St Marys *Freight Hub*—

Stormwater Mangement Report

FOR / Civil Engineering Services

CLIENT / Pacific National

DOCUMENT NO / B18028-RPT-003 REV / C DATE / 24/04/2019

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CONTENTS

Appendices

Document *Control*

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1 INTRODUCTION

1.1 Background

Pacific National (PN) plan to develop the St Marys site in Western Sydney (Lots 2 and 3 DP 876781). The development involves the construction of a Freight Hub Facility on a staged basis to accommodate a new dedicated port shuttle service from Port Botany to St Marys.

The Facility is to be developed to accommodate a maximum operating capacity of 300,000 TEU (Twenty-foot Equivalent Unit) throughput annually. It is proposed to operate the site 24 hours per day, 7 days per week.

The proposed development will form an important port link to move containers to and from Port Botany to greater western Sydney. This will result in increased freight movement via rail and thus relieving the demand on the regional and local road network from container freight related traffic.

1.2 Site Location and Description

The site is known as Lots 2 and 3 DP 876781 with a frontage to Forrester Road, St Marys, NSW owned by Pacific National. It is located within a largely industrial area of St Marys, 8 km east of Penrith, NSW. The site is bounded by Forrester Road and industrial development to the east, the Great Western Railway Line to the south, and Little Creek to the North. Refer to the locality plan shown in Figure 1.

The area to be developed comprises approximately 10 hectares within a 40 hectares land area. The existing terrain can be described as being generally flat, with a slight fall toward the north with the elevation varying from approximately RL 24 - 30m AHD.

1.3 Scope and Objectives

BG&E Pty Ltd (BG&E) has been engaged by Pacific National to prepare a Stormwater Management Plan and Report to support the Development Application of the proposed Freight Hub facility at St Marys.

This Stormwater Management Report aims to outline the existing drainage conditions, as well as provide an overall philosophy for the collection, treatment and disposal of stormwater from the development site and in doing so demonstrate compliance with the requirements as set out in the Revised Planning Secretary's Environmental Assessment Requirements (SEARs).

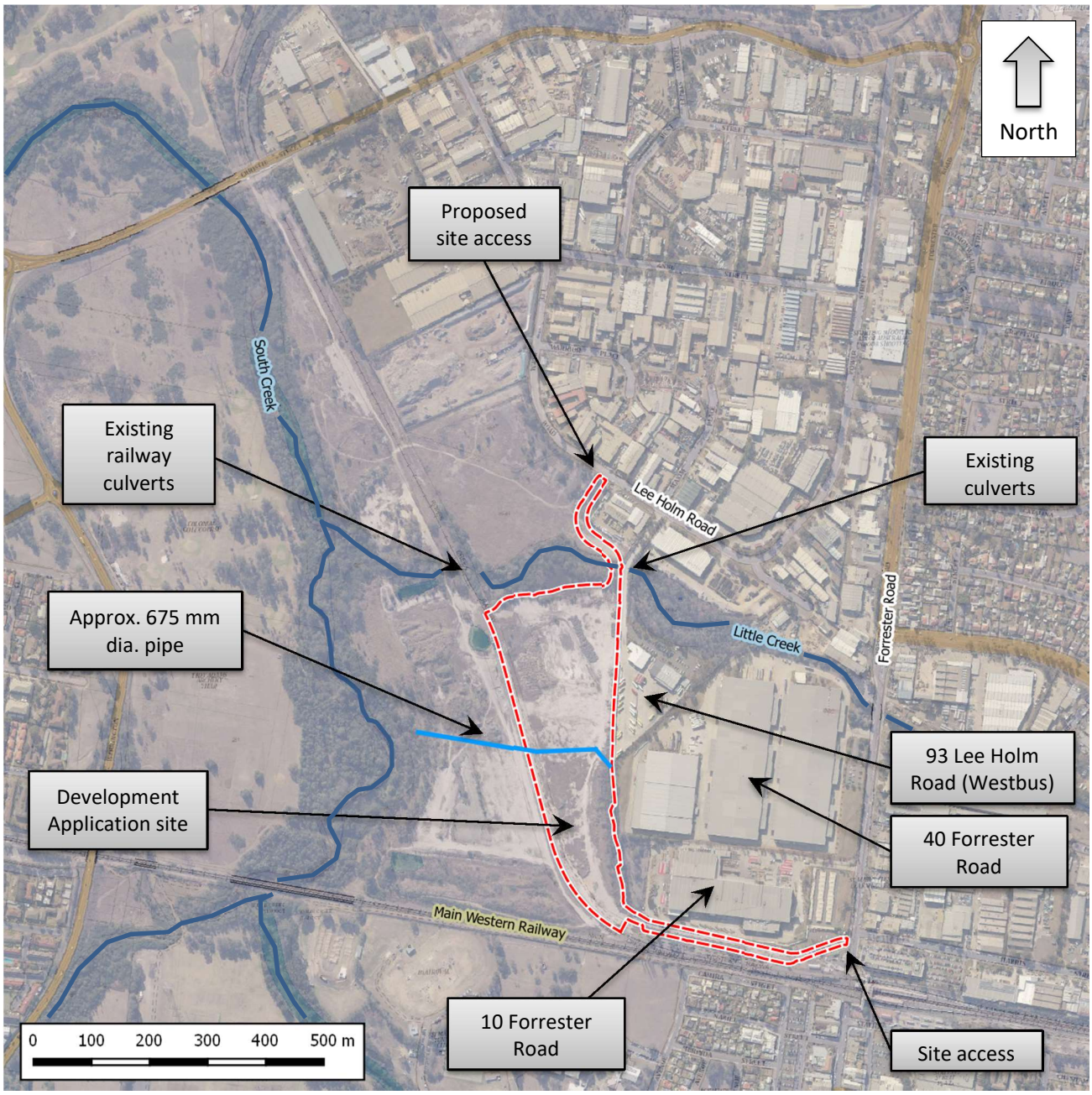


Figure 1 - Locality Plan

2 EXISTING DRAINAGE

2.1 Existing Site Drainage

The existing site is 100% pervious and falls in a northerly direction at approximately 1% towards Little Creek.

An existing basin is present on the northern portion of the proposed development site, to which the majority of the site drains. Site runoff is directed to the basin via two existing 300 mm diameter culverts and cut off drains. The basin in turn discharges to Little Creek, a tributary of South Creek.

Upstream catchments are conveyed through the site via a vegetated channel running along the southern side of the existing access road from Forrester Road. A 300 mm diameter culvert conveys flows under the existing access road to a vegetated channel running along the sites eastern boundary. This vegetated channel follows the alignment of a drainage easement shown on site survey to a low point on the sites eastern boundary near the boundary between 40-88 Forester Road and 93 Lee Holm Road.

Current survey does not pick up any culverts draining from this low point, however site inspections identified that the low point was drained via an existing pit and an approximately 675 mm diameter pipe. It is assumed that this pipe follows the alignment of the easement in a westerly direction towards South Creek. Title searches show the easement being for the benefit of drainage from the railway corridor. Flow that cannot be conveyed by this pipe spills from the low point and flows overland toward the existing basin and Little Creek.

Two large box culverts are present on the site. An approximately 2.4 m x 1.8 m box culvert exists under the access road from Lee Holm Road to the property at 93 Lee Holm Road, while an approximately 2.5 m x 1.8 m culvert exists beneath the rail sidings. These culverts convey Little Creek through the site and are discussed in further detail in *St Marys Freight Hub Desktop Flood Study and Flood Impact Assessment (BG&E, Jan 2019).*

Key features of the existing drainage layout are shown on the Existing Drainage Sketch in Appendix A. Further survey is required during detailed design to confirm existing pipe sizes and pit locations.

2.1.1 Upstream and Adjoining Site Drainage

There are significant upstream local drainage catchments to the site. The following outlines our understanding of these existing catchments for the purpose of the Development Application. Confirmation of these catchments and the exact discharge locations are required during detailed design.

Main Western Line Rail Corridor

Based on LIDAR, aerial photography and Council drainage plans, it is believed that approximately 2.1 ha of rail corridor flow through the site, discharging via an existing headwall adjacent to the south eastern corner of the site and flowing overland toward the existing access road from Forrester Road.

Lot 100 DP1136503 for (93 Lee Holm Road)

Drainage plans for Lot 100 DP1136503 for (93 Lee Holm Road) were provided to BG&E by the site owner. These plans for the Westbus Site show all runoff for storm events up to and including the 1% AEP will discharge toward Little Creek to the north and will not enter the St Marys Freight Hub site. Copies of the plans obtained can be found in Appendix B.

Lot 221 DP1025100 (40 Forrester Road)

Drainage plans for Lot 221 DP1025100 (40 Forrester Road) were provided to BG&E by Council. The drainage plan provided by Penrith City Council for 40 Forrester Road also included the area of 10 Forrester Road. The

plan does not correspond with the current development on Number 10, however the three warehouses shown on Number 40 do appear to correspond to the current site conditions. The plan provided indicates the presence of a pipe network discharging flows to the north to Little Creek. Copies of the plans obtained can be found in Appendix B.

Lot 220 DP1172926 (10 Forrester Road)

Information on the existing drainage within this site was unable to be obtained as neither Council nor the current owners of the site had access to drainage plans. Based on LiDAR and Council's Little Creek flood model, it is believed the property at 10 Forrester Road discharges to the development site near to the existing drainage easement and swale.

The following assumptions have been made based on the drainage plans obtained and review of LiDAR data and aerial photography:

- The intention of the drainage layout on 40 Forrester Road is to discharge stormwater collected in the piped drainage system towards Little Creek to the north.
- For warehouses 1 and 2 (central and eastern), overland flows would also flow to Little Creek the north.
- LiDAR and aerial imagery also show a low lying vegetated area between the Westbus site at 93 Lee Holm Road and the property at 40 Forrester Road. This area appears to drain toward the development site.
- Stormwater runoff that exceeds the pipes network from around warehouse 3 would discharge to a low lying area between 93 Lee Holm Road and 40 Forrester Road and subsequently drain towards the proposed development site.
- It is assumed that the site piped drainage was designed in accordance with Penrith City Council's Stormwater Drainage Policy ES002 which requires internal and piped drainage systems to be designed for the 5% AEP event with an overland flow path provided to the 1% AEP event.

The existing catchments are shown on the Existing Drainage Sketch in Appendix A. Further survey and confirmation of these catchment assumptions are required during detailed design.

3 PROPOSED DRAINAGE

3.1 Basis of Design

The proposed development is subject to the Planning Secretary's Environmental Assessment Requirements, application number 7308. The following sections outline the adopted design objectives for the development.

3.1.1 IFD Data

The flood modelling adopted by Council used Australian Rainfall and Runoff 1987 (ARR1987) methods. For consistency, the drainage design has been carried out using Australian Rainfall and Runoff 1987 (ARR1987) methods and IFD data.

IFD data has been obtained from Appendix E of the *Stormwater Drainage Specification for Building Developments ES002* (Penrith City Council, 2016).

3.1.2 Drainage Network

3.1.2.1 Design Annual Exceedance Probabilities

The sites pit and pipe drainage (excluding trunk drainage for upstream catchments) system shall be designed to accommodate runoff from a 5% AEP rainfall event while the overland flow system will be designed to cater for the 1% AEP event.

The trunk drainage for the upstream networks will be designed to cater for the 1% AEP event.

3.1.2.2 Design Criteria

An allowable flow width of 25m has been adopted for the hardstand area for the minor event. This provides a maximum flow depth of approximately 100mm. The intent of this is to minimise flow paths encroaching on the container storage areas.

Flow widths for the internal access roads to Forrester Road and Lee Holm Road shall be limited to a 1.0m encroachment into trafficable lanes for the minor event.

All other design criteria are to be generally in accordance with Penrith City Council design Standards.

3.1.3 Water Quantity

To ensure no detrimental impacts to downstream waterways, the development will not result in an increase to peak flows in Little Creek.

3.1.4 Water Quality

A water quality treatment train will be implemented to limit the amount of gross pollutants, sediments, nutrients and hydrocarbons discharging to downstream waterways.

3.2 Drainage Strategy

3.2.1 Proposed Drainage Network

It is proposed to separate site runoff from the flows making their way through the site from upstream.

To manage site runoff, it is proposed to provide a pit and pipe network within the proposed roads and hardstand areas to collect and convey runoff from the minor storm events away from roads and hardstand

areas as well as proposed structures. This network is proposed to discharge to Little Creek to the north of the proposed hardstand area.

Runoff from the proposed buildings will be collected by gutters and discharged to proposed rainwater collection tanks. These tanks will overflow to the stormwater network outlined above.

In the major storm event the hardstand areas will direct flows in a northerly direction toward Little Creek. The piped network draining the trapped low point in the Forrest Road access road has been designed to cater for the major event. In the event of failure of this system a backup inlet to the proposed trunk drainage line through the site (outlined below) has been provided 0.1 m above the sag point.

A trunk drainage line is proposed to convey the upstream catchments through the site. The trunk drainage system will start in the south east corner of the site, picking up flows discharging from the upstream rail corridor catchment and discharge to Little Creek on the downstream side of the proposed access road to Lee Holm Road. The existing 675 mm diameter pipe is proposed to be retained and connected to this trunk main, with post development flows through this existing pipe to closely match pre development levels.

Extension of the major drainage culverts on the site has been assessed as part of the flood modelling. Refer to *St Marys Freight Hub Desktop Flood Study and Flood Impact Assessment (BG&E, Jan 2019)* for proposed modifications.

3.2.2 Drainage Modelling

The drainage system has been designed and analysed using the 12d and DRAINS software packages. Both the pre development and post development scenarios were assessed. Refer to Appendix C for result outputs from the post development drains model for both the 5% and 1% AEP. Models can be provided upon request.

3.3 Stormwater Quantity

Whilst the development area for the site does have an increased peak discharge due to an increase in impervious area, the peak flow immediately downstream of the site will not increase. This is due to the site's immediate proximity to Little Creek, resulting in the peak flow from the site passing prior to the occurrence of the peak flows within Little Creek. As outlined in *St Marys Freight Hub Flood Impact Assessment (BG&E, Jan 2019)*, the critical storm for Little Creek is the 2 hour storm event. The hydrographs for the 1% AEP, 2 hour storm for both Little Creek and the outlet of the site drainage are shown in Figure 2 below. As can be seen the site drainage discharge peaks at the 40 minute mark, subsiding prior to Little Creek peaking at the 105 minute mark as it passes through the site.

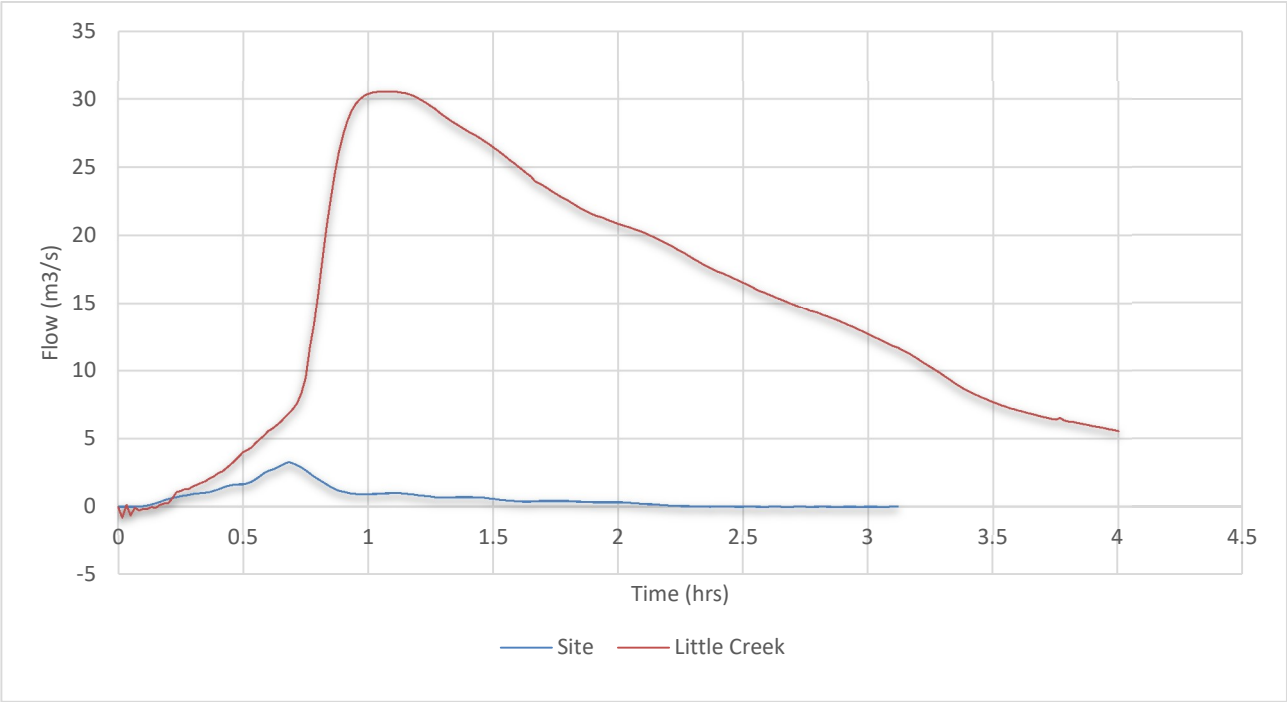


Figure 2 - 1% AEP 2 Hour Storm Hydrograph

3.4 Stormwater Quality

3.4.1 WSUD Objectives

The following polices apply to the site with respect to WSUD requirements:

- Penrith Development Control Plan, 2014, Penrith City Council (The DCP)
- Penrith City Council, WSUD Technical Guidelines, Version 3, June 2015, Penrith City Council

3.4.2 DCP WSUD Controls

The water quality targets outlined in the DCP are as follows:

i) 90% reduction in the post development mean annual load total gross pollutant (greater than 5mm);
ii) 85% reduction in the post development mean annual load of Total Suspended Solids (TSS);
iii) 60% reduction in the post development mean annual load of Total Phosphorus (TP);
iv) 45% reduction in the post development mean annual load of Total Nitrogen (TN);
v) 90% Free Oils and Grease with no visible discharge.

Substantial earthworks was undertaken over the subject site at an unknown time in the past, which has resulted in substantial removal of vegetation. Whilst the site is currently bare earth, it should be noted that the due to substantial compaction of the earth, it is anticipated that significant runoff is generated. As such, the site should effectively be treated as impervious. Currently, it is understood that the water quality treatment device is an existing sediment basin (to be retained).

The WSUD proposal seeks to address the underlying objectives of the DCP, rather than demonstrating that DCP target reductions have been met. Furthermore, justification is provided as to how the principles of the SEARs requirements have been addressed.

The DCP WSUD objectives and SEARs requirements are addressed in the following:

3.4.3 Penrith DCP 2014 WSUD Objectives

The DCP WSUD objectives are listed below:

g) To protect and enhance natural land and water systems such as creeks and rivers, particularly water quality.

h) To maintain and restore the natural water balance;

i) To make more efficient use of water resources by conserving water, particularly potable (drinking) water;

j) To reduce flood risk in urban areas;

k) To reduce erosion of waterways, slopes and banks;

l) To control stormwater pollution and improve water quality in waterways and groundwater;

m) To integrate stormwater management with water supply and waste water treatment; and

n) To integrate stormwater treatment into the landscape so as to maximise the visual and recreational amenity of urban development.

In response to the DCP objectives above, the WSUD proposal:

- Increases water quality improvements to runoff that discharges to Little Creek (and then South Creek). The proposed 2 x GPTs will capture gross pollutants. Proposed paving will limit the amount of sediment that is transported and discharged to the receiving waterways. The proposed storm water discharge points have been designed to limit flow velocities and scour.
- Increases to the efficiency of water resources. Two rainwater tanks (total combined capacity of 125,000 L) have been proposed for re-use within the site. This also has the potential to limit the amount flow that enters the downstream system, and may also reduce peak flows.
- The proposal will reduce the amount of erosion to the receiving waterways by controlled engineered discharge locations.
- It should be noted that the proposed land use is heavy industry with no public access. As such, visual and recreational amenity are not deemed applicable.

3.4.4 SEARs

Below is a discussion related to relevant points in Section 11 (Soil and Water) of the SEARs requirements, and how the proposal addresses these requirements:

The EIS must describe background conditions for any water resource likely to be affected by the development, including:

- *Water Quality Objectives including groundwater as appropriate that represent the community's uses and values for the receiving waters.*

  The proposed land use for the subject site will be for a freight hub. The WSUD proposal therefore improves the water quality of the runoff generated from the site by removal of gross pollutants, and the introduction of rainwater tanks. The post development runoff water quality will be greater than the existing scenario, and is hence deemed appropriate to represent the community's uses and values.

The EIS must assess the impacts of the development on water quality, including:

- *The nature and degree of impact on receiving waters for both surface and groundwater, demonstrating how the development protects the Water Quality Objectives where they are currently being achieved, and contributes towards achievement of the Water Quality Objectives over time*

where they are currently not being achieved. This should include an assessment of the mitigating effects of proposed stormwater and wastewater management during and after construction.

As noted above, the post development water quality entering the receiving water course will be treated prior to discharge from the site, and addresses the water quality objectives of the DCP. The design intent is to improve impact on the receiving waters, by the introduction of the water quality treatment train. Section 4 of this report address how water quality will be managed during construction.

3.4.5 Proposed WSUD Criteria

Whilst the proposal does not meet all targets required by the DCP, it does address the objectives of the DCP and the underlying principles of the SEARs requirements. As such, the proponent is seeking a site specific merit based assessment, based on the above stated underpinning objectives of the DCP and principles or the SEARs requitements.

3.4.6 Proposed Treatment Train

To limit the level of pollutants discharging to downstream waterways the following treatment train is proposed for the site:

- The proposed office building drains to a 25kL rainwater tank. Water will be reused for toilet flushing. The office building is assumed to be two story, resulting in a floor area of approximately 1000 m^2. Based on workplace regulations it is estimated this building will have 7 toilets and 2 urinals. The Penrith City Council WSUD Technical Guidelines (June 2015) outline reuse rates for toilet flushing, resulting in a reuse rate of 0.9kL/day. These figures are to be confirmed by the project hydraulic engineer during detailed design.
- The proposed Transport and Container Repair workshops drain to a 100kL tank. Water will be reused in the proposed Wash Bay. The estimated reuse rate for this facility is 5kL/day. These figures are to be confirmed by the project hydraulic engineer during detailed design.
- Gross Pollutant Traps (GPT) – two Stormwater 360 units are proposed to treat runoff from the hardstand area, the Forrester Road access road and any overflow from the sites rainwater reuse tanks. The units will be placed offline and sized to treat the approximate 3 month ARI peak flow.
- Gully Pit Inserts – Stormwater 360 enviropods are pollutant catching baskets that will be used to capture pollutants in pits on the Lee Holm Road access road as the levels of this part of the site do not allow connection to the proposed Gross Pollutant Traps.
- Vegetated Swale – impervious areas from a number of batters will be treated via a vegetated swale prior to discharging to the piped drainage system.

The indicative proposed location for the treatment devices and associated catchments can be seen on the WSUD sketch in Appendix D.

3.4.7 MUSIC Modelling

A MUSIC model was run to assess the effectiveness of the proposed treatment train in limiting the discharge of pollutants from the site.

The modelling was carried out in accordance with the recommendations contained in the *Draft MUSIC Modelling Guidelines for NSW* (Catchment Management Authority, 2010) and the *WSUD Technical Guidelines* (Penrith City Council, June 2015).

Rainfall for the model was obtained from the eWater Pluviograph Rainfall Data Tool. Six minute data for Penrith Lakes AWS Station 067113 was used for the period 1/1/1999 – 1/1/2008. Evapotranspiration values were used as per Penrith City Council guidelines.

Further information regarding the modelling and inputs can be provided on request. The MUSIC model layout can be seen in Figure 3 below.

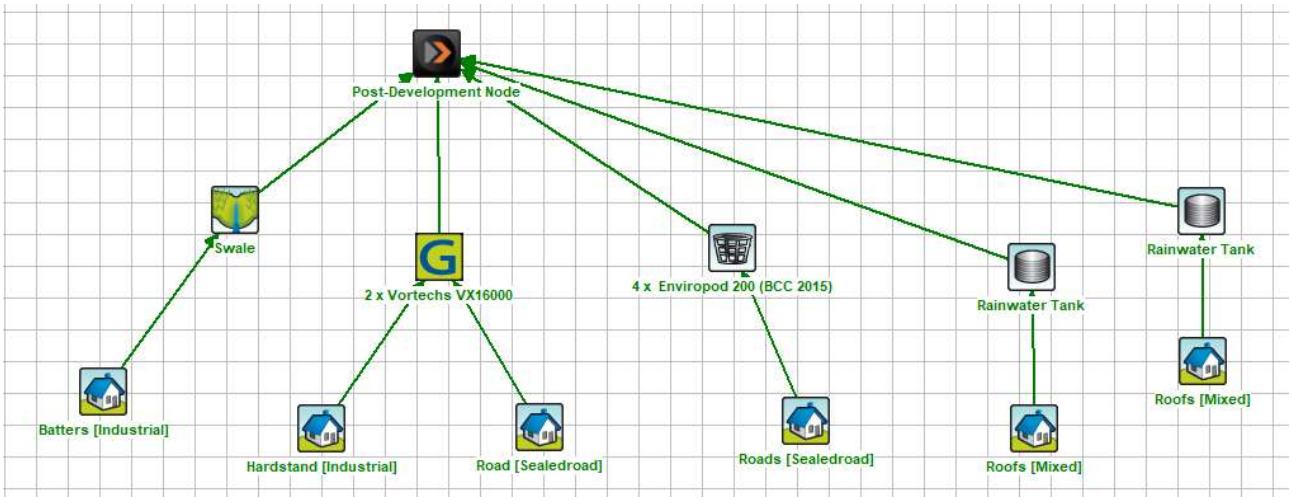


Figure 3 - MUSIC Model Layout

3.4.7.1 Maintenance

The proposed treatment train requires ongoing maintenance if the modelled performance is to be obtained.

- Catch pit inserts – information regarding inspection and maintenance of the Stormwater 360 Enviropods can be found in Appendix E.
- Vortech GPT – information regarding inspection and maintenance of the Stormwater 360 Vortech units can be found in Appendix E.
- Rainwater Reuse Tank – regular maintenance is required to ensure an acceptable level of water quality is maintained within the tank and pumps are able to function as required. As such the following maintenance regime is proposed:
  - Service pumps as per supplier recommendations.
  - Every 3 months – Clean and check first flush devices and filters.
  - Every 6 months – Check tank for defects and repair as necessary.
  - Every 2 years – Remove accumulated sediment and clean out as required.

3.4.8 Merit Based Assessment

For this type of development, it has been deemed that the TSS, gross pollutants and limited amount of expected hydrocarbons will be the governing pollutants of concern. On this basis, the proposed treatment train has been designed in a way to focus on the aforementioned pollutants for the following reasons:

1. The proposed GPTs will remove fine sediment, oil and grease and floating and sinking debris, which will result in an improvement of TSS when compared to the current situation;
2. Hydrocarbons will be intercepted thereby significantly reducing the risk of hydrocarbons entering there receiving waterway;
3. The proposed rainwater tanks have the potential to reduce peak runoff flows entering the downstream receiving system. Furthermore, on-site rainwater re-use will be maximised, reducing the demand on the town supply.

The treatment train as proposed address the objectives and underlying principles of the SEARs requirements.

3.4.9 WSUD conclusion / recommendation

Based on the assessment the preceding section, it is requested that a departure from the DCP WSUD target controls is considered on the grounds of a site specific merit based assessment, noting that the proposed treatment train will focus on the pollutants of concern consistent with the subject development.

4 SEDIMENT AND EROSION CONTROL

4.1 Objectives

The objective of the Construction Phase Management Plan is to ensure compliance with Landcom's "Blue Book" requirements. The purpose of the management plan is to prevent the discharge of polluted stormwater off the site and to ensure that the environmental values of receiving waters are maintained or enhanced. Pollutants typically generated during the Construction Phase are outlined in Table 1.

Pollutant	Sources
Litter	Paper, construction packaging, food packaging, cement bags, off-cut
Sediment	Unprotected exposed soils and stockpiles during earthworks and building
Hydrocarbons	Fuel and oil spills, leaks from construction equipment
Toxic Material	Cement slurry, asphalt prime, solvents, cleaning agents, wash waters (e.g. from tile works)
pH altering substances	Acid sulphate soils, cement slurry and wash waters

Table 1 - Typical Construction Phase Pollutants

4.2 Management of Sedimentation and Erosion

The existing sediment basin is to be retained at the downstream end of the site with temporary cut off drains catching runoff from the entire development site. It is expected that this sediment basin will eliminate almost all risk of sediment being washed off the site. Accidental spills of soil or any other material shall be removed immediately if rainfall is likely to occur or at least upon completion of the days work depending upon the material.

Entry and exit from the site will be restricted to a single stabilised location to minimise the risk of tracking sediment over the site. It is expected that a layer of crushed rock will provide the necessary stabilisation for the access route. A specific area on the site shall be designated for washing down construction plant. The washdown area will be contained by earth bunds. There will be no waste water discharged from the site during construction.

4.3 Management of Contaminated Soils

The site is not known to contain acid sulfate soils. However in the event that Acid Sulfate Soils or Contaminated Land is found on site, a management plan is to be implemented and maintained by a suitably qualified professional.

4.4 Management of Imported Material

Any material imported onto the site (including construction materials) will be stockpiled in a location where it cannot contaminate stormwater runoff. It should be stored clear of flow paths and be surrounded by silt fences on the downstream side.

4.5 Monitoring and Maintenance

Silt traps, sediment fences and structural measures should be checked daily during construction by the Construction Manager. Inspections will ensure the integrity of control structures and other structural measures. Additional inspections will be required immediately following periods of heavy rain. Sediment build-up is to be removed from behind the silt fences and other barriers immediately after each major rainfall event. All noted stormwater treatment devices within this report are to be inspected, maintained, rectified and reported on.

4.6 Responsibility & Reporting

Performance monitoring of all drainage control measures along with erosion and sediment control devices will remain the responsibility of the contractor. Site inspection forms/checklists shall be reported to the Construction Manager following inspection of water quality devices/measures.

The contractor should erect signage at the entrance to the site with contact information (including after-hours contact information). The contractor shall be responsible for the appropriate handling of all complaints.

APPENDIX A

Existing Drainage Sketch

N

LEE HOLM ROAD

FORRESTER ROAD

SOUTH CREEK

EXISTING 2.4m x 1.8m RCBC

EXISTING SEDIMENT BASIN

EXISTING 2.5m x 1.8m RCBC

FLOWS GREATER THAN 5% AEP ONLY TOWARD THE SITE

0.21 Ha

2.01 Ha

3.01 Ha

2.69 Ha

3.51 Ha

0.47 Ha

1.25 Ha

0.05 Ha

5.90 Ha

1.63 Ha

0.91 Ha

e104-1 e104-2 e103-1 e103-2 e102-2 e101-1 e101-2 e101-3 e101-4 e101-5 e100-1 e100-2

Ø375 Ø300 Ø675 Ø675 SWC Ø675 Ø675 Ø300

0 20 40 60 80 100 120m
SCALE 1:2000 AT A1 SIZE

LEGEND

- PROJECT SITE BOUNDARY
- EXISTING GRASSED SWALE
- EXISTING DRAINAGE CATCHMENT BOUNDARY
- 3.51 Ha — EXISTING DRAINAGE CATCHMENT AREA
- OVERLAND FLOW PATH
- e101-3 — EXISTING STORMWATER PIPE AND PIT AND IDENTIFIER
- EXISTING EASEMENTS
- SW — EXISTING STORMWATER PIPE
- S — EXISTING SEWER MAIN
- W — EXISTING WATER MAIN
- OPTIC — EXISTING OPTIC FIBRE
- HV — EXISTING ELECTRICAL HV
- OH — EXISTING ELECTRICAL OH

SKETCH ONLY

BG&E

DATE	30/01/2019
SCALE	1:2000
GRID	
PREPARED	CB
SHEET	1 OF 1

PROJECT: ST MARY'S

TITLE: EXISTING DRAINAGE

PROJECT No. B18028 | SKETCH No. SK-C-0038 | REV A

APPENDIX B

Upstream Catchment Drainage Plans

CONCEPT STORMWATER DRAINAGE CALCULATIONS:

CATCHMENT AREA A (DRAINAGE LINE A)

SITE STORAGE REQUIREMENT:	340.2m³
PERMISSABLE SITE DISCHARGE:	0.146m³/sec.
PROVIDED SITE STORAGE:	630m³
PROVIDED SITE DISCHARGE:	0.139m³/sec.

CATCHMENT AREA B (DRAINAGE LINE B)

SITE STORAGE REQUIREMENT:	44.5m³
PERMISSABLE SITE DISCHARGE:	0.019m³/sec.
PROVIDED SITE STORAGE:	100m³
PROVIDED SITE DISCHARGE:	0.018m³/sec.

CATCHMENT AREA C (DRAINAGE LINE C)

SITE STORAGE REQUIREMENT:	116.3m³
PERMISSABLE SITE DISCHARGE:	0.050m³/sec.
PROVIDED SITE STORAGE:	235m³
PROVIDED SITE DISCHARGE:	0.048m³/sec.

NOTE:

1. SITE STORAGE REQUIREMENT BASED ON VALUE OF 28m³ PER 1000m².
2. PERMISSABLE SITE DISCHARGE BASED ON VALUE OF 12l/sec. PER 1000m².
3. PROVIDED STORAGE VOLUMES BASED ON MAX. PONDING DEPTH OF 200mm.

EXISTING CULVERT NOTE:

DIMENSIONS :	2.4m(W) x 1.8m(H)
CATCHMENT AREA :	120ha
CRITICAL STORM FLOW :	30.3m³/sec.
(100YR ARI, 1hr DURATION,	66.2mm/hr)
DEPTH OF FLOW:	1.048m

STORMWATER TREATEMENT MEASURES:

STORMWATER TREATMENT MEASURES TO CONSIST OF THE FOLLOWING:

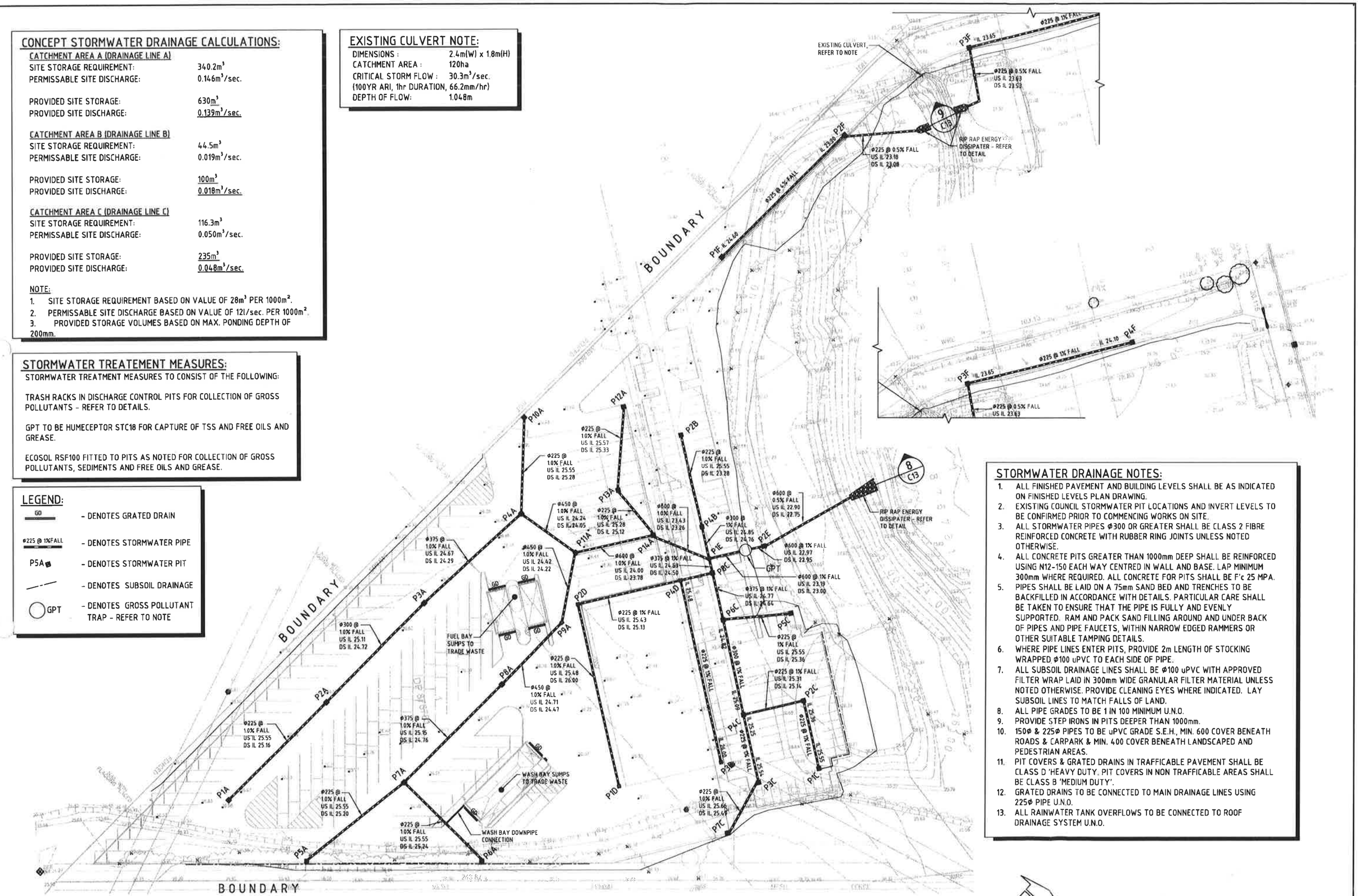
TRASH RACKS IN DISCHARGE CONTROL PITS FOR COLLECTION OF GROSS POLLUTANTS - REFER TO DETAILS.

GPT TO BE HUMECEPTOR STC18 FOR CAPTURE OF TSS AND FREE OILS AND GREASE.

ECOSOL RSF100 FITTED TO PITS AS NOTED FOR COLLECTION OF GROSS POLLUTANTS, SEDIMENTS AND FREE OILS AND GREASE.

LEGEND:

- GO — DENOTES GRATED DRAIN
- Ø225 @ 1%FALL — DENOTES STORMWATER PIPE
- P5A — DENOTES STORMWATER PIT
- DENOTES SUBSOIL DRAINAGE
- GPT — DENOTES GROSS POLLUTANT TRAP - REFER TO NOTE



STORMWATER DRAINAGE NOTES:

1. ALL FINISHED PAVEMENT AND BUILDING LEVELS SHALL BE AS INDICATED ON FINISHED LEVELS PLAN DRAWING.
2. EXISTING COUNCIL STORMWATER PIT LOCATIONS AND INVERT LEVELS TO BE CONFIRMED PRIOR TO COMMENCING WORKS ON SITE.
3. ALL STORMWATER PIPES Ø300 OR GREATER SHALL BE CLASS 2 FIBRE REINFORCED CONCRETE WITH RUBBER RING JOINTS UNLESS NOTED OTHERWISE.
4. ALL CONCRETE PITS GREATER THAN 1000mm DEEP SHALL BE REINFORCED USING N12-150 EACH WAY CENTRED IN WALL AND BASE. LAP MINIMUM 300mm WHERE REQUIRED. ALL CONCRETE FOR PITS SHALL BE F'c 25 MPA.
5. PIPES SHALL BE LAID ON A 75mm SAND BED AND TRENCHES TO BE BACKFILLED IN ACCORDANCE WITH DETAILS. PARTICULAR CARE SHALL BE TAKEN TO ENSURE THAT THE PIPE IS FULLY AND EVENLY SUPPORTED. RAM AND PACK SAND FILLING AROUND AND UNDER BACK OF PIPES AND PIPE FAUCETS, WITHIN NARROW EDGED RAMMERS OR OTHER SUITABLE TAMPING DETAILS.
6. WHERE PIPE LINES ENTER PITS, PROVIDE 2m LENGTH OF STOCKING WRAPPED Ø100 uPVC TO EACH SIDE OF PIPE.
7. ALL SUBSOIL DRAINAGE LINES SHALL BE Ø100 uPVC WITH APPROVED FILTER WRAP LAID IN 300mm WIDE GRANULAR FILTER MATERIAL UNLESS NOTED OTHERWISE. PROVIDE CLEANING EYES WHERE INDICATED. LAY SUBSOIL LINES TO MATCH FALLS OF LAND.
8. ALL PIPE GRADES TO BE 1 IN 100 MINIMUM U.N.O.
9. PROVIDE STEP IRONS IN PITS DEEPER THAN 1000mm.
10. 150Ø & 225Ø PIPES TO BE uPVC GRADE S.E.H., MIN. 600 COVER BENEATH ROADS & CARPARK & MIN. 400 COVER BENEATH LANDSCAPED AND PEDESTRIAN AREAS.
11. PIT COVERS & GRATED DRAINS IN TRAFFICABLE PAVEMENT SHALL BE CLASS D 'HEAVY DUTY'. PIT COVERS IN NON TRAFFICABLE AREAS SHALL BE CLASS B 'MEDIUM DUTY'.
12. GRATED DRAINS TO BE CONNECTED TO MAIN DRAINAGE LINES USING 225Ø PIPE U.N.O.
13. ALL RAINWATER TANK OVERFLOWS TO BE CONNECTED TO ROOF DRAINAGE SYSTEM U.N.O.

FOR CONSTRUCTION

CONCEPT STORMWATER DRAINAGE PLAN
1:500 SCALE

5m 0 10 20 30 40 50m
1:500 SCALE AT A1 SIZE PLOT

ISSUED FOR	DATE	ISSUE
ISSUED FOR CONSTRUCTION	05.01.09	D
ISSUED FOR INFORMATION	17.11.08	D
ISSUED FOR TENDER	11.10.08	C
ISSUED FOR TENDER	08.10.08	B
ISSUED FOR INFORMATION	02.10.08	A
AMENDMENTS	DATE	ISSUE

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PROJECT
WESTBUS FACILITY
LEE HOLM ROAD, ST MARYS

DESIGNED	DRAWN	DATE	CHECKED	SIZE	SCALE	CAD REF:
MW	MW	25.06.08		A1	AS SHOWN	9765 00- C11

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Costin Roe Consulting
Value in Engineering and Management

DRAWING TITLE
STORMWATER DRAINAGE PLAN

DRAWING No C09765.00-C11
ISSUE 0

SUMMARY OF WAREHOUSE AREAS

BUILDING	EXISTING AREA	PROPOSED NEW CONSTRUCTION	DEVELOPED AREAS
WAREHOUSE 1	11,900 sq.m. (TO BE DEMOLISHED)	23,917 sq.m.	23,917 sq.m.
WAREHOUSE 2	11,900 sq.m. (TO BE DEMOLISHED)	23,917 sq.m.	23,917 sq.m.
WAREHOUSE 3	19,067 sq.m:	NIL	19,067 sq.m.
WAREHOUSE 4	4,775 sq.m.	6,953 sq.m.	11,728 sq.m.
WAREHOUSE 5		7,779 sq.m.	7,779sq.m.
TOTALS	47,639 sq.m. (512,798 sq.ft.)	62,566 sq.m. (673,477 sq.ft.)	86,408 sq.m. (930,118 sq.ft.)

EXISTING WAREHOUSING

PROPOSED NEW WAREHOUSING

NOTE
EXISTING DRAIN LINES SHOWN BASED ON CURRENT SURVEY INFORMATION.
DETAIL SURVEY CONFIRMATION WILL BE OBTAINED AT DETAIL DESIGN PHASE TO CONFIRM LEVELS, SIZES AND GRADES.
UPGRADING, IF REQUIRED, WILL BE INCORPORATED IN THE DESIGN.

WAREHOUSE 3
AREA: 18,966sq.m. (204,155 sq.ft.)

WAREHOUSE 2
EXISTING AREA: 11,900 sq.m. (128,095 sq.ft.)
(TO BE DEMOLISHED)

FUTURE WAREHOUSE 5

WAREHOUSE 4
AREA: 4,743 sq.m. (51,052 sq.ft.)
(EXISTING TO BE RETAINED)

WAREHOUSE 1
EXISTING AREA: 11,900 sq.m. (128,075 sq.ft.)
(TO BE DEMOLISHED)

EXISTING WORKSHOP TO BE DEMOLISHED

EXISTING ROADWAY
NEW CONCRETE PAVEMENT
WALL
15m WIDE AWNING
TRUCK PARKING W/H 3
TRUCK PARKING W/H 2
TRUCK PARKING W/H 5
TRUCK PARKING W/H 4
TRUCK PARKING W/H 1
88.2m
NEW ROADWAY
TRANSMISSION LINE EASEMENT (TO BE REMOVED)
10.5m WIDE AWNING
AMENITIES
271.17m
EXISTING WATERCOURSE
TRANSMISSION LINE EASEMENT
DISUSED RAIL LINE
FUTURE EXTENSION
12m WIDE AWNING
83.8m
132.23m
FIRE TANKS
EMPLOYEE CARPARK
146 SPACES
SLIDING GATE
AMENITIES
VISITOR PARK
9000 WIDE LANDSCAPED AREA

FORRESTER ROAD

SITE ENTRY

LEGEND

PROPOSED PAVEMENT DRAINS

PROPOSED PAVEMENT DRAIN FIRST FLUSH INTERCEPTOR PITS

EXISTING DRAINS TO BE UTILISED FOR ROOF DRAINAGE ONLY

PROPOSED ROOF DRAINAGE ONLY DRAINS

EXISTING DRAINS TO BE DISCONTINUED

20000 0 20000 40000 60000 80000 100000
DIMENSIONS ARE IN MILLIMETRES

1:1000 (AT A1 SHEET SIZE)

This is the plan referred to in Penrith City Council's consent:
No. DA 98059 Dated 16/4/98
for Environmental Planning Manager
(Council does not warrant or attest to the accuracy of the detail in this plan.)

No.	Date	Amendment	By
		Revision	

Date	Amount	To	Date	Amount	To
		Issue		Issue	

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ACN 050 214 894

Quality System Australian Standard AS/NZS ISO/IEC 9001:1994 Quality Endorsed Company

FINEMORES
LEADERS IN TRANSPORT

R.A.DONNAN CONSULTING
BUILDING, TRANSPORT & WAREHOUSE PLANNING & DESIGN.
1/2 DAVEY ROAD MONTMORENCY VICTORIA 3094
TELEPHONE (03) 419 5257
FACSIMILE (03) 435 8500

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Job Title: PROPOSED WAREHOUSE FACILITY
LOT 2 FORRESTER RD. ST.MARYS

Drawing Title: PROPOSED STORMWATER SYSTEM

Date: MARCH 1998
Drawn: MTJ
Checked:
Scale: 1 : 1000
Rev:
Job Number: 84043
Drawing Number: CSK-1

CSK-1 1:56 P.M. 16/3/1998

A1

RECEIVED
D/MGT
14 JUN 2011
PENRITH CITY COUNCIL

EXISTING FACTORY

DOWNPIPE FROM NEW WORKSHOP TO BE CONNECTED INTO EXISTING FACTORY DOWNPIPE

EXISTING DOWNPIPE (TYP)

DOWNPIPE FROM NEW WORKSHOP TO BE CONNECTED INTO EXISTING FACTORY DOWNPIPE

A

EXISTING DOWNPIPE

FH

EXIST S.W. PIT

EXISTING DOWNPIPE

NEW MAINTENANCE WORKSHOP

NOM 10045

D.P.

BOX GUTTER

D.P.

9500 | 6995 | 6995 | 6995

1 2 3 4 5

This plan is the Development Application
No 100811
AS REFERRED TO IN CONSENT TO THE

PLAN LAYOUT

EXIST S.W. PIT

ISSUE	DETAILS OF ALTERATIONS	APP BY	DRN	DATE
A	FIRST ISSUE	R.P.	R.P.	05.05.08

ARC
THE AUSTRALIAN REINFORCING COMPANY

ARC
PROPOSED MAINTENENCE WORKSHOP
ST MARYS FACTORY PROJECT
STORMWATER PLAN

1:100	A3	ARC-WS-101	A

APPENDIX C

Drains Results

MINOR EVENT 20 YEAR ARI

DRAINS results prepared from Version 2018.09

PIT / NODE DETAILS Version 8

Name	Max HGL	Max Pond HGL	Max Surfac Flow Arrivi (cu.m/s)	Max Pond Volume (cu.m)	Min Freeboard (m)	Overflow (cu.m/s)	Constraint
1-1	29.96		0.600		1.31	0.387	Inlet Capacity
1-2	28.37		0.433		1.45	0.273	Inlet Capacity
1-3	27.12	28.36	0.374	51.2	1.10	0.000	Inlet Capacity
1-4	26.79		0.000		3.22		None
1-5	26.53		0.000		1.07	0.043	Inlet Capacity
1-6	26.45		0.094		1.00	0.006	Inlet Capacity
1-7	26.09		0.006		1.11	0.068	Inlet Capacity
1-8	25.70		0.000		2.08	0.000	None
e101-2	25.19		0.000		1.56		None
e101-3	24.04		0.000		2.75		None
e101-4	22.09		0.000		2.16		None
e101-5	21.08		0.000				
2-1	27.47	29.00	0.000	0.0	1.53	0.000	None
3-1	26.68	27.77	2.344	1.2	0.82	0.013	Inlet Capacity
10-1	30.17		0.039		0.92	0.026	Inlet Capacity
10-2	30.05		0.016		1.03	0.006	Inlet Capacity
10-3	28.80		0.012		1.15	0.006	Inlet Capacity
10-4	28.13		0.012		0.83	0.001	Inlet Capacity
10-5	28.00	28.92	0.005	0.1	0.90	0.000	Inlet Capacity
10-6	27.91		0.005		1.04	0.002	Inlet Capacity
10-7	27.74		0.014		1.48	0.003	Inlet Capacity
10-8	27.54		0.000		2.32	0.007	Inlet Capacity
10-9	27.25		0.230		1.61	0.148	Inlet Capacity
10-10	26.79		0.300		0.87	0.243	Inlet Capacity
10-11	25.53		0.491		0.93	0.187	Inlet Capacity
10-12	24.56		0.377		1.13	0.193	Inlet Capacity
10-13	24.00		0.390		0.90	0.207	Inlet Capacity
10-14	23.64		0.417		0.70	0.200	Inlet Capacity
10-15	23.36		0.402		0.48	0.010	Inlet Capacity
10-16	23.14	23.73	0.199	4.0	0.45	0.000	Inlet Capacity
10-17	22.99		0.000		0.79		None
10-18	22.74		0.000		1.04		None
10-19	22.51		0.000				
11-1	28.86		0.043		1.08	0.027	Inlet Capacity
12-1	28.32		0.044		0.63	0.015	Inlet Capacity
13-1	28.16	28.94	0.027	0.2	0.73	0.000	Inlet Capacity
14-1	28.23		0.007		0.73	0.005	Inlet Capacity
17-1	23.49		0.016		0.73	0.012	Inlet Capacity
17-2	23.48	24.30	0.036	0.5	0.74	0.023	Inlet Capacity
17-3	23.47		0.112		0.58	0.080	Inlet Capacity
17-4	23.27		0.161		0.47	0.045	Inlet Capacity
20-1	22.70	23.68	0.049	2.2	0.90	0.000	Inlet Capacity
20-2	22.48	23.84	0.093	2.7	1.24	0.000	Inlet Capacity
20-3	22.33		0.000				
21-1	22.78		0.024		1.14	0.012	Inlet Capacity
21-2	22.54		0.022		1.51	0.023	Inlet Capacity
21-3	21.65		0.000				
30-1	31.76		0.012		1.16	0.000	None
30-2	31.72		0.012		1.20	0.000	None
30-3	31.40		0.000				
e40	26.88	27.06	1.303	0.9	0.00	0.037	Outlet System
N2701	24.36		0.000				
e102-2	26.01	26.08	0.076	1.4	0.00	0.069	Outlet System
4-1	25.78	26.00	0.137	1.2	0.09	0.000	Inlet Capacity
16-1	23.52		0.146		0.19	0.045	Inlet Capacity
1-9	25.49		0.134		2.06	0.028	Inlet Capacity
1-10	24.52		0.038		1.86	0.010	Inlet Capacity
1-11	23.91		0.021		1.66	0.010	Inlet Capacity
1-12	23.00		0.019		1.33	0.001	Inlet Capacity
1-13	22.78		0.000				

SUB-CATCHMENT DETAILS

Name	Max Flow Q (cu.m/s)	Paved Max Q (cu.m/s)	Grassed Max Q (cu.m/s)	Paved Tc (min)	Grassed Tc (min)	Supp. Tc (min)	Due to Storm
C 1-1	0.600	0.600	0.000	12.00	12.00	12.00	AR&R 20 year, 25 minutes storm, average 83.87 mm/h, Zone 1
C 1-2	0.102	0.020	0.083	18.26	2.00	17.19	AR&R 20 year, 25 minutes storm, average 83.87 mm/h, Zone 1
C 1-3	0.198	0.121	0.079	5.00	10.00	0.00	AR&R 20 year, 25 minutes storm, average 83.87 mm/h, Zone 1

C 1-6	0.087	0.000	0.087	24.59	24.59	24.59	AR&R 20 year, 1 hour storm, average 50.6 mm/h, Zone 1
C 3-1	2.344	2.246	0.098	8.00	8.00	8.00	AR&R 20 year, 25 minutes storm, average 83.87 mm/h, Zone 1
C 10-1	0.039	0.039	0.000	5.00	10.00	0.00	AR&R 20 year, 25 minutes storm, average 83.87 mm/h, Zone 1
C 10-2	0.016	0.016	0.000	5.00	10.00	0.00	AR&R 20 year, 25 minutes storm, average 83.87 mm/h, Zone 1
C 10-3	0.012	0.012	0.000	5.00	10.00	0.00	AR&R 20 year, 25 minutes storm, average 83.87 mm/h, Zone 1
C 10-4	0.012	0.012	0.000	5.00	10.00	0.00	AR&R 20 year, 25 minutes storm, average 83.87 mm/h, Zone 1
C 10-5	0.005	0.005	0.000	5.00	10.00	0.00	AR&R 20 year, 25 minutes storm, average 83.87 mm/h, Zone 1
C 10-6	0.005	0.005	0.000	5.00	10.00	0.00	AR&R 20 year, 25 minutes storm, average 83.87 mm/h, Zone 1
C 10-7	0.014	0.014	0.000	5.00	10.00	0.00	AR&R 20 year, 25 minutes storm, average 83.87 mm/h, Zone 1
C 10-9	0.230	0.230	0.000	7.88	0.00	0.00	AR&R 20 year, 25 minutes storm, average 83.87 mm/h, Zone 1
C 10-10	0.307	0.307	0.000	7.88	0.00	0.00	AR&R 20 year, 25 minutes storm, average 83.87 mm/h, Zone 1
C 10-11	0.501	0.501	0.000	7.88	0.00	0.00	AR&R 20 year, 25 minutes storm, average 83.87 mm/h, Zone 1
C 10-12	0.381	0.381	0.000	7.88	0.00	0.00	AR&R 20 year, 25 minutes storm, average 83.87 mm/h, Zone 1
C 10-13	0.394	0.394	0.000	7.88	0.00	0.00	AR&R 20 year, 25 minutes storm, average 83.87 mm/h, Zone 1
C 10-14	0.422	0.422	0.000	7.88	0.00	0.00	AR&R 20 year, 25 minutes storm, average 83.87 mm/h, Zone 1
C 10-15	0.407	0.407	0.000	7.88	0.00	0.00	AR&R 20 year, 25 minutes storm, average 83.87 mm/h, Zone 1
C 10-16	0.200	0.183	0.017	13.24	10.00	0.00	AR&R 20 year, 25 minutes storm, average 83.87 mm/h, Zone 1
C 11-1	0.034	0.032	0.002	5.00	10.00	0.00	AR&R 20 year, 25 minutes storm, average 83.87 mm/h, Zone 1
C 12-1	0.034	0.032	0.002	5.00	10.00	0.00	AR&R 20 year, 25 minutes storm, average 83.87 mm/h, Zone 1
C 13-1	0.016	0.015	0.001	5.00	10.00	0.00	AR&R 20 year, 25 minutes storm, average 83.87 mm/h, Zone 1
C 14-1	0.007	0.006	0.000	5.00	10.00	0.00	AR&R 20 year, 25 minutes storm, average 83.87 mm/h, Zone 1
C 17-1	0.016	0.016	0.000	5.00	10.00	0.00	AR&R 20 year, 25 minutes storm, average 83.87 mm/h, Zone 1
C 17-2	0.036	0.034	0.002	5.00	10.00	0.00	AR&R 20 year, 25 minutes storm, average 83.87 mm/h, Zone 1
C 17-3	0.112	0.112	0.000	5.00	10.00	0.00	AR&R 20 year, 25 minutes storm, average 83.87 mm/h, Zone 1
C 17-4	0.162	0.162	0.000	5.00	5.00	5.00	AR&R 20 year, 25 minutes storm, average 83.87 mm/h, Zone 1
C 20-1	0.050	0.050	0.000	5.00	10.00	0.00	AR&R 20 year, 25 minutes storm, average 83.87 mm/h, Zone 1
C 20-2	0.094	0.094	0.000	5.00	10.00	0.00	AR&R 20 year, 25 minutes storm, average 83.87 mm/h, Zone 1
C 21-1	0.024	0.024	0.000	5.00	10.00	0.00	AR&R 20 year, 25 minutes storm, average 83.87 mm/h, Zone 1
C 21-2	0.022	0.022	0.000	5.00	10.00	0.00	AR&R 20 year, 25 minutes storm, average 83.87 mm/h, Zone 1
C 30-1	0.012	0.012	0.000	5.00	10.00	0.00	AR&R 20 year, 25 minutes storm, average 83.87 mm/h, Zone 1
C 30-2	0.012	0.012	0.000	5.00	10.00	0.00	AR&R 20 year, 25 minutes storm, average 83.87 mm/h, Zone 1
C F-40	1.303	1.303	0.000	6.00	6.00	6.00	AR&R 20 year, 25 minutes storm, average 83.87 mm/h, Zone 1
C e102-2	0.080	0.000	0.080	5.00	5.00	5.00	AR&R 20 year, 25 minutes storm, average 83.87 mm/h, Zone 1
C 4-1	0.139	0.139	0.000	5.00	10.00	0.00	AR&R 20 year, 25 minutes storm, average 83.87 mm/h, Zone 1
C 16-1	0.146	0.146	0.000	5.00	5.00	5.00	AR&R 20 year, 25 minutes storm, average 83.87 mm/h, Zone 1
C 1-9	0.134	0.125	0.009	5.00	10.00	0.00	AR&R 20 year, 25 minutes storm, average 83.87 mm/h, Zone 1
C 1-10	0.021	0.021	0.000	5.00	10.00	0.00	AR&R 20 year, 25 minutes storm, average 83.87 mm/h, Zone 1
C 1-11	0.021	0.021	0.000	5.00	10.00	0.00	AR&R 20 year, 25 minutes storm, average 83.87 mm/h, Zone 1
C 1-12	0.020	0.020	0.000	5.00	10.00	0.00	AR&R 20 year, 25 minutes storm, average 83.87 mm/h, Zone 1

Outflow Volumes for Total Catchment (20.2 impervious + 1.62 pervious = 21.8 total ha)

Storm	Total Rainf	Total Runo	Impervious	Pervious Runoff
	cu.m	cu.m (Runc	cu.m (Runc	cu.m (Runoff %)
AR&R 20 ye	3024.76	2667.60 (8	2598.14 (9	69.46 (30.9%)
AR&R 20 ye	4619.90	4230.05 (9	4074.86 (9	155.19 (45.2%)
AR&R 20 ye	5773.06	5357.29 (9	5142.41 (9	214.87 (50.1%)
AR&R 20 ye	6694.13	6256.51 (9	5995.10 (9	261.41 (52.6%)
AR&R 20 ye	7627.38	7165.76 (9	6859.08 (9	306.68 (54.2%)
AR&R 20 ye	8140.12	7655.19 (9	7333.75 (9	321.45 (53.2%)
AR&R 20 ye	9769.27	9234.16 (9	8841.96 (9	392.20 (54.1%)
AR&R 20 ye	11044.11	10469.30 (	10022.14 (	447.16 (54.5%)
AR&R 20 ye	13033.58	12390.99 (	11863.88 (	527.11 (54.5%)
AR&R 20 ye	14606.16	13907.86 (	13319.71 (	588.15 (54.2%)
AR&R 20 ye	17090.00	16306.51 (	15619.18 (	687.33 (54.2%)
AR&R 20 ye	19986.89	19073.91 (	18301.29 (	772.61 (52.1%)

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)	
P 1-1	0.268	3.48	29.675	28.374	AR&R 20 year, 15 minutes storm, average 105.8 mm/h, Zone 1
P 1-2	0.503	4.13	28.129	27.117	AR&R 20 year, 25 minutes storm, average 83.87 mm/h, Zone 1
P 1-3	0.630	2.21	26.994	26.788	AR&R 20 year, 25 minutes storm, average 83.87 mm/h, Zone 1
P 1-4	0.662	2.28	26.650	26.525	AR&R 20 year, 25 minutes storm, average 83.87 mm/h, Zone 1
P 1-5	0.692	1.22	26.512	26.454	AR&R 20 year, 25 minutes storm, average 83.87 mm/h, Zone 1
P 1-6	2.813	3.22	26.240	26.089	AR&R 20 year, 25 minutes storm, average 83.87 mm/h, Zone 1
P 1-7	2.835	3.14	26.010	25.701	AR&R 20 year, 25 minutes storm, average 83.87 mm/h, Zone 1
P e101-1	0.910	2.54	25.536	25.190	AR&R 20 year, 25 minutes storm, average 83.87 mm/h, Zone 1
P 1-8	2.108	3.0	25.554	25.505	AR&R 20 year, 25 minutes storm, average 83.87 mm/h, Zone 1
P e101-2	0.909	2.67	25.066	24.036	AR&R 20 year, 25 minutes storm, average 83.87 mm/h, Zone 1
P e101-3	0.898	3.22	23.896	22.151	AR&R 20 year, 25 minutes storm, average 83.87 mm/h, Zone 1
P e101-4	0.898	4.91	21.940	21.084	AR&R 20 year, 25 minutes storm, average 83.87 mm/h, Zone 1
P 2-1	0.000	0.00	27.465	27.117	AR&R 20 year, 5 minutes storm, average 166.3 mm/h, Zone 1
P 3-1	2.345	2.94	26.520	26.454	AR&R 20 year, 25 minutes storm, average 83.87 mm/h, Zone 1
P 10-1	0.030	1.80	30.099	30.054	AR&R 20 year, 25 minutes storm, average 83.87 mm/h, Zone 1
P 10-2	0.044	2.29	29.967	28.891	AR&R 20 year, 25 minutes storm, average 83.87 mm/h, Zone 1
P 10-3	0.085	1.76	28.704	28.125	AR&R 20 year, 25 minutes storm, average 83.87 mm/h, Zone 1

P 10-4	0.126	1.44	28.028	27.999	AR&R 20 year, 25 minutes storm, average 83.87 mm/h, Zone 1
P 10-5	0.157	1.40	27.941	27.911	AR&R 20 year, 25 minutes storm, average 83.87 mm/h, Zone 1
P 10-6	0.166	2.10	27.789	27.743	AR&R 20 year, 25 minutes storm, average 83.87 mm/h, Zone 1
P 10-7	0.178	1.76	27.700	27.540	AR&R 20 year, 25 minutes storm, average 83.87 mm/h, Zone 1
P 10-8	0.173	1.57	27.492	27.251	AR&R 20 year, 25 minutes storm, average 83.87 mm/h, Zone 1
P 10-9	0.374	2.35	27.055	26.790	AR&R 20 year, 25 minutes storm, average 83.87 mm/h, Zone 1
P 10-10	0.664	3.02	26.540	25.534	AR&R 20 year, 25 minutes storm, average 83.87 mm/h, Zone 1
P 10-11	1.155	3.83	25.240	24.561	AR&R 20 year, 25 minutes storm, average 83.87 mm/h, Zone 1
P 10-12	1.507	3.79	24.362	24.003	AR&R 20 year, 25 minutes storm, average 83.87 mm/h, Zone 1
P 10-13	1.899	2.19	23.910	23.637	AR&R 20 year, 25 minutes storm, average 83.87 mm/h, Zone 1
P 10-14	2.304	2.04	23.533	23.356	AR&R 20 year, 25 minutes storm, average 83.87 mm/h, Zone 1
P 10-15	2.693	2.38	23.213	23.141	AR&R 20 year, 25 minutes storm, average 83.87 mm/h, Zone 1
P 10-16	3.265	2.28	23.009	22.992	AR&R 20 year, 25 minutes storm, average 83.87 mm/h, Zone 1
P 10-17	3.266	2.28	22.781	22.745	AR&R 20 year, 25 minutes storm, average 83.87 mm/h, Zone 1
P 10-18	3.267	2.28	22.571	22.514	AR&R 20 year, 25 minutes storm, average 83.87 mm/h, Zone 1
P 11-1	0.031	1.05	28.795	28.796	AR&R 20 year, 25 minutes storm, average 83.87 mm/h, Zone 1
P 12-1	0.032	1.74	28.254	28.134	AR&R 20 year, 25 minutes storm, average 83.87 mm/h, Zone 1
P 13-1	0.028	2.88	28.083	27.999	AR&R 20 year, 25 minutes storm, average 83.87 mm/h, Zone 1
P 14-1	0.006	1.16	28.200	28.084	AR&R 20 year, 25 minutes storm, average 83.87 mm/h, Zone 1
P 17-1	0.019	0.17	23.489	23.482	AR&R 20 year, 1.5 hours storm, average 39.81 mm/h, Zone 1
P 17-2	0.053	0.33	23.480	23.467	AR&R 20 year, 25 minutes storm, average 83.87 mm/h, Zone 1
P 17-3	0.163	1.02	23.361	23.267	AR&R 20 year, 25 minutes storm, average 83.87 mm/h, Zone 1
P 17-4	0.321	1.14	23.166	23.141	AR&R 20 year, 25 minutes storm, average 83.87 mm/h, Zone 1
P 20-1	0.037	1.72	22.612	22.481	AR&R 20 year, 25 minutes storm, average 83.87 mm/h, Zone 1
P 20-2	0.120	2.96	22.327	22.333	AR&R 20 year, 25 minutes storm, average 83.87 mm/h, Zone 1
P 21-1	0.024	1.87	22.703	22.671	AR&R 20 year, 25 minutes storm, average 83.87 mm/h, Zone 1
P 21-2	0.046	3.19	22.452	21.648	AR&R 20 year, 25 minutes storm, average 83.87 mm/h, Zone 1
P 30-1	0.012	0.62	31.729	31.724	AR&R 20 year, 25 minutes storm, average 83.87 mm/h, Zone 1
P 30-2	0.026	1.99	31.656	31.397	AR&R 20 year, 25 minutes storm, average 83.87 mm/h, Zone 1
P e40	1.282	3.63	26.231	24.358	AR&R 20 year, 25 minutes storm, average 83.87 mm/h, Zone 1
P e102-2	0.072	1.01	25.844	25.782	AR&R 20 year, 25 minutes storm, average 83.87 mm/h, Zone 1
P 4-1	0.201	0.71	25.707	25.701	AR&R 20 year, 25 minutes storm, average 83.87 mm/h, Zone 1
P 16-1	0.145	1.32	23.208	23.141	AR&R 20 year, 25 minutes storm, average 83.87 mm/h, Zone 1
P 1-9	2.196	3.80	25.351	24.518	AR&R 20 year, 25 minutes storm, average 83.87 mm/h, Zone 1
P 1-10	2.184	2.97	24.447	23.963	AR&R 20 year, 25 minutes storm, average 83.87 mm/h, Zone 1
P 1-11	2.196	3.67	23.810	22.995	AR&R 20 year, 25 minutes storm, average 83.87 mm/h, Zone 1
P 1-12	2.228	2.11	22.909	22.779	AR&R 20 year, 25 minutes storm, average 83.87 mm/h, Zone 1

CHANNEL DETAILS

Name	Max Q (cu.m/s)	Max V (m/s)	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
F 1-1	0.336	0.438	2.883	0.258	0.25	2.75	1.33	AR&R 20 year, 25 minutes storm, average 83.87 mm/h, Zone 1
F 1-2	0.184	0.363	12.513	0.023	0.02	20.19	0.64	AR&R 20 year, 25 minutes storm, average 83.87 mm/h, Zone 1
F 1-3	0	0	0.000	0	0	0	0	
F 1-5	0.000	0.086	0.661	0.228	0.18	1.82	1.54	AR&R 20 year, 1 hour storm, average 50.6 mm/h, Zone 1
F 1-6	0.006	0.006	1.830	0.075	0.02	0.60	0.43	AR&R 20 year, 1 hour storm, average 50.6 mm/h, Zone 1
F 1-7	0.000	0.138	1.264	0.198	0.11	1.59	0.58	AR&R 20 year, 25 minutes storm, average 83.87 mm/h, Zone 1
F 1-8	0	0	0.000	0	0	0	0	
F 2-1	0	0	0.000	0	0	0	0	
F 3-1	0.013	0.013	0.000	0.512	0.00	26.68	0.11	AR&R 20 year, 25 minutes storm, average 83.87 mm/h, Zone 1
F 10-1	0.009	0.043	0.241	0.061	0.07	2.33	1.53	AR&R 20 year, 25 minutes storm, average 83.87 mm/h, Zone 1
F 10-2	0.000	0.012	0.392	0.059	0.05	1.09	1.45	AR&R 20 year, 25 minutes storm, average 83.87 mm/h, Zone 1
F 10-3	0.000	0.012	0.366	0.059	0.05	1.10	1.36	AR&R 20 year, 25 minutes storm, average 83.87 mm/h, Zone 1
F 10-4	0.000	0.003	0.115	0.003	0.00	0.07	0.00	AR&R 20 year, 25 minutes storm, average 83.87 mm/h, Zone 1
F 10-5	0	0	0.000	0	0	0	0	
F 10-6	0.000	0.003	0.187	0.014	0.00	0.16	0.00	AR&R 20 year, 2 hours storm, average 33.46 mm/h, Zone 1
F 10-7	0.000	0.005	0.275	0.043	0.03	0.57	1.02	AR&R 20 year, 25 minutes storm, average 83.87 mm/h, Zone 1
F 10-8	0.000	0.014	0.381	0.062	0.06	1.20	1.49	AR&R 20 year, 25 minutes storm, average 83.87 mm/h, Zone 1
F 10-9	0.000	0.302	17.154	0.077	0.05	19.21	1.00	AR&R 20 year, 25 minutes storm, average 83.87 mm/h, Zone 1
F 10-10	0.000	0.493	17.154	0.092	0.07	22.92	1.10	AR&R 20 year, 25 minutes storm, average 83.87 mm/h, Zone 1
F 10-11	0.000	0.377	17.154	0.083	0.06	20.63	1.04	AR&R 20 year, 25 minutes storm, average 83.87 mm/h, Zone 1
F 10-12	0.000	0.390	17.154	0.084	0.06	20.88	1.04	AR&R 20 year, 25 minutes storm, average 83.87 mm/h, Zone 1
F 10-13	0.000	0.418	15.892	0.086	0.06	21.62	1.06	AR&R 20 year, 25 minutes storm, average 83.87 mm/h, Zone 1
F 10-14	0.000	0.403	14.856	0.087	0.06	21.67	1.05	AR&R 20 year, 25 minutes storm, average 83.87 mm/h, Zone 1
F 10-15	0.000	0.020	18.986	0.054	0.00	13.41	0.17	AR&R 20 year, 25 minutes storm, average 83.87 mm/h, Zone 1
F 10-16	0	0	0.000	0	0	0	0	
F 11-1	0.010	0.044	0.224	0.061	0.07	2.30	1.44	AR&R 20 year, 25 minutes storm, average 83.87 mm/h, Zone 1
F 12-1	0.011	0.019	0.115	0.048	0.02	1.44	0.40	AR&R 20 year, 25 minutes storm, average 83.87 mm/h, Zone 1
F 13-1	0	0	0.000	0	0	0	0	
F 14-1	0.001	0.009	0.116	0.019	0.00	0.42	0.00	AR&R 20 year, 25 minutes storm, average 83.87 mm/h, Zone 1
F 17-1	0.000	0.025	0.000	0.071	0.03	1.50	0.44	AR&R 20 year, 25 minutes storm, average 83.87 mm/h, Zone 1
F 17-2	0.000	0.046	0.276	0.082	0.04	1.88	0.52	AR&R 20 year, 25 minutes storm, average 83.87 mm/h, Zone 1
F 17-3	0.000	0.161	0.251	0.133	0.16	3.59	1.58	AR&R 20 year, 25 minutes storm, average 83.87 mm/h, Zone 1
F 17-4	0.000	0.090	0.257	0.107	0.06	2.70	0.52	AR&R 20 year, 25 minutes storm, average 83.87 mm/h, Zone 1

F 20-1	0	0	0.000	0	0	0	0	
F 20-2	0	0	0.000	0	0	0	0	
F 21-1	0.000	0.025	0.000	0.075	0.03	1.64	0.35	AR&R 20 year, 25 minutes storm, average 83.87 mm/h, Zone 1
F 21-2	0.000	0.046	0.000	0.090	0.04	2.13	0.41	AR&R 20 year, 25 minutes storm, average 83.87 mm/h, Zone 1
F 30-1	0	0	0.307	0	0	0	0	
F 30-2	0	0	0.307	0	0	0	0	
F E40	0.000	0.077	2.313	0.069	0.04	1.61	0.52	AR&R 20 year, 25 minutes storm, average 83.87 mm/h, Zone 1
F e102-2	0.000	0.139	0.602	0.176	0.13	1.41	0.75	AR&R 20 year, 25 minutes storm, average 83.87 mm/h, Zone 1
F 4-1	0	0	0.721	0	0	0	0	
F 16-1	0.000	0.090	0.230	0.113	0.05	2.90	0.45	AR&R 20 year, 25 minutes storm, average 83.87 mm/h, Zone 1
F 1-9	0.018	0.039	1.296	0.144	0.10	1.16	0.96	AR&R 20 year, 25 minutes storm, average 83.87 mm/h, Zone 1
F 1-10	0.000	0.021	1.296	0.120	0.08	0.96	1.17	AR&R 20 year, 25 minutes storm, average 83.87 mm/h, Zone 1
F 1-11	0.000	0.019	1.296	0.110	0.07	0.88	1.14	AR&R 20 year, 25 minutes storm, average 83.87 mm/h, Zone 1
F 1-12	0.001	0.001	1.296	0.027	0.00	0.21	0.00	AR&R 20 year, 25 minutes storm, average 83.87 mm/h, Zone 1

DETENTION BASIN DETAILS

Name	Max WL	MaxVol	Max Q Total	Max Q Low Level	Max Q High Level

CONTINUITY CHECK for AR&R 20 year, 1 hour storm, average 50.6 mm/h, Zone 1

Node	Inflow (cu.m)	Outflow (cu.m)	Storage Ch (cu.m)	Difference %
1-1	830.75	825.96	0.00	0.6
1-2	920.73	914.36	0.00	0.7
1-3	1120.50	1116.59	0.00	0.3
1-4	1116.59	1117.87	0.00	-0.1
1-5	1117.87	1113.09	0.00	0.4
1-6	4078.30	4059.15	0.00	0.5
1-7	4059.16	4065.80	0.00	-0.2
1-8	4274.45	4269.45	0.00	0.1
e101-2	1731.17	1712.83	0.00	1.1
e101-3	1712.83	1720.92	0.00	-0.5
e101-4	1720.92	1720.61	0.00	0.0
e101-5	1720.61	1720.61	0.00	0.0
2-1	0.00	0.00	0.00	0.0
3-1	2823.28	2822.36	0.00	0.0
10-1	42.06	42.08	0.00	-0.0
10-2	52.91	52.28	0.00	1.2
10-3	101.70	100.49	0.00	1.2
10-4	151.11	150.58	0.00	0.3
10-5	181.00	180.89	0.00	0.1
10-6	193.26	192.46	0.00	0.4
10-7	207.82	206.17	0.00	0.8
10-8	206.09	206.46	0.00	-0.2
10-9	486.59	481.03	0.00	1.1
10-10	854.32	851.06	0.00	0.4
10-11	1460.35	1454.76	0.00	0.4
10-12	1918.76	1913.95	0.00	0.3
10-13	2394.03	2389.64	0.00	0.2
10-14	2903.05	2899.49	0.00	0.1
10-15	3394.89	3392.82	0.00	0.1
10-16	4187.54	4186.89	0.00	0.0
10-17	4186.89	4186.93	0.00	-0.0
10-18	4186.93	4186.78	0.00	0.0
10-19	4186.78	4186.78	0.00	0.0
11-1	44.10	44.16	0.00	-0.1
12-1	44.61	44.68	0.00	-0.2
13-1	24.78	24.67	0.00	0.4
14-1	7.11	7.21	0.00	-1.5
17-1	17.06	17.03	0.00	0.2
17-2	56.23	56.07	0.00	0.3
17-3	178.69	178.46	0.00	0.1
17-4	355.53	355.33	0.00	0.1
20-1	54.90	53.92	0.00	1.8
20-2	156.01	155.32	0.00	0.4
20-3	155.32	155.32	0.00	0.0
21-1	26.49	26.46	0.00	0.1
21-2	50.72	50.19	0.00	1.0
21-3	50.71	50.71	0.00	0.0
30-1	13.39	13.39	0.00	0.0
30-2	26.98	26.75	0.00	0.8
30-3	26.75	26.75	0.00	0.0
O 1-12	0.53	0.53	0.00	0.0
O 20-1	0.00	0.00	0.00	0.0
O 30-1	0.00	0.00	0.00	0.0
O 30-2	0.00	0.00	0.00	0.0

N139	0.00	0.00	0.00	0.0
e40	1492.96	1491.92	0.00	0.1
N2701	1492.05	1492.05	0.00	0.0
e102-2	57.31	56.92	0.00	0.7
4-1	215.75	215.94	0.00	-0.1
16-1	159.12	159.06	0.00	0.0
1-9	2683.12	2669.43	0.00	0.5
1-10	2692.40	2694.57	0.00	-0.1
1-11	2717.79	2713.97	0.00	0.1
1-12	2735.45	2734.81	0.00	0.0
1-13	2734.28	2734.28	0.00	0.0

Run Log for B18028_006_Rev01.drn run at 16:11:21 on 29/1/2019
No water upwelling from any pit.
Freeboard was less than 0.15m at e102-2, e40, 4-1
The maximum flow in these overflow routes is unsafe: F 1-3, F 2-1, F 3-1, F 17-1, F 21-1, F 21-2
These sag pits have unsafe water levels for minor storms: 4-1, 10-16

MAJOR EVENT 100 YEAR ARI

DRAINS results prepared from Version 2018.09

PIT / NODE DETAILS Version 8

Name	Max HGL	Max Pond HGL	Max Surfac Flow Arrivi (cu.m/s)	Max Pond Volume (cu.m)	Min Freeboard (m)	Overflow (cu.m/s)	Constraint
1-1	30.01		0.734		1.27	0.493	Inlet Capacity
1-2	28.49		0.553		1.34	0.369	Inlet Capacity
1-3	27.25	28.39	0.498	87.4	0.97	0.000	Inlet Capacity
1-4	27.01		0.000		2.99		None
1-5	26.77		0.000		0.83	0.066	Inlet Capacity
1-6	26.65		0.142		0.80	0.011	Inlet Capacity
1-7	26.25		0.011		0.95	0.086	Inlet Capacity
1-8	25.89		0.000		1.90	0.000	None
e101-2	25.30		0.000		1.45		None
e101-3	24.06		0.000		2.72		None
e101-4	22.11		0.000		2.14		None
e101-5	21.09		0.000				
2-1	27.47	29.00	0.000	0.0	1.53	0.000	None
3-1	26.98	27.81	2.825	1.4	0.52	0.022	Inlet Capacity
10-1	30.19		0.049		0.90	0.033	Inlet Capacity
10-2	30.07		0.021		1.02	0.007	Inlet Capacity
10-3	28.94		0.014		1.00	0.007	Inlet Capacity
10-4	28.88		0.014		0.08	0.002	Inlet Capacity
10-5	28.80	28.92	0.006	0.1	0.09	0.000	Inlet Capacity
10-6	28.78		0.006		0.18	0.002	Inlet Capacity
10-7	28.71		0.018		0.51	0.003	Inlet Capacity
10-8	28.65		0.000		1.20	0.009	Inlet Capacity
10-9	28.50		0.304		0.36	0.188	Inlet Capacity
10-10	27.70		0.387		0.00	0.402	Outlet System
10-11	26.44		0.671		0.02	0.245	Inlet Capacity
10-12	25.46		0.495		0.24	0.253	Inlet Capacity
10-13	24.64		0.512		0.27	0.274	Inlet Capacity
10-14	24.14		0.551		0.20	0.263	Inlet Capacity
10-15	23.74		0.531		0.10	0.013	Inlet Capacity
10-16	23.43	23.76	0.290	5.4	0.16	0.000	Inlet Capacity
10-17	23.22		0.000		0.57		None
10-18	22.85		0.000		0.94		None
10-19	22.51		0.000				
11-1	28.97		0.053		0.98	0.034	Inlet Capacity
12-1	28.91		0.054		0.04	0.020	Inlet Capacity
13-1	28.82	28.95	0.035	0.3	0.07	0.000	Inlet Capacity
14-1	28.82		0.008		0.14	0.006	Inlet Capacity
17-1	24.07		0.020		0.15	0.015	Inlet Capacity
17-2	24.02	24.31	0.044	0.6	0.20	0.029	Inlet Capacity
17-3	24.01		0.143		0.04	0.102	Inlet Capacity
17-4	23.68		0.204		0.06	0.057	Inlet Capacity
20-1	22.73	23.69	0.062	2.7	0.87	0.000	Inlet Capacity
20-2	22.54	23.86	0.116	3.4	1.19	0.000	Inlet Capacity
20-3	22.36		0.000				
21-1	22.80		0.031		1.12	0.015	Inlet Capacity
21-2	22.56		0.028		1.48	0.028	Inlet Capacity
21-3	21.66		0.000				
30-1	31.78		0.016		1.14	0.000	None
30-2	31.74		0.016		1.18	0.000	None
30-3	31.41		0.000				
e40	27.05	27.24	1.565	0.9	0.00	0.248	Outlet System
N2701	24.36		0.000				
e102-2	26.44	26.52	0.291	17.1	0.00	0.088	Outlet System
4-1	25.98	26.11	0.173	2.6	0.00	0.000	Outlet System
16-1	23.78		0.185		0.00	0.096	Outlet System
1-9	25.61		0.164		1.93	0.037	Inlet Capacity
1-10	24.70		0.049		1.68	0.013	Inlet Capacity
1-11	24.05		0.025		1.52	0.012	Inlet Capacity
1-12	23.18		0.023		1.15	0.001	Inlet Capacity
1-13	22.78		0.000				

SUB-CATCHMENT DETAILS

Name	Max Flow Q (cu.m/s)	Paved Max Q (cu.m/s)	Grassed Max Q (cu.m/s)	Paved Tc (min)	Grassed Tc (min)	Supp. Tc (min)	Due to Storm
C 1-1	0.734	0.734	0.000	12.00	12.00	12.00	AR&R 100 year, 20 minutes storm, average 121.4 mm/h, Zone 1
C 1-2	0.128	0.015	0.112	13.40	2.00	12.34	AR&R 100 year, 5 minutes storm, average 219.7 mm/h, Zone 1
C 1-3	0.249	0.143	0.106	5.00	10.00	0.00	AR&R 100 year, 25 minutes storm, average 110.6 mm/h, Zone 1

C 1-6	0.134	0.000	0.134	19.60	19.60	19.60	AR&R 100 year, 25 minutes storm, average 110.6 mm/h, Zone 1
C 3-1	2.825	2.704	0.121	8.00	8.00	8.00	AR&R 100 year, 20 minutes storm, average 121.4 mm/h, Zone 1
C 10-1	0.049	0.049	0.000	5.00	10.00	0.00	AR&R 100 year, 5 minutes storm, average 219.7 mm/h, Zone 1
C 10-2	0.021	0.021	0.000	5.00	10.00	0.00	AR&R 100 year, 5 minutes storm, average 219.7 mm/h, Zone 1
C 10-3	0.015	0.015	0.000	5.00	10.00	0.00	AR&R 100 year, 5 minutes storm, average 219.7 mm/h, Zone 1
C 10-4	0.015	0.015	0.000	5.00	10.00	0.00	AR&R 100 year, 5 minutes storm, average 219.7 mm/h, Zone 1
C 10-5	0.007	0.007	0.000	5.00	10.00	0.00	AR&R 100 year, 5 minutes storm, average 219.7 mm/h, Zone 1
C 10-6	0.006	0.006	0.000	5.00	10.00	0.00	AR&R 100 year, 5 minutes storm, average 219.7 mm/h, Zone 1
C 10-7	0.018	0.018	0.000	5.00	10.00	0.00	AR&R 100 year, 5 minutes storm, average 219.7 mm/h, Zone 1
C 10-9	0.304	0.304	0.000	5.36	0.00	0.00	AR&R 100 year, 5 minutes storm, average 219.7 mm/h, Zone 1
C 10-10	0.405	0.405	0.000	5.36	0.00	0.00	AR&R 100 year, 5 minutes storm, average 219.7 mm/h, Zone 1
C 10-11	0.661	0.661	0.000	5.36	0.00	0.00	AR&R 100 year, 5 minutes storm, average 219.7 mm/h, Zone 1
C 10-12	0.503	0.503	0.000	5.36	0.00	0.00	AR&R 100 year, 5 minutes storm, average 219.7 mm/h, Zone 1
C 10-13	0.521	0.521	0.000	5.36	0.00	0.00	AR&R 100 year, 5 minutes storm, average 219.7 mm/h, Zone 1
C 10-14	0.557	0.557	0.000	5.36	0.00	0.00	AR&R 100 year, 5 minutes storm, average 219.7 mm/h, Zone 1
C 10-15	0.537	0.537	0.000	5.36	0.00	0.00	AR&R 100 year, 5 minutes storm, average 219.7 mm/h, Zone 1
C 10-16	0.256	0.232	0.024	12.15	10.00	0.00	AR&R 100 year, 20 minutes storm, average 121.4 mm/h, Zone 1
C 11-1	0.042	0.041	0.001	5.00	10.00	0.00	AR&R 100 year, 5 minutes storm, average 219.7 mm/h, Zone 1
C 12-1	0.042	0.041	0.001	5.00	10.00	0.00	AR&R 100 year, 5 minutes storm, average 219.7 mm/h, Zone 1
C 13-1	0.020	0.019	0.001	5.00	10.00	0.00	AR&R 100 year, 5 minutes storm, average 219.7 mm/h, Zone 1
C 14-1	0.008	0.008	0.000	5.00	10.00	0.00	AR&R 100 year, 5 minutes storm, average 219.7 mm/h, Zone 1
C 17-1	0.020	0.020	0.000	5.00	10.00	0.00	AR&R 100 year, 5 minutes storm, average 219.7 mm/h, Zone 1
C 17-2	0.044	0.043	0.001	5.00	10.00	0.00	AR&R 100 year, 5 minutes storm, average 219.7 mm/h, Zone 1
C 17-3	0.143	0.143	0.000	5.00	10.00	0.00	AR&R 100 year, 5 minutes storm, average 219.7 mm/h, Zone 1
C 17-4	0.206	0.206	0.000	5.00	5.00	5.00	AR&R 100 year, 5 minutes storm, average 219.7 mm/h, Zone 1
C 20-1	0.064	0.064	0.000	5.00	10.00	0.00	AR&R 100 year, 5 minutes storm, average 219.7 mm/h, Zone 1
C 20-2	0.119	0.119	0.000	5.00	10.00	0.00	AR&R 100 year, 5 minutes storm, average 219.7 mm/h, Zone 1
C 21-1	0.031	0.031	0.000	5.00	10.00	0.00	AR&R 100 year, 5 minutes storm, average 219.7 mm/h, Zone 1
C 21-2	0.028	0.028	0.000	5.00	10.00	0.00	AR&R 100 year, 5 minutes storm, average 219.7 mm/h, Zone 1
C 30-1	0.016	0.016	0.000	5.00	10.00	0.00	AR&R 100 year, 5 minutes storm, average 219.7 mm/h, Zone 1
C 30-2	0.016	0.016	0.000	5.00	10.00	0.00	AR&R 100 year, 5 minutes storm, average 219.7 mm/h, Zone 1
C F-40	1.565	1.565	0.000	6.00	6.00	6.00	AR&R 100 year, 15 minutes storm, average 139.7 mm/h, Zone 1
C e102-2	0.097	0.000	0.097	5.00	5.00	5.00	AR&R 100 year, 15 minutes storm, average 139.7 mm/h, Zone 1
C 4-1	0.176	0.176	0.000	5.00	10.00	0.00	AR&R 100 year, 5 minutes storm, average 219.7 mm/h, Zone 1
C 16-1	0.185	0.185	0.000	5.00	5.00	5.00	AR&R 100 year, 5 minutes storm, average 219.7 mm/h, Zone 1
C 1-9	0.164	0.159	0.005	5.00	10.00	0.00	AR&R 100 year, 5 minutes storm, average 219.7 mm/h, Zone 1
C 1-10	0.027	0.027	0.000	5.00	10.00	0.00	AR&R 100 year, 5 minutes storm, average 219.7 mm/h, Zone 1
C 1-11	0.027	0.027	0.000	5.00	10.00	0.00	AR&R 100 year, 5 minutes storm, average 219.7 mm/h, Zone 1
C 1-12	0.025	0.025	0.000	5.00	10.00	0.00	AR&R 100 year, 5 minutes storm, average 219.7 mm/h, Zone 1

Outflow Volumes for Total Catchment (20.2 impervious + 1.62 pervious = 21.8 total ha)

Storm	Total Rainf	Total Runo	Impervious	Pervious Runoff
	cu.m	cu.m (Runc	cu.m (Runc	cu.m (Runoff %)
AR&R 100 \	3996.03	3638.53 (9	3497.31 (9	141.23 (47.6%)
AR&R 100 \	6111.36	5720.39 (9	5455.62 (9	264.78 (58.4%)
AR&R 100 \	7622.84	7204.55 (9	6854.85 (9	349.70 (61.8%)
AR&R 100 \	8832.38	8390.54 (9	7974.62 (9	415.93 (63.4%)
AR&R 100 \	10058.29	9590.40 (9	9109.51 (9	480.89 (64.4%)
AR&R 100 \	10740.54	10251.30 (	9741.09 (9	510.21 (64.0%)
AR&R 100 \	14577.60	13995.40 (	13293.32 (	702.08 (64.9%)
AR&R 100 \	17195.13	16546.68 (	15716.41 (	830.26 (65.0%)
AR&R 100 \	26245.04	25316.78 (	24094.84 (	1221.94 (62.7%)
AR&R 100 \	19250.98	18548.46 (	17619.85 (	928.62 (65.0%)

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)	
P 1-1	0.297	3.22	29.704	28.487	AR&R 100 year, 20 minutes storm, average 121.4 mm/h, Zone 1
P 1-2	0.586	3.07	28.246	27.252	AR&R 100 year, 25 minutes storm, average 110.6 mm/h, Zone 1
P 1-3	0.809	1.99	27.129	27.015	AR&R 100 year, 20 minutes storm, average 121.4 mm/h, Zone 1
P 1-4	0.855	1.66	26.910	26.767	AR&R 100 year, 20 minutes storm, average 121.4 mm/h, Zone 1
P 1-5	0.908	1.43	26.746	26.650	AR&R 100 year, 20 minutes storm, average 121.4 mm/h, Zone 1
P 1-6	3.486	3.47	26.342	26.252	AR&R 100 year, 25 minutes storm, average 110.6 mm/h, Zone 1
P 1-7	3.479	3.15	26.167	25.888	AR&R 100 year, 25 minutes storm, average 110.6 mm/h, Zone 1
P e101-1	0.938	2.62	25.713	25.296	AR&R 100 year, 25 minutes storm, average 110.6 mm/h, Zone 1
P 1-8	2.729	3.1	25.698	25.666	AR&R 100 year, 25 minutes storm, average 110.6 mm/h, Zone 1
P e101-2	0.938	2.68	25.117	24.065	AR&R 100 year, 25 minutes storm, average 110.6 mm/h, Zone 1
P e101-3	0.937	3.06	23.944	22.216	AR&R 100 year, 25 minutes storm, average 110.6 mm/h, Zone 1
P e101-4	0.937	4.96	21.949	21.093	AR&R 100 year, 25 minutes storm, average 110.6 mm/h, Zone 1
P 2-1	0.000	0.00	27.465	27.252	AR&R 100 year, 5 minutes storm, average 219.7 mm/h, Zone 1
P 3-1	2.827	3.26	26.717	26.650	AR&R 100 year, 20 minutes storm, average 121.4 mm/h, Zone 1
P 10-1	0.035	1.83	30.107	30.072	AR&R 100 year, 5 minutes storm, average 219.7 mm/h, Zone 1
P 10-2	0.055	2.46	29.977	28.945	AR&R 100 year, 25 minutes storm, average 110.6 mm/h, Zone 1
P 10-3	0.107	0.97	28.907	28.877	AR&R 100 year, 15 minutes storm, average 139.7 mm/h, Zone 1
P 10-4	0.150	0.94	28.827	28.805	AR&R 100 year, 15 minutes storm, average 139.7 mm/h, Zone 1
P 10-5	0.187	0.66	28.790	28.780	AR&R 100 year, 20 minutes storm, average 121.4 mm/h, Zone 1

P 10-6	0.209	0.74	28.742	28.712	AR&R 100 year, 15 minutes storm, average 139.7 mm/h, Zone 1
P 10-7	0.254	0.90	28.705	28.653	AR&R 100 year, 20 minutes storm, average 121.4 mm/h, Zone 1
P 10-8	0.314	1.11	28.646	28.501	AR&R 100 year, 15 minutes storm, average 139.7 mm/h, Zone 1
P 10-9	0.473	1.67	28.332	27.704	AR&R 100 year, 20 minutes storm, average 121.4 mm/h, Zone 1
P 10-10	0.738	2.61	27.346	26.441	AR&R 100 year, 15 minutes storm, average 139.7 mm/h, Zone 1
P 10-11	1.350	3.06	26.073	25.456	AR&R 100 year, 20 minutes storm, average 121.4 mm/h, Zone 1
P 10-12	1.758	2.76	25.300	24.642	AR&R 100 year, 20 minutes storm, average 121.4 mm/h, Zone 1
P 10-13	2.222	2.57	24.485	24.137	AR&R 100 year, 15 minutes storm, average 139.7 mm/h, Zone 1
P 10-14	2.738	2.42	23.987	23.744	AR&R 100 year, 15 minutes storm, average 139.7 mm/h, Zone 1
P 10-15	3.244	2.87	23.536	23.434	AR&R 100 year, 15 minutes storm, average 139.7 mm/h, Zone 1
P 10-16	3.950	2.76	23.240	23.216	AR&R 100 year, 15 minutes storm, average 139.7 mm/h, Zone 1
P 10-17	3.954	2.76	22.908	22.853	AR&R 100 year, 15 minutes storm, average 139.7 mm/h, Zone 1
P 10-18	3.954	2.76	22.571	22.514	AR&R 100 year, 15 minutes storm, average 139.7 mm/h, Zone 1
P 11-1	0.037	0.44	28.944	28.945	AR&R 100 year, 5 minutes storm, average 219.7 mm/h, Zone 1
P 12-1	0.042	0.59	28.888	28.877	AR&R 100 year, 25 minutes storm, average 110.6 mm/h, Zone 1
P 13-1	0.037	0.33	28.807	28.805	AR&R 100 year, 15 minutes storm, average 139.7 mm/h, Zone 1
P 14-1	0.013	0.18	28.817	28.779	AR&R 100 year, 25 minutes storm, average 110.6 mm/h, Zone 1
P 17-1	0.024	0.22	24.068	24.021	AR&R 100 year, 5 minutes storm, average 219.7 mm/h, Zone 1
P 17-2	0.069	0.43	24.016	24.014	AR&R 100 year, 5 minutes storm, average 219.7 mm/h, Zone 1
P 17-3	0.209	1.32	23.864	23.677	AR&R 100 year, 5 minutes storm, average 219.7 mm/h, Zone 1
P 17-4	0.411	1.45	23.488	23.434	AR&R 100 year, 5 minutes storm, average 219.7 mm/h, Zone 1
P 20-1	0.047	1.87	22.624	22.535	AR&R 100 year, 25 minutes storm, average 110.6 mm/h, Zone 1
P 20-2	0.148	2.58	22.371	22.361	AR&R 100 year, 25 minutes storm, average 110.6 mm/h, Zone 1
P 21-1	0.030	1.84	22.716	22.685	AR&R 100 year, 5 minutes storm, average 219.7 mm/h, Zone 1
P 21-2	0.058	3.42	22.461	21.657	AR&R 100 year, 5 minutes storm, average 219.7 mm/h, Zone 1
P 30-1	0.016	0.61	31.747	31.743	AR&R 100 year, 5 minutes storm, average 219.7 mm/h, Zone 1
P 30-2	0.032	2.11	31.664	31.406	AR&R 100 year, 5 minutes storm, average 219.7 mm/h, Zone 1
P e40	1.326	3.75	26.354	24.360	AR&R 100 year, 15 minutes storm, average 139.7 mm/h, Zone 1
P e102-2	0.119	1.68	26.106	25.985	AR&R 100 year, 20 minutes storm, average 121.4 mm/h, Zone 1
P 4-1	0.238	0.84	25.898	25.888	AR&R 100 year, 20 minutes storm, average 121.4 mm/h, Zone 1
P 16-1	0.185	1.68	23.510	23.434	AR&R 100 year, 5 minutes storm, average 219.7 mm/h, Zone 1
P 1-9	2.841	4.04	25.456	24.700	AR&R 100 year, 25 minutes storm, average 110.6 mm/h, Zone 1
P 1-10	2.889	3.13	24.617	24.137	AR&R 100 year, 25 minutes storm, average 110.6 mm/h, Zone 1
P 1-11	2.908	3.90	23.933	23.178	AR&R 100 year, 25 minutes storm, average 110.6 mm/h, Zone 1
P 1-12	2.935	2.60	23.049	22.779	AR&R 100 year, 25 minutes storm, average 110.6 mm/h, Zone 1

CHANNEL DETAILS

Name	Max Q (cu.m/s)	Max V (m/s)	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
F 1-1	0.430	0.557	3.042	0.291	0.30	2.95	1.41	AR&R 100 year, 25 minutes storm, average 110.6 mm/h, Zone 1
F 1-2	0.256	0.481	12.575	0.028	0.02	20.22	0.72	AR&R 100 year, 25 minutes storm, average 110.6 mm/h, Zone 1
F 1-3	0	0	0.350	0	0	0	0	
F 1-5	0.000	0.132	0.661	0.267	0.24	2.13	1.67	AR&R 100 year, 25 minutes storm, average 110.6 mm/h, Zone 1
F 1-6	0.011	0.011	1.830	0.098	0.04	0.79	0.52	AR&R 100 year, 25 minutes storm, average 110.6 mm/h, Zone 1
F 1-7	0.000	0.174	1.264	0.215	0.13	1.72	0.62	AR&R 100 year, 5 minutes storm, average 219.7 mm/h, Zone 1
F 1-8	0	0	0.381	0	0	0	0	
F 2-1	0	0	1.130	0	0	0	0	
F 3-1	0.022	0.022	0.759	0.535	0.00	27.09	0.06	AR&R 100 year, 20 minutes storm, average 121.4 mm/h, Zone 1
F 10-1	0.012	0.054	0.241	0.066	0.08	2.61	1.58	AR&R 100 year, 5 minutes storm, average 219.7 mm/h, Zone 1
F 10-2	0.000	0.014	0.982	0.062	0.06	1.20	1.55	AR&R 100 year, 15 minutes storm, average 139.7 mm/h, Zone 1
F 10-3	0.000	0.014	0.917	0.062	0.06	1.20	1.51	AR&R 100 year, 15 minutes storm, average 139.7 mm/h, Zone 1
F 10-4	0.000	0.003	0.115	0.005	0.00	0.12	0.00	AR&R 100 year, 15 minutes storm, average 139.7 mm/h, Zone 1
F 10-5	0	0	0.404	0	0	0	0	
F 10-6	0.000	0.003	0.468	0.016	0.00	0.18	0.00	AR&R 100 year, 2 hours storm, average 44.1 mm/h, Zone 1
F 10-7	0.000	0.006	0.688	0.045	0.03	0.62	1.12	AR&R 100 year, 15 minutes storm, average 139.7 mm/h, Zone 1
F 10-8	0.000	0.018	0.955	0.066	0.07	1.33	1.59	AR&R 100 year, 5 minutes storm, average 219.7 mm/h, Zone 1
F 10-9	0.000	0.390	17.154	0.083	0.06	20.81	1.07	AR&R 100 year, 5 minutes storm, average 219.7 mm/h, Zone 1
F 10-10	0.072	0.733	17.154	0.103	0.08	25.71	1.11	AR&R 100 year, 20 minutes storm, average 121.4 mm/h, Zone 1
F 10-11	0.000	0.496	17.154	0.090	0.07	22.54	1.10	AR&R 100 year, 5 minutes storm, average 219.7 mm/h, Zone 1
F 10-12	0.000	0.514	17.154	0.091	0.07	22.83	1.11	AR&R 100 year, 5 minutes storm, average 219.7 mm/h, Zone 1
F 10-13	0.000	0.552	15.892	0.095	0.07	23.77	1.12	AR&R 100 year, 5 minutes storm, average 219.7 mm/h, Zone 1
F 10-14	0.000	0.532	14.856	0.095	0.07	23.81	1.11	AR&R 100 year, 5 minutes storm, average 219.7 mm/h, Zone 1
F 10-15	0.000	0.025	18.986	0.080	0.00	20.02	0.18	AR&R 100 year, 20 minutes storm, average 121.4 mm/h, Zone 1
F 10-16	0	0	0.288	0	0	0	0	
F 11-1	0.013	0.055	0.224	0.065	0.08	2.56	1.44	AR&R 100 year, 25 minutes storm, average 110.6 mm/h, Zone 1
F 12-1	0.015	0.025	0.115	0.053	0.02	1.79	0.42	AR&R 100 year, 25 minutes storm, average 110.6 mm/h, Zone 1
F 13-1	0	0	0.091	0	0	0	0	
F 14-1	0.001	0.011	0.116	0.022	0.00	0.50	0.19	AR&R 100 year, 5 minutes storm, average 219.7 mm/h, Zone 1
F 17-1	0.000	0.031	0.000	0.077	0.03	1.71	0.45	AR&R 100 year, 5 minutes storm, average 219.7 mm/h, Zone 1
F 17-2	0.000	0.059	0.692	0.088	0.05	2.08	0.55	AR&R 100 year, 5 minutes storm, average 219.7 mm/h, Zone 1
F 17-3	0.000	0.205	0.630	0.144	0.18	3.95	1.67	AR&R 100 year, 5 minutes storm, average 219.7 mm/h, Zone 1
F 17-4	0.000	0.115	0.644	0.126	0.06	3.32	0.47	AR&R 100 year, 20 minutes storm, average 121.4 mm/h, Zone 1
F 20-1	0	0	0.291	0	0	0	0	
F 20-2	0	0	0.392	0	0	0	0	

F 21-1	0.000	0.031	0.000	0.082	0.03	1.87	0.36	AR&R 100 year, 5 minutes storm, average 219.7 mm/h, Zone 1
F 21-2	0.000	0.058	0.000	0.095	0.04	2.31	0.44	AR&R 100 year, 5 minutes storm, average 219.7 mm/h, Zone 1
F 30-1	0	0	0.769	0	0	0	0	
F 30-2	0	0	0.769	0	0	0	0	
F E40	0.199	0.296	3.320	0.209	0.14	2.45	0.69	AR&R 100 year, 15 minutes storm, average 139.7 mm/h, Zone 1
F e102-2	0.000	0.176	1.775	0.192	0.15	1.53	0.80	AR&R 100 year, 5 minutes storm, average 219.7 mm/h, Zone 1
F 4-1	0	0	1.555	0	0	0	0	
F 16-1	0.038	0.153	0.576	0.138	0.07	3.72	0.54	AR&R 100 year, 25 minutes storm, average 110.6 mm/h, Zone 1
F 1-9	0.024	0.050	1.296	0.158	0.11	1.26	1.01	AR&R 100 year, 25 minutes storm, average 110.6 mm/h, Zone 1
F 1-10	0.000	0.026	1.296	0.129	0.09	1.03	1.24	AR&R 100 year, 15 minutes storm, average 139.7 mm/h, Zone 1
F 1-11	0.000	0.024	1.296	0.118	0.09	0.94	1.21	AR&R 100 year, 25 minutes storm, average 110.6 mm/h, Zone 1
F 1-12	0.001	0.001	1.296	0.031	0.01	0.24	0.38	AR&R 100 year, 25 minutes storm, average 110.6 mm/h, Zone 1

DETENTION BASIN DETAILS

Name	Max WL	MaxVol	Max Q Total	Max Q Low Level	Max Q High Level

CONTINUITY CHECK for AR&R 100 year, 20 minutes storm, average 121.4 mm/h, Zone 1

Node	Inflow (cu.m)	Outflow (cu.m)	Storage Ch (cu.m)	Difference %
1-1	661.03	657.50	0.00	0.5
1-2	742.31	739.65	0.00	0.4
1-3	913.64	929.71	0.00	-1.8
1-4	929.71	938.63	0.00	-1.0
1-5	938.63	943.95	0.00	-0.6
1-6	3330.88	3307.13	0.00	0.7
1-7	3307.12	3318.83	0.00	-0.4
1-8	3546.68	3543.99	0.00	0.1
e101-2	1186.73	1166.73	0.00	1.7
e101-3	1166.73	1186.48	0.00	-1.7
e101-4	1186.48	1186.54	0.00	-0.0
e101-5	1186.54	1186.54	0.00	0.0
2-1	0.00	0.00	0.00	0.0
3-1	2257.79	2256.81	0.00	0.0
10-1	33.47	33.48	0.00	-0.0
10-2	40.16	39.36	0.00	2.0
10-3	78.30	76.99	0.00	1.7
10-4	116.87	117.04	0.00	-0.1
10-5	144.88	145.10	0.00	-0.2
10-6	154.35	153.74	0.00	0.4
10-7	166.05	164.99	0.00	0.6
10-8	165.08	169.82	0.00	-2.9
10-9	392.73	389.01	0.00	0.9
10-10	686.04	691.16	0.00	-0.7
10-11	1175.97	1178.83	0.00	-0.2
10-12	1548.04	1547.93	0.00	0.0
10-13	1929.93	1931.51	0.00	-0.1
10-14	2340.03	2338.78	0.00	0.1
10-15	2732.97	2732.33	0.00	0.0
10-16	3367.82	3369.97	0.00	-0.1
10-17	3369.97	3370.22	0.00	-0.0
10-18	3370.22	3370.24	0.00	-0.0
10-19	3370.24	3370.24	0.00	0.0
11-1	37.32	37.48	0.00	-0.4
12-1	38.51	38.50	0.00	0.0
13-1	23.54	23.38	0.00	0.7
14-1	5.71	5.64	0.00	1.3
17-1	13.58	13.57	0.00	0.1
17-2	45.07	44.54	0.00	1.2
17-3	142.45	142.58	0.00	-0.1
17-4	283.48	283.74	0.00	-0.1
20-1	43.30	43.36	0.00	-0.1
20-2	124.24	123.68	0.00	0.4
20-3	123.68	123.68	0.00	0.0
21-1	21.08	20.61	0.00	2.2
21-2	40.31	39.85	0.00	1.1
21-3	40.28	40.28	0.00	0.0
30-1	10.66	10.63	0.00	0.2
30-2	21.45	21.41	0.00	0.2
30-3	21.41	21.41	0.00	0.0
O 1-12	0.72	0.72	0.00	0.0
O 20-1	0.00	0.00	0.00	0.0
O 30-1	0.00	0.00	0.00	0.0
O 30-2	0.00	0.00	0.00	0.0
N139	0.00	0.00	0.00	0.0
e40	1187.95	1186.14	0.00	0.2

N2701	1141.52	1141.52	0.00	0.0
e102-2	98.88	106.34	0.00	-7.5
4-1	236.59	237.54	0.00	-0.4
16-1	126.61	126.48	0.00	0.1
1-9	2473.65	2459.22	0.00	0.6
1-10	2477.49	2499.65	0.00	-0.9
1-11	2518.11	2519.51	0.00	-0.1
1-12	2536.60	2540.06	0.00	-0.1
1-13	2539.34	2539.34	0.00	0.0

Run Log for B18028_006_Rev01.drn run at 12:30:40 on 23/1/2019
No water upwelling from any pit.
Freeboard was less than 0.15m at 17-4, 17-3, 16-1, e102-2, e40, 4-1, 17-1, 14-1, 13-1, 12-1, 10-15, 10-11, 10-10, 10-5, 10-4
The maximum pond depth in these sag pits is unsafe: e40, 4-1, 20-2, 10-16
The maximum flow in these overflow routes is unsafe: F 3-1, F 17-1, F 21-1, F 21-2

APPENDIX D

WSUD Sketch

100,000L RAINWATER
RE-USE TANK

25,000L RAINWATER
RE-USE TANK

2 x STORMWATER 360
VORTECH VX1600 GPTS

LEE HOLM ROAD

MATCHLINE
ADJOINS BELOW

MATCHLINE
ADJOINS ABOVE

FORRESTER ROAD

WESTERN RAILWAY

CATCHMENT LEGEND

HARDSTAND TO GPT	TOTAL AREA = 7.81 Ha
ROOF TO RAINWATER TANK	TOTAL AREA = 0.39 Ha
ROAD TO GPT	TOTAL AREA = 0.49 Ha
ROAD TO CATCHPIT INSERT	TOTAL AREA = 0.44 Ha
BATTER TO SWALE	TOTAL AREA = 0.55 Ha

LEGEND

- PROJECT SITE BOUNDARY
- PROPOSED STORMWATER PIPE AND PIT
- PROPOSED GRASSED SWALE
- EXISTING EASEMENTS
- EXISTING STORMWATER PIPE
- EXISTING SEWER MAIN
- EXISTING WATER MAIN
- EXISTING OPTIC FIBRE
- EXISTING ELECTRICAL HV
- EXISTING ELECTRICAL OH

SKETCH ONLY

0 10 20 30 40 50 60m
SCALE 1:1000 AT A1 SIZE

BG&E

DATE	31/01/2019
SCALE	1:1000
GRID	
PREPARED	CB
SHEET	1 OF 1

PROJECT: ST MARY'S

TITLE: WSUD LAYOUT

PROJECT No. B18028 | SKETCH No. SK-C-0037 | REV A

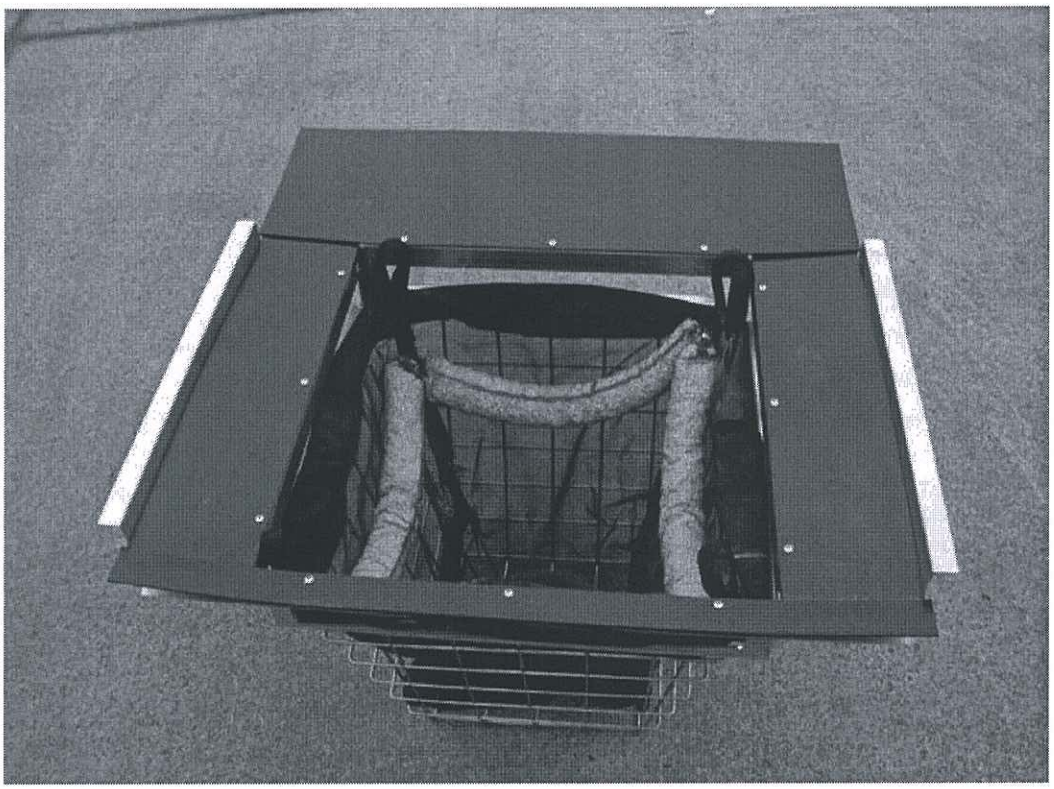
APPENDIX E

WSUD Maintenance

Stormwater360
AUSTRALIA

Operations and Maintenance

Enviropod



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APPENDICES

1 INTRODUCTION

The following report details the recommended methods for cleaning and maintaining the Enviropod Stormwater Gully Pit Insert. The aspects associated with cleaning included in this manual are methods for grate removal, filter bag cleaning, unit inspection, filter bag rejuvenation and the re-installation of the filter bags. This plan should be used in conjunction with the appropriate traffic management plans and site safety plans produced for each project. Other Stormwater360 (IES) documents which IES staff should use in conjunction with this report include the IES Employee Health and Safety Manual. It is recommended that contractors develop their own health and safety plans for activities to ensure that the workers are placed in a safe work environment.

Enviropod filter in service.

Each stormwater treatment device must be inspected and maintained regularly to ensure it is working properly throughout the estimated design life. The Enviropod filters require servicing every 1 - 6 months depending on site characteristics; however the maintenance requirements are less labour intensive than alternate traditional treatments. During each inspection and clean, details of the mass, volume and type of material observed should be record to provide ongoing data for future management plan revisions and the optimisation of the maintenance frequency. It is essential that maintenance (including inspections, recording and reporting) be carried out in a systematic manner and is carried out by qualified and experienced personnel. It is also advisable that the treatment device owner has a nominated person responsible for overseeing the management process.

Maintenance is an essential component of stormwater management enabling ongoing at source control of stormwater pollution. Maintenance will also prevent failures such as structural failure (e.g. prevents blocked outlets) or aesthetic failure (e.g. debris accumulation). All stormwater treatment devices require maintenance to ensure the ongoing performance of the system.

Stormwater360 (IES) is a specialised stormwater consultancy with trained and experienced staff. The company has a comprehensive database with detailed information on every Enviropod filter

sold and serviced by IES (formerly Enviropod), collecting site-specific data that can be easily accessed and analysed as required.

This document consists primarily of the processes and tasks associated with the hand maintenance and inductor maintenance procedures. It does not include detail of the traffic management requirements or occupational health and safety requirements. Contractors or IES staff should utilise their own Employee Health and Safety Manual, which details the policies and procedures for safe work.

2 Enviropod Health and Safety

The following section details some of the considerations which may be required for a contactor to comply with relevant health and safety regulations regarding the manual handing activities, hazards associated with the waste material and issues associated with working on roads.

Cleaning of Enviropod filters is a specialist activity. Material collected can be harmful if not handled correctly. Sediments may contain heavy metals and carcinogenic substances as well as harmful objects such as broken glass and syringes. As all of the Enviropod units are located on roads particular care must be taken due to the potential build-up of hydrocarbon based products and other vehicle based contaminants which may be carcinogenic or toxic. It is essential that Occupational Safety and Health guidelines are followed at all times, and that the following steps are carried out to ensure safe and successful maintenance operations.

In additional to the hazards associated with the cleaning handling of material in the filter bags, there also hazards associated with traffic at the work site, the removal of the grate, pedestrians and other non-worker personnel, and general work place hazards associated with working outdoors.

This section is not intended to address all the safety issues associated with Enviropod maintenance, providing only information and suggestions on safety aspects associated with the maintenance procedures. A separate safety plan should be prepared for each project address the specific requirements of the project.

The procedures indicated in the Operations section of this manual are recommend as the safest and most efficient manner in conducting the maintenance of Enviropod Units (Section 3), however contractors and cleaning staff may vary the procedure in response to the site conditions, varying work practices or general preferences in the cleaning techniques. Please note that procedures outlined in this manual are not exhaustive, and that any changes should still comply with general safe work practices.

2.1 Personnel Health and Safety

All contractors and staff shall comply with all current Health and Safety Legislation and take all practicable steps to:

- Comply with all applicable laws, regulations and standards.
- Ensure that all employees, contractors and visitors are informed of and understand their obligations in respect of current Health and Safety Legislation.
- Ensure that employees understand and accept their responsibility to practice and promote a safe and healthy work environment.

All relevant precautions must be taken to prevent contact with sediment and litter when maintaining filters. The following personal protective equipment (PPE) safety equipment should be worn:

- Puncture resistant gloves.
- Steel capped safety boots.
- Fluorescent safety vest.
- Overalls or similar skin protection.
- Safety apron. (if necessary)*
- Eye protection. (if necessary)*

*Higher personal safety conditions may be required when maintaining units that may contain more hazardous material, for example pits where syringes have be observed or pits located in areas associated with such activities.

2.2 Traffic Control

All stormwater collection pits are typically situated either in/on roads and car parks or adjacent to roads in the footpath or swales. Traffic control requirements at each of these locations is typically the same, with most of the state and local road authorities requiring the same controls implemented whether the work is to be conducted on the road or on the road reserve.

As traffic requirements vary based on the road usage and the specific road configuration, traffic control plans should be prepared for each site. Given that maintenance is typically a quick process, the contractor should liaise with the relevant road authority to determine the specific road safety requirements for each location to ensure that on site workers can conduct the cleaning operations safely and efficiently, while complying with all laws and regulations.

NSW RTA working on roads safety manual indicates the signage requirements, placement of barricades or witches hats and the positioning of traffic control personnel. In addition to standard safety requirements IES recommends that the maintenance vehicle be used to increase safety, through shielding the work area from oncoming traffic.

Plate 1 indicates the vehicle placed to shield the work area with cones placed around the vehicle. Plate 2 indicates at head on view, note the vehicle is positioned to allow access to the drive, whilst still blocking the pit from on-coming traffic. The vehicle has a flashing light on the roof and the hazard lights switched on.

Plate 1 Vehicle positioned near pit, preventing traffic from passing close to the pit.

Plate 1 Head-on view, indicating the placement of the vehicle near the pit.

2.3 Confined Spaces

Confined spaces poses a serious safety hazard for all personnel, however during the normal maintenance procedures there should be no reason to enter a confined space. All maintenance procedures are able to be conducted from the surface. Confined space entry procedures are not included as part of this manual, for IES employees confined space entry procedures are included as part of the IES Safety Manual. It is recommend that all contractors evaluate their own needs for confined space entry and compliance with Occupation Health and Safety regulations.

When repairs or maintenance activities cannot be conducted from the surface, the contractor/cleaner should evaluate the need to enter the confined space, considering all alternative options. Where there is a need to proceed in a confined space, only staff with current confined space training shall operate in a confined space. Appropriate measures and controls shall be put in place to meet confined space entry requirements. Safety equipment must be worn where deemed necessary and where gas or oxygen hazard occurs, staff trained in its use will only use BA gear. **Non-trained staff must not go into confined spaces.**

3 Operations

This section details the specific activities required to clean the Enviropod units. Please note it has been written for use by someone who has never encountered a stormwater pit or an Enviropod unit, providing a step by step process for each of the cleaning stages.

3.1 Maintenance & Monitoring of Enviropod filters

The maintenance frequency is dependent on several variables, such as catchment area, surrounding land use, vegetation type, traffic loading and rainfall patterns. IES recommends that during the first year of operation the units should be monitored monthly, with maintenance as required.

The ensure that the unit performs optimally, the material collected by the filter bag should be emptied when the level of material is no more than approximately **half to two thirds** of the total bag depth or when there is evidence of material overflow. Although the bag has greater storage area, it is recommended that it is not left to fill completely prior to empting, for the following reasons; the bags are capable of retaining a heavy mass of material (in excess of 50kg); material near the top of the bag can be resuspended during high to extreme rainfall events; and blockage of the overflow sections can occur, when material is allowed to build up above the filter bag.

Maintenance frequency should be adjusted to accommodate variable rainfall patterns. Regions east of the Great Dividing Range typically are dominated by greater rainfall during summer and Autumn Months, as such more maintenance is typically required during these periods. It is recommended that biannual inspections be carried out in November and April, while quarterly inspections should be conducted in February, April, July and November.

It is also recommended that additional monitoring should be conducted following moderate to extreme rainfall events, in particular, when preceding months have had little to no rainfall. This monitoring is considered necessary to accommodate for higher volumes of runoff generated during major rainfall events, an anticipated greater accumulation of surface contamination during low rainfall periods and to ensure that the units have not been damaged due to high pipe velocities.

Attached in Appendix A & B is an example of an Enviropod Service Receipt and Generic Monitoring Form which is to be completed by the Cleaning Contractor when servicing any Filters. Relevant information is recorded and forwarded to the client following each maintenance clean.

Table 1: FREQUENCY OF MAINTENANCE ACTIVITY

	INSPECTION/MINOR MAINTENANCE (TIMES/YEAR)	MAJOR MAINTENANCE (TIMES/YEAR)
Enviropod	12 (and after major storms)	2-6 (except in case of a spill)

3.2 *Stormwater Pit Cover Removal*

There are several different types of stormwater pit covers used throughout Australia. These grates/lids are constructed of three main materials, cast iron, galvanised steel and concrete. Stormwater pits covers will either be hinged (lockable) or simply placed on a recessed frame, with cover which are not hinged are typically heavy, to prevent the grate being easily knocked open by passing traffic. Each different pit cover requires different techniques to safely remove the cover to gain access to the Enviropod Unit.

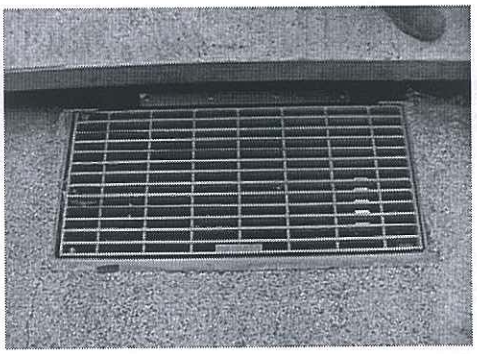

Plate 2 Hinged galvanised steel pit grate

Plate 3 Heavy duty hinged galvanised steel pit grate

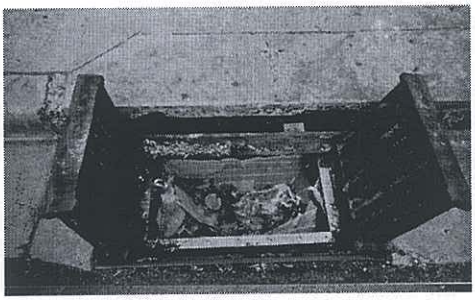

Plate 4 Hinged cast iron grate

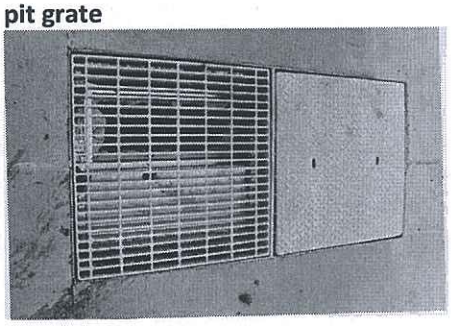

Plate 5 Non-hinged heavy duty galvanised steel pit grate

Plate 6 Non-hinged cast iron grate

3.2.1 Hinged Pit Grates

Hinged pit grates are typically either light duty galvanised steel, heavy duty galvanised steel or two-piece cast iron. Generally hinged pit grates can be opened by one person, however heavy duty galvanised lids and cast iron lids may require two people. If you are unclear about the type of grate, always use two people.

To open a hinged pit grate follow the following steps:

1. Insert the lifting hooks beneath the grate. (Position indicated in Plate 7)
2. Check hinge point is not damaged and debris is not caught in the hinge area.
3. Note many cast iron hinges are not hinged securely (to enable the removal of the grate). This may result in the pit grate not being able to sit in an open position. Additionally the hinge pins may also be damaged or corroded, which may allow for the pit grate to fall into pit. Such pit grates can be removed using the method indicated below for non-hinged grates.
4. Fully open pit grate, ensuring that the grate will stay in the open position without any external forces applied. Grates which do not remain open without being held should be removed or secured during cleaning or maintenance activities. Plate 8 and Plate 9 indicate the grate being opened and grate resting freely in the open position, respectively.

Plate 7 Lifting the grate

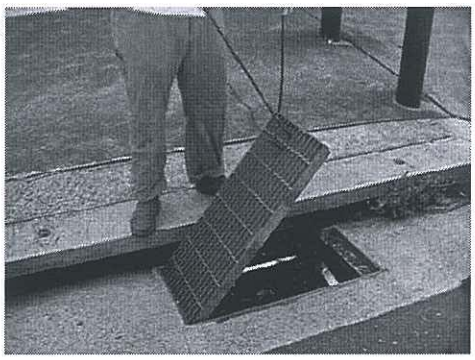

Plate 8 Opening Grate

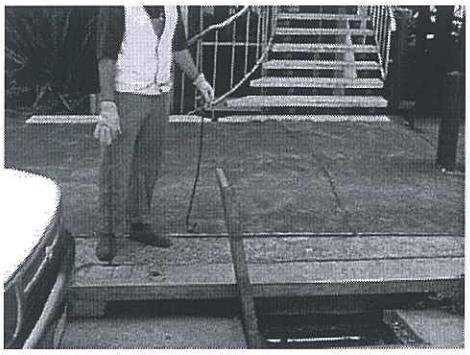

Plate 9 Fully open grate

Plate 10 Lowing grate

To close an open hinged grate

1. Place lifting hooks through grate. (same position to remove grate)
2. Gently lower grate into position. (Plate 10)
3. Note some grates have offset hinges points that prevent the grate from falling over, such pits require the hinged side of the grate to be lifted while the grate is lowered into position. (insert picture)

3.2.2 Non-Hinged Pit Grates

Non hinged pits are typically constructed of cast iron, concrete or heavy duty galvanised steel. As such the pit grates are generally heavy and difficult to remove, generally requiring two people to safely remove the lids.

To remove a non-hinged pit grate:

1. Place lifting hooks beneath grate, where possible in the four corners of the grate (Plate 11). Concrete lids may have Gatic lifting points, a key arrangement or holes in the lid, as such special equipment, such as Gatic lifters may be required.
2. Position each person either side of the grate. (Plate 12)
3. Lift the grate, ensuring that good heavy lifting posture is used at all times.
4. Place the grate on an angle on the gutter, to allow for the lifting hooks to be removed. (Plate 13)
5. For extremely heavy one piece grates and concrete Gatic covers, insert the lifters in place and slide the lids back. Note some lids may still require two people. (Picture required)

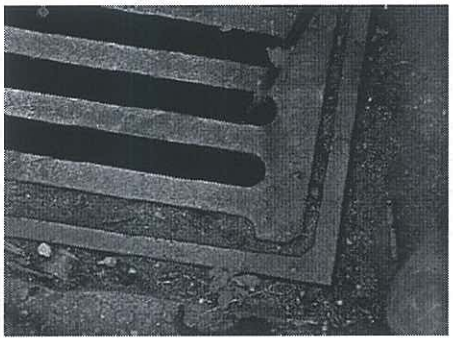

Plate 11 Insert hook near edge of grate

Plate 12 Position each lifter either side of the grate

Plate 13 Lift grate and move grate to one side

Plate 14 Lift grate above the support frame

Plate 15 Reinstated non hinged grate

To reinstate a non-hinged pit grate

1. Place lifting hooks though the grate. Note do not place hooks at the very edge of the grate, as this will make it difficult to place grate on the support.
2. Lift the grate into position and lower onto the supporting frame (Plate 14), ensuring that the grate sits level with the finished surface. If the grate does not sit securely remove the pit cover and check for debris in the pit cover frame, then try to lower grate again.
3. Check final position of the cover, ensuring that the cover sits flush with the surface and does not create a trip or traffic hazard. (Plate 15)

Note all grates should be reinstated to the original condition.

Care should be taken with old or damaged pit covers and grates. Grates or covers observed to be in poor condition should be first inspected to determine whether further damage will occur if an attempt to remove the grate is made. Pits grates which appear to be severely damaged or appear as though they would break while being removed should not be removed. Contact the client (and pit owner if not the client) and IES (IES Sydney office number is 02 9907 1401) to discuss an appropriate action. Pit grates and covers damaged by the contractor will be repaired at the cost of the contractor, or as part of an arrangement with the pit owner.

3.2.3 Pits unable to be opened

Pits may be unable to be opened for several reasons, including through corrosion, new road surfaces covering the pit lid, and foreign material jammed in the lid. The following steps may assist in opening the pits:

- Chip away new road coverings or concrete/bitumen spills using a pinch bar or similar device. **Care must be taken not to damage road surfaces**.
- Corroded or jammed pits may be loosened from the grate frame by using a lubricant such as RP7 and tapping the grate frame and grate. **Note if the grate or grate frame appears severely corroded, the grate should not be opened and IES and the client should be contacted to discuss options.**
- Pits which cannot be opened may require a hydraulic lifting arm to fully remove the lid.

3.3 Cleaning Methods

One of the following methods of maintenance should be used for the servicing of these Enviropod Filters:

- Cleaning using Inductor Truck.
- Hand Maintenance.

One of the advantages of the Enviropod units is that it doesn't require specialised equipment for maintenance. In certain situations it may be more feasible to maintain the units using the inductor truck method, while for other projects hand maintenance may be the preferred option. The cleaning method for the Enviropod units should be evaluated specifically for each project.

3.3.1 Cleaning using Inductor Truck

The following steps indicate a safe and efficient method to clean the Enviropod using an Inductor:

1. Open gully pit. (See Section 3.2)
2. Place the inductor hose over the material collected in the filter bag and switch on the inductor.
3. Using the inductor hose suck all of the sediment, organic leaf material, litter etc., collected in the filter bag
4. Allow the filter bag to be sucked up into the inductor hose for a few seconds to allow for the filter mesh pores to be cleaned. Care is to be taken by the operator not to damage the filter, i.e. ensure that there are no sharp edges on the inductor hose.
5. If material has built up around the overflows, use the inductor hose to clear the accumulated material.
6. Remove filter bag from the pit.
7. Sediment retained in the gully pit grate is to be removed.

8. Back opening channels are to be cleared of any debris to ensure flow is not hindered. Debris can be collected using the inductor truck.
9. All gully pit waste is to be removed from the pit.
10. Check the Enviropod unit. (See Section 3.4)
11. Check filter bag. (See Section 3.5)
12. Reinstate filter bag and gully pit lids.

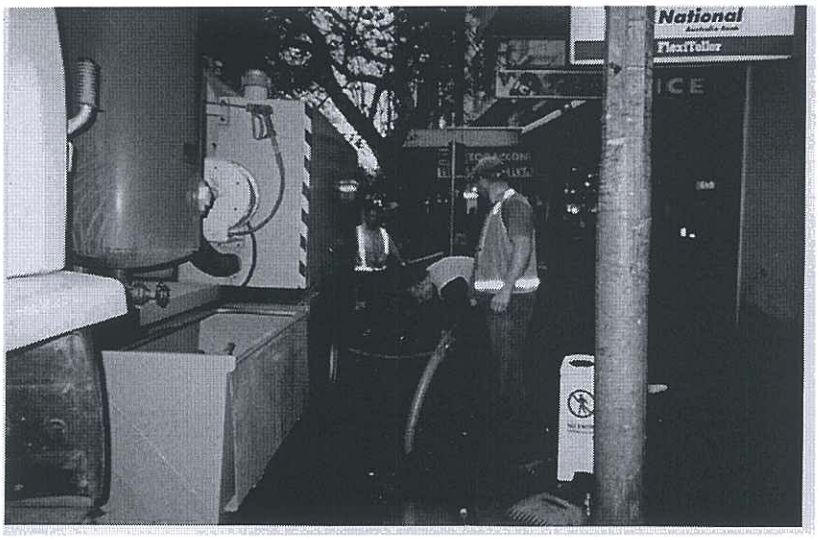

Plate 16 Cleaning an Enviropod using the inductor method

Gully pit sediments under no circumstances are to be backwashed into the gully pit.

3.3.2 Hand Maintenance

Two people are generally preferred to maintain the units by hand. However for shallow units and units which contain mainly leaf material (low overall accumulated weight), may be cleaned by one person. Note additional personnel may be required for traffic management purposes or for general safety.

The following steps indicate a safe and efficient method to clean the Enviropod manually by hand:

1. Open gully pit. (See Section 3.2)
2. Place the lifting hooks in the lifting loops of the filter bag. (See Plate 17)
3. For extremely heavy and overfilled bags either use a hydraulic lifting arm to lift the bag, or remove excess material using a shovel or similar piece of equipment. IES prefers the use of a post hole shovel, due to the reduced strain on the back when digging and the ability of the shovel to grab material vertically. (Insert Picture)
4. Lift the bag vertically off the supporting frame, ensuring that no undue pressure is placed on the filter bag. (See Plate 18)
5. Lift the bag clear of the stormwater pit. (See Plate 19)
6. Position the bag over the truck or other collection vehicle, taking hold of the loops at the base of the bag. (See Plate 20 and Plate 21)
7. Lift and empty the filter bag by holding the bottom lifting loops only. (See Plate 22)
8. Completely empty the filter bag. (See Plate 23)
9. Brush the filter bag with a stiff brush to remove bound sediment from the filter pores. (See Plate 24)

10. Check the filter bag. (See Section 3.5)
11. Check the Enviropod unit. (See Section 3.4)
12. Reinstate filter bag, ensuring bag is installed the correct way. (See Plate 25 and Plate 26)
13. Reinstate gully pit lids. (See Plate 27 and Plate 28)

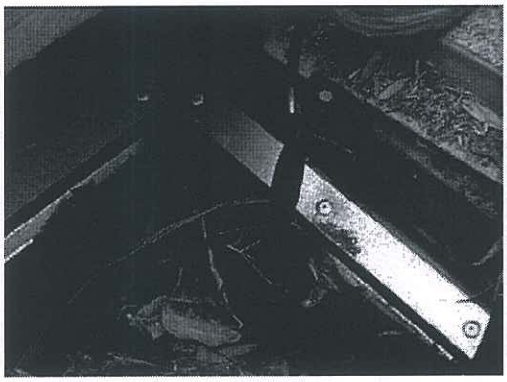

Plate 17 Place the lifting hooks through the bag loops

Plate 18 Lift the bag from the cage and support frame

Plate 19 Lift the bag from the stormwater pit

Plate 20 Lift the bag onto the collection vehicle

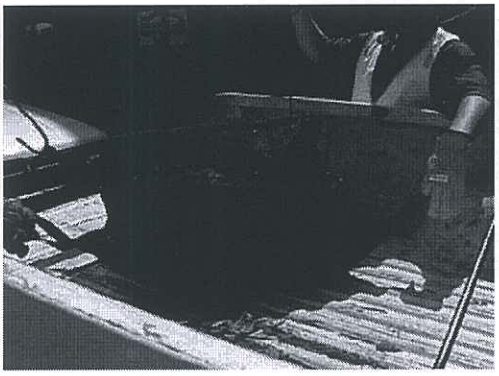

Plate 21 Grab the bottom lifting loops

Plate 22 Lifting the bottom bag loops empty the filter bag

Plate 23 Completely empty the contents of the filter bag

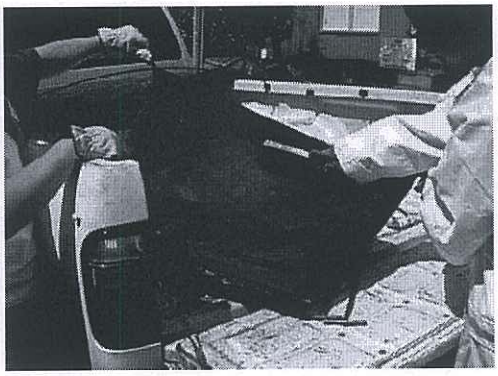

Plate 24 Brush the pores filter bag with a stiff brush

Plate 25 Reinstall filter bag

Plate 26 Ensure that the unit is positioned correctly, with the lifting loops on the inside

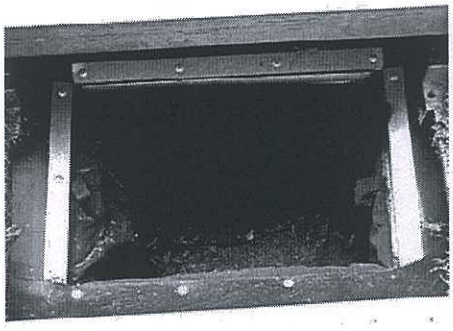

Plate 27 Correctly installed filter bag

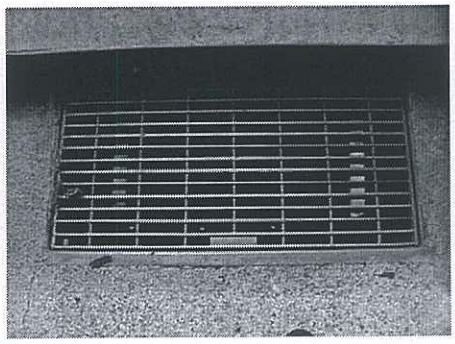

Plate 28 Installed filter bag and sealed pit

3.4 Unit Inspection

After the Enviropod filter bag is removed, emptied and cleaned, the following should be checked to ensure that the unit has not been damaged:

- All connections and joints should be checked and broken rivets replaced (See Plate 29);
- The plastic pit seals should be inspected for unit movement or damage (See Plate 30); and

- The cage should be inspected for damage or movement (See Plate 31).

The overflow diversion channels, and the area between the Enviropod cage and pit wall should also be inspected for the accumulation of debris. Any observed debris should be removed and disposed of off-site. Accumulated material within the outlet pipe may need to be flushed.

Note: If the units are not cleaned regularly the mobilisation of material collected in the Enviropod unit may occur, as such cleaning of the units in accordance with this management plan is required. As this plan is based on observations and data collected during the monitoring period, ongoing adjustment of the cleaning frequency is generally required to improve the overall efficiency in the removal of collected material and prevent material overflow.

Plate 29 Check seals are pushed against the pit walls

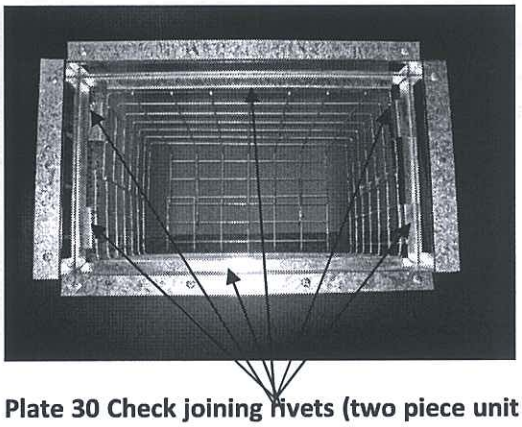

Plate 30 Check joining rivets (two piece unit shown above)

3.5 Filter Bag Inspection and Rejuvenation

Following the emptying and cleaning of the filter bags, the filter bag should be inspected to evaluate the bag condition. Given the nature of stormwater the filter bag from some Enviropod units can become considerably clogged with fine sediment. Filters can also be damaged by various objects in stormwater as well as fauna. Sharp objects such as sticks combined with high velocity water and a large mass in the filter bag can cause small tears in the filter material. Animals such as rats have also been known to chew through fine mesh filter bags located in gully pits near takeaway food outlets.

3.5.1 Clogged Filters

Clogged filter bags can be clean using several different methods. If the bag cleaning techniques described in the general maintenance sections above are not able to clean the filter bags the following options should be considered:

- Using a stiff brush and a bucket of soapy water scrub the filter bag surface.
- Remove filter bags from the pit and wash the bags using a high pressure water spray. Care has to be taken to not transfer the contamination elsewhere. Waste water from the process should be collected of and disposed of correctly.
- Remove the filter bags from the pits and the support rings and wash the bags in an industrial washing machine.

The final option presented above typically results in the bags appearing like new, with no visible stain or pore clogging within the filter mesh.

Plate 31 Slightly clogged filter bag, indicated by the brown stain on in the centre of the bag

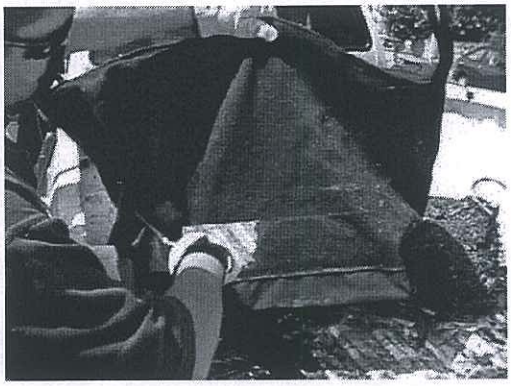

Plate 32 A clean used filter bag

3.5.2 Damaged Filters

Damaged filters can often be repaired, provided the damage is small. Small tears in the fabric may occur do to several reasons, however the overall strength & structure of the nylon fabric typically prevents small tears becoming much large. Although the bag is unlikely to tear further care must be used when clean torn bags as not to spill the collected material into the pit.

Small tears may repaired by either sewing the tear back together, with additional fabric to increase the strength of the stitching, or by sewing a patch of the filter material onto the filter bag. The filter bags may need to be replaced if large tears are present, as the filter bag is no longer able to function as intended.

IES is able to repair bags or replace bags which have been damaged during maintenance. Please contact IES Sydney office on 02 9907 1401 for details or a quote.

3.6 Disposal of Material

All gully pit wastes from the site are to be taken off site and disposed of at a transfer station or similar approved disposal site. Stormwater Sediments can contain Lead, Copper, Zinc, Mercury, hydrocarbons and PCBs, which are harmful to both humans and the receiving environment. Appropriate sampling and laboratory analysis may be required to classify the material as suitable for reuse, or disposal under appropriate local guidelines.

4 Emergency Procedures

4.1 Spill Procedures

In the event of a spill discharging into any gully pit all sediment is to be extracted and the filter bags are to be removed and replaced with rejuvenated filter bags. Normal operation procedures apply to additional cleaning as a result of spills.

4.2 Blockages

In the unlikely event of surface flooding around a gully pit fitted with an Enviropod the following steps should be carried out:

Check Enviropod over flow bypass. The Enviropod filter has been designed with an overflow mechanism built into the filter box. If surface flooding still exists check the overflow slots underneath the rubber seal. If debris is lodged in the overflow slots these can be easily cleared by hand or steel rod.

If overflow is clear and surface flooding still exists remove Enviropod and check outlet pipe for blockages.

Removal of the Enviropod may be difficult if the filter is clogged and the Enviropod is holding water. If the filter is clogged, brush the side walls of the filter with a yard broom or similar. This will dislodge particles trapped at the interface allowing contained water to flow through the filter.

If the outlet pipe is blocked, it is likely that a gully sucker truck will be required to unblock it. Debris should be removed from the Enviropod with the gully sucker truck before removal of the Enviropod filter.

If a gully sucker truck is not available and the Enviropod needs to be removed by hand, follow the steps below:

- Remove excess debris by hand or brush the side of the filter.
- Lift and place filter ring through the filter box and into cage.
- Remove Filter box.
- Lift cage containing filter bag and ring out of the pit.
- Unblock outlet pipe.

Appendix A
Service Receipt Example

Enviropod Service Receipt

Site:
Contractor:
Location:
Year:

Job Number:
Receipt Number:
Week Serviced:

Service Frequency:
Enviropods on Site:

Enviropods Cleaned:
Bags Checked:
Frames and Seals Checked:
Overflows Checked
Tonnage:

If Damaged, Action:
If Damaged, Action:
If Blocked, Cleaned:

Comments

This service has been performed in accordance with Enviropod Management Plan (EMP) for above site. Please file this receipt with EMP and keep on site for compliance inspections.

Signature:

Position:

Appendix B
Maintenance Form Example

Enviropod Maintenance Form

Client:

Project:

Bag:

Date:

NOTE: **See maps for detailed location.**

Pit No.	Map No.	Location (ENVIROPOD Sites)	Bag Size	Date	% Organics	% Litter	% Sediment	Fullness - F, 1/2, 1/4 or 0	Notes	Grate
1										
2										
3										
4										
5										
6										
7										
8										
9										
10										
11										
12										
13										
14										
15										
16										
17										
18										
19										
20										
21										
22										
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24										
25										
26										
27										
28										
29										
30										

Vortechs®

Operations and Maintenance Guide

Stormwater360
AUSTRALIA

Contents

1. INTRODUCTION

The following report details the recommended methods for cleaning and maintaining the Vortechs Stormwater Treatment System. The aspects associated with cleaning included in this manual are methods for cover removal, unit inspection, and minor and major maintenance activities. This plan should be used in conjunction with the appropriate traffic management plans and site safety plans produced for each project. Other Stormwater360 (SW360) documents which SW360 staff should use in conjunction with this report include the SW360 Employee Health and Safety Manual. It is recommended that contractors develop their own health and safety plans for activities to ensure that the workers are placed in a safe work environment.

Vortechs System in service

Maintenance is an essential component of stormwater management enabling ongoing at source control of stormwater pollution. Maintenance will also prevent failures such as structural failure (e.g. prevents blocked outlets) or aesthetic failure (e.g. debris accumulation). All stormwater treatment devices require maintenance to ensure the ongoing performance of the system.

Stormwater360 is a specialised stormwater consultancy with trained and experienced staff. The company has a comprehensive database with detailed information on every Vortechs filter sold and serviced by SW360, collecting site-specific data that can be easily accessed and analysed as required.

This document consists primarily of the processes and tasks associated with the hand maintenance and inductor maintenance procedures. It does not include detail of the traffic management requirements or occupational health and safety requirements. Contractors or SW360 staff should utilise their own Employee Health and Safety Manual, which details the policies and procedures for safe work.

2. VORTECHS HEALTH AND SAFETY

The following section details some of the considerations which may be required for a contactor to comply with relevant health and safety regulations regarding the manual handing activities, hazards associated with the waste material and issues associated with working on roads.

Cleaning of Vortechs is a specialist activity. Material collected can be harmful if not handled correctly. Sediments may contain heavy metals and carcinogenic substances as well as harmful objects such as broken glass and syringes. As all of the Vortechs units are located on roads particular care must be taken due to the potential buildup of hydrocarbon based products and other vehicle based contaminants which may be carcinogenic or toxic. It is essential that Occupational Safety and Health guidelines are followed at all times, and that the following steps are carried out to ensure safe and successful maintenance operations.

In additional to the hazards associated with the cleaning & handling of material, there also hazards associated with traffic at the work site, the removal of the grate, pedestrians and other non-worker personnel, and general work place hazards associated with working outdoors.

This section is not intended to address all the safety issues associated with Vortechs maintenance, providing only information and suggestions on safety aspects associated with the maintenance procedures.

The procedures indicated in the Operations section of this manual are recommend as the safest and most efficient manner in conducting the maintenance of Vortechs Units (Section 3), however contractors and cleaning staff may vary the procedure in response to the site conditions, varying work practices or general preferences in the cleaning techniques. Please note that procedures outlined in this manual are not exhaustive, and that any changes should still comply with general safe work practices.

2.1 Personnel Health and Safety

All contractors and staff shall comply with all current Health and Safety Legislation and take all practicable steps to:

- Comply with all applicable laws, regulations and standards.
- Ensure that all employees, contractors and visitors are informed of and understand their obligations in respect of current Health and Safety Legislation.
- Ensure that employees understand and accept their responsibility to practice and promote a safe and healthy work environment.

All relevant precautions must be taken to prevent contact with sediment and litter when maintaining filters. The following personal protective equipment (PPE) safety equipment should be worn:

- Puncture resistant gloves.
- Steel capped safety boots.
- Fluorescent safety vest.
- Overalls or similar skin protection.
- Eye protection. (if necessary)*

*Higher personal safety conditions may be required when maintaining units that may contain more hazardous material, for example pits where syringes have be observed or pits/systems located in areas associated with such activities.

2.2 Confined Spaces

Confined space poses a serious safety hazard for all personnel; however during the normal maintenance procedures there should be no reason to enter a confined space. All maintenance procedures for the Vortechs system are able to be conducted from the surface.

Confined space entry procedures are not included as part of this manual, for SW360 employees confined space entry procedures are included as part of the SW360 Safety Manual. It is recommend that all contractors evaluate their own needs for confined space entry and compliance with Occupation Health and Safety regulations.

When repairs or maintenance activities cannot be conducted from the surface, the contractor/cleaner should evaluate the need to enter the confined space, considering all alternative options. Where there is a need to proceed in a confined space, only staff with current confined space training shall operate in a confined space. Appropriate measures and controls shall be put in place to meet confined space entry requirements. Safety equipment must be worn where deemed necessary and where gas or oxygen hazard occurs; staff trained in its use will only use BA gear. **Non-trained staff must not go into confined spaces**.

3. OPERATIONS

This section details the specific activities required to clean the Vortechs units. Please note it has been written for use by someone who has never encountered a stormwater pit or a Vortechs unit, providing a step by step process for each of the cleaning stages.

3.1 Maintenance & Monitoring of Vortechs Filters

The maintenance frequency is dependant on several variables, such as catchment area, surrounding land use, vegetation type, traffic loading and rainfall patterns. Inspection is the key to effective maintenance and is easily performed. Stormwater360 recommends ongoing quarterly inspections of the accumulated sediment.

Attached in Appendix A is an example of a Vortechs Service Receipt and Maintenance & Performance Monitoring Form which is to be completed by the Cleaning Contractor when servicing any system. Relevant information is recorded and forwarded to the client and/or Council (depending upon regulations) when immediately following each maintenance/inspection clean. The frequency of each procedure is set-out below in Table2.

Table 2: FREQUENCY OF MAINTENANCE ACTIVITY

ITEM	PERIOD	RESPONSIBILITY	MAINTENANCE PROCEDURE
Inspection - Inspect & Record Data	3-Monthly or after Major Storms	Maintenance Contractor and/or Owner	Follow procedure set out on page 9 of the Vortechs Operations Manual
Minor Maintenance; • Remove Floatables	3-Monthly or after Major Storms	Maintenance Contractor	Follow procedure set out on page 9 of the Vortechs Operations Manual
Major Maintenance; • Evacuation of Chamber	12 month (typ) or as required	Maintenance Contractor	Follow procedure set out on page 8 of the Vortechs Operations Manual
Emergency Maintenance	After Major Storms or Spills	Maintenance Contractor	Follow procedure set out on page 8 of the Vortechs Operations Manual

3.2 Stormwater Pit Cover Removal

There are several different types of stormwater pit covers used throughout Australia. These grates/lids are constructed of three main materials, cast iron, galvanised steel and concrete. Stormwater pits covers on all Vortechs units will cast iron type simply placed on a recessed frame (lockable) to prevent the grate being easily knocked open by passing traffic. A GATIC type lifter (long handle only) and socket set with 1/2in driver will be required to unlock and open the cover.

The following steps indicate a safe and efficient method to clean the Vortechs using an Inductor:

1. Ensure all PPE is worn.
2. Locate locking nut and remove with appropriate sized 1/2in driver and socket.
3. Place GATIC lifter in recess and lever cover open.
4. Slide cover across frame and onto surrounding ground/pavement. Never attempt to lift the cover.
5. Repeat steps 4 & 2 when inspection/maintenance is complete

3.3 Cleaning Methods

One of the following methods of maintenance should be used for the servicing of the Vortechs system:

- Major Maintenance (Cleaning using Inductor Truck).
- Minor Maintenance (Using grapple or net to remove floatables).
- Inspection

3.3.1 Major/Emergency Maintenance (Cleaning using Inductor Truck)

The following steps indicate a safe and efficient method to clean the Vortechs using an Inductor truck. Please complete in conjunction with the form in Appendix A & B as part of this procedure.

1. Open gully pit. (See Section 3.2)
2. Place the inductor hose from the suction truck over the material collected in the sump and switch on the inductor.
3. Using the inductor hose suck all of the sediment, organic leaf material, litter etc, collected in the sump
4. If material has built up around the overflows, use the inductor hose to clear the accumulated material.
5. Check the Vortechs unit. (See Section 3.4)
6. Remove the Suction hose.
7. Spray the inside of the Vortechs system with a high pressure water blaster to remove any accumulated grit. Do not use any chemicals.
8. Replace gully pit cover.

Plate 1 Cleaning a Vortechs using the inductor method

3.3.2 Minor Maintenance

The following steps indicate a safe and efficient method to clean the Vortechs manually by hand. Please complete in conjunction with the form in Appendix A & B as part of this procedure.

1. Open cover. (See Section 3.2)
2. Visually inspect the floating debris from surface and performance composition assessment of material.
3. Measure depth floating debris & record.
4. Measure depth to sediment pile & record.
5. Remove the accumulated floating debris by a net or grapple from the surface of the pit.
6. Complete paperwork.
7. Reinstate pit lids (See Section 3.2).

3.4 Unit Inspection

Pollutant deposition and transport may vary from year to year and quarterly inspections will help insure the system is cleaned out at the appropriate time. Inspections should be performed every 3 month or after major storm events. It is very useful to keep a record of each inspection. A Monitoring & Maintenance form (Attached in Appendix B) for doing so is provided.

The Vortechs should be cleaned when the sediment depth has accumulated to a depth of three feet in the treatment sump. Take two measurements with a stadia rod or similar measuring device; one measurement from the manhole opening to the top of the sediment pile and the other from the manhole opening to the water surface. If the distance measured is less than the distance given in the following table, the Vortechs should be maintained to ensure effective treatment.

Vortechs Model	Design Treatment Capacity cfs (l/s)	Sediment Storage yd^3 (m^3)
1000	0 - 1.6 (0 - 45)	0.7 (0.54)
2000	1.6 - 2.8 (45-80)	1.2 (0.91)
3000	2.8 - 4.5 (80-125)	1.8 (1.38)
4000	4.5 - 6.0 (125-175)	2.4 (1.84)
5000	6.0 - 8.5 (175-240)	3.2 (2.45)
7000	8.5 - 11.0 (240-315)	4.0 (3.06)
9000	11.0 - 14.0 (315-400)	4.8 (3.67)
11000	14.0 - 17.5 (400-495)	5.6 (4.28)
16000	17.5 - 25.0 (495-710)	7.1 (5.43)

Table 1. Vortechs Maintenance Indicators

3.5 Disposal of Material

All Vortechs wastes from the site are to be taken off site and disposed of at a transfer station or similar approved disposal site/facility. No waste material shall be dewatered on-site in case of accidental spills. Dewatering must only be performed at the waste facility. Stormwater Sediments can contain Lead, Copper, Zinc, Mercury, hydrocarbons and PCBs, which are harmful to both humans and the receiving environment. Appropriate sampling and laboratory analysis may be required to classify the material as suitable for reuse, or disposal under appropriate local guidelines.

4 EMERGENCY PROCEDURES

4.1 Spill Procedures

In the event of a spill discharging into any gully pit all sediment is to be extracted and removed from site. Normal operation procedures apply to additional cleaning as a result of spills.

Appendix A

Service Receipt Example

Vortechs Service Receipt

Site:
Contractor:
Location:
Year:

Job Number:
Receipt Number:
Week Serviced:

Service Frequency:
Vortechs s on Site:

Vortechs s Cleaned:
Bags Checked:
Overflows Checked
Tonnage:

If Damaged, Action:
If Blocked, Cleaned:

Comments

This service has been performed in accordance with Vortechs Operations Management Plan (EMP) for above site. Please file this receipt with EMP and keep on site for compliance inspections.

Signature:

Position:

Appendix B
Monitoring & Maintenance Form (log) Example

Vortechs Maintenance & Performance Monitoring Log

Location: _____
_____
Device Model: _____
Owner of Site: _____
Person Responsible for
Maintenance and Contract #:_____
_____

Date	Water Surface to Sediment Distance[1]	Floatable Layer Thickness[2] and Composition	Maintenance Performed[3]	Maintenance Personnel	Estimated Volume of Sediment[4]	Estimated Volume of Floatables	Wet Mass Removed[6]	Comments

1 The water depth to sediment is determined by taking two measurements with a stadia rod: one measurement from the manhole opening to the top of the sediment pile and the other from the manhole opening to the water surface. When the difference between the two measurements is less than the value from the table below, maintenance should be performed.

2. For optimum performance, the system should be cleaned out when the floating hydrocarbon layer accumulates to an appreciable thickness. In the event of a spill, the system should be cleaned immediately. For composition purposes estimate the percentage organics & litter e.g. 60% Litter, 40% Organics.

3. Maintenance Activities Performed are;
   A) Inspection
   B) Minor – Deploying oil absorbents and/or removal floatables by grapple or net.
   C) Major – Evacuation of entire chamber including grit and floatables

4. To estimate the volume the sediment in the chamber, = 2.05m *subtract* (1) Water Surface to Sediment Distance *multiply by* 1.14 (m^3).

5. To estimate the volume of floatables in the chamber, = (2) Floatable Layer Thickness *multiply by* 1.14 (m^3).

6. Obtain the wet mass of the tipped pollutants by weighing the debris at the tip facility or by scales (Minor Maintenance).