	9.13	10.21
24	3.22	4.18	5.50	6.29	7.31	8.67	9.70
30	2.74	3.57	4.74	5.44	6.34	7.54	8.47
36	2.41	3.15	4.20	4.83	5.65	6.74	7.58
48	1.95	2.55	3.44	3.98	4.67	5.60	6.32
60	1.64	2.15	2.92	3.39	4.00	4.81	5.45
72	1.41	1.86	2.54	2.96	3.50	4.23	4.79

lote: The above rainfall intensities were derived using the procedures described in Chapter 2 of the Institution of Engineers Australia, publication, 'Australian Rainfall & Runoff', 1987 ed.

APPENDIX E – PRE DEVELOPMENT CALCULATIONS

Figure 1 shows the adopted discretisation of the site into three sub-areas. The Rafts model was used to determine the pre-development peak discharges for the site.

The catchment parameters used in the pre-development analysis are shown in Table 1

TABLE 1 Predevelopment Catchment Parameters

Sub-Area Ref	A	B	C
Area (Ha)	2.35	3.77	1.63
Slope (%)	2.00	2.60	2.41
% Impervious	5	5	5
Mannings n	0.035	0.035	0.035

The pre-development peak discharges for the critical storm duration of 120 minutes are given in Table 2

TABLE 2 Pre-development Peak Discharges

ARI (Years)	Discharge (m^3/s)
5	0.89
20	1.47
100	2.15

APPENDIX A
RAFTS MODEL RESULTS

```
#####################################################################################
Erskine Park

Results for period from 23:59.0 31/12/1988
                     to  2:29.0  1/ 1/1989
#####################################################################################

                               ROUTING INCREMENT (MINS) =       0.50
                               STORM DURATION (MINS)    =       120.
                               RETURN PERIOD (YRS)      =       100.
                               BX                       =     1.0000
                               TOTAL OF FIRST SUB-AREAS  (ha) =       7.75
                               TOTAL OF SECOND SUB-AREAS (ha) =       0.00
                               TOTAL OF ALL SUB-AREAS (ha)    =       7.75

    SUMMARY OF CATCHMENT AND RAINFALL DATA
Link      Catch. Area      Slope     % Impervious      Pern          B         Link
Label      #1      #2     #1    #2      #1    #2      #1     #2     #1     #2     No.
          (ha)              (%)            (%)
Cat-A      2.350  0.000  2.000 0.000  5.000 0.000  .035 0.00  .0292 0.000  1.000
Cat-B      3.770  0.000  2.600 0.000  5.000 0.000  .035 0.00  .0328 0.000  2.000
Cat-C      1.630  0.000  2.410 0.000  5.000 0.000  .035 0.00  .0220 0.000  2.001
1-40      .00001  0.000  1.900 0.000  5.000 0.000  .035 0.00  0.000 0.000  1.001

Link    Average  Init. Loss  Cont. Loss    Excess Rain    Peak    Time   Link
Label  Intensity  #1     #2    #1     #2      #1     #2    Inflow    to     Lag
         (mm/h)     ( mm )       (mm/h)        ( mm )    (m^3/s)  Peak  mins
Cat-A    43.538 15.00 0.000  3.000 0.000  67.101  0.000  0.6233  42.00 0.000
Cat-B    43.538 15.00 0.000  3.000 0.000  67.101  0.000   1.025  41.00 0.000
Cat-C    43.538 15.00 0.000  3.000 0.000  67.101  0.000   1.525  40.50 1.000
1-40     43.538 15.00 0.000  3.000 0.000  67.101  0.000   2.148  41.50 0.000


#####################################################################################
Erskine Park

Results for period from 23:59.0 31/12/1988
                     to  3:19.0  1/ 1/1989
#####################################################################################

                               ROUTING INCREMENT (MINS) =       0.50
                               STORM DURATION (MINS)    =       120.
                               RETURN PERIOD (YRS)      =        20.
                               BX                       =     1.0000
                               TOTAL OF FIRST SUB-AREAS  (ha) =       7.75
                               TOTAL OF SECOND SUB-AREAS (ha) =       0.00
                               TOTAL OF ALL SUB-AREAS (ha)    =       7.75

    SUMMARY OF CATCHMENT AND RAINFALL DATA
Link      Catch. Area      Slope     % Impervious      Pern          B         Link
Label      #1      #2     #1    #2      #1    #2      #1     #2     #1     #2     No.
          (ha)              (%)            (%)
Cat-A      2.350  0.000  2.000 0.000  5.000 0.000  .035 0.00  .0292 0.000  1.000
Cat-B      3.770  0.000  2.600 0.000  5.000 0.000  .035 0.00  .0328 0.000  2.000
Cat-C      1.630  0.000  2.410 0.000  5.000 0.000  .035 0.00  .0220 0.000  2.001
1-40      .00001  0.000  1.900 0.000  5.000 0.000  .035 0.00  0.000 0.000  1.001
```

Link Label	Average Intensity (mm/h)	Init. Loss #1 (mm)	Init. Loss #2	Cont. Loss #1 (mm/h)	Cont. Loss #2	Excess Rain #1 (mm)	Excess Rain #2	Peak Inflow (m^3/s)	Time to Peak	Link Lag mins
Cat-A	33.485	15.00	0.000	3.000	0.000	47.144	0.000	0.4223	45.00	0.000
Cat-B	33.485	15.00	0.000	3.000	0.000	47.144	0.000	0.7115	45.00	0.000
Cat-C	33.485	15.00	0.000	3.000	0.000	47.144	0.000	1.043	44.00	1.000
1-40	33.485	15.00	0.000	3.000	0.000	47.144	0.000	1.466	45.00	0.000

##
Erskine Park

Results for period from 23:59.0 31/12/1988
to 4:59.0 1/ 1/1989
##

```
ROUTING INCREMENT (MINS) =        1.00
STORM DURATION (MINS)    =        120.
RETURN PERIOD (YRS)      =          5.
BX                       =      1.0000
TOTAL OF FIRST SUB-AREAS  (ha) =        7.75
TOTAL OF SECOND SUB-AREAS (ha) =        0.00
TOTAL OF ALL SUB-AREAS (ha)    =        7.75
```

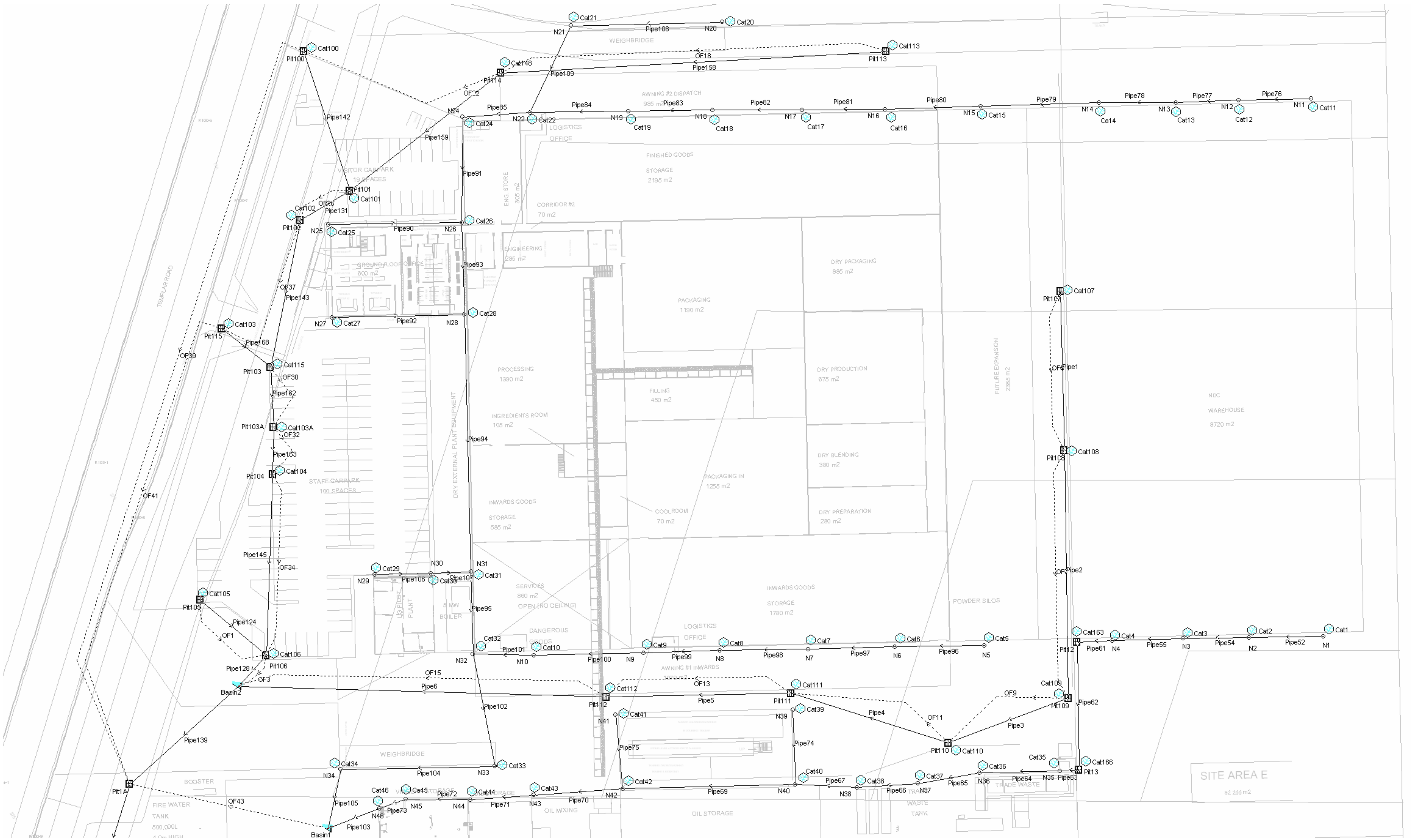
SUMMARY OF CATCHMENT AND RAINFALL DATA

Link Label	Catch. Area #1 (ha)	Catch. Area #2	Slope #1 (%)	Slope #2	% Impervious #1 (%)	% Impervious #2	Pern #1	Pern #2	B #1	B #2	Link No.
Cat-A	2.350	0.000	2.000	0.000	5.000	0.000	.035	0.00	.0292	0.000	1.000
Cat-B	3.770	0.000	2.600	0.000	5.000	0.000	.035	0.00	.0328	0.000	2.000
Cat-C	1.630	0.000	2.410	0.000	5.000	0.000	.035	0.00	.0220	0.000	2.001
1-40	.00001	0.000	1.900	0.000	5.000	0.000	.035	0.00	0.000	0.000	1.001

Link Label	Average Intensity (mm/h)	Init. Loss #1 (mm)	Init. Loss #2	Cont. Loss #1 (mm/h)	Cont. Loss #2	Excess Rain #1 (mm)	Excess Rain #2	Peak Inflow (m^3/s)	Time to Peak	Link Lag mins
Cat-A	25.952	15.00	0.000	3.000	0.000	32.305	0.000	0.2517	48.00	0.000
Cat-B	25.952	15.00	0.000	3.000	0.000	32.305	0.000	0.4270	46.00	0.000
Cat-C	25.952	15.00	0.000	3.000	0.000	32.305	0.000	0.6401	46.00	1.000
1-40	25.952	15.00	0.000	3.000	0.000	32.305	0.000	0.8911	47.00	0.000

Run completed at: 19th February 2008 16:33:27

APPENDIX F – DRAINS MODEL AND PLANS



DRAINS results prepared 11 April, 2008 from Version 2008.02

PIT / NODE DETAILS				Version 8			
Name	Max HGL	Max Pond HGL	Max Surface Flow Arriving (cu.m/s)	Max Pond Volume (cu.m)	Min Freeboard (m)	Overflow (cu.m/s)	Constraint
N5	82.94		0.063				
N6	82.69		0.073				
N7	81.56		0.073				
N8	80.97		0.073				
N9	76.15		0.051				
N10	68.11		0.078				
N32	61.08		0.002				
N33	58.71		0.005				
N34	55.35		0.005				
N1	64.65		0.055				
N2	64.5		0.055				
N3	63.89		0.047				
N4	62.76		0.048				
Pit12	62.51	56.35	0	0	-6.16		Outlet System
Pit13	61.53	56.2	0	0	-5.33		Outlet System
N35	60.67		0.007				
N36	59.89		0.001				
N37	59.52		0.004				
N38	59.14		0.004				
N40	58.78		0.014				
N42	57.27		0.014				
N43	56.6		0.011				
N44	55.43		0.007				
N45	54.61		0.008				
N46	54.6		0.002				
N11	101.36		0.055				
N12	101.27		0.055				
N13	100.96		0.047				
N14	100.35		0.048				
N15	99.61		0.063				
N16	98.67		0.073				
N17	97.12		0.073				
N18	94.82		0.073				
N19	91.65		0.073				
N22	71.79		0.069				
N24	67.71		0.027				
N26	66.47		0.008				
N28	65.38		0.008				
N31	62.1		0.002				
Pit105	53.1		0.046		0	0.053	Outlet System
Pit106	53.26		0.065		0	0.014	Inlet Capacity
Pit1A	52.02	52.95	0.31	0	0.78		None
N207	47.95		0				
N25	66.48		0.008				
N29	62.1		0.006				
N30	62.1		0.006				
N41	57.28		0.017				
N39	58.79		0.017				
N27	65.38		0.008				
N20	71.82		0.005				
N21	71.8		0.005				
Pit107	56.05		0.016		0	0.001	Outlet System
Pit108	56.01		0.016		0.04	0.001	Inlet Capacity
Pit109	55.86		0.008		0.34	0	None
Pit110	55.64		0.032		0.12	0.002	Inlet Capacity
Pit111	54.9	56.34	0.034	0	1.4	0	None
Pit112	54.47	55.9	0.056	0	1.38	0	None
Pit100	54.53		0.069		0.47	0.015	Inlet Capacity
Pit101	54.49	55.94	0.037	0	1.41	0	None
Pit102	54.13		0.011		1.27	0	None
Pit103	53.82	53.82	0.191	0	-0.13	0	Outlet System
Pit103A	53.43	53.49	0.032	0	0.03	0	None
Pit104	53.37	53.51	0.079	0	0.08	0	None
Pit115	53.95	53.96	0.076	0	-0.05	0	Outlet System
Pit113	55.23	55.23	0.051	0	-0.1	0	Outlet System
Pit114	55.16	55.14	0.114	0	-0.12	0	Outlet System

SUB-CATCHMENT DETAILS							
Name	Max	Paved	Grassed	Paved	Grassed	Supp.	Due to Storm

Cat33	0.005	0.005	0	5	0	0	AR&R 100 year, 25 minutes storm, average 107.24 mm/h, Zone 1
Cat34	0.005	0.005	0	5	0	0	AR&R 100 year, 25 minutes storm, average 107.24 mm/h, Zone 1
Cat1	0.055	0.055	0	5	0	0	AR&R 100 year, 25 minutes storm, average 107.24 mm/h, Zone 1
Cat2	0.055	0.055	0	5	0	0	AR&R 100 year, 25 minutes storm, average 107.24 mm/h, Zone 1
Cat3	0.047	0.047	0	5	0	0	AR&R 100 year, 25 minutes storm, average 107.24 mm/h, Zone 1
Cat4	0.048	0.048	0	5	0	0	AR&R 100 year, 25 minutes storm, average 107.24 mm/h, Zone 1
Cat163	0	0	0	5	7	0	AR&R 100 year, 25 minutes storm, average 107.24 mm/h, Zone 1
Cat166	0	0	0	5	7	0	AR&R 100 year, 25 minutes storm, average 107.24 mm/h, Zone 1
Cat35	0.007	0.007	0	5	0	0	AR&R 100 year, 25 minutes storm, average 107.24 mm/h, Zone 1
Cat36	0.001	0.001	0	5	0	0	AR&R 100 year, 25 minutes storm, average 107.24 mm/h, Zone 1
Cat37	0.004	0.004	0	5	0	0	AR&R 100 year, 25 minutes storm, average 107.24 mm/h, Zone 1
Cat38	0.004	0.004	0	5	0	0	AR&R 100 year, 25 minutes storm, average 107.24 mm/h, Zone 1
Cat40	0.014	0.014	0	5	0	0	AR&R 100 year, 25 minutes storm, average 107.24 mm/h, Zone 1
Cat42	0.014	0.014	0	5	0	0	AR&R 100 year, 25 minutes storm, average 107.24 mm/h, Zone 1
Cat43	0.011	0.011	0	5	0	0	AR&R 100 year, 25 minutes storm, average 107.24 mm/h, Zone 1
Cat44	0.007	0.007	0	5	0	0	AR&R 100 year, 25 minutes storm, average 107.24 mm/h, Zone 1
Ca45	0.008	0.008	0	5	0	0	AR&R 100 year, 25 minutes storm, average 107.24 mm/h, Zone 1
Cat46	0.002	0.002	0	5	0	0	AR&R 100 year, 25 minutes storm, average 107.24 mm/h, Zone 1
Cat11	0.055	0.055	0	5	0	0	AR&R 100 year, 25 minutes storm, average 107.24 mm/h, Zone 1
Cat12	0.055	0.055	0	5	0	0	AR&R 100 year, 25 minutes storm, average 107.24 mm/h, Zone 1
Cat13	0.047	0.047	0	5	0	0	AR&R 100 year, 25 minutes storm, average 107.24 mm/h, Zone 1
Ca14	0.048	0.048	0	5	0	0	AR&R 100 year, 25 minutes storm, average 107.24 mm/h, Zone 1
Cat15	0.063	0.063	0	5	0	0	AR&R 100 year, 25 minutes storm, average 107.24 mm/h, Zone 1
Cat16	0.073	0.073	0	5	0	0	AR&R 100 year, 25 minutes storm, average 107.24 mm/h, Zone 1
Cat17	0.073	0.073	0	5	0	0	AR&R 100 year, 25 minutes storm, average 107.24 mm/h, Zone 1
Cat18	0.073	0.073	0	5	0	0	AR&R 100 year, 25 minutes storm, average 107.24 mm/h, Zone 1
Cat19	0.073	0.073	0	5	0	0	AR&R 100 year, 25 minutes storm, average 107.24 mm/h, Zone 1
Cat22	0.069	0.069	0	5	0	0	AR&R 100 year, 25 minutes storm, average 107.24 mm/h, Zone 1
Cat24	0.027	0.027	0	5	0	0	AR&R 100 year, 25 minutes storm, average 107.24 mm/h, Zone 1
Cat26	0.008	0.008	0	5	0	0	AR&R 100 year, 25 minutes storm, average 107.24 mm/h, Zone 1
Cat28	0.008	0.008	0	5	0	0	AR&R 100 year, 25 minutes storm, average 107.24 mm/h, Zone 1
Cat31	0.002	0.002	0	5	0	0	AR&R 100 year, 25 minutes storm, average 107.24 mm/h, Zone 1
Cat105	0.046	0.03	0.016	5	7	0	AR&R 100 year, 25 minutes storm, average 107.24 mm/h, Zone 1
Cat106	0.036	0.024	0.013	5	7	0	AR&R 100 year, 25 minutes storm, average 107.24 mm/h, Zone 1
Cat25	0.008	0.008	0	5	0	0	AR&R 100 year, 25 minutes storm, average 107.24 mm/h, Zone 1
Cat29	0.006	0.006	0	5	0	0	AR&R 100 year, 25 minutes storm, average 107.24 mm/h, Zone 1
Cat30	0.006	0.006	0	5	0	0	AR&R 100 year, 25 minutes storm, average 107.24 mm/h, Zone 1
Cat41	0.017	0.017	0	5	0	0	AR&R 100 year, 25 minutes storm, average 107.24 mm/h, Zone 1
Cat39	0.017	0.017	0	5	0	0	AR&R 100 year, 25 minutes storm, average 107.24 mm/h, Zone 1
Cat27	0.008	0.008	0	5	0	0	AR&R 100 year, 25 minutes storm, average 107.24 mm/h, Zone 1
Cat20	0.005	0.005	0	5	0	0	AR&R 100 year, 25 minutes storm, average 107.24 mm/h, Zone 1
Cat21	0.005	0.005	0	5	0	0	AR&R 100 year, 25 minutes storm, average 107.24 mm/h, Zone 1
Cat107	0.016	0.016	0	5	0	0	AR&R 100 year, 25 minutes storm, average 107.24 mm/h, Zone 1
Cat108	0.015	0.015	0	5	0	0	AR&R 100 year, 25 minutes storm, average 107.24 mm/h, Zone 1
Cat109	0.008	0.008	0	5	0	0	AR&R 100 year, 25 minutes storm, average 107.24 mm/h, Zone 1
Cat110	0.032	0.032	0	5	0	0	AR&R 100 year, 25 minutes storm, average 107.24 mm/h, Zone 1
Cat111	0.031	0.031	0	5	7	0	AR&R 100 year, 25 minutes storm, average 107.24 mm/h, Zone 1
Cat112	0.056	0.056	0	5	7	0	AR&R 100 year, 25 minutes storm, average 107.24 mm/h, Zone 1
Cat100	0.069	0.045	0.024	5	7	0	AR&R 100 year, 25 minutes storm, average 107.24 mm/h, Zone 1
Cat101	0.037	0.031	0.006	5	7	0	AR&R 100 year, 25 minutes storm, average 107.24 mm/h, Zone 1
Cat102	0.011	0.009	0.002	5	7	0	AR&R 100 year, 25 minutes storm, average 107.24 mm/h, Zone 1
Cat115	0.191	0.159	0.032	5	7	0	AR&R 100 year, 25 minutes storm, average 107.24 mm/h, Zone 1
Cat103A	0.032	0.024	0.008	5	7	0	AR&R 100 year, 25 minutes storm, average 107.24 mm/h, Zone 1
Cat104	0.079	0.059	0.02	5	7	0	AR&R 100 year, 25 minutes storm, average 107.24 mm/h, Zone 1
Cat103	0.076	0.063	0.013	5	7	0	AR&R 100 year, 25 minutes storm, average 107.24 mm/h, Zone 1
Cat113	0.051	0.042	0.008	5	7	0	AR&R 100 year, 25 minutes storm, average 107.24 mm/h, Zone 1
Cat148	0.114	0.095	0.019	5	7	0	AR&R 100 year, 25 minutes storm, average 107.24 mm/h, Zone 1

Outflow Volumes for Total Catchment (4.19 impervious + 0.39 pervious = 4.57 total ha)

Storm	Total Rainfall	Total Runoff	Impervious Ru	Pervious Runoff
	cu.m	cu.m (Runoff	cu.m (Runoff	cu.m (Runoff %)
AR&R 100 ye	2043.37	1939.60 (94.9	1828.86 (97.8	110.73 (64.1%)
AR&R 100 ye	3552.53	3404.93 (95.8	3210.57 (98.7	194.36 (64.8%)

PIPE DETAILS

Name	Max Q	Max V	Max U/S	Max D/S	Due to Storm
	(cu.m/s)	(m/s)	HGL (m)	HGL (m)	
Pipe96	0.063	1.6	82.935	82.691	AR&R 100 year, 25 minutes storm, average 107.24 mm/h, Zone 1
Pipe97	0.136	3.4	82.691	81.564	AR&R 100 year, 25 minutes storm, average 107.24 mm/h, Zone 1
Pipe98	0.209	2.9	81.564	80.974	AR&R 100 year, 25 minutes storm, average 107.24 mm/h, Zone 1
Pipe99	0.282	7.1	80.974	76.152	AR&R 100 year, 25 minutes storm, average 107.24 mm/h, Zone 1
Pipe100	0.332	8.4	76.152	68.109	AR&R 100 year, 25 minutes storm, average 107.24 mm/h, Zone 1
Pipe101	0.41	10.3	68.109	61.085	AR&R 100 year, 25 minutes storm, average 107.24 mm/h, Zone 1
Pipe102	1.123	7.1	61.085	58.707	AR&R 100 year, 25 minutes storm, average 107.24 mm/h, Zone 1
Pipe104	1.127	7.1	58.707	55.351	AR&R 100 year, 25 minutes storm, average 107.24 mm/h, Zone 1
Pipe105	1.132	16	55.351	54.575	AR&R 100 year, 25 minutes storm, average 107.24 mm/h, Zone 1
Pipe52	0.055	1.4	64.651	64.496	AR&R 100 year, 25 minutes storm, average 107.24 mm/h, Zone 1
Pipe54	0.109	2.8	64.496	63.887	AR&R 100 year, 25 minutes storm, average 107.24 mm/h, Zone 1
Pipe55	0.156	3.9	63.887	62.764	AR&R 100 year, 25 minutes storm, average 107.24 mm/h, Zone 1
Pipe61	0.204	5.1	62.764	62.51	AR&R 100 year, 25 minutes storm, average 107.24 mm/h, Zone 1
Pipe62	0.204	2.9	61.872	61.534	AR&R 100 year, 25 minutes storm, average 107.24 mm/h, Zone 1
Pipe63	0.204	2.9	60.896	60.67	AR&R 100 year, 25 minutes storm, average 107.24 mm/h, Zone 1
Pipe64	0.211	3	60.67	59.886	AR&R 100 year, 25 minutes storm, average 107.24 mm/h, Zone 1

Pipe65	0.212	3	59.886	59.52	AR&R 100 year, 25 minutes storm, average 107.24 mm/h, Zone 1
Pipe66	0.216	3.1	59.52	59.14	AR&R 100 year, 25 minutes storm, average 107.24 mm/h, Zone 1
Pipe67	0.22	3.1	59.14	58.779	AR&R 100 year, 25 minutes storm, average 107.24 mm/h, Zone 1
Pipe69	0.251	3.5	58.779	57.266	AR&R 100 year, 25 minutes storm, average 107.24 mm/h, Zone 1
Pipe70	0.282	4	57.266	56.595	AR&R 100 year, 25 minutes storm, average 107.24 mm/h, Zone 1
Pipe71	0.293	4.1	56.595	55.432	AR&R 100 year, 25 minutes storm, average 107.24 mm/h, Zone 1
Pipe72	0.301	4.3	55.432	54.613	AR&R 100 year, 25 minutes storm, average 107.24 mm/h, Zone 1
Pipe73	0.309	4.4	54.613	54.597	AR&R 100 year, 25 minutes storm, average 107.24 mm/h, Zone 1
Pipe103	0.311	4.4	54.597	54.575	AR&R 100 year, 25 minutes storm, average 107.24 mm/h, Zone 1
Pipe76	0.055	1.2	101.36	101.275	AR&R 100 year, 25 minutes storm, average 107.24 mm/h, Zone 1
Pipe77	0.109	2.4	101.275	100.963	AR&R 100 year, 25 minutes storm, average 107.24 mm/h, Zone 1
Pipe78	0.156	3.4	100.963	100.348	AR&R 100 year, 25 minutes storm, average 107.24 mm/h, Zone 1
Pipe79	0.204	2.9	100.348	99.612	AR&R 100 year, 25 minutes storm, average 107.24 mm/h, Zone 1
Pipe80	0.267	3.8	99.612	98.674	AR&R 100 year, 25 minutes storm, average 107.24 mm/h, Zone 1
Pipe81	0.34	4.8	98.674	97.117	AR&R 100 year, 25 minutes storm, average 107.24 mm/h, Zone 1
Pipe82	0.413	5.8	97.117	94.824	AR&R 100 year, 25 minutes storm, average 107.24 mm/h, Zone 1
Pipe83	0.486	6.9	94.824	91.653	AR&R 100 year, 25 minutes storm, average 107.24 mm/h, Zone 1
Pipe84	0.559	14	91.653	71.793	AR&R 100 year, 25 minutes storm, average 107.24 mm/h, Zone 1
Pipe85	0.637	9	71.793	67.706	AR&R 100 year, 25 minutes storm, average 107.24 mm/h, Zone 1
Pipe91	0.664	5.7	67.706	66.474	AR&R 100 year, 25 minutes storm, average 107.24 mm/h, Zone 1
Pipe93	0.68	5.8	66.474	65.376	AR&R 100 year, 25 minutes storm, average 107.24 mm/h, Zone 1
Pipe94	0.696	5.9	65.376	62.097	AR&R 100 year, 25 minutes storm, average 107.24 mm/h, Zone 1
Pipe95	0.71	6.1	62.097	61.085	AR&R 100 year, 25 minutes storm, average 107.24 mm/h, Zone 1
Pipe124	0.04	1	53.102	53.255	AR&R 100 year, 25 minutes storm, average 107.24 mm/h, Zone 1
Pipe128	0.685	1.6	53.227	53.227	AR&R 100 year, 25 minutes storm, average 107.24 mm/h, Zone 1
Pipe139	0.325	1.1	52.023	52.015	AR&R 100 year, 1.5 hours storm, average 51.79 mm/h, Zone 1
Pipe141	0.351	2.4	51.643	47.946	AR&R 100 year, 1.5 hours storm, average 51.79 mm/h, Zone 1
Pipe90	0.008	0.2	66.478	66.474	AR&R 100 year, 25 minutes storm, average 107.24 mm/h, Zone 1
Pipe106	0.006	0.1	62.098	62.097	AR&R 100 year, 25 minutes storm, average 107.24 mm/h, Zone 1
Pipe107	0.012	0.2	62.097	62.097	AR&R 100 year, 25 minutes storm, average 107.24 mm/h, Zone 1
Pipe75	0.017	0.4	57.282	57.266	AR&R 100 year, 25 minutes storm, average 107.24 mm/h, Zone 1
Pipe74	0.017	0.4	58.794	58.779	AR&R 100 year, 25 minutes storm, average 107.24 mm/h, Zone 1
Pipe92	0.008	0.2	65.38	65.376	AR&R 100 year, 25 minutes storm, average 107.24 mm/h, Zone 1
Pipe108	0.005	0.3	71.821	71.799	AR&R 100 year, 25 minutes storm, average 107.24 mm/h, Zone 1
Pipe109	0.009	0.2	71.799	71.793	AR&R 100 year, 25 minutes storm, average 107.24 mm/h, Zone 1
Pipe1	0.015	0.4	56.04	56.013	AR&R 100 year, 25 minutes storm, average 107.24 mm/h, Zone 1
Pipe2	0.03	0.8	55.972	55.864	AR&R 100 year, 25 minutes storm, average 107.24 mm/h, Zone 1
Pipe3	0.038	1	55.796	55.645	AR&R 100 year, 25 minutes storm, average 107.24 mm/h, Zone 1
Pipe4	0.068	1.7	55.427	54.901	AR&R 100 year, 25 minutes storm, average 107.24 mm/h, Zone 1
Pipe5	0.101	1.4	54.747	54.473	AR&R 100 year, 25 minutes storm, average 107.24 mm/h, Zone 1
Pipe6	0.156	3.3	54.114	53.227	AR&R 100 year, 25 minutes storm, average 107.24 mm/h, Zone 1
Pipe142	0.053	0.5	54.513	54.492	AR&R 100 year, 25 minutes storm, average 107.24 mm/h, Zone 1
Pipe131	0.22	2	54.209	54.128	AR&R 100 year, 1.5 hours storm, average 51.79 mm/h, Zone 1
Pipe143	0.23	1.4	53.978	53.825	AR&R 100 year, 1.5 hours storm, average 51.79 mm/h, Zone 1
Pipe162	0.504	3.2	53.518	53.433	AR&R 100 year, 25 minutes storm, average 107.24 mm/h, Zone 1
Pipe163	0.535	1.5	53.374	53.365	AR&R 100 year, 25 minutes storm, average 107.24 mm/h, Zone 1
Pipe145	0.611	1.7	53.294	53.255	AR&R 100 year, 25 minutes storm, average 107.24 mm/h, Zone 1
Pipe168	0.072	1	53.871	53.825	AR&R 100 year, 25 minutes storm, average 107.24 mm/h, Zone 1
Pipe158	0.075	1.1	55.212	55.156	AR&R 100 year, 25 minutes storm, average 107.24 mm/h, Zone 1
Pipe159	0.137	1.9	54.92	54.492	AR&R 100 year, 25 minutes storm, average 107.24 mm/h, Zone 1

CHANNEL DETAILS

Name	Max Q (cu.m/s)	Max V (m/s)	Chainage (m)	Max HGL (m)	Due to Storm

OVERFLOW ROUTE DETAILS

Name	Max Q U/S	Max Q D/S	Safe Q	Max D	Max DxV	Max Width	Max V	Due to Storm
OF43	0.31	0	7.665	0.054	0.04	14.87	0.68	AR&R 100 year, 1.5 hours storm, average 51.79 mm/h, Zone 1
OF1	0.053	0	7.665	0.027	0.01	9.13	0.42	AR&R 100 year, 1.5 hours storm, average 51.79 mm/h, Zone 1
OF3	0.014	0	7.665	0.017	0.01	5.54	0.3	AR&R 100 year, 1.5 hours storm, average 51.79 mm/h, Zone 1
OF5	0.001	0	7.665	0.005	0	1.65	0.13	AR&R 100 year, 25 minutes storm, average 107.24 mm/h, Zone 1
OF7	0.001	0	7.665	0.005	0	1.65	0.14	AR&R 100 year, 25 minutes storm, average 107.24 mm/h, Zone 1
OF9	0	0	7.665	0	0	0	0	
OF11	0.002	0	7.665	0.009	0	2.84	0.21	AR&R 100 year, 25 minutes storm, average 107.24 mm/h, Zone 1
OF13	0	0	7.665	0	0	0	0	
OF15	0	0	7.665	0	0	0	0	
OF58	0.015	0	7.665	0.018	0.01	5.84	0.3	AR&R 100 year, 25 minutes storm, average 107.24 mm/h, Zone 1
OF26	0	0	7.665	0	0	0	0	
OF37	0	0	7.665	0	0	0	0	
OF30	0	0	7.665	0	0	0	0	
OF32	0	0	7.665	0	0	0	0	
OF34	0	0	7.665	0	0	0	0	
OF56	0	0	7.665	0	0	0	0	
OF18	0	0	7.665	0	0	0	0	
OF22	0	0	7.665	0	0	0	0	

DETENTION BASIN DETAILS

Name	Max WL	MaxVol	Max Q Total	Max Q Low Level	Max Q High Level
Basin1	54.58	0	0.31	0	0.31
Basin2	53.23	0	0.325	0.325	0

CONTINUITY CHECK for AR&R 100 year, 25 minutes storm, average 107.24 mm/h, Zone 1

Node	Inflow (cu.m)	Outflow (cu.m)	Storage Char (cu.m)	Difference %
N5	52.42	52.42	0	0
N6	113.58	113.58	0	0
N7	174.74	174.76	0	0
N8	235.91	235.95	0	0
N9	278.33	278.33	0	0
N10	343.64	343.7	0	0
N32	938.84	936.98	0	0.2
N33	940.82	938.17	0	0.3
N34	942.01	939.48	0	0.3
Basin1	1200.08	0	1199.96	0
N1	45.87	45.87	0	0
N2	91.74	91.74	0	0
N3	131.05	131.06	0	0
N4	171.03	171.04	0	0
Pit12	171.07	171.14	0	0
Pit13	171.17	171.13	0	0
N35	176.72	176.68	0	0
N36	177.59	177.56	0	0
N37	181.01	181	0	0
N38	184.28	184.3	0	0
N40	210.24	210.29	0	0
N42	236.24	236.3	0	0
N43	245.91	245.91	0	0
N44	252.02	251.94	0	0
N45	258.89	258.8	0	0
N46	260.72	260.6	0	0
N11	45.87	45.87	0	0
N12	91.74	91.74	0	0
N13	131.05	131.06	0	0
N14	171.03	171.05	0	0
N15	223.47	223.5	0	0
N16	284.65	284.69	0	0
N17	345.85	345.86	0	0
N18	407.01	407.04	0	0
N19	468.2	468.19	0	0
N22	533.98	534.05	0	0
N24	556.33	555.8	0	0.1
N26	569.34	568.85	0	0.1
N28	582.39	581.84	0	0.1
N31	593.76	593.08	0	0.1
Pit105	36.47	36.46	0	0
Pit106	584.06	580.74	0	0.6
Basin2	718.82	718.77	0.04	0
Pit1A	718.77	716.95	0	0.3
N207	716.95	716.95	0	0
N25	6.77	6.77	0	0
N29	4.94	4.94	0	0
N30	9.87	9.87	0	0
N41	14.15	14.15	0	0
N39	14.15	14.15	0	0
N27	6.77	6.77	0	0
N20	3.84	3.84	0	0
N21	7.69	7.69	0	0
Pit107	13.1	13.08	0	0.2
Pit108	25.88	25.86	0	0.1
Pit109	32.41	32.42	0	0
Pit110	59.54	59.53	0	0
Pit111	85.74	84.95	0.79	0
Pit112	131.73	130.94	0.79	0
Pit100	54.06	54.06	0	0
Pit101	210.31	209.64	0.57	0
Pit102	218.67	218.35	0	0.1
Pit103	434.92	434.33	0	0.1
Pit103A	459.8	457.89	0	0.4
Pit104	521.07	518.93	0	0.4
Pit115	61.51	61.5	0	0
Pit113	41.13	39.98	1.14	0
Pit114	133.03	133.25	0	-0.2

Water was lost from the system at Pit1A.

Is this correct? If this water re-enters the system further downstream you should draw an overflow route from this location.

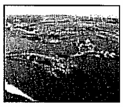
Upwelling occurred at Pit105
Freeboard was less than 0.15m at Pit103A, Pit114, Pit113, Pit115, Pit104, Pit103, Pit107, Pit110, Pit108, Pit106

The following overflow routes carried water uphill (adding energy): OF11, OF1
These results may be invalid. You should check for water flowing round in circles at these locations. You may need to reformulate the model.

APPENDIX G – BROWN CONSULTING – PAD 4 STORMWATER CONCEPT PLAN EASTERN LANDS ERSKINE PARK

BROWN
CONSULTING

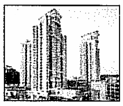
PAD 4 STORMWATER CONCEPT PLAN EASTERN LANDS ERSKINE PARK

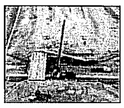


JULY 2006

Report No. W03033.12-06C

Prepared for CSR Limited

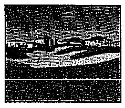




BROWN CONSULTING

Engineers & Managers

PEOPLE & PROJECTS



Stormwater flows from the roof areas will be directed to the OSD tank in the south-west corner of the site. The downpipes and drainage network for this system will need to be sized to convey the 100 year ARI flows to the tank.

It is proposed to provide a reconstructed creek system for the part of the overall development site (pads 4, 5 and 7 and the road drainage) draining to the southern boundary of the site. This is covered in detail in the report *South Eastern Creek Realignment, Erskine Park* by Brown Consulting.

3 CONCEPT OSD SYSTEM DESIGN

3.1 PRE-DEVELOPED FLOWS

The pre-developed site flows for Pad 4 have been determined using the *DRAINS* computer package with RAFTS type hydrology. These flows were established to enable comparison between existing and developed site flows.

Table 3.1 below summarises the pre-development catchment characteristics adopted to determine these flows.

Table 3.1 Pre-Development Catchment Characteristics

Variable	Pad 4
Area (ha)	7.76
Slope (%)	1.9
% Imp	5
Manning 'n'	0.035

Table 3.2 below summarises the peak flows from Pad 4 for the pre-development scenario.

Table 3.2 Pre-Development Peak Flows

ARI (Years)	Flow (m^3/s)
5	0.84
20	1.24
100	1.89

3.2 POST-DEVELOPED FLOWS

For the post-developed scenario the same pad area adopted for the pre-developed flows was adopted, however the fraction impervious was increased to 90% impervious as per Table 4 of the "Penrith City Council Guidelines for Engineering Works for Subdivision and Developments." The slope was also reduced to 1% as this is the estimated finished grade on all pipes and surfaces for the post-development scenario, and the roughness was reduced to 0.015.

Table 3.3 below summarises the peak flow of the site for the post-developed scenario. The results of the *DRAINS* run have been attached in **Appendix C**.

Table 3.3 Post-Development Peak Flows

ARI (Years)	Flow (m^3/s)
5	2.62
20	3.48
100	4.32

As the post-development peak flows exceed the pre-developed flows, On-Site Stormwater Detention will need to be provided.

3.3 POST-DEVELOPED FLOWS WITH OSD SYSTEM

All runoff from non-roof areas will be directed to a water quality device before being discharged from the site. The truck parking and overflow car park areas will drain to the bio-retention basin in the south-west of the site, whilst the other car park areas will drain to central bio-filtration swales then to the OSD tank. The bio-retention basin will store small storm volumes (up to 1 year ARI), with the stored water passing through a bio-filtration medium before being released to the drainage swale to the west of the site. Any flows in excess of the volume of this water quality basin will pass through a high level overflow pipe into Swale 2 to the west of the site.

All roof area runoff will be conveyed directly to the OSD tank. This OSD tank will be equipped with a high early discharge chamber, and both the tank and the bio-retention basin will form the OSD for the site.

The proposed OSD has been designed to limit the post-developed flows to the pre-development flows summarised in **Table 3.2**. This design was undertaken in the DRAINS program.

Table 3.4 below summarises the design characteristics adopted for the OSD tank, whilst **Table 4.2** summarises the design characteristics of the basin. The *DRAINS* results for the basin are attached in **Appendix B**, and the peak flows for the 5, 20, and 100 year ARI are summarised in **Table 3.5**.

Table 3.4 Pad 4 OSD Tank Characteristics

Variable	Detention
Base RL	45.50
Low Level Outlet RL	45.50
Orifice Diameter (mm)	600
Top RL	47.00
Base Area (m^2)	866
Tank Vol (m^3)	1300

Table 3.5 demonstrates that the proposed OSD tank and basin will satisfactorily reduce the post-developed flows to the pre-developed flows.

Table 3.5 Post-Development Peak Flows with OSD

ARI (Years)	Flow (m^3/s)
5	0.78
20	0.82
100	1.45

4 STORMWATER TREATMENT

4.1 STORMWATER QUALITY OBJECTIVES

The stormwater treatment objectives for the proposed bio-retention basin have been adopted from the "Erskine Park Employment Area" DCP. The identified target pollutant removal efficiencies from this document are summarised below in **Table 4.1**.

Table 4.1 Pollutant Removal Objectives

Nutrient	Pollutant Removal Criteria (%)
Total Phosphorous	45
Total Nitrogen	45
Total Suspended Solids	80

BROWN

4.2 STORMWATER TREATMENT STRATEGY

The stormwater treatment strategy for the site includes; bio-retention basins, litter pits and bio-filtration swales. In addition, stormwater reuse will be undertaken to reduce potable water demand. This will take the form of rainwater tanks that will be allocated to the site for potential use for irrigation, toilet flushing and other non-potable uses, possibly such as truck washing.

The clean water from the roof area of the Pad 4 site will be directed to the OSD tank rather than the water quality basin. All other runoff from Pad 4 will be directed to water quality devices before being discharged.

4.3 PAD 4 WATER QUALITY BASIN

The proposed water quality basin has been sized using the MUSIC water quality program. The model data and results have been attached in **Appendix C** and a summary of the designed basin details is shown below in **Table 4.2**.

Table 4.2 Pad 4 Bio-Filtration Basin Details

Parameter	
Basin Base Area (m^2)	520
Bio-filter Area (m^2)	520
Base Level (m AHD)	45.5
Depth of Ponding (m) when overflow begins	1.3
Volume 1 Year ARI (m^3)	600
Peak Flow 1 Year ARI (m^3/s)	0.38
Volume of Filtration Basin (m^3) at Overflow Level	700
Filter Depth (m)	0.6

The basin has been designed to store greater than the 1 Year ARI storm event and drain this via a subsoil drainage system under the bio-filter layer. All flows which exceed the 1 Year ARI will overflow to the grass buffer strip to the west, then across the buffer strip to the swale.

The basin has been run through the *MUSIC* program to assess whether the design will meet the requirements spelled out in the "Erskine Park Employment Area – Development Control Plan" shown in **Table 4.1**. The input data and results of this model have been attached in **Appendix C. Table 4.3** below compares the post-treatment annual pollutant loads with the pre-treatment pollutant loads calculated in the *MUSIC* model, and the calculated removal efficiency these represent.

Table 4.3 Comparison of Pre-treatment and Post-treatment Pollutant Loads for the Developed Site from the MUSIC Model

Site	Loads (kg/y)		
	TSS	TP	TN
Pre-treatment	1620	4.3	31.8
Post-treatment	132	0.88	11.3
Removal Efficiency	91.8%	79.8%	64.5%

Table 4.3 above demonstrates that the treatment train designed will adequately meet the requirements of the Erskine Park Employment Area DCP, and reduce the post-development pollutant loads by more than the amounts shown in **Table 4.1**.

5 SOIL & WATER MANAGEMENT DURING CONSTRUCTION

Sedimentation and erosion controls will be constructed prior to commencement of any work to minimise the discharge of sediment from the site. The controls will be designed and installed in accordance with the requirements of the NSW Department of Housing 'Soils & Construction' manual.

5.1 TEMPORARY SEDIMENT & EROSION CONTROLS

The engineering bulk earthworks drawings show the concept sediment and erosion control plan for the development.

- A single all weather access way at the front of the property consisting of 50-75mm aggregate or similar material at a minimum thickness of 150mm, laid over geo-fabric and constructed prior to commencement of works.
- A shaker pad will be used at the entrance to the site to remove clay from vehicles leaving the site so as to maintain public roads in a clean condition.
- This sediment control basin should be located where the proposed water quality basin is to be constructed immediately to the west of the site. Once the majority of the site has been constructed the basin should then be converted to its ultimate use as a water quality control basin.
- Disturbed areas will be rehabilitated with indigenous plant species, landscaped and treated by approved methods of erosion mitigation such as mulching, revegetation with native grasses or other suitable stabilising processes within fifteen days of the completion of works.
- All runoff and erosion controls will be installed before any works are carried out at the site.
- Upslope clean surface runoff will be diverted via diversion drains and sediment fencing around the disturbed areas.
- Installing *SoilLocker* at the down-slope of the disturbed areas to capture sediment and debris escaping from the site.

- *SoilLocker* shall be installed on the boundary of the creek buffer area.
- Topsoil stockpiling stripped from the construction site shall be diverted away from drainage lines, stormwater inlets and be suitably covered by impervious membrane material and screened by sediment fencing.
- Sediment end erosion controls shall be inspected weekly or after each storm event for litter, sediment, and organic waste accumulation. All sediment/debris shall be removed within two (2) working days.

5.2 SEDIMENT BASIN CONCEPT DESIGN

The sediment basin has been designed to capture the first 25mm runoff from the 75th percentile, 5-day rainfall event, as per the NSW Department of Housing Guidelines. An additional 50% capacity has been provided for storage of sediment.

The concept design is based on the equation: $V = 10.C_v.A.R_{5day\ 75th\%\ ile}$

As recommended by the *NSW Department of Housing (1998)*, a volumetric runoff coefficient (C_v) of 0.5 has been adopted for the construction phase. The outlet to each of the basins will be a slow control discharge. A spillway will be incorporated into the basin design for an overflow.

5.3 SEDIMENT BASIN FLOCCULATION & DISCHARGE WATER QUALITY CRITERIA

Runoff captured in the sediment basin will be treated with an approved flocculating agent before discharging water, as the catchment contains soils that are classified as fine dispersible, which do not readily settle from suspension. The flocculation should ensure that discharges contain no more than 50 mg/L of suspended solids or 30 NTU before being discharged. Furthermore, dewatering should preferably be over existing stable, grassed areas and not directly into the creek.

6 CONCLUSION

This Stormwater Concept Plan describes the management of stormwater within Pad 4. The report sets out the basic stormwater parameters that need to be met by the future development of the site.

The proposal satisfies the requirements for stormwater quality and quantity control identified by Penrith Council in the DCP for the area.