APPENDIX G

STORMWATER MANAGEMENT PLAN

Lot 5182 Bagot Road, City of Darwin

Stormwater Management Plan

Planit Consulting

November 2012

Document Verification

Job Title	Lot 5182 Bagot Road, City of Darwin
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Approval for Issue

Name	Signature	Date
Mitchell Baskerville		
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EXECUTIVE SUMMARY

ADG Engineers (Aust.) Pty Ltd was engaged by Planit Consulting to prepare a Stormwater Management Plan (SMP) suitable for submission to City of Darwin (COD) for a development located at Lot 5182 Bagot Road.

The proposed development is a commercial boxy good development for various detached low level retail buildings.

This report comprises of the stormwater quantity and quality assessments to determine the requirements for stormwater conveyance through the development, onsite stormwater detention and the need for stormwater treatment measures.

After comparing the proposed and existing conditions, it has been determined that an increase in stormwater runoff will be created. The percentage of impervious surface areas will increase from less than 5% to a post-development impervious area of more than 60%. Due to the flow characteristics of the upstream catchments, no additional flow mitigation is recommended.

The proposed development offers the opportunity to provide stormwater quality treatment where none exists at present. Removal of gross pollutants and hydrocarbons by Gross Pollutant Traps (GPT's) with hydrodynamic separators will significantly reduce the pollutant loading discharged from the developed site.

1 INTRODUCTION

1.1 BACKGROUND

ADG Engineers (Aust.) Pty Ltd was engaged by Planit Consulting to prepare a Stormwater Management Plan (SMP) suitable for submission to City of Darwin (COD) and the Northern Territory Government Department of Natural Resources Division (NTG) for a development located at Lot 5182 Bagot Road. This SMP is intended to provide additional information in support of a Master Plan for a proposed commercial building development on Bagot Road, herein described as 'the subject site'.

1.2 Scope

This report comprises of stormwater quantity and hydraulic assessments to determine the requirements for onsite stormwater detention, storm flow capacity and the need for stormwater treatment measures. Furthermore, the report includes the following details:

- Catchment hydrology for both the pre and post development scenarios including;
  - Site topography,
  - Catchment characteristics and assumptions,
  - Rational method calculations,
- Existing Infrastructure within the site boundary,
- Hydraulic evaluation of overland flow paths and cross road drainage,

All relevant standards and guidelines are addressed in the SMP including the requirements of the Subdivision and Development Guidelines (SDG) by Darwin City Council (2005), Australian Rainfall and Runoff by IEAust (2001), and Stormwater Drainage Design in Small Urban Catchments by ARRB (Report No. 34 –Argue).

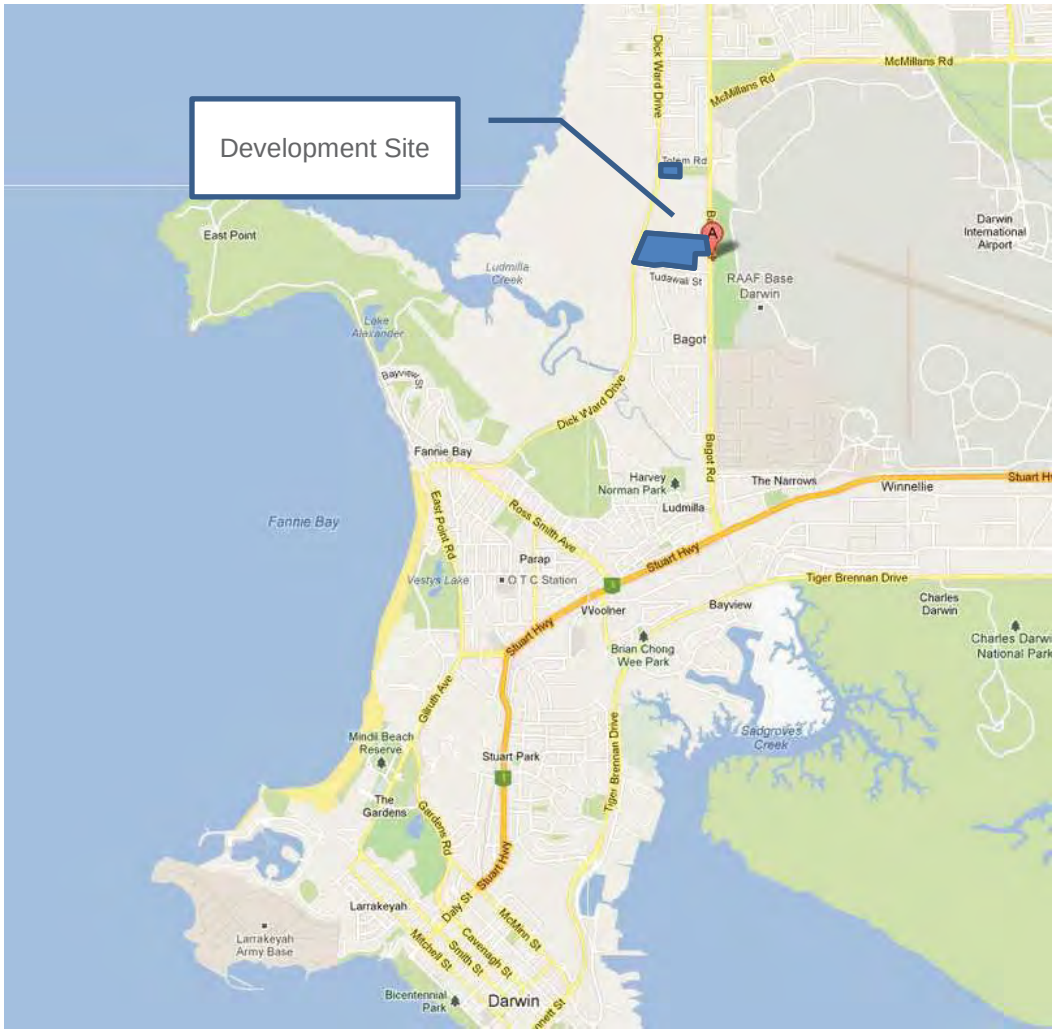
1.3 Property Detail

Title Details	Lot 5182
Site Area	33 Hectares
Boundary Roads	Bagot Road (east) Dick Ward Drive (west) Fitzer Drive (south) Totem Road (north)

1.4 Existing Site

The subject land comprises of Lot 5182 on Bagot Road and is located in the suburb of Ludmilla within the City of Darwin government area. The site is bound by residential lots to the south, a retail commercial area to the north, the Darwin International Airport to the east and Crown Land including a sewage treatment plan, to the west. There are stormwater and electrical easement within the development area. A large concrete lined open drain within the easement on the southern boundary adjacent to Fitzer Drive discharges Crown Land to the west via culverts under Dick Ward Drive. Various culverts discharging into the site from the east under Bagot Road and the remainder of the culverts discharging from the site are identified in the survey drawing in **Appendix A**. The Site is split into two development areas, noted in Figure 2 below as Subject Site A and Site B.

A locality map is presented in **Error! Reference source not found.** below.



As accessed on Google Maps 12/11/2012

Figure 1: Location Map

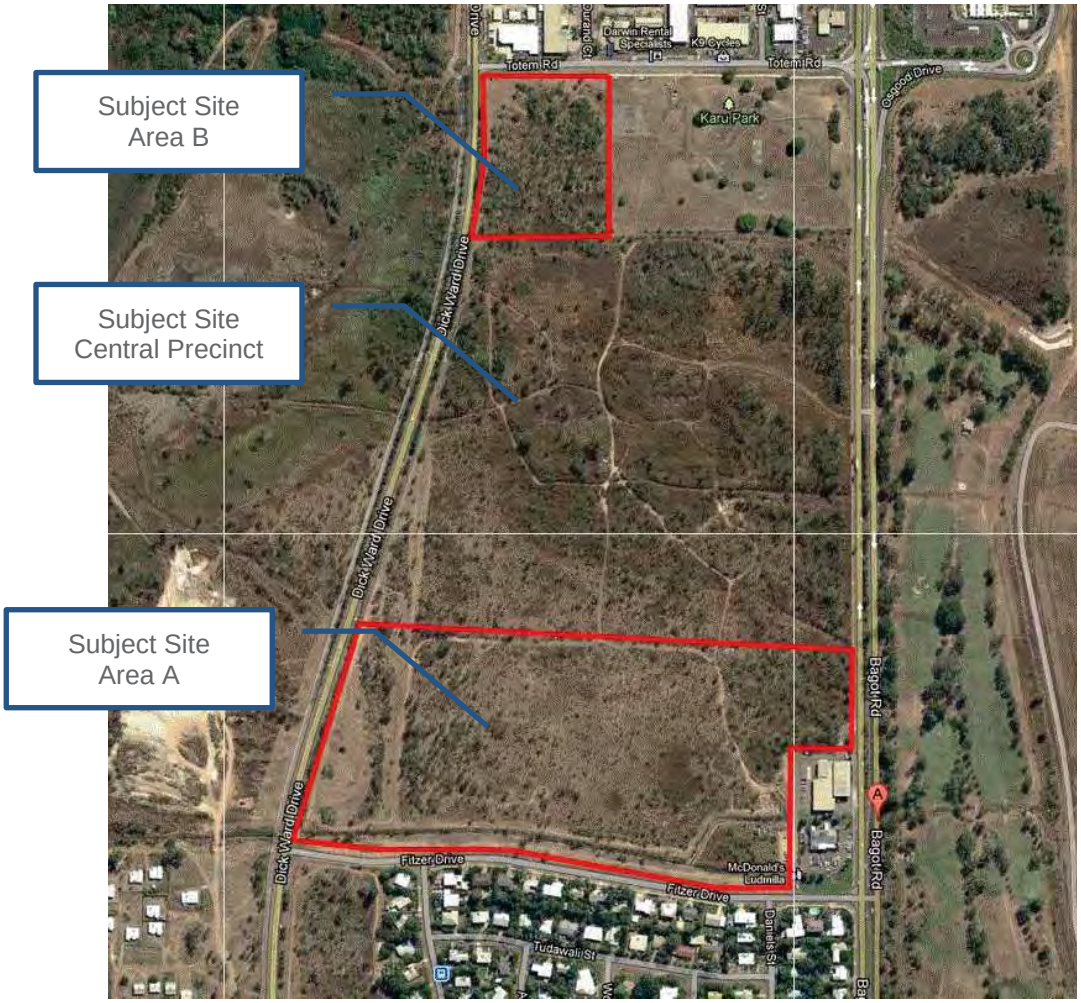
The site slopes from east to west with an approximate fall of 1%. Refer site survey in **Appendix A** for surface level details. An existing service station and fast food restaurant is located on a separate allotment in the south-east corner fronting Bagot Road.

The site currently has 5 separate stormwater easements from channels and culverts flows from the upstream catchments.

The subject site consists of grassed fields and light brush. Refer to the Ecological Assessment by VDM Consulting for additional details.

The site generally drains by overland flow from east to west. There are naturally formed channels and a concrete lined channel that convey discharge from the culverts crossing Bagot Road into the site. Only the concrete lined drain on the southern boundary has conveyance from inlet to discharge. The remaining inlets and channels broaden out, spreading the stormwater flow into sheet flow.

Refer to figure 2 below for the current site conditions.



As accessed on Google Maps 12/11/2012

Figure 2: Site Condition with Indicative Easement Locations

2 PROPOSED DEVELOPMENT

The proposed development is a single story commercial development with associated carparking, roadworks, and services infrastructure. The proposed building footprints and hardstand areas will occupy approximately 60% of the total site. The remainder of the site will mostly be made up of landscaped areas.

The development area has been split into 3 different areas within Lot 5182.

- Area A
  - 16ha
  - Internal (private) and external (public) road network
  - Internal and external stormwater drainage network
  - Stormwater detention and treatment (GPT)
- Area B
  - 2ha
  - Internal road and stormwater network only
  - Stormwater detention and treatment (GPT)
- Central Precinct
  - 15ha
  - No works proposed in this area at this time
  - Identified as an important wildlife corridor and should be excluded from infrastructure works.

2.1 Stormwater Treatment

The proposed development will require the discharged stormwater to be treated in terms of quality and quantity. Refer to sections 3 and 4 of this report for additional information.

2.2 Lawful Points of Discharge

The lawful point of discharge for the site will be to the existing drainage easement and culverts under Dick Ward Drive, located to the west of the site.

3 PROPOSED DRAINAGE STRATEGY

There will be two major strategies relating to the subject site. The development site will modify the land area within the allotment boundary. The development site also receives a significant amount of stormwater flow from upstream catchments and is conveyed through culverts and open channels.

3.1 Development Site Drainage

The site's drainage strategy is nominated on the stormwater drainage plan in **Appendix C**. Roof water will be collected into the rainwater tanks with overflows piped to the stormwater network. The carpark will have subsurface drainage which will be capable of conveying the minor event to the detention tanks. The carparks will be graded such that overland flow in the major event can exit to the east within the drainage channels or the road network. The stormwater inlets will be designed to cater for the minor storm event with a blockage factor of 50%. Gross pollutant traps with hydrodynamic separators will be located to receive all hard stand runoff to remove all gross

pollutants and hydrocarbon pollutants. A suitably sized stormwater detention tank or tanks is to be constructed at the 'end of line' to mitigate the discharge flow from the constructed development.

Standard road drainage, per City of Darwin standards and specifications, will be included in the road design. This includes standard side inlet pits and subsoil drainage to the required construction requirements and tolerances for a future handover to council.

All proposed developed surface areas will require a recommended minimum surface fall of 1%, with an absolute minimum grade of 0.75%, to mitigate issues associated with standing water including mosquito breeding.

It is expected the subject site will be required to be filled with a suitable material to achieve the required flood immunity from the Q100 storm surge and enable the stormwater network to be designed and constructed within the TOD requirements. The filling of the site will not affect adjacent property due to the proposed design constraints noted above.

3.2 External Catchment Drainage

The external site catchment of 138ha is shown on sketch SK02 in Appendix C. The existing cross-road drainage culverts convey the upstream flows and there is no recommendation for upgrading the current level of flood immunity. The final design is to confirm no worsening of the upstream head water level and road flood immunity during the design storm events.

The existing open channel along the southern boundary will need to be modified to allow for the proposed road network. A stormwater structure is proposed to divert the open channel flow from the 'forked' section to the main channel, as shown in the drainage plan in **Appendix C** and the survey plan **in Appendix A.** The discharge flow from the proposed development into this channel will not exceed the current capacity of the drain and culverts. The channel will remain a TOD infrastructure asset and this report assumes council will continue to maintain it.

The existing cross-road drainage culverts under Dick Ward Drive convey the discharge from the site to the lowland areas west of the development. The final design is to confirm no worsening of the upstream head water level and road flood immunity during the design storm events.

4 STORMWATER QUANTITY ASSESSMENT

The aim of this section of the report is to provide a description of how the developed site will not cause any worsening to the existing stormwater infrastructure. Calculations showing the volumes and flow rates for the stormwater flows both before and after the change in site characteristics are presented.

The following items are also addressed in this report.

- Identification of internal sub-catchments,
- Detailed assumptions and calculations of peak flows for both pre and developed conditions,
- Design of mitigation measures to ensure no adverse impacts are caused by overland stormwater flows (if required),
- Confirmation that no adverse impacts are caused external to the site either from increase in peak flows or redirection/concentration of flows during storm events

4.1 Hydrologic Analysis

The recurrence intervals and design standards from AR&R have been adopted for this analysis as per the City of Darwin Subdivision Development Guidelines (SDG).

The existing site condition is predominantly vacant land. There is an existing service station and fast food development to the south east of the site. The stormwater drainage for the service station consists of overland flow and a stormwater pipe flow which runs through the drainage easement to the south of the subject site. This infrastructure will need to be maintained at its current level of service to ensure there is no detrimental effect on the existing buildings.

Stormwater drainage on the remainder of the site currently consists of overland flow and channel flow toward the existing culverts to the west of the site under Dick Ward Drive.

4.1.1 Major and Minor Storm Event

The major event taken for this site is the Q100 event and the initial (minor) event adopted will be 1 in 10 year ARI in accordance with the recommended storm recurrence intervals in section 3.9.5 of the SDG.

The subject site is prone to storm surge, as identified below in Figure 3. It is assumed the Q100 storm event and the Q100 storm surge **do not occur at the same time**. The light blue area represents the Q100 extents and the dark blue represents the 1 in 1000 year event.

Figure 3: Primary and Secondary Storm Surge Location

4.1.2 Rational Method for Peak Flow Rate

The peak flow rate of the subject site has been obtained using the rational method in accordance with ARR section 1.3.2. Summaries of the hydrology calculations can be seen below for the pre and post development scenarios.

Design equation: $Q = (2.78 \times 10^{-3}) C_y I_y A$

Q = Peak flow rate (m3/s) for average recurrence interval

C_y = Co-efficient of runoff for ARI of y years (dimensionless)

A = Catchment area (ha)

I_y = Average rainfall intensity (mm/hr) for a design duration of t hours and an ARI of y years

Catchment Area

The breakdown of areas of each sub-catchment in the existing site and proposed development is shown in Table 2 below. An impervious area of 90% has been assumed in the stormwater management/treatment system for any future development of the balance land. Refer to works area, as nominated on sketch SK01 in Appendix C

Table 1: Proposed development Sub-catchment Areas

Areas (ha)	*Pre-Development*	*Post-Development*
Total	18	18
Roof/Pavement	0	16.2
Landscaping/Grass	0	1.8

Coefficient of Run-off

From the Bureau of Meteorology IFD intensity/frequency duration data the $^{1}I_{10}$ for this area is 116mm/hr.

The site has poor grass cover and a soil permeability of 'medium' has been selected. On this basis, a C_{10} value of 0.7 was used for the pre-developed condition.

The proposed development will have a fraction impervious of 60% therefore the C_{10} value for the developed site is 0.82. From this the "C" values for each of the design storms were determined and are shown below in **Error! Reference source not found.**.

Table 2: Coefficient of Run Off

	Pre-development	***Post Developed***
C_{10}	0.7	0.82
C_{100}	0.84	0.98

Time of Concentration

The time of concentration for each sub-catchment is shown in Table 4 below. For the pre-developed site the toc was calculated by sheetflow across the whole length of site

Table 3: Time of Concentration Calculations

Sheet flow Section using Friends Eq Toc = (107 n L^0.333)/S^0.2		
	Pre-Development	Post-Development
L m	150	100
Slope %	1.0	1.0
n	0.035	0.020
Travel time mins	41	24.5
Sum of Toc mins	**41**	**24.5**

Intensity

The rainfall intensity for each sub-catchment in each design storm based on the time of concentration calculated above is shown below in Table 5.

Table 4: Rainfall Intensity for Design Storms

Rainfall intensity (mm/hr)	*Pre-development*	*Post-development*
I_{10}	101	131
I_{100}	146	190

Peak Flow Rates

The peak flow rates for each sub-catchment in each design storm are shown in Table 6 below.

Table 5: Peak Flow Rates for Design Storms

Peak Flow Rate (m3/s)	*Pre-development*	*Post-development*
Q_{10}	3.535	5.371
Q_{100}	6.132	9.348

4.2 Stormwater Detention

The calculations in table 5 above show that the stormwater flows for the Minor storm event (Q_{10}) have increased from 3.5 m^3/s to 5.4m^3/s. Similarly, the increase for the Q_{100} event is 6.1 m^3/s to 9.3m^3/s. It is necessary to provide on-site stormwater detention so as to not impact the existing stormwater infrastructure and the receiving environment.

The Basha Equation was used to calculate the preliminary detention volumes for both the Minor and Major storm events and can be found in **Appendix C**. Computer modelling will be used (XP Storm) at the detailed design stage of the project to more accurately determine the required on-site detention volumes.

The calculations have shown that a detention tank with a storage volume of 10,515m^3 may be required to mitigate the post developed stormwater run-off volumes to those of the pre developed site. The actual detention volume will be considerably lower due to the routing calculations from detail modelling. The higher flow discharge from the subject site will enable the existing infrastructure, Dick Ward Drive culvers, additional capacity during a regional storm event. The downstream catchment and surrounding properties will not be adversely effected from the additional flow:

- Development discharges directly to the regional receiving water body
- Post-Developed flow from the subject site will be discharged prior to upstream flows from regional events entering the stormwater network.
- Additional retardation of upstream flows will not improve the localized flooding extents.

- Higher flow rates from the subject site will still be less than the flow from a regional storm event. All discharges will be mitigated to prevent scour and higher flood levels.

As shown below, no detention tanks are will be required.

4.3 Preliminary Hydraulic Modelling

Using the available data sources, a preliminary XP Storm model has been created to develop the existing capacity and development constraints. A model was developed to include the upstream and development site catchments, as shown below in Figure 4.

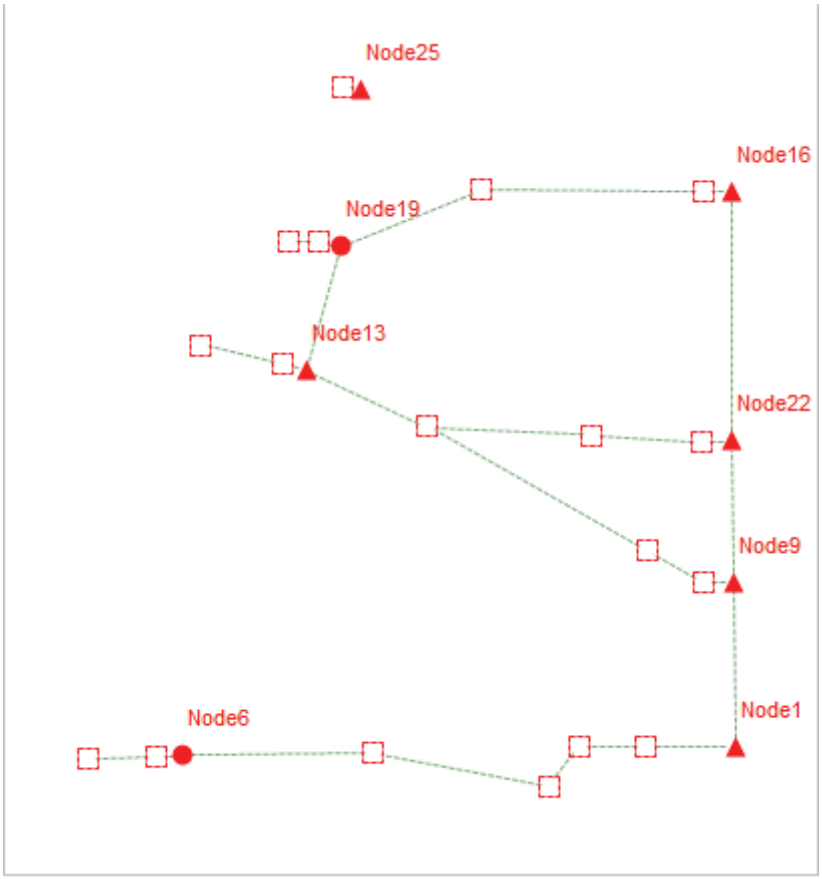


Figure 4: XP Storm Model

4.3.1 Pre-Development Model

The existing model identified the existing flow characteristics of the existing infrastructure. The results are included in **appendix B.**

4.3.2 Post-Development Model

The post-developed catchments were modified to include the proposed developments impervious areas and characteristics. The results are included in **appendix B.**

The increased flow from the development did not adversely affect the existing culvert drainage characteristics, as shown in Table 6 below.

Culvert flow		
Culvert 6_7	Pre- Developed	Post Developed
Q10	10.402	10.4
Q100	14.199	14.198
Culvert 13_14		
Q10	4.208	4.145
Q100	6.698	6.63
Culvert 25_26		
Q10	0.892	1.44
Q100	1.307	1.534

Table 6: Culvert Flow

.

4.4 Stormwater Quantity Assessment Summary

The proposed stormwater management system will not adversely impact on flooding or drainage of properties that are upstream, downstream or adjacent to the site. The proposed development will create higher stormwater runoff flow rates; however, they will be mitigated through the use of an on-site stormwater detention tank. Release from the development will be modified such the total site stormwater run-off flow rates can be controlled by the existing culverts for all storm events up to and including the Q_{100}. The site will be graded to ensure that in the major event the site will drain via overland flow to the existing discharge points.

5 STORMWATER QUALITY ASSESSMENT

This assessment identifies issues relating to storm water runoff quality and assesses possible methods of treatment if required. The aim of this section of the report is to determine practical approaches to achieving improvements in the quality of the stormwater run-off from the site that can be readily implemented.

The objective is to provide the following in accordance with the SDG:

- Rainwater harvesting,
- All of the site's impervious areas discharge to suitable treatment device/s.

5.1 Water Balance

Stormwater discharge from commercial buildings would benefit from re-use of captured roofwater. Non-potable uses such as irrigation and toilet flushing can be accommodated within the plumbing and drainage design.

5.2 Stormwater Treatment

All impervious surfaces within the allotments will produce pollutant loading including gross pollutants and hydrocarbons. The subject site will provide removal of the above pollutants prior to discharge into the proposed and existing stormwater network.

5.3 Lifecycle Costs

A lifecycle cost analysis is not a part of the scope of this report. All the recommended water quality treatment infrastructure lies within the development site and it shall be maintained and serviced by the owners of the development at no cost to Council.

5.4 Water Quality Monitoring

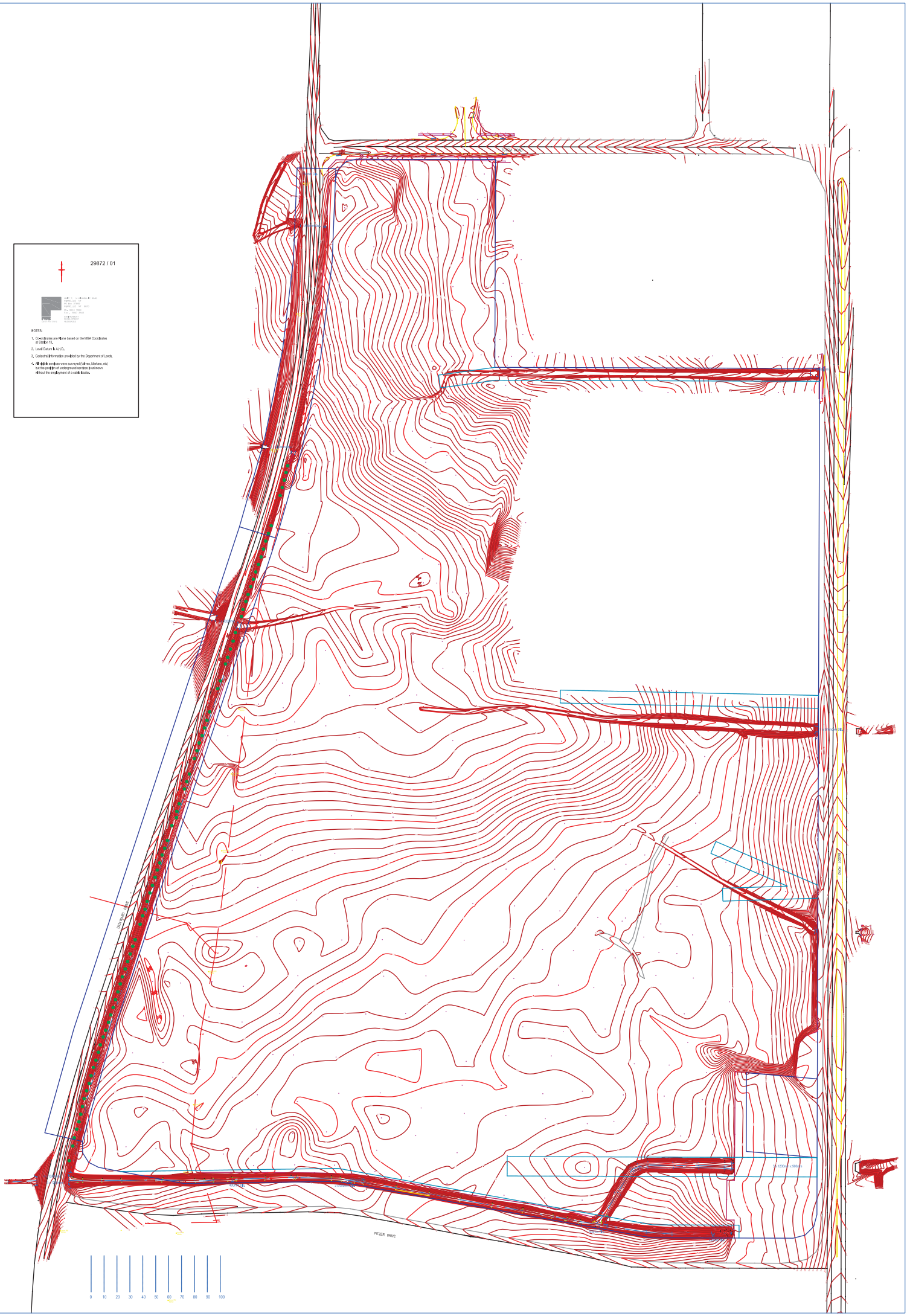
No water quality monitoring is proposed for this development at this stage due to the nature of the development and the fact that no monitoring currently takes place.

6 CONCLUSIONS

As shown above, the proposed development can be designed and constructed in accordance with the standards providing a high quality commercial development that is sustainable and responsible.

A detailed design coordinated with a hydraulic model is required to specify the finished surface levels. Detailed engineering diagrams and management requirements for the proposed development are to be submitted to the Northern Territory Government and the City of Darwin for approval prior to any works commencing on site with design certification prepared by a qualified stormwater engineer or scientist.

Appendix A
Site Survey


29872 / 01
NOTES:
1. Coordinates are Plane based on the MGA Coordinates at Station 15.
2. Level Datum is AHD.
3. Cadastral information provided by the Department of Lands.
4. All visible services were surveyed (Valves, Markers, etc) but the position of underground services is unknown without the employment of a cable locator.
FITZER DRIVE
0
10
20
30
40
50
60
70
80
90
100

Appendix B
XP Storm Data

Conduit Data

Pre Development

Name	Storm	Shape	Length	Roughness	Diameter (Hei	Number of Ba	Entrance Loss	Exit Loss
Link22	Q10	Trapezoidal	182.820	0.0350	1.000	1.000	0.000	0.000
culvert1_2	Q10	Rectangular	99.260	0.0130	1.200	3.000	0.500	0.500
road1_2	Q10	Circular	10.000	0.0130	0.300	1.000	0.000	0.000
weir1_2	Q10							
Link2	Q10	Trapezoidal	72.560	0.0150	1.100	1.000	0.000	0.000
Link3	Q10	Trapezoidal	55.080	0.0150	1.100	1.000	0.000	0.000
Link4	Q10	Trapezoidal	199.830	0.0150	1.500	1.000	0.000	0.000
Link5	Q10	Trapezoidal	210.180	0.0150	1.500	1.000	0.000	0.000
cvrt6_7a	Q10	Circular	27.470	0.0130	1.250	4.000	0.500	0.500
cvrt6_7b	Q10	Circular	27.470	0.0130	1.250	3.000	0.500	0.500
weir6_7	Q10							
Link7	Q10	Trapezoidal	76.080	0.0350	0.300	1.000	0.000	0.000
Link23	Q10	Trapezoidal	155.670	0.0350	0.700	1.000	0.000	0.000
clvt9_10	Q10	Circular	34.880	0.0130	0.525	1.000	0.000	0.000
weir9_10	Q10							
Link9	Q10	Trapezoidal	70.890	0.0300	0.400	1.000	0.000	0.000
Link10	Q10	Trapezoidal	280.590	0.0035	0.300	1.000	0.000	0.000
Link11	Q10	Trapezoidal	148.140	0.0035	0.300	1.000	0.000	0.000
clvt13_14	Q10	Circular	25.540	0.0130	1.050	3.000	0.500	0.500
weir13_14	Q10							
Link26	Q10	Trapezoidal	141.310	0.0130	1.000	1.000	0.000	0.000
Link13	Q10	Trapezoidal	93.870	0.0350	0.300	1.000	0.000	0.000
clvt16_17	Q10	Circular	31.280	0.0130	0.600	4.000	0.500	0.500
weir16_17	Q10							
Link15	Q10	Trapezoidal	249.110	0.0350	1.500	1.000	0.000	0.000
Link16	Q10	Trapezoidal	166.970	0.0350	0.300	1.000	0.000	0.000
clvt19_20	Q10	Circular	24.140	0.0130	1.200	1.000	0.000	0.000
weir19_20	Q10							
Link18	Q10	Trapezoidal	32.880	0.0350	0.300	1.000	0.000	0.000
Link24	Q10	Trapezoidal	276.070	0.0350	1.000	1.000	0.000	0.000
clvt22_23	Q10	Circular	34.050	0.0130	0.500	5.000	0.500	0.500
weir22_23	Q10							
Link20	Q10	Trapezoidal	122.130	0.0300	1.100	1.000	0.000	0.000
Link21	Q10	Trapezoidal	183.000	0.0350	0.300	1.000	0.000	0.000
Link25	Q10	Circular	20.560	0.0130	0.800	1.000	0.000	0.000

Hydrologic Data

Pre Development

Name	Storm	Subcatchm	Sub-Catchme	Area	Impervious Pe	Slope
Node1	Q10	1	☒	74.250	0.0	0.0130
Node1		2	☒	1.650	100.0	0.1300
Node2	Q10		☐	0.000	0.0	0.0000
Node3	Q10		☐	0.000	0.0	0.0000
Node4	Q10		☐	0.000	0.0	0.0000
Node5	Q10		☐	0.000	0.0	0.0000
Node6	Q10	1	☒	1.400	0.0	0.0100
Node6		2	☒	1.400	100.0	0.0100
Node7	Q10		☐	0.000	0.0	0.0000
Node8	Q10		☐	0.000	0.0	0.0000
Node9	Q10	1	☒	20.250	0.0	0.0130
Node9		2	☒	0.450	100.0	0.0130
Node10	Q10		☐	0.000	0.0	0.0000
Node11	Q10		☐	0.000	0.0	0.0000
Node12	Q10		☐	0.000	0.0	0.0000
Node13	Q10	1	☒	13.750	0.0	0.0100
Node14	Q10		☐	0.000	0.0	0.0000
Node15	Q10		☐	0.000	0.0	0.0000
Node16	Q10	1	☒	27.000	0.0	0.0130
Node16		2	☒	0.600	100.0	0.0130
Node17	Q10		☐	0.000	0.0	0.0000
Node18	Q10		☐	0.000	0.0	0.0000
Node19	Q10	1	☒	13.750	0.0	0.0100
Node20	Q10		☐	0.000	0.0	0.0000
Node21	Q10		☐	0.000	0.0	0.0000
Node22	Q10	1	☒	13.500	0.0	0.0130
Node22		2	☒	0.300	100.0	0.0130
Node23	Q10		☐	0.000	0.0	0.0000
Node24	Q10		☐	0.000	0.0	0.0000
Node25	Q10	1	☒	6.200	0.0	0.0100
Node26	Q10		☐	0.000	0.0	0.0000

Hydrologic Data

Pre Development

Name	Storm	Subcatchm	Infiltration Ref	Routing Meth	Unit Hydrogra
Node1	Q10	1	perv	Laurenson	Nash
Node1		2	imp	Laurenson	Nash
Node2	Q10				Nash
Node3	Q10				Nash
Node4	Q10				Nash
Node5	Q10				Nash
Node6	Q10	1	perv	Laurenson	Nash
Node6		2	imp	RUNOFF	Nash
Node7	Q10				Nash
Node8	Q10				Nash
Node9	Q10	1	perv	Laurenson	Nash
Node9		2	imp	Laurenson	Nash
Node10	Q10				Nash
Node11	Q10				Nash
Node12	Q10				Nash
Node13	Q10	1	perv	Laurenson	Nash
Node14	Q10				Nash
Node15	Q10				Nash
Node16	Q10	1	perv	Laurenson	Nash
Node16		2	imp	Laurenson	Nash
Node17	Q10				Nash
Node18	Q10				Nash
Node19	Q10	1	perv	Laurenson	Nash
Node20	Q10				Nash
Node21	Q10				Nash
Node22	Q10	1	perv	Laurenson	Nash
Node22		2	imp	Laurenson	Nash
Node23	Q10				Nash
Node24	Q10				Nash
Node25	Q10	1	perv	Laurenson	Nash
Node26	Q10				Nash

E15

Pre Development

Name	Storm	Link Name	Max Flow cms	Max Velocity m/s	Node Name	Invert Elevation m
Link22	Q10	Link22	2.352	0.60	Node1	8.100
culvert1_2	Q10	Link1	10.191	2.50	Node1	8.100
road1_2	Q10	Link1	0.000	0.00	Node1	8.100
weir1_2	Q10	Link1	0.000	0.00	Node1	8.100
Link2	Q10	Link2	10.190	2.98	Node2	7.200
Link3	Q10	Link3	10.191	2.69	Node3	6.700
Link4	Q10	Link4	10.191	2.37	Node4	6.230
Link5	Q10	Link5	10.191	2.18	Node5	5.610
cvrt6_7a	Q10	Link6	5.944	1.60	Node6	5.010
cvrt6_7b	Q10	Link6	4.458	1.60	Node6	5.010
weir6_7	Q10	Link6	0.000	0.00	Node6	5.010
Link7	Q10	Link7	10.402	0.87	Node7	4.970
Link23	Q10	Link23	0.000	0.00	Node9	9.300
clvt9_10	Q10	Link8	0.989	7.29	Node9	9.300
weir9_10	Q10	Link8	0.000	0.00	Node9	9.300
Link9	Q10	Link9	0.989	0.76	Node10	7.500
Link10	Q10	Link10	0.989	1.87	Node11	7.490
Link11	Q10	Link11	4.545	0.93	Node12	5.000
clvt13_14	Q10	Link12	4.208	1.78	Node13	3.600
weir13_14	Q10	Link12	0.000	0.00	Node13	3.600
Link26	Q10	Link26	2.390	0.76	Node13	3.600
Link13	Q10	Link13	4.207	0.66	Node14	3.450
clvt16_17	Q10	Link14	0.680	1.39	Node16	9.210
weir16_17	Q10	Link14	0.000	0.00	Node16	9.210
Link15	Q10	Link15	0.678	0.61	Node17	8.900
Link16	Q10	Link16	0.677	0.40	Node18	7.500
clvt19_20	Q10	Link17	2.739	4.99	Node19	4.000
weir19_20	Q10	Link17	0.000	0.00	Node19	4.000
Link18	Q10	Link18	2.739	0.47	Node20	3.550
Link24	Q10	Link24	3.632	0.93	Node22	7.900
clvt22_23	Q10	Link19	3.062	3.16	Node22	7.900
weir22_23	Q10	Link19	0.538	0.00	Node22	7.900
Link20	Q10	Link20	3.602	1.80	Node23	7.290
Link21	Q10	Link21	3.591	0.47	Node24	5.300
Link25	Q10	Link25	0.892	3.85	Node25	4.883

E15

Pre Development

Name	Storm	Max Water Elevation m
Link22	Q10	9.739
culvert1_2	Q10	9.739
road1_2	Q10	9.739
weir1_2	Q10	9.739
Link2	Q10	7.718
Link3	Q10	7.244
Link4	Q10	6.975
Link5	Q10	6.387
cvrt6_7a	Q10	5.949
cvrt6_7b	Q10	5.949
weir6_7	Q10	5.949
Link7	Q10	5.405
Link23	Q10	9.756
clvt9_10	Q10	9.756
weir9_10	Q10	9.756
Link9	Q10	7.881
Link10	Q10	7.513
Link11	Q10	5.055
clvt13_14	Q10	4.622
weir13_14	Q10	4.622
Link26	Q10	4.622
Link13	Q10	3.714
clvt16_17	Q10	9.569
weir16_17	Q10	9.569
Link15	Q10	9.153
Link16	Q10	7.555
clvt19_20	Q10	4.621
weir19_20	Q10	4.621
Link18	Q10	3.797
Link24	Q10	9.223
clvt22_23	Q10	9.223
weir22_23	Q10	9.223
Link20	Q10	7.653
Link21	Q10	5.617
Link25	Q10	5.258

Conduit Data

Post Development

Name	Storm	Shape	Length	Roughness	Diameter (Hei	Number of Ba
Link22	Q10	Trapezoidal	182.820	0.0350	1.000	1.000
culvert1_2	Q10	Rectangular	99.260	0.0130	1.200	3.000
road1_2	Q10	Circular	10.000	0.0130	0.300	1.000
weir1_2	Q10					
Link2	Q10	Trapezoidal	72.560	0.0150	1.100	1.000
Link3	Q10	Trapezoidal	55.080	0.0150	1.100	1.000
Link4	Q10	Trapezoidal	199.830	0.0150	1.500	1.000
Link5	Q10	Trapezoidal	210.180	0.0150	1.500	1.000
cvrt6_7a	Q10	Circular	27.470	0.0130	1.250	4.000
cvrt6_7b	Q10	Circular	27.470	0.0130	1.250	3.000
weir6_7	Q10					
Link7	Q10	Trapezoidal	76.080	0.0350	0.300	1.000
Link23	Q10	Trapezoidal	155.670	0.0350	0.700	1.000
clvt9_10	Q10	Circular	34.880	0.0130	0.525	1.000
weir9_10	Q10					
Link9	Q10	Trapezoidal	70.890	0.0300	0.400	1.000
Link10	Q10	Trapezoidal	280.590	0.0035	0.300	1.000
Link11	Q10	Trapezoidal	148.140	0.0035	0.300	1.000
Link26	Q10	Trapezoidal	141.310	0.0130	1.000	1.000
clvt13_14	Q10	Circular	25.540	0.0130	1.050	3.000
weir13_14	Q10					
Link13	Q10	Trapezoidal	93.870	0.0350	0.300	1.000
clvt16_17	Q10	Circular	31.280	0.0130	0.600	4.000
weir16_17	Q10					
Link15	Q10	Trapezoidal	249.110	0.0350	1.500	1.000
Link16	Q10	Trapezoidal	166.970	0.0350	0.300	1.000
clvt19_20	Q10	Circular	24.140	0.0130	1.200	1.000
weir19_20	Q10					
Link18	Q10	Trapezoidal	32.880	0.0350	0.300	1.000
Link24	Q10	Trapezoidal	276.070	0.0350	1.000	1.000
clvt22_23	Q10	Circular	34.050	0.0130	0.500	5.000
weir22_23	Q10					
Link20	Q10	Trapezoidal	122.130	0.0300	1.100	1.000
Link21	Q10	Trapezoidal	183.000	0.0350	0.300	1.000
Link25	Q10	Circular	20.560	0.0130	0.800	1.000

Conduit Data

Post Development

Name	Storm	Entrance Loss	Exit Loss
Link22	Q10	0.000	0.000
culvert1_2	Q10	0.500	0.500
road1_2	Q10	0.000	0.000
weir1_2	Q10		
Link2	Q10	0.000	0.000
Link3	Q10	0.000	0.000
Link4	Q10	0.000	0.000
Link5	Q10	0.000	0.000
cvrt6_7a	Q10	0.500	0.500
cvrt6_7b	Q10	0.500	0.500
weir6_7	Q10		
Link7	Q10	0.000	0.000
Link23	Q10	0.000	0.000
clvt9_10	Q10	0.000	0.000
weir9_10	Q10		
Link9	Q10	0.000	0.000
Link10	Q10	0.000	0.000
Link11	Q10	0.000	0.000
Link26	Q10	0.000	0.000
clvt13_14	Q10	0.500	0.500
weir13_14	Q10		
Link13	Q10	0.000	0.000
clvt16_17	Q10	0.500	0.500
weir16_17	Q10		
Link15	Q10	0.000	0.000
Link16	Q10	0.000	0.000
clvt19_20	Q10	0.000	0.000
weir19_20	Q10		
Link18	Q10	0.000	0.000
Link24	Q10	0.000	0.000
clvt22_23	Q10	0.500	0.500
weir22_23	Q10		
Link20	Q10	0.000	0.000
Link21	Q10	0.000	0.000
Link25	Q10	0.000	0.000

Hydrologic Data

Post Development

Name	Storm	Subcatchm	Area	Impervious Pe	Slope	Infiltration Ref
Node1	Q10	1	74.250	0.0	0.0130	perv
Node1		2	1.650	100.0	0.1300	imp
Node2	Q10		0.000	0.0	0.0000	
Node3	Q10		0.000	0.0	0.0000	
Node4	Q10		0.000	0.0	0.0000	
Node5	Q10		0.000	0.0	0.0000	
Node6	Q10	1	1.400	0.0	0.0100	perv
Node6		2	1.400	100.0	0.0100	imp
Node7	Q10		0.000	0.0	0.0000	
Node8	Q10		0.000	0.0	0.0000	
Node9	Q10	1	20.250	0.0	0.0130	perv
Node9		2	0.450	100.0	0.0130	imp
Node10	Q10		0.000	0.0	0.0000	
Node11	Q10		0.000	0.0	0.0000	
Node12	Q10		0.000	0.0	0.0000	
Node13	Q10	1	7.220	0.0	0.0100	perv
Node13		2	6.030	100.0	0.0100	imp
Node14	Q10		0.000	0.0	0.0000	
Node15	Q10		0.000	0.0	0.0000	
Node16	Q10	1	27.000	0.0	0.0130	perv
Node16		2	0.600	100.0	0.0130	imp
Node17	Q10		0.000	0.0	0.0000	
Node18	Q10		0.000	0.0	0.0000	
Node19	Q10	1	13.750	0.0	0.0100	perv
Node20	Q10		0.000	0.0	0.0000	
Node21	Q10		0.000	0.0	0.0000	
Node22	Q10	1	13.500	0.0	0.0130	perv
Node22		2	0.300	100.0	0.0130	imp
Node23	Q10		0.000	0.0	0.0000	
Node24	Q10		0.000	0.0	0.0000	
Node25	Q10	1	2.480	0.0	0.0100	perv
Node25		2	3.720	100.0	0.0100	imp
Node26	Q10		0.000	0.0	0.0000	

Hydrologic Data

Post Development

Name	Storm	Subcatchm	Routing Meth	Unit Hydrogra
Node1	Q10	1	Laurenson	Nash
Node1		2	Laurenson	Nash
Node2	Q10			Nash
Node3	Q10			Nash
Node4	Q10			Nash
Node5	Q10			Nash
Node6	Q10	1	Laurenson	Nash
Node6		2	Laurenson	Nash
Node7	Q10			Nash
Node8	Q10			Nash
Node9	Q10	1	Laurenson	Nash
Node9		2	Laurenson	Nash
Node10	Q10			Nash
Node11	Q10			Nash
Node12	Q10			Nash
Node13	Q10	1	Laurenson	Nash
Node13		2	Laurenson	Nash
Node14	Q10			Nash
Node15	Q10			Nash
Node16	Q10	1	Laurenson	Nash
Node16		2	Laurenson	Nash
Node17	Q10			Nash
Node18	Q10			Nash
Node19	Q10	1	Laurenson	Nash
Node20	Q10			Nash
Node21	Q10			Nash
Node22	Q10	1	Laurenson	Nash
Node22		2	Laurenson	Nash
Node23	Q10			Nash
Node24	Q10			Nash
Node25	Q10	1	Laurenson	Nash
Node25		2	Laurenson	Nash
Node26	Q10			Nash

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Post Development

Name	Storm	Link Name	Max Flow cms	Max Velocity m/s	Node Name	Invert Elevation m
Link22	Q10	Link22	2.356	0.60	Node1	8.100
culvert1_2	Q10	Link1	10.236	2.51	Node1	8.100
road1_2	Q10	Link1	0.000	0.00	Node1	8.100
weir1_2	Q10	Link1	0.000	0.00	Node1	8.100
Link2	Q10	Link2	10.236	2.99	Node2	7.200
Link3	Q10	Link3	10.236	2.70	Node3	6.700
Link4	Q10	Link4	10.236	2.37	Node4	6.230
Link5	Q10	Link5	10.237	2.19	Node5	5.610
cvrt6_7a	Q10	Link6	5.967	1.60	Node6	5.010
cvrt6_7b	Q10	Link6	4.476	1.60	Node6	5.010
weir6_7	Q10	Link6	0.000	0.00	Node6	5.010
Link7	Q10	Link7	10.442	0.87	Node7	4.970
Link23	Q10	Link23	0.000	0.00	Node9	9.300
clvt9_10	Q10	Link8	1.004	5.05	Node9	9.300
weir9_10	Q10	Link8	0.000	0.00	Node9	9.300
Link9	Q10	Link9	1.004	0.77	Node10	7.500
Link10	Q10	Link10	1.004	1.88	Node11	7.490
Link11	Q10	Link11	4.702	0.91	Node12	5.000
Link26	Q10	Link26	1.974	0.53	Node13	3.600
clvt13_14	Q10	Link12	4.216	1.78	Node13	3.600
weir13_14	Q10	Link12	0.000	0.00	Node13	3.600
Link13	Q10	Link13	4.215	0.66	Node14	3.450
clvt16_17	Q10	Link14	0.688	1.35	Node16	9.210
weir16_17	Q10	Link14	0.000	0.00	Node16	9.210
Link15	Q10	Link15	0.686	0.61	Node17	8.900
Link16	Q10	Link16	0.685	0.34	Node18	7.500
clvt19_20	Q10	Link17	2.751	5.00	Node19	4.000
weir19_20	Q10	Link17	0.000	0.00	Node19	4.000
Link18	Q10	Link18	2.751	0.47	Node20	3.550
Link24	Q10	Link24	3.650	0.93	Node22	7.900
clvt22_23	Q10	Link19	3.076	3.17	Node22	7.900
weir22_23	Q10	Link19	0.655	0.00	Node22	7.900
Link20	Q10	Link20	3.733	1.82	Node23	7.290
Link21	Q10	Link21	3.722	0.48	Node24	5.300
Link25	Q10	Link25	1.144	4.10	Node25	4.883

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Post Development

Name	Storm	Max Water Elevation m
Link22	Q10	9.751
culvert1_2	Q10	9.751
road1_2	Q10	9.751
weir1_2	Q10	9.751
Link2	Q10	7.719
Link3	Q10	7.245
Link4	Q10	6.977
Link5	Q10	6.389
cvrt6_7a	Q10	5.951
cvrt6_7b	Q10	5.951
weir6_7	Q10	5.951
Link7	Q10	5.406
Link23	Q10	9.766
clvt9_10	Q10	9.766
weir9_10	Q10	9.766
Link9	Q10	7.884
Link10	Q10	7.513
Link11	Q10	5.056
Link26	Q10	4.623
clvt13_14	Q10	4.623
weir13_14	Q10	4.623
Link13	Q10	3.714
clvt16_17	Q10	9.572
weir16_17	Q10	9.572
Link15	Q10	9.155
Link16	Q10	7.556
clvt19_20	Q10	4.623
weir19_20	Q10	4.623
Link18	Q10	3.798
Link24	Q10	9.232
clvt22_23	Q10	9.232
weir22_23	Q10	9.232
Link20	Q10	7.661
Link21	Q10	5.623
Link25	Q10	5.318

Appendix C
Proposed Drainage Plan

XREFS:

LEGEND

- PROPERTY BOUNDARY
- PROPERTY EASEMENT
- EXISTING NOMINAL KERB LINE
- EXISTING NOMINAL KERB LINE
- PROPOSED NOMINAL KERB LINE
- LIMIT OF WORKS
- EXISTING ROAD
- PROPOSED PAD
- FUTURE PAD
- PROPOSED MINOR ROAD
- PROPOSED MAJOR ROAD
- PROPOSED BUILDING
- EXISTING FLOW ARROW

PROPOSED WORKS AREA TABLE

LOCATION	AREA (m²)
PROPOSED MAJOR ROAD	10789
PROPOSED MINOR ROAD	9445
PROPOSED PADS	124253
BUILDINGS	71861

FUTURE WORKS AREA TABLE

LOCATION	AREA (m²)
FUTURE ROADS	8488
FUTURE PADS	120576

- New Stormwater Infastructure
- New Stormwater Open Drain
- New Road Culvert

EXISTING 4x1350Ø
EXISTING 3x1250Ø
Power and Sewer Easement to be relocated to east of Dick Ward Drive
DICK WARD DRIVE
Discharge into open channel
EXISTING 3x1050Ø
EXSITING 1200Ø
DICK WARD DRIVE
EXISTING 800Ø
SEWER & POWERLINE EASEMENT
PROPOSED ROAD
DRAINAGE EASEMENT
FITZER DRIVE
FUTURE ROAD
POWER EASEMENT
SITE A
16.06HA
SITE B
2.03HA
FUTURE ROAD
CONCRETE LINED CHANNEL
NEW ROAD
DRAINAGE EASEMENT
KARU PARK
TOTEM ROAD
.5m DEEP CONCRETE INED CHANNEL
NEW ROAD
McDONALDS
SERVICE STATION
New structure for open channel diversion
3x1200x900
BAGOT ROAD
New diversion of minor culvert
EXISTING CULVERT SIZE AND TYPE TO BE CONFIRMED
EXISTING CULVERT SIZE AND TYPE TO BE CONFIRMED
RAAF GOLF COURSE
BAGOT ROAD

0 20 40 60 80 100m
SCALE 1:2000
AT ORIGINAL SIZE (A1)

NOTE:
- Allotment connections not shown for clarity. Allotment connections to be min 375mm connections from back of SEP.

- Rainwater/Retention Tanks not shown for clarity. Each building to nominate final location of tank for detail design.

Rev	Date	Description	By	Chk
01	10.10.12	Issued for Information	JD	MVI

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Client: PLANIT CONSULTING

Project Name: INDUSTRIAL SUBDIVISION BAGOT ROAD, DARWIN

Title: PRELIMINARY LAYOUT PLAN

Discipline	Status
CIVIL	PRELIMINARY

Designed By	Checked By	Approved By
MVI	MVI	

Project No.	Drawn By	Scale at A1
13808	JD	1:2000

Drawing No.	Revision
SK01	01

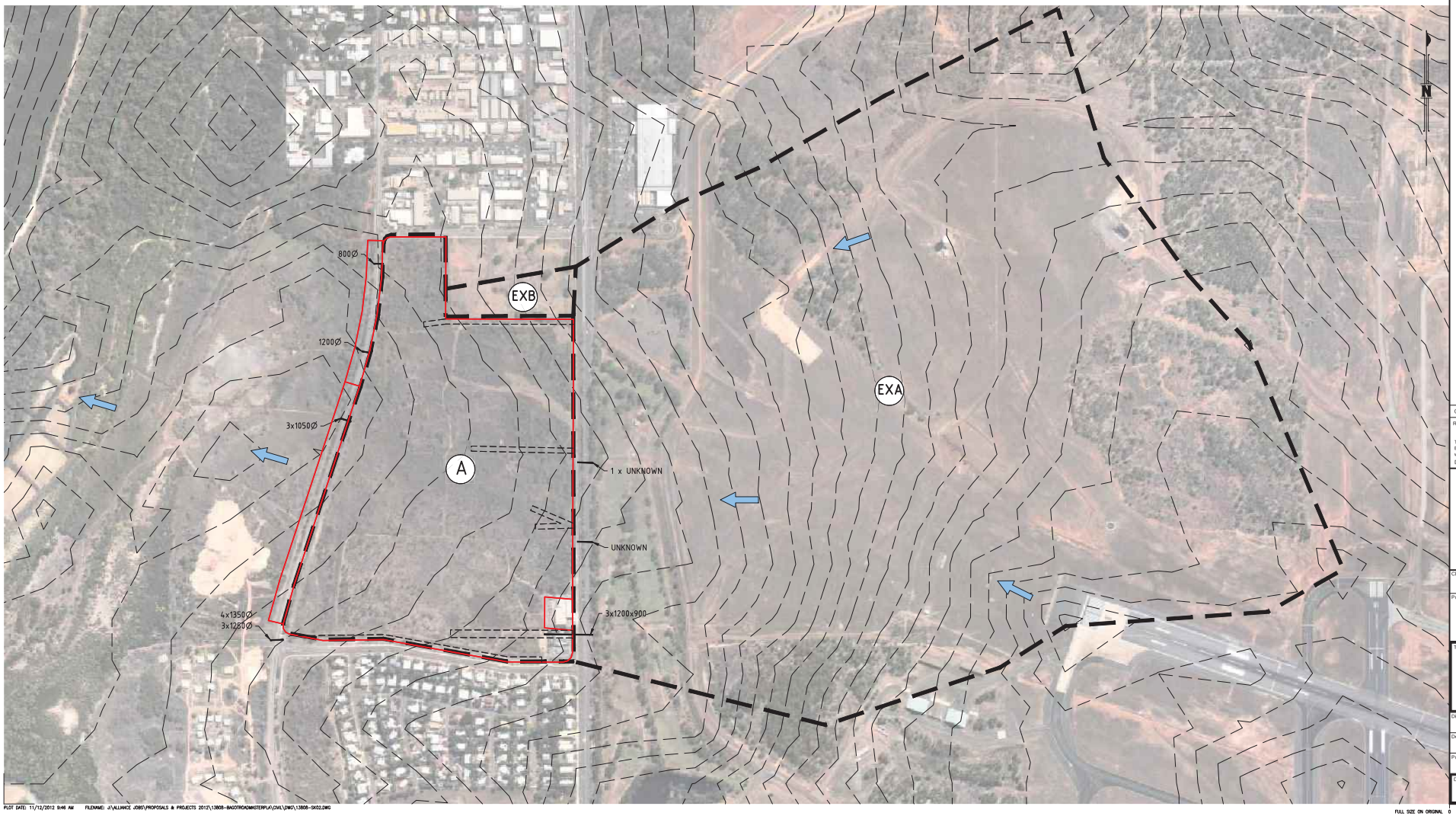
FULL SIZE ON ORIGINAL 0 10 20 30 40 50 60 70 80 90 100mm

PLOT DATE: 11/13/2012 7:41 AM FILENAME: J:\ALLIANCE JOBS\PROPOSALS & PROJECTS 2012\13808-BAGOTROADMASTERPLA\CIVIL\DWG\13808-SK01.DWG

LEGEND

- SITE BOUNDARY
- EXISTING SURFACE CONTOURS (12.0)
- EXISTING LOT BOUNDARY
- (A) CATCHMENT LABEL
- CATCHMENT BOUNDARY
- FLOW PATH

CATCHMENT TABLE		
CATCHMENT	AREA (ha)	FRACTION IMPERVIOUS (Fi)
A	33.5	0.02
EX A	138	0.02
EX B	1.9	0.02



0 40 80 120 160 200m

SCALE 1:4000

AT ORIGINAL SIZE (A1)

Rev	Date	Description	By	Chk
01	XX.XX.XX	Issued for Xxxxxxxxxx	XXX	XXX

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Client

Project Name

Title
PRE-DEVELOPMENT
CATCHMENT PLAN

Discipline		Status
CIVIL		PRELIMINARY
Designed By	Checked By	Approved By
AM	ML	
Project No.	Drawn By	Scale
13808	JS	1:4000 (at A1)
Drawing No.		Revision
SK02		01

PLOT DATE: 11/12/2012 9:46 AM FILENAME: J:\ALLIANCE JOBS\PROPOSALS & PROJECTS 2012\13808-BAGOTROADMASTERPLAN\CIVIL\DWG\13808-SK02.DWG

FULL SIZE ON ORIGINAL 0 10 20 30 40 50 60 70 80 90 100mm