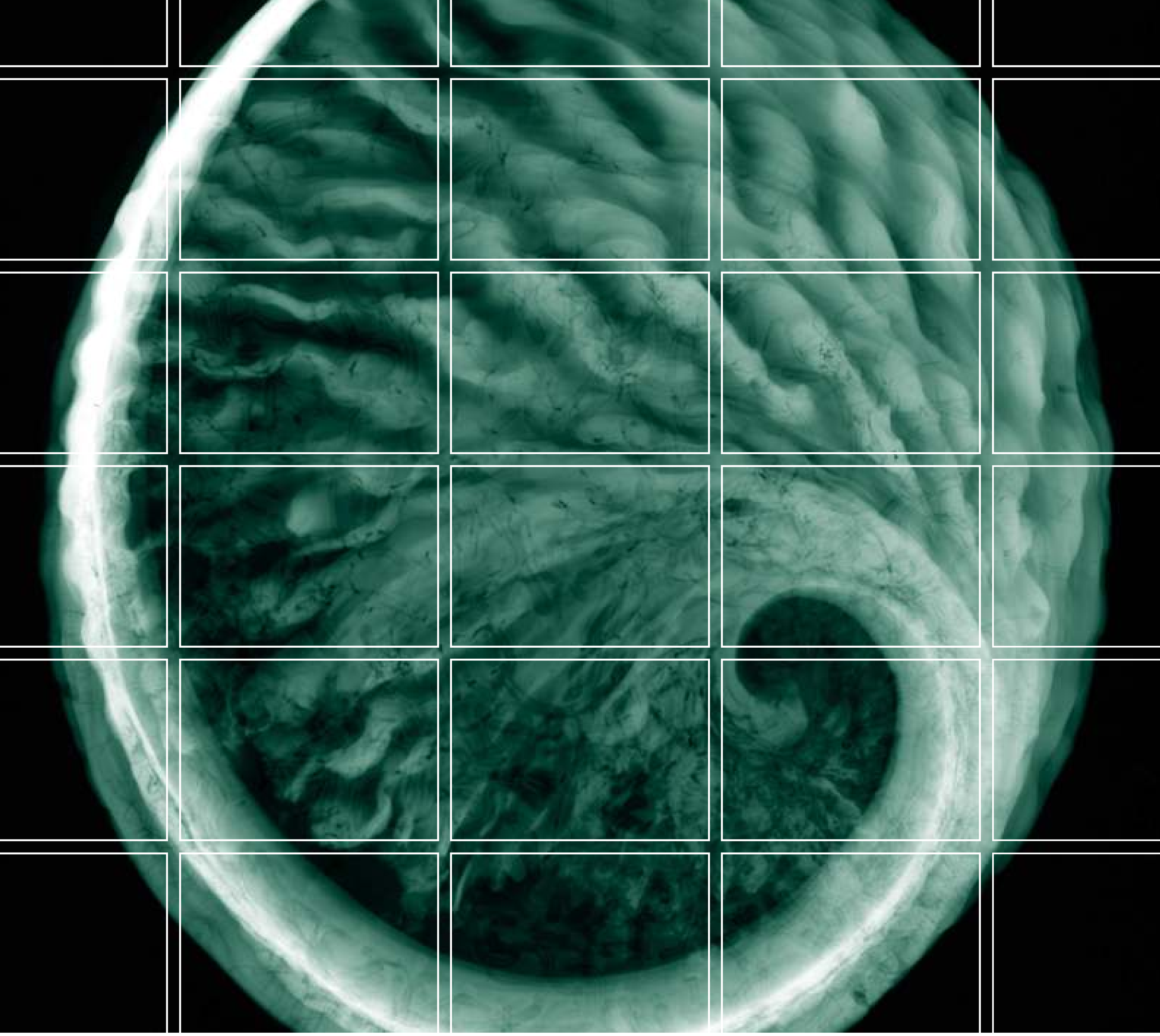


Warwick Farm Printing Project

Environmental Planning and
Assessment – Water

for Independent Print Media Group Pty Ltd

October 2008

0086333

www.erm.com

Delivering sustainable solutions in a more competitive world

ERM

Approved by:	*Denis van Moeffaert*
Position:	Water Engineer
Signed:	
Date:	*2 October, 2008*
Approved by:	*Chris Jack*
Position:	Partner
Signed:	
Date:	*2 October, 2008*

Environmental Resources Management Australia Pty Ltd Quality System

CLIENT: Independent Print Media Group Pty Ltd

Warwick Farm Printing Project

Environmental Planning and Assessment – Water

October 2008

Reference: 0086333

Environmental Resources Management Australia
Building C,
33 Saunders Street,
Pyrmont, NSW 2009
Telephone +61 2 8584 8888
Facsimile +61 2 8584 8800
www.erm.com

CONTENTS

LIST OF TABLES

EXECUTIVE SUMMARY

IPMG is the market leading print group in Australia and is looking to expand and develop its business in Western Sydney, which involves the modification, refurbishment and extension of the existing Kimberley Clark manufacturing plant into a new facility for print production, warehousing and distribution. The proposed development is a Major Project to which part 3A of the Environmental Planning and Assessment Act 1979 (the Act) applies. ERM has been engaged by IPMG to address the Director General's Requirements (DGRs) as they relate to water, including the preparation of a concept stormwater management plan, an assessment of wastewater generation and treatment and a water balance.

The design for extension of the existing manufacturing plant will result in an increase of impervious area of 4,000 m² or approximately 5% of the total site area. This leads to quicker, more frequent and higher peak discharges. Discharge as a function of catchment area and the runoff coefficient is calculated for the roof area, landscaped areas and impervious areas, for a 1:10 year and a 1:100 year storm event. The increased discharge for all storms up to and including a 100 year event can be accommodated by the existing stormwater pipe system. Therefore On-site Detention (OSD) is not necessary according to Liverpool Council's OSD Policy. Following consultation with Liverpool City Council, stormwater treatment on site should include Gross Pollutant Traps (GPTs). GPTs filter coarse particles from stormwater and improve the quality of stormwater before it enters waterways.

The Rotogravure printing process used by IPMG utilises two key elements to produce printed products, namely cylinder production and the printing press. Both cylinder production and the printing press generate wastewater streams. Wastewater streams resulting from the printer cylinder production are treated by a closed loop system. Wastewater from the preparation process is first pumped into a holding tank and then sent through to a filter. After filtration, 95% of the liquid is water returned back into the system via deionizer units. The 5% of material, now a 'thin sludge' is sent to 1,000 litre tanks. The tanks are emptied periodically by disposal contractors.

A Vapour Recovery Unit is proposed to treat wastewater streams generated by the printing press. These wastewater streams exist of toluene solvent used to dilute the ink in the printing process. The vapour recovery system consists of five recovery vessels. Solvent laden air is pumped through the vessels which contain beds of activated carbon. The activated carbon beds recover the solvent and emit only clean air. After each process cycle the carbon is cleaned and reactivated by pumping steam through the recovery vessel supplied from two package boilers located near to the recovery system. Solvent is recovered from the steam first by cooling, and then by phase separation where the water is recovered, polished and then returned to the boiler. Recovered solvent is stored and reused in the print process, or can be recovered for reuse by ink manufacturers.

A water balance for the project on site has been prepared. This includes calculation of the total site water use and the component of this water usage that can be supplied from the rainwater tanks. In an attempt to minimise the impact of the development on the Sydney Water mains supply the redevelopment has been designed to treat and reuse wastewater and to capture rainwater for non-potable use on site. Consequently, the rainfall capture and storage system proposed as part of the redevelopment will lead to a reduction in mains water usage of 69% compared with a scenario where all site water usage is supplied by mains water.

1 INTRODUCTION

1.1 OVERVIEW

The Independent Print Media Group Pty Ltd (IPMG) is the market leading print group in Australia with plants located in Sydney, Melbourne and Brisbane. IPMG is looking to expand and develop its business in Western Sydney, which involves the modification, refurbishment and extension of the existing Kimberley Clark manufacturing plant at 23 Scrivener Street, Warwick Farm, NSW into a new facility for print production, warehousing and distribution. The proposed development is a Major Project to which part 3A of the Environmental Planning and Assessment Act 1979 (the Act) applies.

The development will have an impact on water usage, stormwater management, and wastewater streams. The project will increase the impervious area on the site by 4,000 m^2 through the construction of a new warehouse which will increase stormwater flow volumes and velocities. The development also includes the installation of three rotary printing presses, a vapour recovery unit and an ink supply system which will impact on water usage, wastewater generation and treatment.

The objective of this report is to address the Director General's Requirements (DGRs) under Part 3A of the *Environmental Planning and Assessment Act* (the Act) as they relate to water. A separate erosion and sediment control plan will be prepared for the construction at the facility.

1.2 REPORT STRUCTURE

To meet the objectives outlined above, the report has been structured around the DGRs. This includes the preparation of a concept stormwater management plan (Chapter 2), an assessment of wastewater generation and treatment (Chapter 3) and a water balance (Chapter 4).

1.3 SITE DESCRIPTION AND SURROUNDING LAND USES

The site location is presented on *Figure 1* in *Annex A*. The 7.9 hectare site is located in an industrial area at Warwick Farm in the Liverpool local government area. The site is bounded by the Main Southern Railway on its western side, Priddle Street to the north, Scrivener Street and small industrial units to the east, and the Liverpool Hospital car park to the south. The site contains a large warehouse type building, approximately 3.5 hectares in area, currently owned and operated by Kimberley Clark for the manufacture, storage and distribution of paper products. The current operation is winding down and Kimberley Clark is relocating elsewhere.

The existing building was built in the early 1970s and extended in the 1980s. It is currently in good condition and is equipped with a fire sprinkler system, has double insulation in the roof areas and the manufacturing area is air conditioned. The "L-Shaped" building occupies a footprint of approximately 3.5ha with a roadway around the periphery and a small carpark in the northwest area of the site. The building is a mixture of brick and corrugated metal construction. The remainder of the site not covered by the building and the roadway, is landscaped and covered with grass and native trees.

Surrounding uses include a range of large industrial operations (including Visy Australia), light industrial units, stables associated with Warwick Farm Racecourse (currently zoned residential 2(b) Racecourse), and ancillary buildings and parking associated with Liverpool Hospital. The site and surrounding land uses are presented in *Figure 2* in *Annex A*.

The site is zoned 4(a) Industrial under Liverpool Local Environmental Plan (LEP) 1997. Industries, warehousing and distribution are all permissible with consent in the zone. It should be noted that warehousing and distribution are ancillary to the main use which is printing.

1.4 CATCHMENT DESCRIPTION

The Liverpool local government area covers substantial portions of both the Georges River catchment and the Hawkesbury-Nepean River catchment. The stormwater drainage catchment area for the site is presented in *Figure 3* in *Annex A*. The Site's catchment area leads to a small watercourse on the opposite side of the corner of Scrivener and Priddle Streets, which receives culvert drainage and flows west to Horseshoe Pond.

1.5 CONSULTATION

During the preparation of this Environmental Planning and Assessment Report relating to soil and water, consultation has been conducted with The NSW Department of Water and Energy (DWE), Liverpool City Council (LCC) and Sydney Water (SW).

As noted in correspondence from Greg Brady of DWE on 02/07/2008 (see *Annex B*), the department does not have any concerns relating to the development provided it does not impact on groundwater resources.

Liverpool City Council has been consulted with respect to any impact on their Stormwater System. Additional information has been obtained from the Council to determine the capacity of their existing stormwater infrastructure in Priddle Street. Additional detail is provided in Chapter 2.

Sydney Water does not own stormwater infrastructure that will be affected in the area and referred to Liverpool City Council for matters relating to stormwater. The site does not require a trade waste agreement since none of the wastewater generated on the site other than domestic wastewater from showers, toilets etc will be discharged to the sewer system. Additional detail is provided in Chapter 3.

2 STORMWATER MANAGEMENT SYSTEM

2.1 STATUTORY STORMWATER PLANNING CONTROLS

Liverpool City Council's *Development Control Plan (DCP) No. 6 for Industrial Areas* is designed to ensure that stormwater runoff from industrial developments is collected and discharged in an appropriate manner. The DCP states that "a Stormwater Management Plan (SMP) is required to detail the proposed stormwater infrastructure provision and stormwater treatment on and downstream of the subject site." The DCP also states that "all DAs must be supported by documentation demonstrating how the development incorporates water efficient processes, water recycling, and water conservation."

Water Conservation

1. "Water conservation shall be promoted in all developments. The development should incorporate water efficient fittings and processes and incorporate water reuse options should be pursued."

2. "All development is to harvest and collect rainwater or where possible connect to a recycled water scheme in order to utilise non-potable water sources for landscape irrigation, fire fighting and toilet flushing."

Pollution Control

1. All industrial developments must control any emissions in accordance with the Environment Protection Authority (EPA) requirements and the Protection of the Environment Operations Act 1997.

2. Any water discharged from the development must be treated on-site prior to discharge in accordance with the EPA and/or Sydney Water requirements.

All calculations and recommendations in the next sections of the Stormwater Management System comply with *Liverpool's "Handbook for Drainage Design Criteria"*. That handbook contains design Intensity-Frequency-Duration (IFD) tables, percentages for impervious areas, runoff coefficients and the On Site Detention Policy.

Other relevant publications or reports that are relevant to stormwater as part of this report are:

- *New South Wales Specification 220, Stormwater Drainage General*
- *New South Wales Specification 223, Drainage Structures*

- *New South Wales Development Construction Specification C230, Subsurface Drainage General*
- *Liverpool's City Councils Stormwater Drainage Design Specification D5*
- *Managing Urban Stormwater: Treatment Techniques (EPA)*
- *Managing Urban Stormwater: Source Control. Draft (EPA)*
- *Managing Urban Stormwater: Harvesting and Reuse (DEC)*

2.2 IMPACT OF THE PROPOSED DEVELOPMENT

2.2.1 Existing stormwater system

Figure 4 in *Annex A* presents a schematic overview of the existing stormwater system on the site. Currently runoff from all impervious areas including the warehouse roof and hardstanding areas is discharged to two stormwater pipes with diameter 1500mm, in Priddle Street.

The maximum capacity of the receiving 1500mm pipes in Priddle Street (see *Figure 4* in *Annex A*) is determined using the Manning equation:

$Q = A \times V$

$V = 1/n \times R^{0.66} \times S^{0.5}$

Where

Q = Capacity (m^3/sec)

A = Area (m^2)

n = Manning roughness coefficient

R = Hydraulic radius (= D/4)

S = Hydraulic gradient (m/m)

V = Velocity (m/s)

According to these calculations, the southern receiving stormwater pipe has a maximum capacity of 7.5 m^3/s and the northern pipe 3.76 m^3/s.

The current stormwater flow in the receiving pipes is determined taking the total catchment area into account. The Time of Concentration (T_c) for the total catchment area as presented in *Figure 3* in *Annex A* is 39 minutes. The following formula is used to calculate T_c:

$T_c = (58 \times L)/(A^{0.1} \times S^{0.2})$

Where

T_c = Time of Concentration (s)

L = Distance from the furthest point of the catchment to the bottom of the catchment (m)

A = Area (m^2)

S = Hydraulic gradient (m/m)

The peak discharge for a 1:10 year storm event with duration of 39 minutes is 0.433 m^3/s. The following formula is used to calculate the peak discharge:

$Q = c \times I \times A$

Where

Q = Discharge (m^3/sec)

C = run-off coefficient

I = rain intensity (mm/hr)

A = Area (m^2)

It is assumed that all drainage water from the site is connected to the southern stormwater pipe.

2.2.2 *Hydrological Assessment*

The design storm discharges were assessed for the site to determine the potential of the development to impact on downstream flooding and assist in the determination of appropriate stormwater controls. This analysis was carried out for the site in its existing and proposed development scenarios.

The proposed development area is approximately 79,380 m^2. The surface coverage is predominantly impervious areas and roof area. The development of the site is likely to increase stormwater runoff due to the increase in impervious surfaces as well as changes to the soil surface layer. Impervious surfaces reduce the quantity of rainwater that infiltrates to the soil, increase the concentration runoff and increase the potential for pollutants to be transported to streams and waterways. These two effects lead to quicker, more frequent and higher peak discharges, and larger flood volumes. The design for the development will result in an increase of impervious area of 4,000 m^2 or approximately 5% of the total site area as presented in *Figures 5 and 6* in *Annex A*.

The intensity-frequency-duration (IFD) design rainfall information for the Liverpool area is presented in *Table 1*. A design rainfall event is specified by rainfall duration and average rainfall intensity of a particular average recurrence interval (ARI).

Table 1 ***Rainfall Intensity Frequency Duration for Liverpool Council (in mm/hour)***

Time	**Average Recurrence Interval (ARI) in Years**						
	1	**2**	**5**	**10**	**20**	**50**	**100**
5 min	86.52	110.77	140.03	156.59	178.86	207.81	229.53
6	81.06	103.78	131.25	145.92	167.79	195.06	215.49
10	66.37	84.96	107.65	120.48	137.64	160.07	176.90
15	55.57	71.16	90.16	101.00	115.46	134.28	148.44
20	48.50	62.13	78.77	88.26	100.94	117.42	129.42
30	39.46	50.58	64.21	72.00	82.40	95.91	106.10
45	31.59	40.52	51.53	57.84	68.24	77.16	85.41
1 hour	26.74	34.31	43.69	49.09	58.24	65.56	72.60

The minor system design Average Recurrence Interval (ARI) for Liverpool City Council is 1:10 year event for commercial/industrial area "minor" systems.

The minor (piped) system is designed to mitigate nuisance flooding. The major system is the continuous overland flow path or floodway system that is designed to accommodate less frequent large flood events and overflows from the minor system.

The minor system of the site consists of the arrangement of kerbs, gutters, roadside channels, sumps and underground pipelines designed to fully contain and convey runoff generated during a typical storm event.

The major drainage system generally consists of an arrangement of pavements, roadway reserves, floodways, retarding basins, and major cut off drains etc. that are planned to convey a design flood of 100 Years Average Recurrence Interval (ARI).

Using the Rational Method outlined in *Australian Rainfall and Runoff (ARR)*, it was estimated that the site in its current state has a Time of Concentration (T_c) of 16 minutes. The time of concentration is the name given to the time it would take for a drop of rainwater in a reasonably intense storm to get from the furthest point on the catchment to the bottom of the catchment. The development of the site does not affect the T_c.

The overall increase in site stormwater discharge is shown in *Table 2*, which summarises peak flows from the site for a range of design events in both the existing and developed state.

Table 2 ***Pre- and Post-Development Site Runoff***

ARI	Peak Discharge - Q (L/s)	
(Years)	Existing	Developed
1	90.24	93.74
2	115.6	120.08
5	146.56	152.24
10	164.21	170.59
20	187.80	195.09
50	218.47	226.95
100	240.79	250.14

Table 2 shows an increase in post-development site runoff, due to the increase in impervious areas proposed within the development. Discharge calculations for a 1:10 year event and a 1:100 year event as a function of catchment area and the runoff coefficient for the roof area, landscaped areas and impervious areas, before development are shown in *Tables 3 and 4.*

Table 3 ***Discharge Calculations for a 1 in 10 year storm of 10 min duration before development***

Surface	Area (ha)	c	I (mm/hr) 1:10 year 10 min	Q (m³/s)	Q (L/s)
Roof area (incl awnings)	3.81	0.95	120.48	1.2113	1211,3
Impervious area	2.83	0.95	120.48	0.8991	899,1
Landscaping area	1.30	0.30	120.48	0.1305	130.5
TOTAL				2.2410	2241.0

1. Q (m^3/s) = C x I x A / 3600
2. 1m^3 = 1000L
3. c = permeability factor/run-off coefficient

Table 4 ***Discharge Calculations for a 1 in 100 year storm of 10 min duration before development***

Surface	Area (ha)	c	I (mm/hr) 1:100 10 min	Q (m³/s)	Q (L/s) – 10 min
Roof area (incl awnings)	3.81	0.95	176.90	1.7786	1778.6
Impervious area	2.83	0.95	176.90	1.3202	1320.2
Landscaping area	1.3	0.30	176.90	0.1916	191.6
TOTAL				3.2904	3290.4

1. Q (m^3/s) = C x I x A / 3600
2. 1m^3 = 1000L
3. c = permeability factor/run-off coefficient

Discharge calculations for a 1:10 year event and a 1:100 year event as a function of catchment area and permeability for the roof area, landscaped areas and impervious areas, after development are shown in *Tables 5 and 6.*

Table 5 ***Discharge Calculations for a 1 in 10 year storm with duration 10 min after development***

Surface	Area (ha)	c	I (mm/hr) 1:10 year 10 min	Q (m^3/s)	Q (L/s)
Roof area (incl awnings)	4.21	0.95	120.48	1.3385	1338.5
Impervious area	2.83	0.95	120.48	0.8991	899.1
Landscaping area	0.9	0.3	120.48	0.0904	90.4
TOTAL				2.3280	2328

1. Q (m^3/s) = C x I x A / 3600
2. $1m^3$ = 1000L
3. c = permeability factor/run-off coefficient

Table 6 ***Discharge Calculations for a 1 in 100 year storm with duration 10 min after development***

Surface	Area (ha)	c	I (mm/hr) 1:100 10 min	Q (m^3/s)	Q (L/s) – 10 min
Roof area (incl awnings)	4.21	0.95	176.9	1.9653	1965.3
Impervious area	2.83	0.95	176.9	1.3202	1320.2
Landscaping area	0.9	0.3	176.9	0.1327	132.7
TOTAL				3.4182	3418.2

1. Q (m^3/s) = C x I x A / 3600
2. $1m^3$ = 1000L
3. c = permeability factor/run-off coefficient

The additional discharge from the proposed development for a 1:10 year storm of 10 minutes duration is 87 l/s and 127.8 l/s for a 1:100 year storm with 10 minutes duration, or less then 4% increase in discharge for both events.

Section 2.2.1 shows that the capacity of the receiving pipes is more than adequate for the increased stormwater flow. The current maximum capacity of the southern receiving stormwater pipe is 7.5 m^3/s, while the total discharge after development for a 1 in 100 year storm event is 3.418 m^3/s.

Note that a possible detention volume in the proposed rainwater tanks (see *Figure 7* in *Annex A*) is not taken into consideration. In other words, it is assumed that the proposed rainwater tanks are constantly full and can not function as detention tanks.

2.3 MITIGATION OF THE STORMWATER IMPACTS

2.3.1 *Onsite Stormwater Detention Policy*

According to Liverpool City Council's On-site Stormwater Detention Policy, On-site Detention (OSD) shall apply to all developments where any of the following situations occur:

- where there is an existing stormwater system that is unable to cater for the increase in discharge due to development;
- when the development will involve an increase in impervious area on the site; and
- where it is intended to connect stormwater directly to the street kerb and gutter only and the discharge for the 1:100 year storm exceeds 20 litres per second for the 1 in 10 year ARI;

OSD will not be required where it can be shown that:

- The increased discharge for all storms up to and including a 100 year event can be accommodated by the existing stormwater pipe system; and
- Sites substantially inundated by flooding (this is to be confirmed by Council's engineer).

The site is located within the Georges River floodplain and is known to be affected by flooding. Consultation with Liverpool City Council Engineer Stephen Monte confirmed that part of the site is flood prone and that OSD is not required *(see Annex C).*

2.3.2 *Stormwater quality assessment*

Stormwater Treatment

Following consultation with Stephen Monte from Liverpool City Council on 25/06/2008 stormwater treatment on site should include Gross Pollutant Traps (GPTs). GPTs are generally constructed from metal frames with removable trash bags. These traps capture floating debris and litter such as leaf litter and general municipal waste that is bigger than the weave of the trash bags.

GPTs filter coarse particles from stormwater and improve the quality of stormwater before it enters waterways. The material collected should be emptied on a regular basis and disposed to a landfill. GPTs act only as a primary treatment mechanism, improvements in water quality downstream will be incidental to contamination that is associated with coarse particles. Improvements to dissolved water quality will be limited.

Chemical Storage

A range of raw materials will be stored on site including around 25,000 tonnes of paper rolls, ink, solvents, acids, alkalis, plating materials and finished goods. Flooding of the buildings on site could potentially lead to printing chemicals or other hazardous substances being released from the site and impacting on the Georges River. The consequences of contaminant release include reduced water quality and risk to aquatic ecosystems. All dangerous goods are proposed to be securely stored and handled at least 0.5m above the 100 year flood level and contained within the structure.

Cleaning and spillages

The maintenance and cleaning of vehicles and any other equipment or plant must be carried out in areas from where contaminants cannot be released into any waters, roadside gutter or external stormwater drainage system.

Any spillage of wastes, contaminants or other materials must be cleaned up as quickly as practicable using the designated mobile spill kits or other suitable means. Such spillages must not be cleaned up by hosing, sweeping or otherwise releasing such wastes, contaminants or material to any external stormwater drainage system, roadside gutter or waters.

2.4 *MANAGEMENT OF THE MITIGATION MEASURES*

Gross Pollutant Traps are suggested as stormwater quality mitigation.

GPT's only need to be installed for the extension if there are no improvements to be made on the existing infrastructure. A GPT will be installed at the end of the new stormwater pipe prior to discharging to the Liverpool City Council stormwater main in Priddle Street. This location has been chosen to allow easy access for cleaning and maintenance activities. GPT maintenance is an essentially manual task involving frequent litter removal. This usually involves manual scraping of pollutants from the screen on a frequent (e.g. monthly) basis. Removing the collected sediment from the GPT is typically done every six months. Small Gross Pollutant Traps can be located underground, minimising visual impacts.

2.5 *RECOMMENDATION*

Impervious surfaces on the site increase with 5% after development. This leads to quicker, more frequent and higher peak discharges, and larger flood volumes. However, Section 2.2 shows that there is enough capacity in the receiving pipelines in Priddle Street to cope with this increase. On-site Detention is not necessary according to Liverpool Council's On-site Detention Policy.

Stormwater treatment on site should include Gross Pollutant Traps. The GPT comprises three basic functional elements: a trash rack, an apron and a slow draining pool as a sediment trap. This may be a permanent pool, or it may drain to dry condition.

3 WASTEWATER PREDICTIONS AND TREATMENT

3.1 IMPACT

The Rotogravure printing process used by IPMG utilises two key elements to produce printed products, namely cylinder production and the printing press. Both cylinder production and the printing press generate wastewater streams. These two elements are described in detail below.

3.1.1 The Cylinder

The cylinder consists of a copper covered steel tube with the diameter customised to for each printing job. The copper covering is electro-mechanically etched to produce a series of tiny cells from 2 to 5 µm in depth, covering approximately 35,000 cells per cm^2. These create the image to be printed. After the cylinder is etched the surface is hard chromed to give it resilience against mechanical damage whilst rotating on the press.

The chemicals used in the mechanical process of cylinder production are mainly chrome, copper (copper electrolytes and copper sulphates), a sulphuric acid mix and silver oxides. These chemicals affect the waste and wastewater streams.

3.1.2 The press

The finished chromed cylinder is mounted into the gravure press printing unit where it is immersed and rotated in a bath of ink. The liquid ink fills the cells and surplus ink is removed from the rotating cylinder surface via a doctor blade leaving only the ink retained in the cells to be delivered to the paper by the rotating cylinder. Paper is pressed by a roller onto the cylinder where the ink is transferred to the paper. The wet ink is dried by hot air circulating in a chamber over the printing unit and the dried paper continues through the process until it is cut and folded into the finished product.

The ink drying process at the printing presses evaporates the ink carrier solvent. The heat for this process is achieved by the circulation of steam through heat exchanges at each printing unit.

3.2 MITIGATION

Wastewater streams resulting from the galvanic process of the printing cylinder preparation are treated by a closed loop system described in *Section 3.2.1* below and presented in *Figure 8* in *Annex A*.

A Vapour Recovery Unit (VRU) is proposed to control emissions and to recover toluene solvent used to dilute the ink in the printing process, as described in Section 3.2.2 and presented in *Figure 9* in *Annex A*.

3.2.1 *Printer cylinder preparation*

The mechanical engraving process consists of eight steps. This chapter describes the printer cylinder preparation with the proposed wastewater treatment system. These steps are described in order of production, from cylinder out of press, to newly engraved cylinder ready for next job.

Step 1: stripping station

The stripping station is where chrome and copper is manually removed from the cylinder. The copper/chrome shell is sold to a suitable resource recovery contractor.

Waste generated: The stripping station uses no chemicals (except for the copper/chrome shell which is sold to a suitable resource recovery contractor).

Step 2: degreasing station

The degreasing station prepares the cylinder surface so it can accept the next copper/chrome shell. This process is also used after engraving to ensure the chrome has a clean surface.

Waste generated: The degreasing station first uses a diluted sulphuric acid mix to de-oxidize the surface and is then water rinsed. The cylinder is then sprayed with a separation solution which contains silver oxide. This process uses around 25 litres of water each time a cylinder is degreased. All of the liquid is pumped from the degreasing station to the closed loop system described in Section 3.3.1.

Step 3: copper bath

The copper bath consists of two baths:

- The upper tank, where a titanium basket sits, contains copper pallets. The tank liquid consists of a copper electrolyte of 250gms copper sulphate and 60gms of sulphuric acid. The mix is automatically adjusted by a precision dosing pump. The liquid remains in the tank, and is 'topped up' in dose measure after each cylinder production, so there is no disposal required. The cylinder is immersed in the solution and the basket containing pallets automatically adjusts up and down depending on the cylinder circumference.

- After the cylinder is plated, the main upper tank is automatically drained to the secondary tank and the cylinder is rinsed with water containing a small amount of electrolyte. The rinse water is sent to the closed loop system. The bath dries and when the cylinder is removed the electrolyte solution returns to the main tank.

Waste generated: The only liquid that leaves the tank is the rinse water, which goes to the closed loop system.

Step 4: copper polishing

The copper coated cylinder is transferred to the polishing unit. This process prepares the copper surface for engraving and grinds the copper cylinder to the exact circumference required. Polishing is carried out by a series of spray jets. The water rinses out the grinding residue, which consists of copper, stone from the grinding wheels, silicant and binding material.

The solution produced from the polishing process is run through separate paper filtration, which removes all the trace elements from the water. The filtered water is returned back into the polishing tank for reuse.

Waste generated: No chemicals are used in the polishing process. Water solution that runs through the paper filter is returned to the polishing tank for reuse as described above. The unit is a fully closed loop system.

Step 5: engraving

The engraving unit is fitted with a vacuum extraction unit which removes the engraved copper particles and transports them into a collection bucket. There is very little copper from an engraved cylinder. What little there is collected as pure copper for subsequent sale.

Waste generated: No chemicals or liquids are used in the engraving process and no waste is generated.

Step 6: degreasing station

Refer to Step 2; the degreasing process is a repeat of Step 2, described above.

Step 7: chrome tank

A computer on the chromic acid tank reads the data supplied by the central system relating to the cylinder circumference and doses only enough chrome which is heated to 55°C to coat the cylinder. A chemical additive "fumex" is also coated to the cylinder as a film to create bubbles and stop evaporation. The hot air generated in this process is exhausted via an exit pipe to a filter. The filter extracts chrome particles out of the water, and the water is returned back into the system. This filtered water is returned to the chrome tank via a closed loop system.

The filter exhausts to atmosphere after processing. It is not possible to remove all chrome from the air; however the filter guarantees a maximum emission of 0.01mg chrome/m^3. The NSW Department of Energy and Climate Change Clean Air Regulation stack emission limit for total Group 1 & 2 metals and hazardous substances (including chrome) is 1 mg/m^3 total for a new Group 6 plant in NSW.

Step 8: chrome polishing

This process is similar to the polishing system used for copper described in Step 4, with several differences which are described below. When the cylinder is loaded it is still hot from the chrome coating process. It is cooled by an air stream and then polished with a paper attachment. The grinding wheels are not used.

The water which is used during the process contains traces of chrome. The cylinder is dried at the end of the rinsing process.

Waste generated: No chemicals are added in this process. The water is pumped through the closed loop filtration system to remove the chrome traces.

The closed loop system is described in detail below:

Wastewater from the cylinder printer preparation process is first pumped into a holding tank. This tank needs to be able to hold up to three days liquid in case the filtration unit is out of operation for an extended period. The liquid from the holding tank is then sent to the filter. The capacity of the filter is more than adequate to process wastewater at full production rates. The filter runs continually until the holding tank is empty. During full production all processing tanks will not be in operation at the same time. When the plant is operating at maximum capacity by running two shifts, it is anticipated that the small tank will not be filled. The printing process will be able to run for approximately 1.5 days before all holding tanks reach capacity and the filter starts operating.

After filtration, 95% of the liquid is water and it is returned back into the system via deioniser units (see *Figure 8* in *Annex A*). The 5% of material, now a 'thin sludge' is sent to holding tanks, which are periodically emptied by disposal contractors.

3.2.2 *Vapour recovery system*

The ink drying process at the printing presses separates the toluene solvent used to dilute the ink. As a mitigation measure, a vapour recovery system is used to remove the toluene solvent separated by the ink drying process at the printing presses.

The process is presented in *Figure 9* in *Annex A* and described in detail below:

- The vapour recovery system consists of five recovery vessels, each approximately 3.5 metres in diameter and approximately 17 metres in length, located parallel to the inner eastern wall of the factory. Solvent laden air (SLA) is pumped through the vessels, which contain beds of activated carbon. The activated carbon beds recover the solvent and emit only clean air.

- After each process cycle (of approximately 40 minutes) the carbon is cleaned and reactivated by pumping steam through the recovery vessel supplied from two package boilers located near to the recovery system. Wastewater from the boilers both during operation and maintenance will contain a weak solution of sulphite. The wastewater is first pumped into a 20 000L holding tank before treatment in the closed loop filtration system, Prior to returning to the boilers as shown in *Figure 9* in *Annex A*.

- Solvent is recovered from the steam first by cooling, and then by phase separation where the water is recovered, polished and then returned to the boiler.

Recovered solvent is stored and reused in the print process, or can be recovered for reuse by ink manufacturers.

3.3 MANAGEMENT

3.3.1 Printer cylinder preparation

The closed loop system is a fully automatic operation including the changeover from one waste container to the next. The process is fully alarmed should the unit shut down for any reason.

3.3.2 Vapour recovery system

The vapour recovery system requires regular maintenance. Planned annual maintenance as well as any additional maintenance is carried out by an authorised supplier.

The vapour recovery system will be operated by trained personnel only. At least two people will be designated as responsible for the plant in accordance with the operational procedures and record-keeping.

3.4 RECOMMENDATION

It is recommended that industrial wastewater streams from the cylinder preparation and the printing process are treated by a closed loop filtration unit and vapour recovery system, as described above. No additional industrial wastewater is discharged to the sewer, so there is no need for a trade waste agreement with Sydney Water.

Domestic wastewater from showers, toilets, etc will continue to be discharged to the sewer system.

4 *DETAILED WATER BALANCE*

A detailed water balance for the project has been prepared and is detailed in the following section. In an attempt to minimise the impact of the development on the Sydney Water mains supply the redevelopment has been designed to treat and reuse wastewater and to capture rainwater for non-potable use on site. *Figure 6* in *Annex A* gives an overview of the impervious areas, landscaped areas and roof areas where rainwater will be captured. A detailed water balance is presented in *Tables 7a* and *7b* below. This includes calculation of the total site water use and the component of this water usage that can be supplied from the rainwater tanks. *Figure 7* provides a schematic view of where water will be used across the site. *Figure 8* provides a schematic overview of the daily volumes used in various parts of the printing process and for general site use.

4.1 *WATER SUPPLY*

As part of the redevelopment a significant rainfall capture system is planned to be installed. This involves the installation of three dedicated rainwater tanks, each with 600,000L capacity. The rainwater capture system will have a total capacity of 1,800,000L and will collect rainwater from a total of 8862m^2 of roof area. The rainwater capture system is independent of two dedicated tanks that are used for firefighting.

This storage system is able to supply all non-potable water usage on the site. It is anticipated that by implementing the rainwater capture, storage and usage system that the site will reduce mains water usage by 69%.

An assessment of the historical rainfall data from the Liverpool Bureau of Meteorology (BoM) station (067035) between 1996 and 2007 was undertaken. It was determined that the lowest monthly rainfall over this period was 38.1mm. The lowest monthly rainfall on record would produce a volume of 337,938 Litres to be captured in the rainwater storage tanks which would lead to a shortfall of 6.9% in relation to site water usage. However, assuming the worst case monthly shortfall it would take 5.9 years to empty the rainwater storage from full capacity. The historical rainfall record indicates that a period of prolonged low rainfall of 5.9 years has not occurred in the past.

Based on the information above the 1,800,000L rainwater storage is considered sufficient to supply current projected water usage detailed below.

4.2 *TOTAL PROJECTED SITE WATER USAGE*

Total water usage on site can be divided in process water usage and miscellaneous water usage relating to staff amenities. The total water usage on site is 19,415 L/day or 6,334,724 L/year as shown in *Table 7a*.

The following sections provide detail on the process water usage and miscellaneous water usage on site.

4.2.1 *Process water usage*

Process water is required for the pre-press phase (cylinder preparation), the printing phase and the recovery phase of the printing process.

Wastewater produced by the pre-press phase flows to the closed loop filtration system (as described in Chapter 3). The vast amount of this wastewater stream, namely 95%, is then sent back through a deioniser unit to the pre-press phase, as shown in *Figure 8* in *Annex A*. Only 5% of the wastewater flow is lost and sent to a storage tank to be collected by a disposal company. In summary, the pre-press phase uses 1,632 L/day of deionised water and 480 L/day of mains water.

During the printing phase, paper is pressed by a roller onto the cylinder where ink is transferred to the paper. Hot air is then circulated in a chamber over the printing unit to dry the paper. The heat for this process is achieved by the circulation of steam through heat exchangers at each printing unit. Two boilers are used to generate this steam and steam losses are estimated at 10%. Assuming a machine usage of 408 Litres/hour and 372 Litres/hour and 10% steam loss, the water usage is calculated to be 1,872 L/day (Steam Press 1 uses 979 L/day and Steam Press 2 uses 893 L/day).

In the vapour recovery system, activated carbon beds are used to recover the solvent. Steam supplied from two package boilers is pumped through the recovery vessel to clean and reactivate the carbon through the recovery vessel. Steam losses for the recovery system are estimated at 20%. The recovery system uses a total of 375 L/day (Boiler 1: 196 L/day and Boiler 2: 179 L/day) as presented in *Table 7a*.

The total amount of process water usage equates to 4,358 Litres/day or 1,363,557 Litres/year.

4.2.2 *Miscellaneous water usage*

Staff on site use water for a number of activities such as showering, hand washing, catering and toilets. The following figures were assumed to estimate the volumes of water used by staff:

- Number of days of operation: 6 days/week
- Number of staff: 190 person
- Average toilet use per day: 3 visits/person
- Litres water usage per toilet use: 6.5 Litres/ usage

Other water usage on site that is not related to the printing process includes irrigation and vehicle washing. The total miscellaneous water usage on site is 15,056 L/day or 4,971,167 L/year.

Table 7a Total Water Usage on Site

PROCESS WATER USAGE	*Litres/hr*	*Litres/hr*	*Litres/day*	*Litres/week*	*Litres/month*	*Litre/year*
Pre Press						
Deionised Water		68	1,632	9,792	42,549	510,583
Tap Water		20	480	2,880	12,514	150,171
Press Room	*Machine usage*	*Loss (10%)*				
Steam is recycled to be used repeatedly through presses.						
Steam Press 1 (allow for 10% water loss every cycle)	408	40.8	979	5,875	25,529	306,350
Steam Press 2 (allow for 10% water loss every cycle)	372	37.2	893	5,357	23,277	279,319
Steam Recovery	*Machine usage*	*Loss (20%)*				
Recovery of Steam from Presses						
Steam Press 1 (allow for 20% water loss every cycle)	41	8.2	196	1,175	5,106	61,270
Steam Press 2 (allow for 20% water loss every cycle)	37	7.4	179	1,071	4,655	55,864
Sub Total		**182**	**4,358**	**26,150**	**113,630**	**1,363,557**
MISCELLANEOUS WATER USAGE	*Litres/Use*	*Litres/hr*	*Litres/day*	*Litres/week*	*Litres/month*	*Litre/year*
Toilets	6.5	154.4	3,705	22,230	96,595	1,159,136
Showers (fresh water only)		*48.25*	*1,158*	*6,948*	*30,191*	*362,289*
Hand Wash Basins ((fresh water only)		*25*	*600*	*3,600*	*15,643*	*187,714*
Canteen/Tea Making ((fresh water only)		*190*	*4,560*	*27,360*	*118,886*	*1,426,629*
Irrigation (365 days per year)			5,000	35,000	152,083	1,825,000
Vehicle Washing			33	199	867	10,400
Sub Total			**15,056**	**95,337**	**414,264**	**4,971,167**
Total Water Usage on Site			**19,415**	**121,488**	**527,894**	**6,334,724**

4.3 WATER USAGE SUPPLIED FROM RAINWATER CAPTURE

Table 7b presents the different parts of the site which can be supplied with rainwater. Showering, hand wash basins and canteen activities require potable water and must be supplied with mains water.

The total water usage that can be supplied from the rainwater tanks is 13.097 L/day or 4,358,092 L/year.

4.3.1 Process water usage

All process water can be provided by the rainwater tanks as presented in *Table 7b*. The total process water usage to be provided by the rainwater tanks is 4,358 L/day or 1,363,557 L/year.

4.3.2 Miscellaneous water usage

The toilets, irrigation facilities and vehicle washing can be supplied by rainwater. Mains water is provided for showering, hand wash basins and canteen activities.

The total amount of water usage provide by rainwater tanks for these activities is 8,738 L/day or 2,994,536 L/year.

Table 7b: Total Water Usage that can be supplied from the rainwater tanks

PROCESS	*Litres/hr*	*Litres/hr*	*Litres/day*	*Litres/week*	*Litres/month*	*Litre/year*
Pre Press						
Deionised Water		68	1,632	9,792	42,549	510,583
Tap Water		20	480	2,880	12,514	150,171
Press Room	**Machine usage**	**Loss (10%)**				
Steam is recycled to be used repeatedly through presses.						
Steam Press 1 (allow for 10% water loss every cycle)	408	40.8	979	5,875	25,529	306,350
Steam Press 2 (allow for 10% water loss every cycle)	372	37.2	893	5,357	23,277	279,319
Steam Recovery	**Machine usage**	**Loss (20%)**				
Recovery of Steam from Presses						
Steam Press 1 (allow for 20% water loss every cycle)	41	8.2	196	1,175	5,106	61,270
Steam Press 2 (allow for 20% water loss every cycle)	37	7.4	179	1,071	4,655	55,864
Sub Total		**182**	**4,358**	**26,150**	**113,630**	**1,363,557**
MISCELLANEOUS	*Litres/hr*	*Litres/hr*	*Litres/day*	*Litres/week*	*Litres/month*	*Litre/year*
Toilets	6.5	154.4	3,705	22,230	96,595	1,159,136
Irrigation (365 days per year)			5,000	35,000	152,083	1,825,000
Vehicle Washing			33	199	867	10,400
Sub Total			**8,738**	**57,429**	**249,545**	**2,994,536**
Total Water Usage that can be supplied from Tanks			**13,097**	**83,580**	**363,174**	**4,358,092**

4.4 WATER SAVINGS

On an annual basis a total of 6,334,724 Litres of water is used on site. Of the total projected water use 4,358,092 Litres can be provide by the rainwater storage. In addition there will be a minimum 1,979,631 Litres required to be provided by mains water annually.

Consequently, the rainfall capture and storage system proposed as part of the redevelopment will lead to a reduction in mains water usage of 69% compared with a scenario where all site water usage is supplied by mains water.

REFERENCES

Liverpool City Council's On-site Stormwater Detention Policy

Liverpool City Council's Development Control (DCP) Plan No. 6 for Industrial Areas

Liverpool City Council's handbook for drainage design criteria

New South Wales Specification 220, Stormwater Drainage General

Liverpool City Council's Stormwater Drainage Design Specification D5

New South Wales Development Construction Specification C230, Subsurface Drainage General

New South Wales Specification 223, Drainage Structures

Preliminary environmental assessment, 23 Scrivener Street, Warwick Farm Lot 1 DP774089, JBA Urban Planning Consultants

www.liverpoolcouncil.com.au

Managing Urban Stormwater:: Treatment techniques (EPA)

Managing Urban Stormwater: Source Control. Draft (EPA)

Managing Urban Stormwater: Harvesting and Reuse (DEC)

Mechanical engraving – environmental analysis, Vapour Recovery System

Annex A

Figures

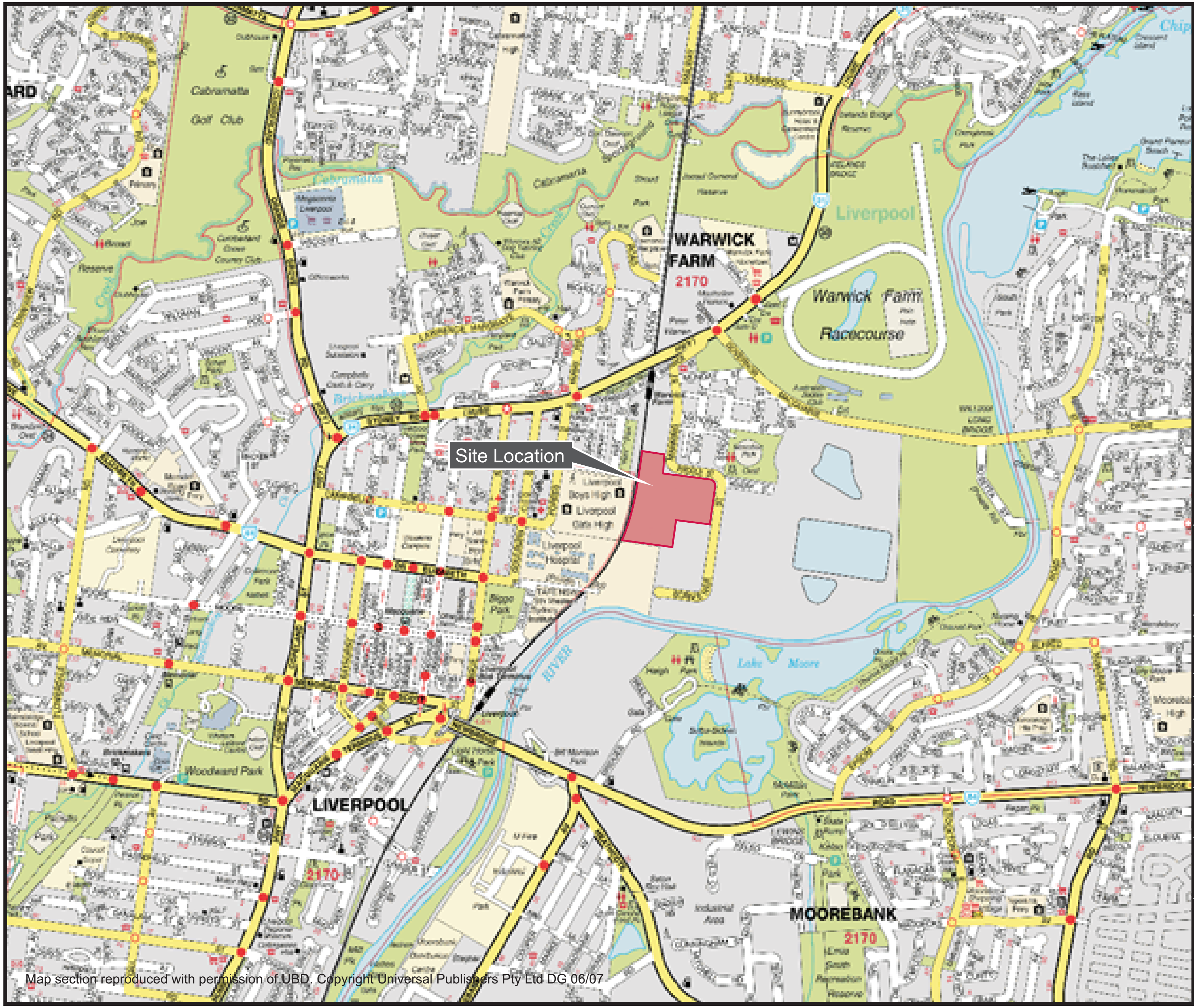


Figure 1
Site Location

Client:	IPMG		
Project:	Warwick Farm Printer Project		
Drawing No:	0086333s_03		
Date:	08/07/2008	Drawing size:	A4
Drawn by:	ML	Reviewed by:	-
Source:	UBD		
Scale:	Refer to Scale Bar		

N

0 200 400 600m

Environmental Resources Management Australia Pty Ltd
Building C, 33 Saunders St, Pyrmont, NSW 2009
Telephone +61 2 8584 8888

ERM

Legend

The Site

Proposed Extension

Figure 2

The Site and Surrounding Land Uses

Client:	IPMG		
Project:	Warwick Farm Printer Project		
Drawing No:	0086333s_04		
Date:	23/06/2008	Drawing size:	A4
Drawn by:	ML	Reviewed by:	-
Source:	UBD		
Scale:	Not to Scale		

N

Environmental Resources Management Australia Pty Ltd
Building C, 33 Saunders St, Pyrmont, NSW 2009
Telephone +61 2 8584 8888

ERM

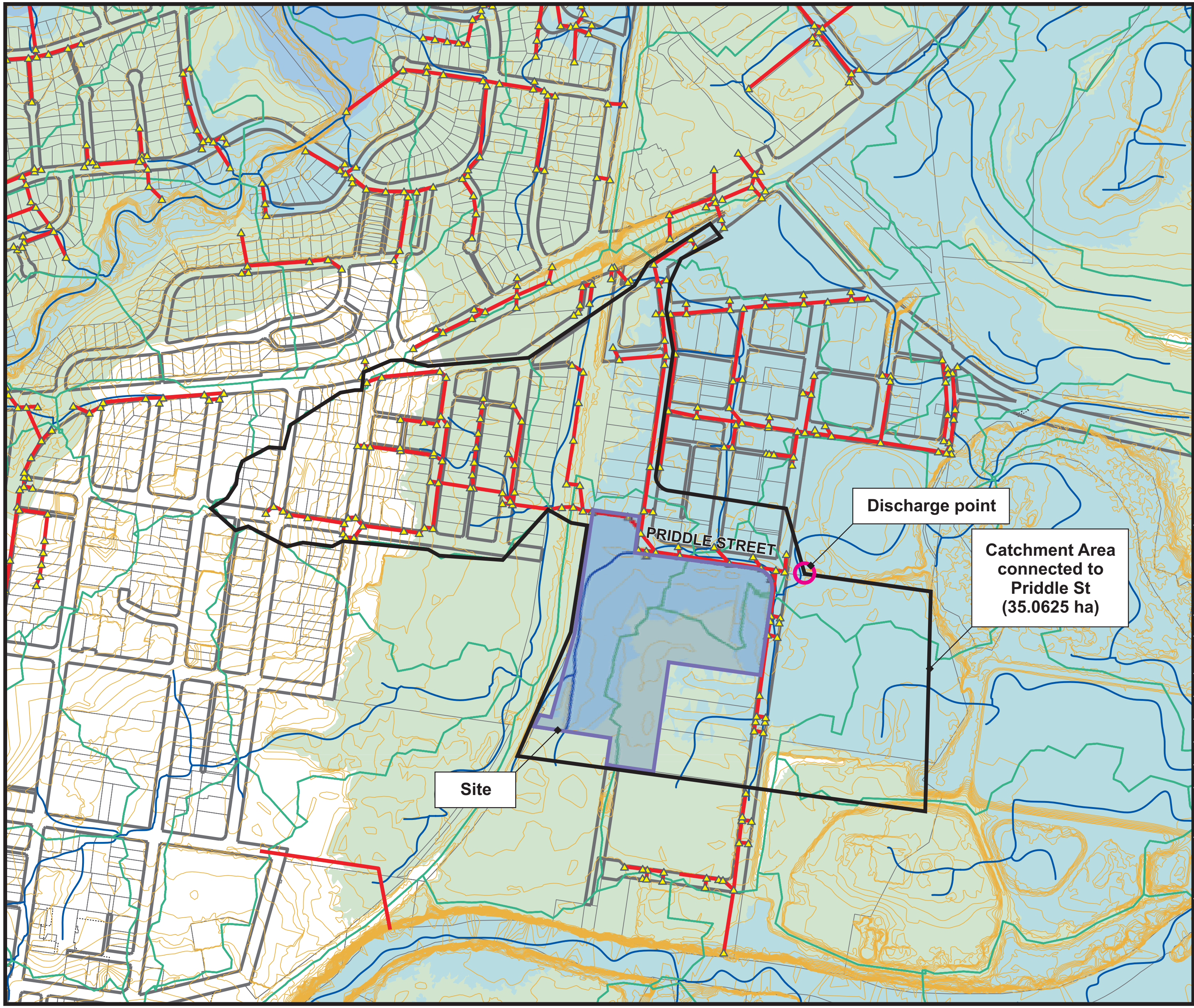


Figure 3

Catchment Area

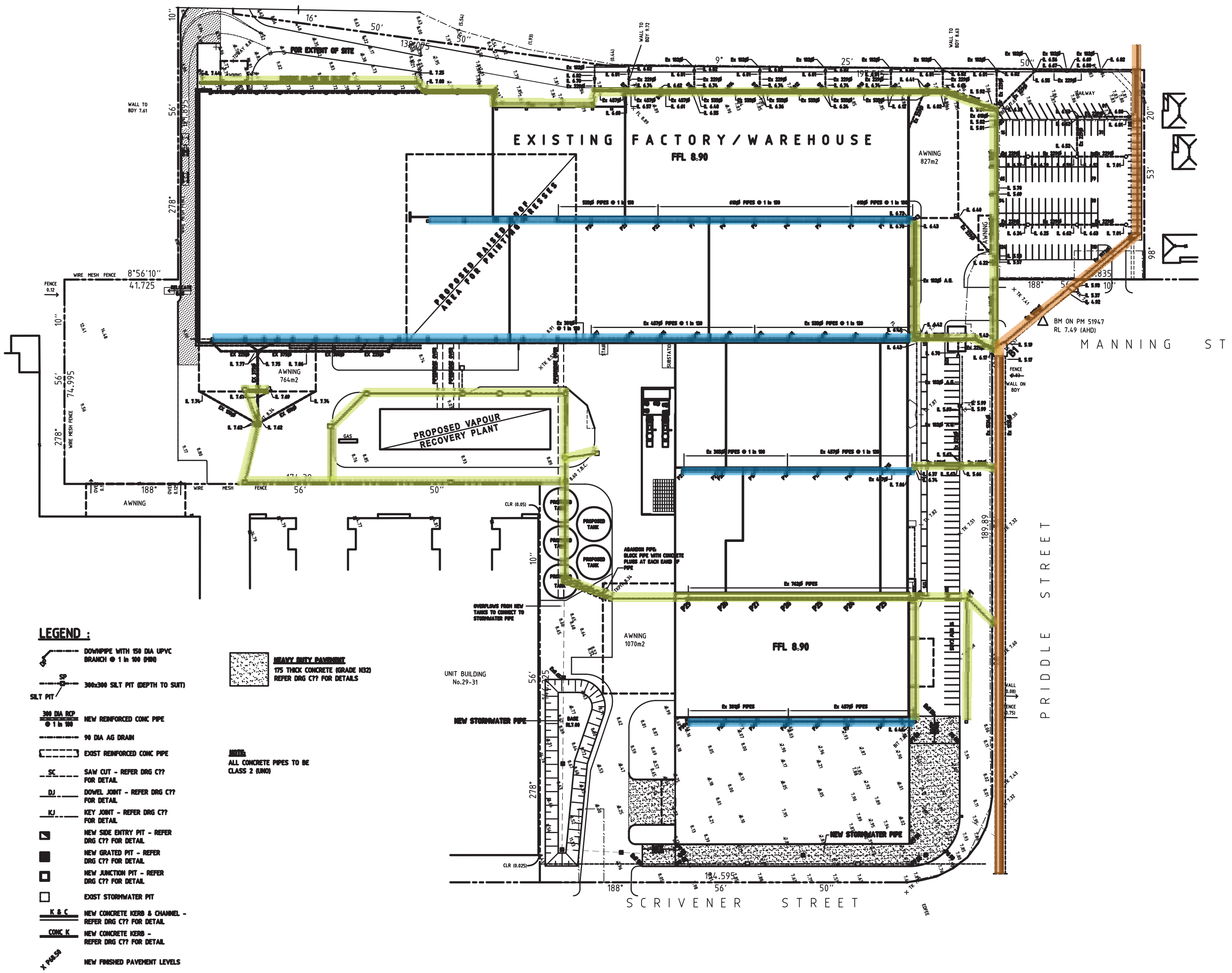
Client:	IPMG		
Project:	Warwick Farm Printer Project		
Drawing No:	0086333s_10		
Date:	02/10/2008	Drawing size:	A4
Drawn by:	ML	Reviewed by:	-
Source:	-		
Scale:	Refer to Scale Bar		

N

0 200 400m

Environmental Resources Management Australia Pty Ltd
Building C, 33 Saunders St, Pyrmont, NSW 2009
Telephone +61 2 8584 8888

ERM



Legend

- Roof Stormwater System
- Pavement Stormwater Drainage
- Receiving Stormwater Pipe

Figure 4

Overview Existing Stormwater System

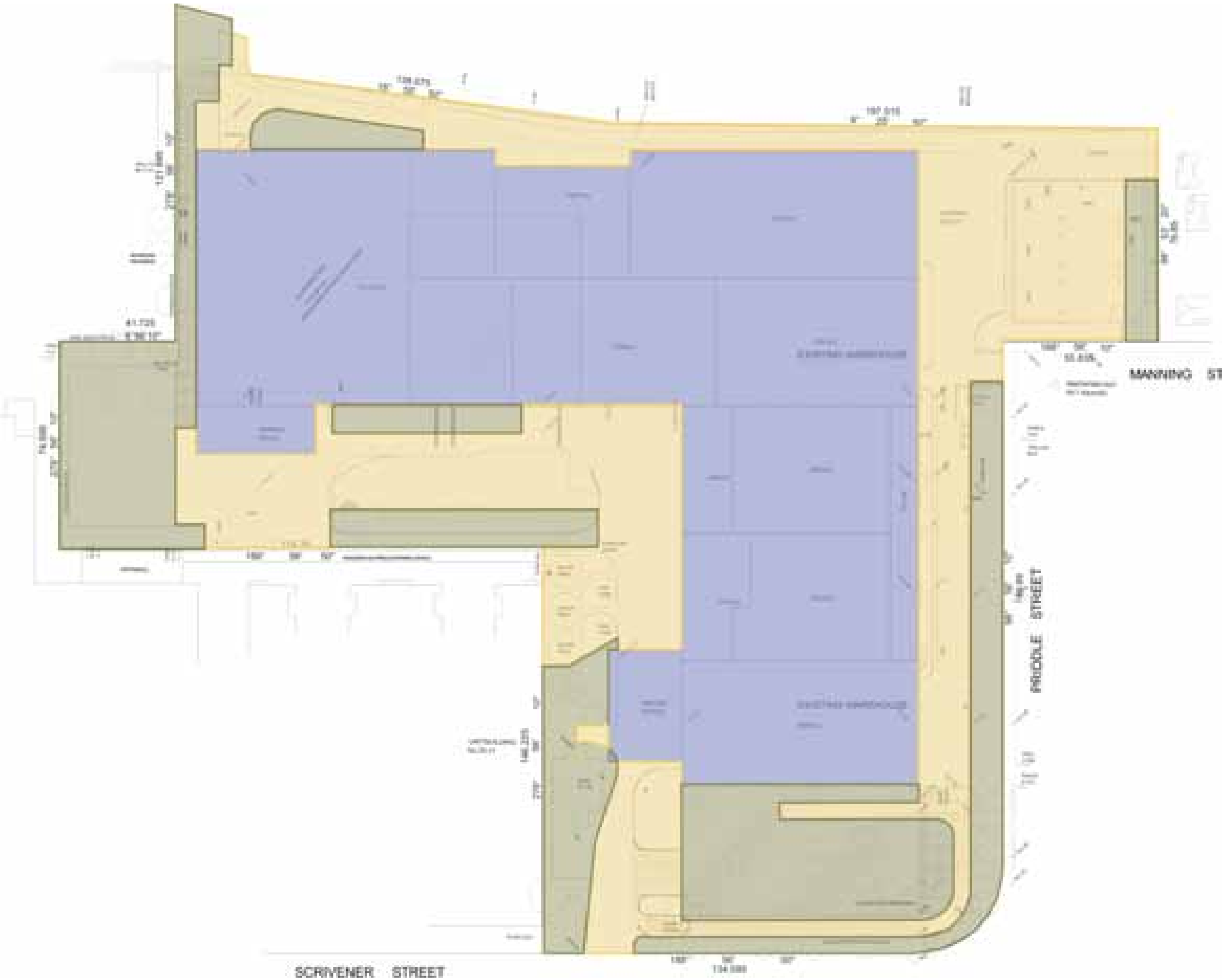
Client:	IPMG		
Project:	Warwick Farm Printer Project		
Drawing No:	0086333s_08		
Date:	02/10/2008	Drawing size:	A4
Drawn by:	ML	Reviewed by:	-
Source:	-		
Scale:	Refer to Scale Bar		

N

0 50m

Environmental Resources Management Australia Pty Ltd
Building C, 33 Saunders St, Pyrmont, NSW 2009
Telephone +61 2 8584 8888

ERM



Legend

- Impervious Area
- Roof Area
- Landscaping Area

Figure 5

Stormwater Site Overview (Pre Development)

Client:	IPMG		
Project:	Warwick Farm Printer Project		
Drawing No:	0086333s_02		
Date:	08/07/2008	Drawing size:	A4
Drawn by:	ML	Reviewed by:	-
Source:	-		
Scale:	Refer to Scale Bar		

N

0 20 40 60m

Environmental Resources Management Australia Pty Ltd
Building C, 33 Saunders St, Pyrmont, NSW 2009
Telephone +61 2 8584 8888

ERM

Legend

- Impervious Area
- Roof Area
- Landscaping Area

Figure 6

Stormwater Site Overview (Post Development)

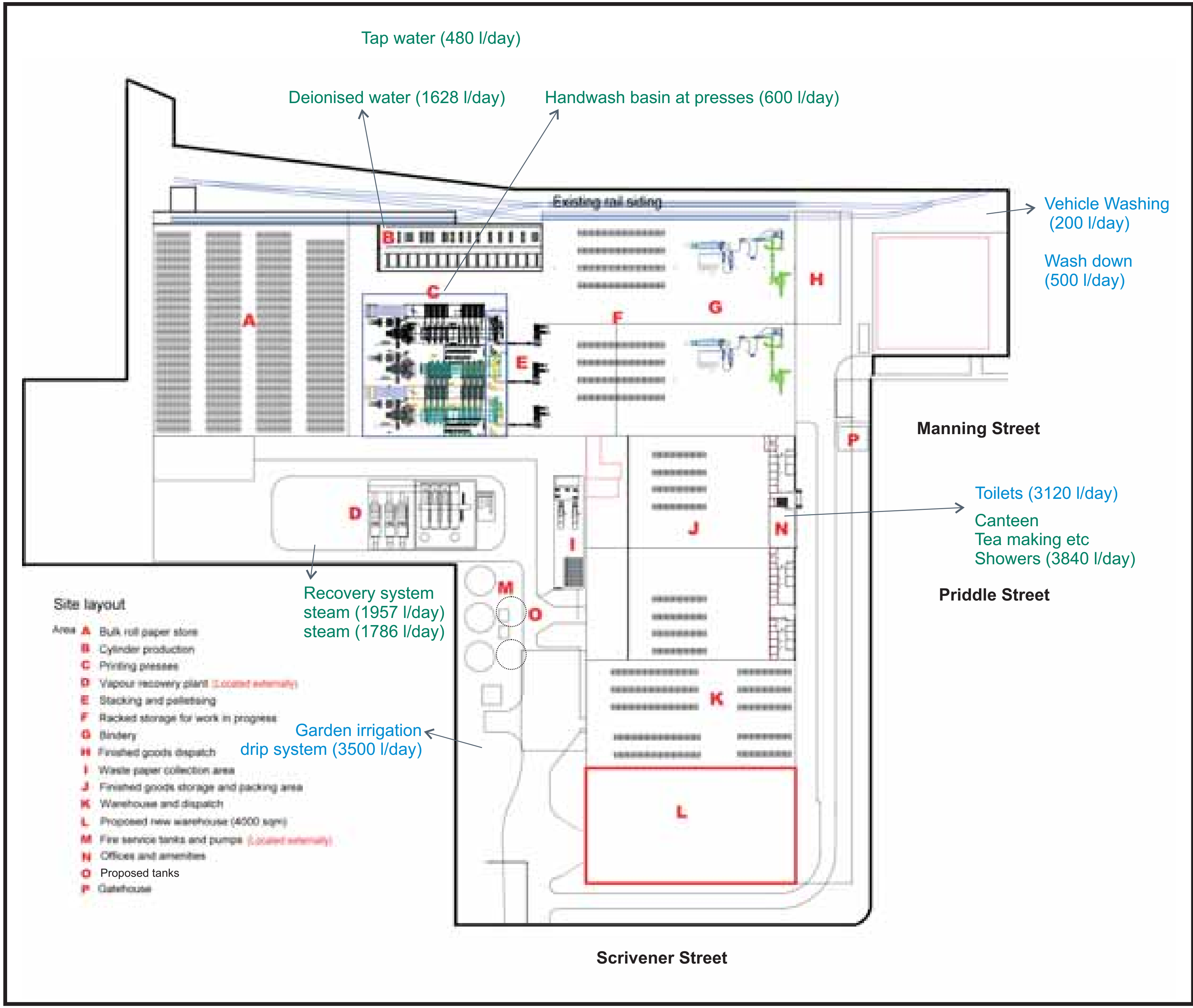
Client:	IPMG		
Project:	Warwick Farm Printer Project		
Drawing No:	0086333s_01_R1		
Date:	07/08/2008	Drawing size:	A4
Drawn by:	ML	Reviewed by:	-
Source:	-		
Scale:	Refer to Scale Bar		

N

0 20 40 60m

Environmental Resources Management Australia Pty Ltd
Building C, 33 Saunders St, Pyrmont, NSW 2009
Telephone +61 2 8584 8888

ERM



Legend

- Total Projected Purchased Water (Total 11,491 l/day)
- Total Reused Water from Roof System (Total 7320 l/day)

Notes:

In alternative 1 rainwater is used for the printing press process.
In alternative 2 purchased water is used for the printing press process.

Figure 7

Schematic Overview Water Use / Water Availability

Client:	IPMG		
Project:	Warwick Farm Printer Project		
Drawing No:	0086333s_07		
Date:	02/10/2008	Drawing size:	A4
Drawn by:	ML	Reviewed by:	-
Source:	-		
Scale:	Refer to Scale Bar		

N

0 50m

Environmental Resources Management Australia Pty Ltd
Building C, 33 Saunders St, Pyrmont, NSW 2009
Telephone +61 2 8584 8888

ERM

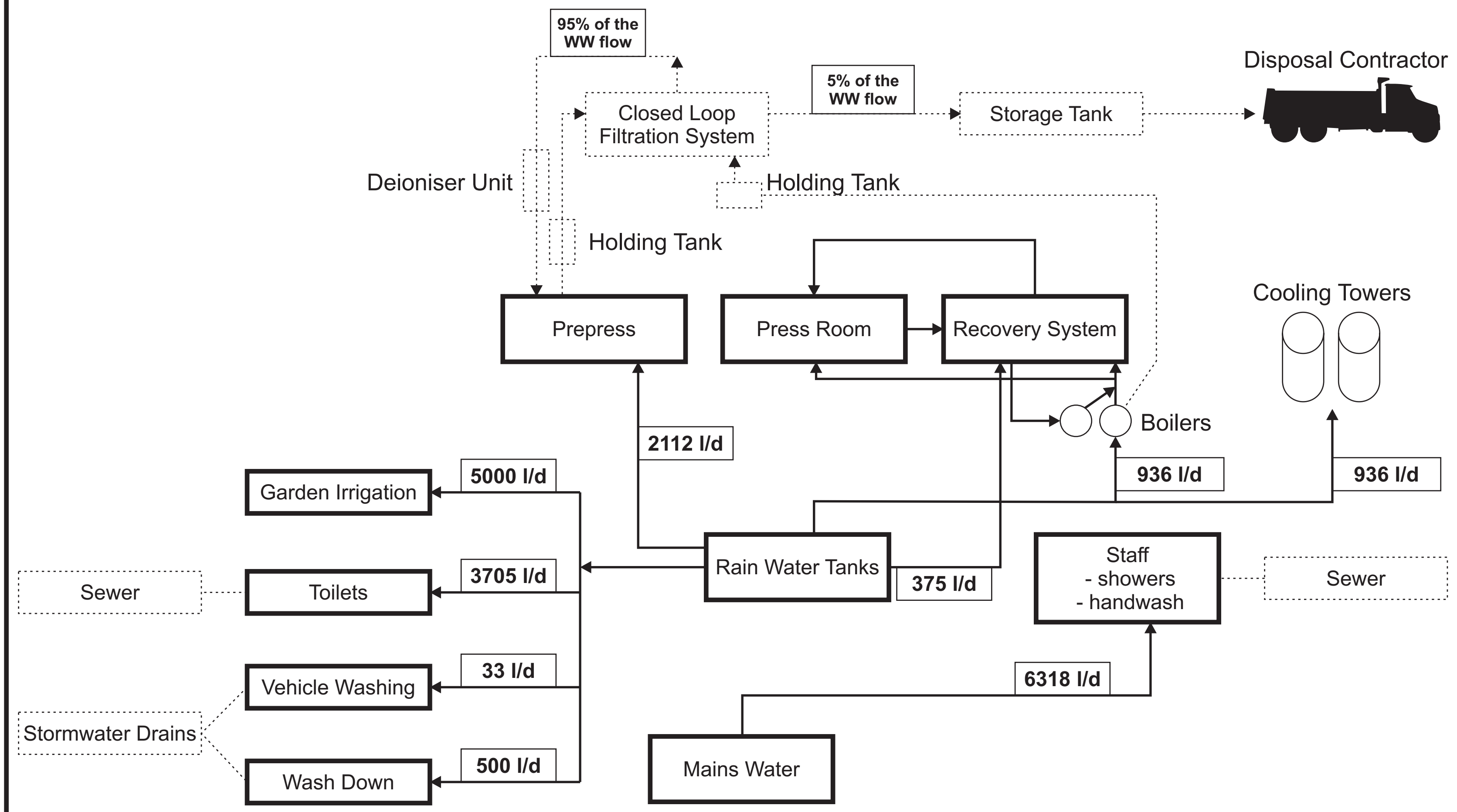


Figure 8

Water Balance

Client:	IPMG		
Project:	Warwick Farm Printer Project		
Drawing No:	0086333s_05_R1		
Date:	02/10/2008	Drawing size:	A4
Drawn by:	ML	Reviewed by:	-
Source:	-		
Scale:	Not to Scale		

Environmental Resources Management Australia Pty Ltd
Building C, 33 Saunders St, Pyrmont, NSW 2009
Telephone +61 2 8584 8888

ERM

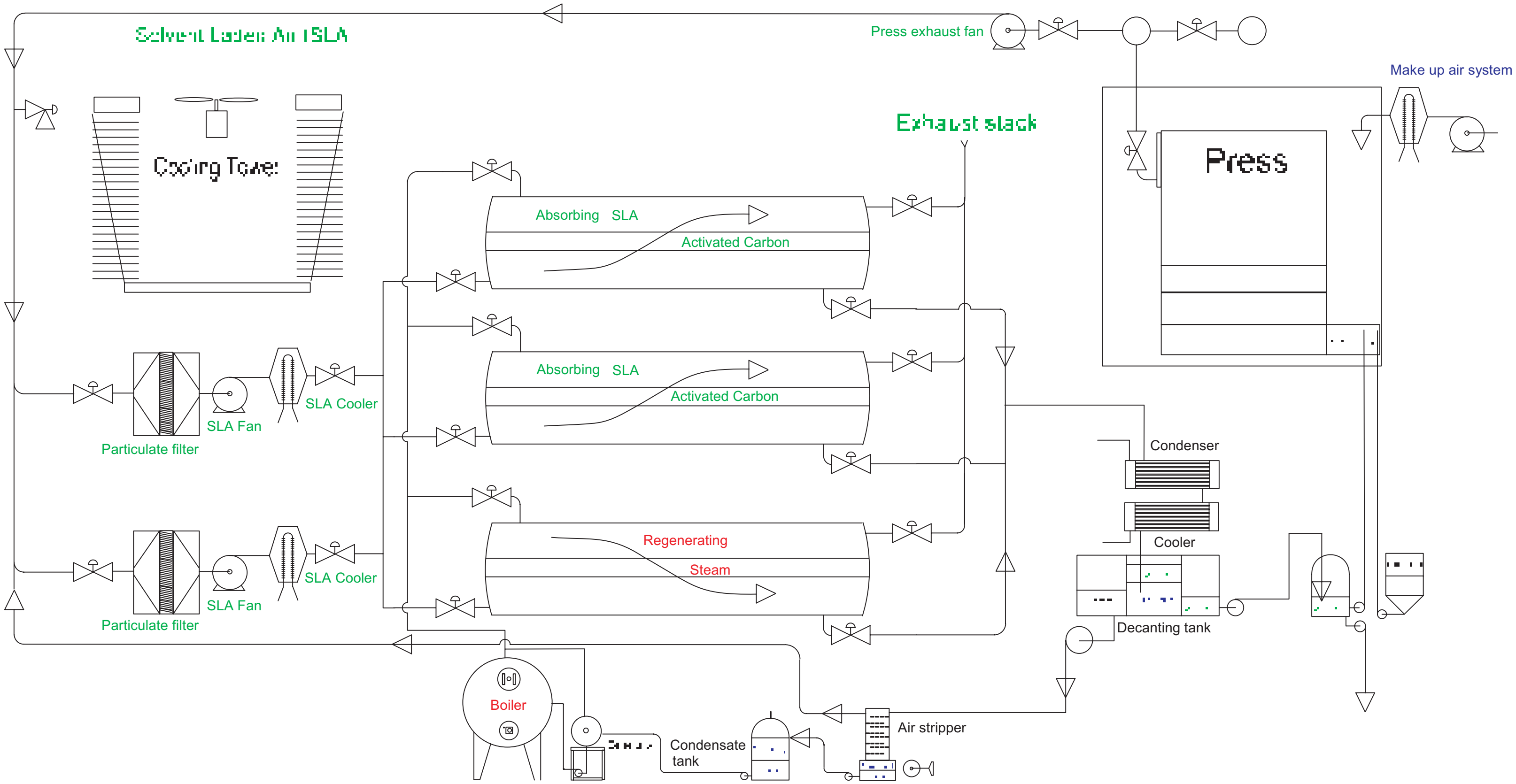


Figure 9

Vapour Recovery Plant

Client:	IPMG		
Project:	Warwick Farm Printer Project		
Drawing No:	0086333s_09		
Date:	02/10/2008	Drawing size:	A4
Drawn by:	ML	Reviewed by:	-
Source:	-		
Scale:	Not to Scale		

Environmental Resources Management Australia Pty Ltd
Building C, 33 Saunders St, Pyrmont, NSW 2009
Telephone +61 2 8584 8888

ERM

Annex B

Letter from The Department Of Water And Energy (Greg Brady)

NSW Government
Department of Water & Energy

Environmental Resources Management Australia
Referred to: Ref. No:
Date Received 08 JUL 2008
Checked By:

Environmental Resources Management
Building C, 33 Saunders Street
PYRMONT NSW 2009

Contact: Greg Brady
Phone: 02 9895 7441
Fax: 9895 7501
Email: greg.brady@dnr.nsw.gov.au

Our ref: 10 ERM2008/0761
Your ref: project application 08-0088

4/7/2008

Attention: Denis van Moeffaert

Dear Sir

Re: Printing facility-23 Scrivener Street, Warwick Farm

I refer to your recent e-mail concerning a proposed development for the subject property.

The view expressed relys upon: Site Plan, job No 07/200, dwr No 7200-TP01, rev D, dated 5/6/08, by Davis, Naismith & McGovern, and areial photography.

There is a small watercourse on the opposite side of street of the corners of Scrivener and Priddle Streets. From that point it appears to be piped under Priddle Street. The proposal will have no impact upon the creek, except maybe issues relating to flooding.

As flooding is an issue that is normally considered by council (and a detention basin is being proposed on-site), the Department does not have any concerns relating to this project, and does not need the project to be further referred, unless matters relating to impact upon groundwater are identified.

Yours Sincerely

Greg Brady
Licensing South

Level, 11, 10 Valentine Avenue – Parramatta NSW 2150
P O Box 3720, Parramatta NSW 2124
Telephone : (02) 9895 7441 Facsimile : (02) 9895 7501

Annex C

Liverpool Council's Stormwater Recommendations (Stephen Monte)

From: Stephen Monte
[mailto:S.Monte@liverpool.nsw.gov.au] **Sent:** Wednesday, 25
June 2008 3:14 PM **To:** Denis van Moeffaert **Subject:** RE:
Kimberley Clark

Denis,

Please find comments below in red.

regards

Stephen Monte BE(Civil)MIEAust

Senior Land Development Engineer Assets & Infrastructure

Liverpool City Council 1 Hoxton Park Rd, Liverpool NSW 2170

Phone 9821 9338 Mobile 0401 560 070 Fax 9821 9153

Creating our future together

From: Denis van Moeffaert [mailto:Denis.vanMoeffaert@ERM.com] **Sent:** Wednesday, 25 June 2008 2:06 PM **To:** Stephen Monte **Subject:** Kimberley Clark

Hi Steve,

IPMG has bought Kimberley Clarks' factory/warehouse on Manning Street/Priddle Street. My role is to help IPMG with their Development Application, which includes a Stormwater Management Plan.

I have three questions regarding this stormwater study:

* The area is affected by flooding. According to Liverpool's Onsite Stormwater Detention policy there is no OSD required for sites inundated by flooding. Can I apply this to this site?

OSD would not normally be required in these area, unless the existing drainage system can not cope with the increase.

* What kind of Stormwater Quality Control Measures must we apply? Is provision of Gross Pollutant Traps sufficient for this site? GPT would be fine.

* The development involves an increase of 4000 m^2 impervious area, which increases the discharge flow to the receiving stormwater pipes. How much is the capacity of the receiving stormwater pipes in Priddle Street? Is there capacity in the stormwater pipes for this increase? As above, you need to tell council if the existing pipe can handle the increase based on grade, size, catchment etc. Our information is very limited because it is so old. My guess would be that some sort of osd would be required, or provision of a rain water tank if the water can be used up onsite.

Thanks,

With kindly regards,

Denis Van Moeffaert

MSc Water and Environment

Environmental Resources Management

ERM has over 100 offices across the following countries worldwide

Australia
Argentina
Belgium
Brazil
China
France
Germany
Hong Kong
Hungary
India
Indonesia
Ireland
Italy
Japan
Korea
Malaysia
Mexico
Netherlands
Peru
Poland
Portugal
Puerto Rico
Singapore
Spain
Sri Lanka
Sweden
Taiwan
Thailand
UK
USA
Venezuela
Vietnam

Environmental Resources Management

Building C, 33 Saunders Street
Pyrmont NSW 2009
Locked Bag 24,
Broadway NSW 2007

T: 61 2 8584 8888
F: 61 2 8584 8800
www.erm.com

ERM