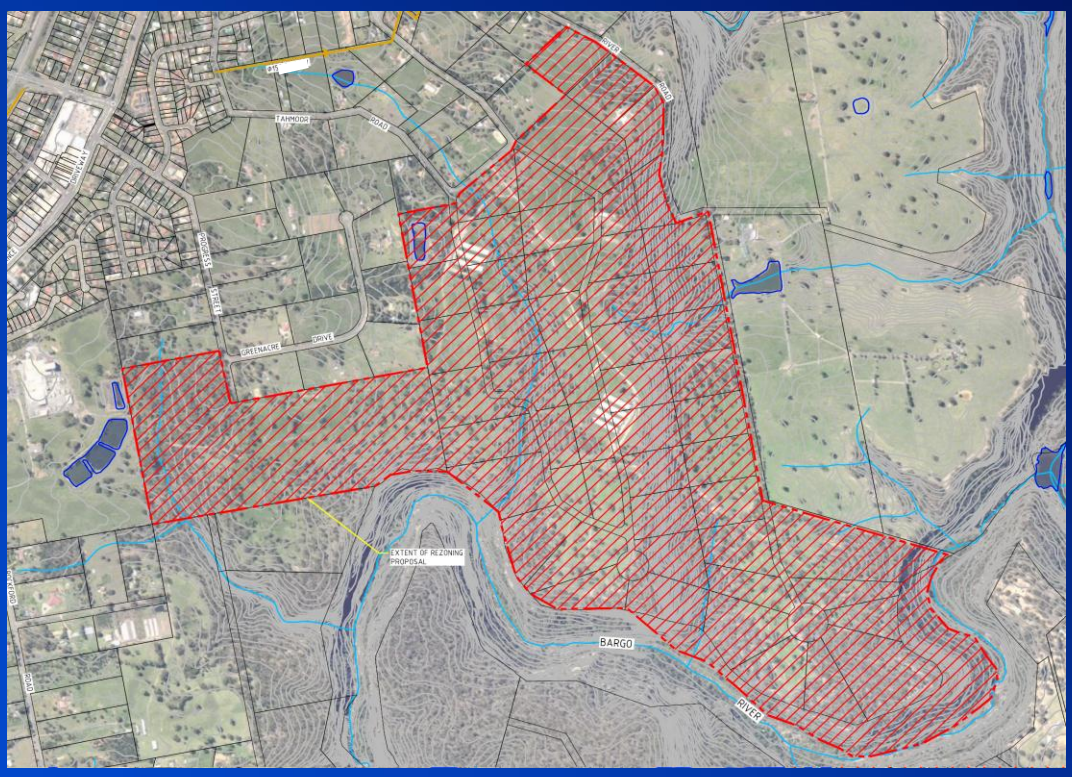
INGHAMS, TAHMOOR

Preliminary Stormwater Management Strategy



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URBIS

INGHAMS, TAHMOOR

Rezoning

Preliminary Stormwater Management Strategy

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EXECUTIVE SUMMARY

Hyder Consulting have been commissioned by Urbis on behalf of Ingham Property Development Pty Ltd to undertake a preliminary review of the stormwater requirements for a proposal to rezone a portion of land within Tahmoor. The site is currently zoned rural small holdings (RU4) and the proposal is to re-zone the land to large lot residential (R5) with lot sizes ranging from approximately 1,500 m^2 to 4,000 m^2.

The site, located to the south of the East Tahmoor lands, comprises of approximately 167 hectares that is currently zoned RU4 *Rural Small Holding* under the Wollondilly Local Environmental Plan 2011. This site currently comprises a series of large contiguous rural lots, and occupies an existing duck farm operation. The remainder of the land is used for general grazing. Further, it is noted that the *Picton Tahmoor Thirlmere New Urban Lands Planning Proposal* seeks to rezone a portion of land in East Tahmoor (to the north of the Ingham's site) from RU4 Rural Small Holdings to R2 Low Density Residential. The Inghams Planning Proposal complements the current proposed rezoning to the north of the site, albeit offering a unique and larger form of future residential subdivision on the periphery of the existing township of Tahmoor.

The site is located within the Wollondilly Local Government Area; therefore, the requirements identified by Council's Growth Management Strategy apply. The proposed residential development does not need to comply with the Drinking Water Catchments State Environmental Planning Policy since the site is located outside of Sydney's Drinking Water Catchment defined by the Sydney Catchment Authority (SCA).

The assessment for stormwater quantity was undertaken using the program DRAINS. This modelling assessed the hydrology of the existing site using the RAFTS module and the developed site using the ILSAX module. Development of the site will require a number of regional storage basins in order to attenuate the site's peak flows prior to their discharge into Bargo River, a major tributary of the Upper Nepean River.

A generic storage volume of 270 m^3 per hectare for a regional basin was adopted based on analysis of the representative subcatchment that is characterised by an average catchment slope and average-sized lots. This rate of detention storage requirement was used to determine the sizes of the other regional basins.

Individual lot detention was also analysed as an alternate solution to regional basins. The assessment resulted in a rate of 45 m^3 of detention volume required per 1000 m^2 of lot development.

The estimated detention volume, both as a regional or individual requirement, was based on a representative 'average' catchment and may therefore either be an overestimation or underestimation for the other catchments. This approach, however, should be acceptable for this preliminary assessment.

Flows from two external catchments upstream of the developed site will be managed by means of pits and culverts that will allow the conveyance of the external flows through the site.

The assessment for stormwater quality was carried out using the MUSIC software to investigate the potential impact of the development upon the quality of stormwater leaving the site. The conversion of the existing rural land into a residential development will result in the increase of pollutants generated and leaving the site. However, the results of the MUSIC modelling indicate that the proposed water quality treatment train is able to achieve the required post-development pollutant removal reduction objectives for Gross Pollutants, Total Suspended Solids (TSS), Total Phosphorus (TP) and Total Nitrogen (TN). The combination of gross pollutant traps (GPT) and bioretention system in a treatment train, when applied to all subcatchments, will allow the proposed development to meet the statutory pollutant reduction requirements.

1 INTRODUCTION

Hyder have been appointed by Urbis on behalf of Ingham Property Development Pty Ltd to undertake a preliminary review of the stormwater requirements for a proposal to rezone a portion of land in Tahmoor. The site is currently zoned rural small holdings (RU4) and the proposal is to re-zone the developable are of the site to large lot residential (R5) with lot sizes ranging from approximately 1,500 m^2 to 4,000 m^2.

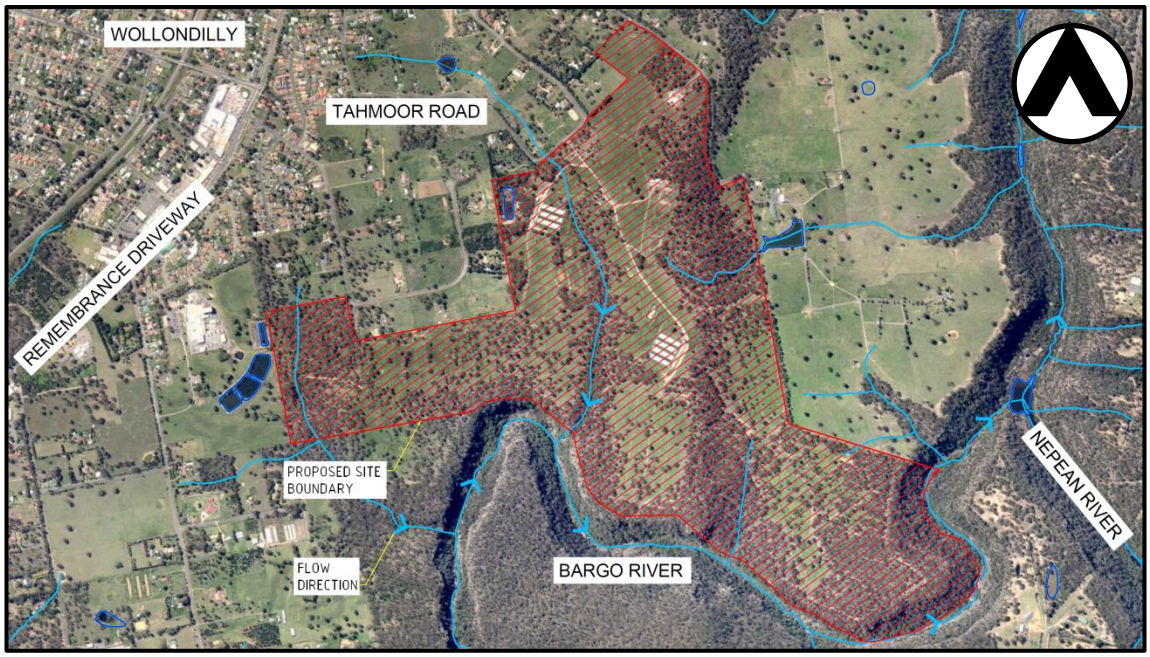


Figure 1 Site Location (Image source: NearMap)

1.1 SITE DESCRIPTION

The Inghams owned land comprises a number of lots with a total land area of approximately 166.45 ha. Inghams intends to retain the turkey processing facility located north west of the site.

Sitting at an average altitude of approximately 280 m AHD, the site is located south east of Tahmoor and about 95 km south west of Sydney. The site is situated south of Remembrance Driveway and north of Bargo River (see **Figure 1**).

The site generally grades between 3 and 6% towards the watercourses within the site. The terrain becomes steeper, between 10 and 20%, in areas adjacent to Bargo River.

The existing land use is farming. The site consists of grasslands, areas with sparsely spaced trees and densely vegetated riparian zones along Bargo River and its tributaries.

It is proposed that the future subdivision of the site will accommodate approximately 240 large residential lots within the indicative development footprint, as indicated in **Figure 2**.

Figure 2 Proposed Site Layout

2 PLANNING REQUIREMENTS

2.1 WOLLONDILLY COUNCIL

The site is located within the Wollondilly Local Government Area and the proposed rezoning was considered in accordance with the Wollondilly Local Environment Plan 2011 (WLEP) and the Wollondilly Development Control Plan (19 December 2011). The DCP sections that relate to stormwater and flooding are as follows:

- Section 2.6 – Water
- Section 2.7 - Flood Affected Land
- Section 2.11 - Development in Sydney's Drinking Water Catchments

In reference to the third section listed above, we note that the site is located just outside of Sydney's Drinking Water Catchment as defined by the Sydney Catchment Authority (SCA).The Upper Nepean River subcatchment, which forms part of Sydney's Drinking Water Catchment, begins south of Bargo River.

This assessment did not address any of the requirements of the Sydney Catchment Authority.

2.2 OFFICE OF ENVIRONMENT AND HERITAGE

The document '*Guidelines for developments adjoining land and water managed by DECCW"* sets the guidelines for part of this development, particularly with regards to runoff discharging into Bargo River. Section 2.2 – Stormwater Runoff of the DECCW guidelines requires the following:

- Investigation of existing stormwater flows from the adjoining property into DECCW land;
- Identification of existing impacts on DECCW land;
- No increase in existing peak flows (5 and 100 year ARI);
- No increase to annual average load of nutrients and sediments; and
- No increase in the natural annual average runoff volume.

In addition, DECCW expects the proposed development to provide positive benefits to their landholding when potentially impacted.

2.3 SYDNEY REGIONAL ENVIRONMENTAL PLAN (SREP) NUMBER 20

Part 2 Clause 6 Section 10 of this document relates to catchments discharging to the Nepean River. This document recommends the consideration of a total water cycle management plan to support a proposal for the rezoning of land.

3 WATER QUANTITY

3.1 ASSESSMENT METHODOLOGY

For this project DRAINS was used to develop a hydrological rainfall-runoff catchment model to determine discharges from the site. DRAINS software is a multi-purpose program for designing and analysing urban stormwater drainage systems and catchments. The RAFTS and ILSAX modules in DRAINS were used to assess the site under existing and post-developed conditions respectively.

The RAFTS module adopted the following hydrologic parameters:

- Storage Multiplier (Bx) = 1.6
- Pervious Area Initial Loss = 10 mm
- Pervious Area Continuing Loss = 2.5 mm / hr
- Impervious Area Initial Loss = 0.1 mm
- Impervious Area Continuing Loss = 0.1 mm / hr

The ILSAX module used the following hydrologic data and parameters:

- IFD Data from the Bureau of Meteorology (BOM)
- Paved (impervious) area depression storage of 1 mm
- Grassed (pervious) area depression storage of 5 mm
- Soil type of 3

The DRAINS model was run for storm durations ranging from 5 minutes to 4.5 hours for the 5, 20 and 100 year ARIs.

3.2 EXISTING CONDITIONS

The delineation of the existing catchment and the determination of impervious areas were based on the site's latest aerial photograph and Department of Lands (2005) 2 m contours. The percentage of impervious areas within the existing site was estimated to be about 3%.

3.2.1 EXISTING DRAINAGE CONFIGURATION

The site drains to two major rivers, the Bargo and Nepean Rivers, which are both part of the Hawkesbury-Nepean River system. Approximately 80% of the site drains into Bargo River and the remainder drains into Nepean River located east of the site. The Nepean River receives flows from Bargo River before flowing further downstream and discharging into Hawkesbury River.

3.2.2 DRAINS MODEL SET-UP

The site was split into a number of drainage catchments for Bargo and Nepean Rivers which are shown in **Figure 3**. A more detailed subcatchment plan used to develop the DRAINS model for the existing conditions is shown in the Existing Subcatchment Plan included in **Appendix A**.

The properties of the subcatchments used as model input data are summarised in **Table 1.** Both the Manning's "n" and the percentage imperviousness were based on the latest aerial photograph.

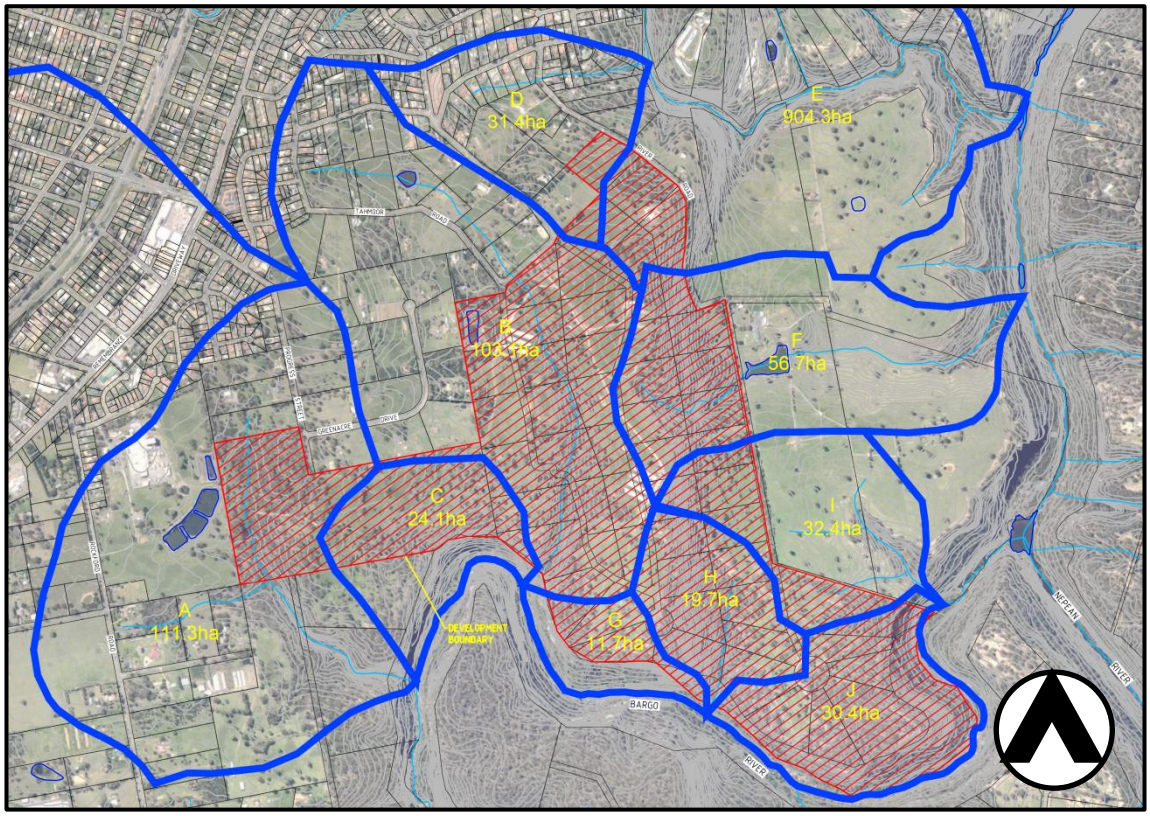


Figure 3 Existing Catchment Delineation Plan

Table 1 Existing subcatchment properties used as DRAINS model input data

Catchment	Subcatchment	Area (ha)	Percentage Imperviousness (%)	Average Slope (%)	Manning's n
A	A1	3.64	3	3	0.03
B	B1	40.27	20	4	0.04
	B2	15.49	8	6	0.04
	B3	25.09	5	5	0.035
	B4	5.07	1	6	0.03
	B5	17.09	4	11	0.03
C	C1	0.46	3	2	0.025
	C2	8.98	1	10	0.04
	C3	5.35	0	8	0.04
D	D1	5.21	7	6	0.025
E	E1	5.75	7	7	0.025
	E2	0.35	11	9	0.03
F	F1	7.47	3	19	0.08
	F2	12.2	5	14	0.08
G	G1	8.51	0	30	0.08
H	H1	19.52	0	10	0.08
I	I1	6.6	1	15	0.06
	I2	5.12	0	9	0.04
J	J1	4.63	0	20	0.04
	J2	5.06	0	11	0.06

3.2.3 RESULTS

A summary of the existing site's 100 year peak flow rates determined by rainfall-runoff modelling is given in **Table 2**. Output from the DRAINS modelling which includes the results of the 5 and 20 year analyses are included in **Appendix B**.

Table 2 Existing subcatchment 100 year ARI peak flow rates and critical storm durations

Catchment	Subcatchment	Peak Flow (m^3/s) 100 year ARI	Critical Storm Duration (min) 100 year ARI
A	A1	0.88	60
B	B1	10.35	120
	B2	4.00	120
	B3	5.30	120
	B4	1.47	120
	B5	5.65	120
C	C1	0.02	90
	C2	2.48	120
	C3	1.34	120
D	D1	1.92	120
E	E1	2.17	90
	E2	0.19	25
F	F1	1.90	120
	F2	2.62	120
G	G1	2.27	120
H	H1	2.88	120
I	I1	1.75	120
	I2	1.45	120
J	J1	1.70	120
	J2	1.14	90
	J3	1.28	90

3.3 POST-DEVELOPMENT CONDITIONS

The post-developed site was split into 11 catchments. In order to limit site discharges from the proposed development to be no greater than the existing values, an investigation to locate and size the regional detention basins was undertaken. The catchment break-up and the approximate locations of the required detention basins are shown in **Figure 4** and in more detail in **Appendix B**.

To size all eleven basins, a detailed basin analysis was completed for one proposed catchment. The analysis from this 'representative' catchment provided a rate of detention volume per hectare required to mitigate post-development flows. This rate was then applied to the remaining 10 catchments to size their respective detention basins.

The detailed analysis was undertaken for Catchment C (Basin 9) as it consisted of average-sized lots within the development. Using the DRAINS software package, Basin 9 was sized to mitigate peak flows from Catchment C for all storm durations for the 5, 20 and 100 year ARI events.

Catchment C has a total area of 7.35 ha and in the post-developed state is assumed to have 30% imperviousness.

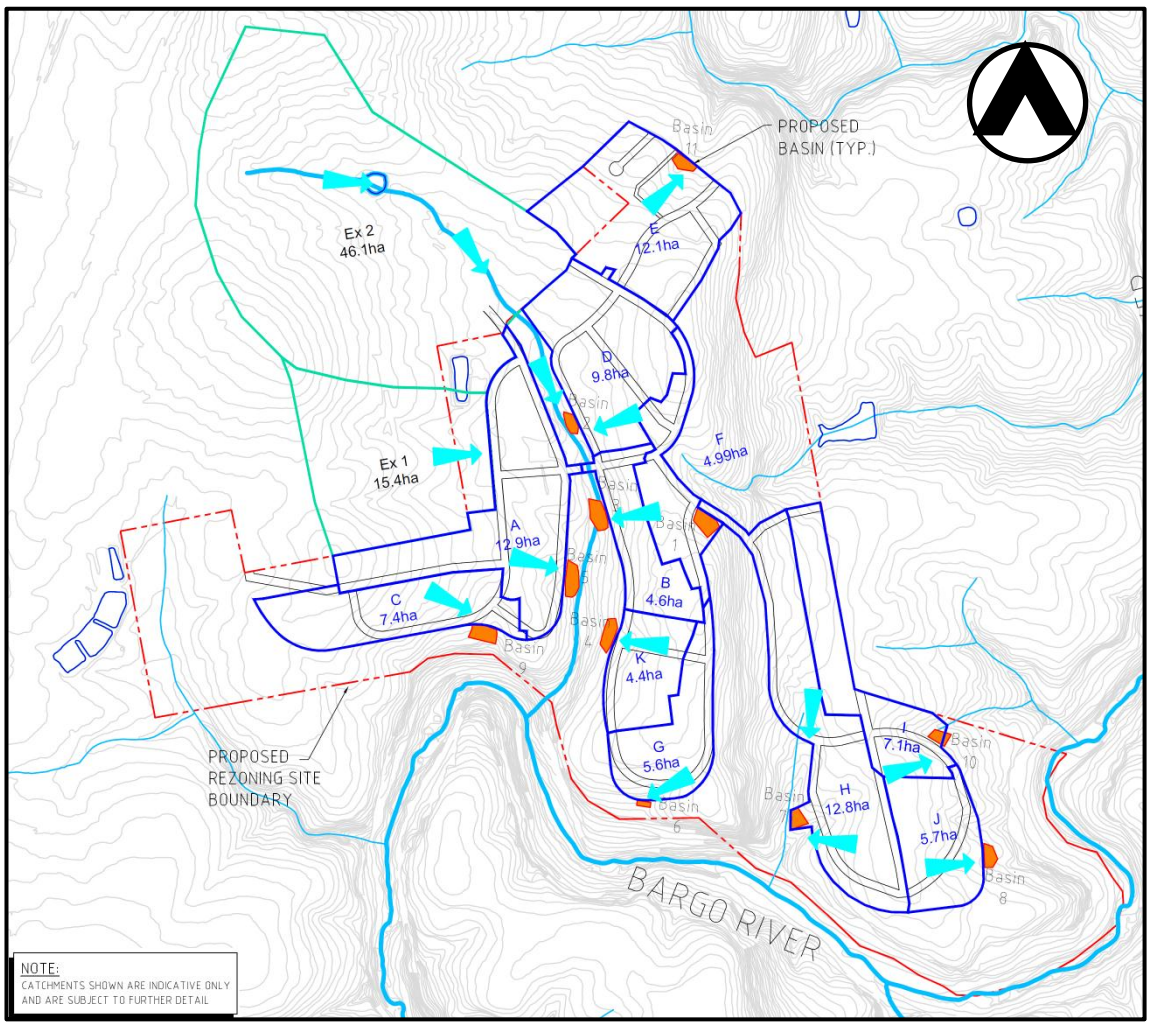


Figure 4 Post-Development Catchment Plan

3.3.1 RESULTS

Regional detention

Based on the results of the DRAINS analysis, a detention storage volume of 270 m³ per hectare is required for Catchment C to limit its post-developed discharges to be no greater than the existing flows.

Table 3 Comparison of existing and post-developed peak flow rates for Catchment C

Storm Event		Existing Peak Flows (m^3/s)	Post-Development Peak Flows (m^3/s)	
ARI (years)	Critical storm duration (min)		Unmitigated	Mitigated (with detention storage)
5	120	1.24	1.95	0.59
20	120	1.88	2.78	1.26
100	120	2.54	3.41	2.0

Based on the detention volume per hectare determined for Catchment C, the detention storage volumes for all other basins were calculated. The properties of the basins and the corresponding tributary catchments are summarised in **Table 4**.

Table 4 Volume and area of detention basins required for the post-developed subcatchments

Basin	Post-Developed Catchment	Catchment Area (ha)	Basin Volume Required (m³)	Basin Area (m²)
1	F	4.86	1,312	3,154
2	D	9.81	2,648	4,706
3	B	4.61	1,245	3,068
4	K	4.41	1,192	3,000
5	A	12.93	3,490	5,599
6	G	5.55	1,498	3,386
7	H	12.82	3,461	5,568
8	J	5.67	1,532	3,427
9	C	7.35	1,984	3,963
10	I	7.08	1,912	3,880
11	E	12.11	3,268	5,368

In estimating the required basin areas, we assumed the basins to have an average depth of 2 m and enclosed by a 3 m wide berm that has 1V: 6H internal and external batters. It should be noted that the basin sizes were calculated based on average-sized lots. Hence, the basin for some catchments may either be undersized or oversized.

Individual lot detention

Individual lot detention was investigated as an alternate solution to regional basins for limiting site discharge. As before, the assessment was based on Catchment C. Basin 9's detention volume of 1,984 m^3 was divided by the aggregated total area of the lots of 4.43 ha. This resulted in a detention storage requirement rate of approximately 45 m³ per 1,000 m².

We note the above storage requirement rate is the average detention volume required for the attenuation of peak flows from individual lots. Since the above detention volume requirement rate was based Catchment C's mid-range lot sizes which range from 2,000 m^2 to 3,000 m^2, it may not be representative of the lots that are outside this range. In other words, this storage rate may be an overestimation for the larger lots as they would have lower imperviousness than an average lot. For smaller lots, the detention rate may be an underestimation as they would have higher imperviousness.

Combined option

The final configuration of the development may incorporate a combination of regional and individual lot style of detention.

3.4 FLOODING

A number of watercourses receive runoff coming from the proposed development and discharge the flows into Bargo River.

3.4.1 EXISTING FLOOD INFORMATION

At the time of this writing, there is no available flood information from Council that could be used in this assessment.

3.4.2 DEVELOPMENT

The proposed subdivision will meet the requirements of Section 2.7 of Council's Development Control Plan (2011) and the NSW Floodplain Development Manual. In particular, Section 2.7.2 identifies Council as the authority for determining the level of flooding analysis required to set development boundaries.

Council requires the proposed development to be set above the flood planning level (FPL) which is 0.5 m above the 100 yr ARI flood level.

Prior to submission of a Development Application on the site if further flooding information is not available, a consultative meeting with Council will allow the determination of the type and magnitude of flooding investigation required for the development. Hyder suggests the following items be considered in this meeting:

- A flooding assessment completed as per the *NSW Floodplain Development Manual (2005);*
- Flood extents are reviewed by Council for approval; and
- The development adopts the 100 year flood extent and provides a minimum 0.5 m freeboard to habitable floor levels.

3.4.3 EXTERNAL FLOWS

As shown in the proposed catchment plan in **Figure 4** and in **Appendix A**, there are two external catchments Ex 1 and Ex 2 that are located upstream of the proposed development. Catchment Ex 1 has a natural drainage path that leads straight into the developed site. Pits and pipes will be required to convey the flows from Catchment Ex 1 and discharging them to the watercourse that runs through the middle of the site.

Catchment Ex 2, on the other hand, will follow its natural drainage path and bypass the development site. However, a culvert will be required under the road located between Catchment A and Catchment B to convey these bypassing external flows.

4 WATER QUALITY

The stormwater quality management strategy proposed for the development site which incorporates Water Sensitive Urban Design (WSUD) principles have been designed in order to meet the pollutant load reduction targets specified in Australian Runoff Quality (ARQ) (Engineers Australia, 2006). Adopted throughout NSW, ARQ is a design guideline that provides an overview of current best practice in the management of urban stormwater and is in line with Wollondilly Shire Council's Growth Management Strategy 2011.

ARQ's stormwater quality management objectives for New South Wales are shown in **Table 5.** These are the percentage reduction targets in pollutant loads relative to the developed catchment with no water quality controls, that is, Base Scenario.

Table 5 Reduction rate targets for water quality treatment (Source: ARQ, 2006)

Pollutant	Percentage Reduction (%)
Reduction in average annual Total Suspended Solids (TSS) export load	85
Reduction in average annual Total Phosphorous (TP) export load	45
Reduction in average annual Total Nitrogen (TN) export load	45

4.1 ASSESSMENT METHODOLOGY

A water quality treatment assessment was undertaken to determine the most appropriate treatment for the site so the required water quality targets can be met. A preliminary MUSIC water quality (Version 5) model was developed to investigate the potential impacts of the development on the quality of stormwater leaving the site. A range of treatment measures were included in the model, usually as part of a treatment train, to determine the most effective solution for the treatment of runoff from the site.

All eleven subcatchments (see **Figure 4**) will drain to bio retention basins provided as end-of-the-line treatment for stormwater leaving each site.

The following tasks were undertaken to develop the MUSIC model:

- Selection of appropriate meteorological data (i.e. rainfall and potential evapotranspiration);
- Defining the component catchment areas (source nodes); and
- Selection and input of soil / groundwater properties and pollutant generation characteristics of the source nodes.

A more detailed discussion of the above tasks is given below.

4.2 MUSIC MODEL PARAMETERS

4.2.1 METEOROLOGIC DATA

Rainfall data, obtained from BOM, was from the rainfall gauge at Parry Drive, Bowral NSW (Station 68102). Located approximately 35 km south west of the site, the Bowral station is the closest rainfall gauge with 6 min pluviograph data. The 18 year data used in this assessment is from December 1992 to February 2011.

A summary of the rainfall and potential evapotranspiration data used in the MUSIC model is given in **Table 6**.

Table 6 Meteorologic data used in MUSIC modelling

Rainfall Station	Bowral Rainfall Station, Station 68102
Time Step	6 min
Data Period	18 years (Dec 1992 – Feb 2011)
Mean annual rainfall (mm)	618
Mean annual potential evapotranspiration (mm)	1214

4.2.2 CATCHMENT AREAS

The proposed development site was subdivided into eleven subcatchments with each subcatchment divided up further into their source nodes. In MUSIC modelling, the source nodes represent the various land use areas comprising a catchment. Split catchment modelling approach was undertaken to model the developed catchment, with adopted impervious fraction of 100% for roof area (25% of total lot area has been adopted for roofs), 90% for roads, 15% for other lot areas (ground level), 20% for public open space areas and 5% for basin areas. The summary of total catchment areas and percentage imperviousness are summarised in **Table 7**.

Table 7 Catchment definition reporting table

Basin No.	Catchment ID	Area (ha)	Percentage Impervious (%)
1	F	4.86	51
2	D	10.27	45
3	B	4.92	45
4	K	4.71	44
5	A	13.49	56
6	G	5.89	53
7	H	13.14	43
8	J	6.02	36
9	C	7.75	44
10	I	7.42	35
11	E	12.11	37.8

The catchment land use breakdown for each catchment with impervious fraction is provided in **Appendix C.**

4.2.3 SOIL & GROUNDWATER PARAMETERS

The soil characteristics adopted as default parameters in the MUSIC model for the site are shown in **Table 8**. In the absence of site specific data, the said parameters were obtained from the Draft NSW MUSIC Modelling Guidelines (BMT-WBM, 2010).

Table 8 Rainfall Runoff Parameters

Characteristic	Value
Rainfall Threshold (mm/day)	1
Soil Storage Capacity (mm)	200
Initial Storage (% of Capacity)	30
Field Capacity (mm)	170
Infiltration Capacity Coefficient –a	200
Infiltration Capacity Coefficient –b	1
Initial Depth (mm)	10
Daily Recharge Rate (%)	25
Daily Baseflow Rate (%)	5
Daily Deep Seepage Rate (%)	0

4.2.4 STORMWATER POLLUTANT CHARACTERISTICS

The pollutant generation parameters for baseflow and stormflow conditions for the adopted land use types were selected using a combination of values in *Urban Stormwater Quality: Statistical Overview* (Duncan, 1999) and *Stormwater Flow and Quality, and the Effectiveness of Non-proprietary Stormwater Treatment Measures* (Fletcher et al., 2004). The adopted values are summarised in **Table 9**.

Table 9 Pollutant source node parameters

Residential urban (general) source node	**TSS log values**		**TP log values**		**TN log values**	
	Mean	Std. dev	Mean	Std. dev	Mean	Std. dev
Base Flow (log mg/L)	1.1	0.170	-0.820	0.190	0.320	0.120
Storm Flow (log mg/L)	2.2	0.320	-0.450	0.250	0.420	0.190
Roof source node	**TSS log values**		**TP log values**		**TN log values**	
	Mean	Std. dev	Mean	Std. dev	Mean	Std. dev
Base Flow (log mg/L)	1.1	0.170	-0.820	0.190	0.320	0.120
Storm Flow (log mg/L)	1.55	0.39	-0.92	0.290	0.420	0.190
Roads source node	**TSS log values**		**TP log values**		**TN log values**	
	Mean	Std. dev	Mean	Std. dev	Mean	Std. dev
Base Flow (log mg/L)	1.1	0.170	-0.820	0.190	0.320	0.120
Storm Flow (log mg/L)	2.380	0.40	-0.600	0.50	0.420	0.190
Agriculture (existing) source node	**TSS log values**		**TP log values**		**TN log values**	
	Mean	Std. dev	Mean	Std. dev	Mean	Std. dev
Base Flow (log mg/L)	1.4	0.13	-0.88	0.13	0.074	0.13
Storm Flow (log mg/L)	2.3	0.31	-0.27	0.3	0.59	0.26

4.3 PROPOSED TREATMENT MEASURES

The proposed stormwater quality management strategy, which incorporates Water Sensitive Urban Design (WSUD) principles, aims to minimise the impact of the development on the natural water cycle by reducing the export of pollutants, sediments and nutrients from the site into downstream watercourses. Stormwater from the development will flow through a stormwater quality treatment train prior to discharge from the site and the treatment train will ensure the development's compliance with the water quality objectives.

For each subcatchment, the proposed water quality treatment train will consist of the following:

- Gross Pollutant Trap (GPT) to treat road and lot drainage; and
- Biofiltration system to treat flows coming from the GPT.

A more detailed description of the above treatment devices is given below.

Gross Pollutant Traps

Gross Pollutant Traps (GPT) are devices used for the removal of solids conveyed by stormwater. The GPT proposed for the site is the Rocla CDS Unit (or approved equivalent), which can also remove smaller particles, as well as oil and grit. Hence, a GPT like the CDS not only protects lakes, rivers, streams and coastal areas from stormwater runoff pollutants but also from hazardous material spills.

The CDS unit includes a continuously deflective screen to divert solids in the stormwater and a sump designed to capture and store gross pollutants and coarse sediments. As a primary treatment measure, the CDS unit will be a vital component of the treatment train and is relied upon in the treatment of runoff before reaching the biofiltration system. **Table 10** shows the modelled pollutant removal rates for a CDS unit:

Table 10 GPT pollutant reductions

Pollutant	Pollutant Removal Reduction (%)
TSS	70
TP	30
TN	0
GP	95

Biofiltration Basin

A biofiltration system such as a raingarden is a vegetated area where runoff is filtered through a filter media layer (e.g. loamy sand) as it percolates downwards to a receiving underlying drainage. Specific vegetation is incorporated into the landscaping of bioretention areas to promote nutrient uptake and hence reduce nutrient loads in the discharging stormwater.

The biofiltration system is incorporated into the proposed development as a planted bioretention filter area possibly within a detention basin. The raingarden will treat frequent flows coming from the development after minor storm events. A bifurcation pit is included in the upstream stormwater drainage system to divert low flows into the biofiltration basin while allowing high flows to bypass the raingarden and discharge into the adjacent detention basin.

A typical section of a bioretention system is presented in **Figure 5** below.

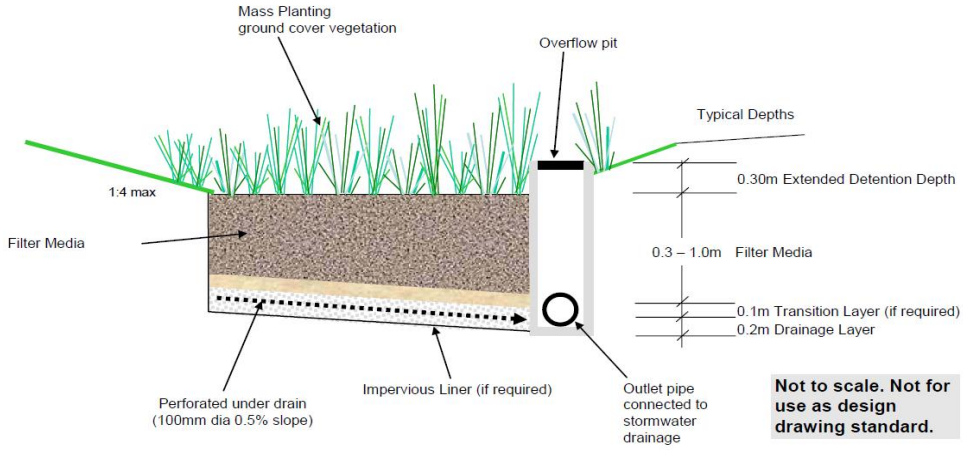


Figure 5 Typical Biofiltration basin cross-section

A total of eleven bioretention basins are proposed for the site to provide natural treatment processes including physical, chemical and biological treatment of site runoff. In general, the raingardens will be located within the footprint of detention basins. The location of these raingardens and the corresponding catchments they service are shown in **Figure 4**. All raingardens were modelled in MUSIC using the properties and parameters given in **Table 11** and **Table 12** respectively**.**

Table 11 Biofiltration Properties

Basin No.	Catchment Area (ha)	Filter Area (m^2)
1	4.86	220
2	10.27	465
3	4.92	220
4	4.71	210
5	13.49	750
6	5.89	310
7	13.14	565
8	6.02	220
9	7.75	350
10	7.42	260
11	12.11	460

Table 12 Biofiltration node parameters

Property	Value
Extended Detention Depth (m)	0.30
Saturated Hydraulic Conductivity (mm/hr)	125
Filter Depth (m)	0.5
TN Content of Filter Media (mg/kg)	800
Orthophosphate Content of Filter Media (mg/kg)	40

4.4 MUSIC MODEL RESULTS

Results of the MUSIC modelling for the existing and post-development scenarios are summarised in **Tables 13 to 16**.

Table 13 Existing pollutant loads aggregated for the 11 catchments

Statistic	TSS (mg/L)	TP (mg/L)	TN (mg/L)
10th	0	0	0
Mean	8.05	0.029	0.001
90th	24.7	0.13	0.000005
Mean Annual Loads **(kg/Yr)**	4280	12	84.7

Table 14 Post-development (before treatment) pollutant loads aggregated for the 11 catchments Base Scenario

Statistic	TSS (mg/L)	TP (mg/L)	TN (mg/L)
10th	0	0	0
Mean	12	0.0965	0.0073
90th	17	0.212	0.000272
Mean Annual Loads **(kg/Yr)**	50100	81.2	640

Table 15 Post development (after treatment) pollutant loads Treated Scenario aggregated for the 11 catchments

Statistic	TSS (mg/L)	TP (mg/L)	TN (mg/L)
10th	0	0	0
Mean	1.74	0.0416	0.003
90th	2.88	0.066	0.006
Mean Annual Loads **(kg/Yr)**	2470	21.5	259

Table 16 Treatment train effectiveness

Pollutant	Post-development source generation (kg/yr)	Residual load after treatment (kg/yr)	Pollutant removal reduction achieved (%)	Required Reduction (%)
Gross Pollutants	7660	0	100	90
TSS	50,300	2470	95	85
TP	82	21.5	74	45
TN	639	259	60	45

The results of the MUSIC modelling outlined in **Table 16** indicate that the proposed water quality treatment train is successful in achieving the required post-development pollutant removal for gross pollutants, TSS, TP and TN. The combination of GPT and bio-retention system in a treatment train, when applied to all subcatchments, will allow the proposed development to meet the pollutant reduction requirements specified in ARQ.

4.4.1 EROSION AND SEDIMENT CONTROL MEASURES

Measures to control erosion and sediment control are to be consistent with measures outlined in *"Blue Book Volume 1 (Landcom, 2004)'* and the *'Blue Book Volume 2 (DECC, 2008)'*

5 CONCLUSION

Based on the investigations completed in this report, the site will be able to satisfy the likely stormwater management requirements imposed on the development. A summary of the key findings include:

Water Quantity

- A volume of detention of approximately 270m³/ha (450m³/ha for individual lot detention).
- Existing analysis of flooding is not available, further flooding investigations are recommended to be completed prior to a submission for development approval.

Water Quality

- The proposed water quality treatment train sufficiently meets the requirements of Australian Runoff Quality (2006).

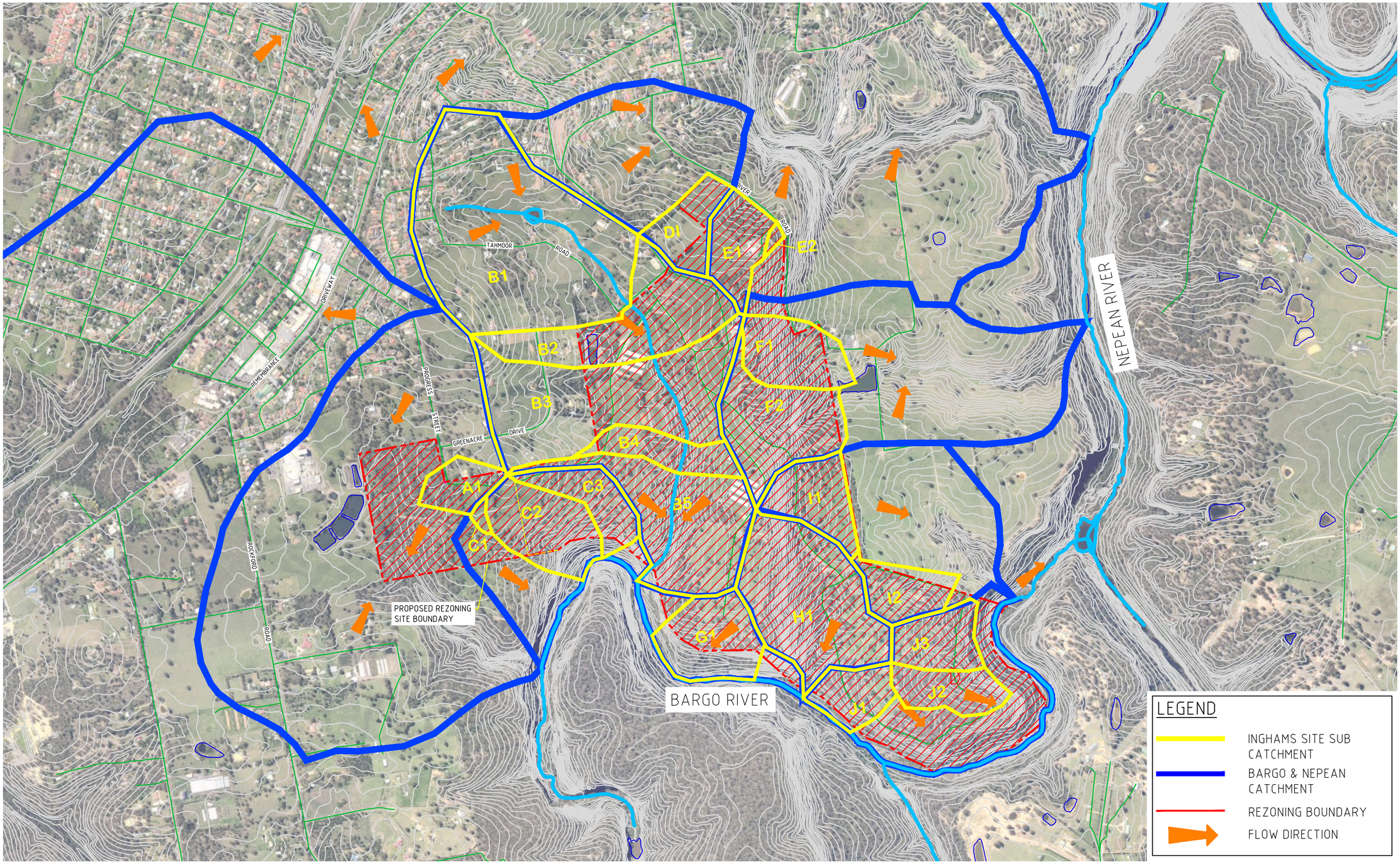
The proposed site is likely to be able to accommodate the residential development as described in this report.

APPENDIX A

DRAWINGS

SW001 – Existing Sub Catchment Plan

SW002 – Proposed Catchment Plan



Issue	Description	Date
P2	ISSUE FOR INFORMATION	29.05.2013
P1	ISSUE FOR INFORMATION	20.02.2013

100mm on Original.

0 150 300 450 600m

1 : 6000

Client: INGHAM PROPERTY DEVELOPMENT PTY. LTD.

Status: PRELIMINARY
NOT TO BE USED FOR CONSTRUCTION

		Current Issue Signatures	
Scales	1 : 6000	Drawn	B.CHISWELL
Original Size	A1	Designed	C.McCLELLAND
Height Datum	AHD	Checked	
Grid		Approved	

Filename:

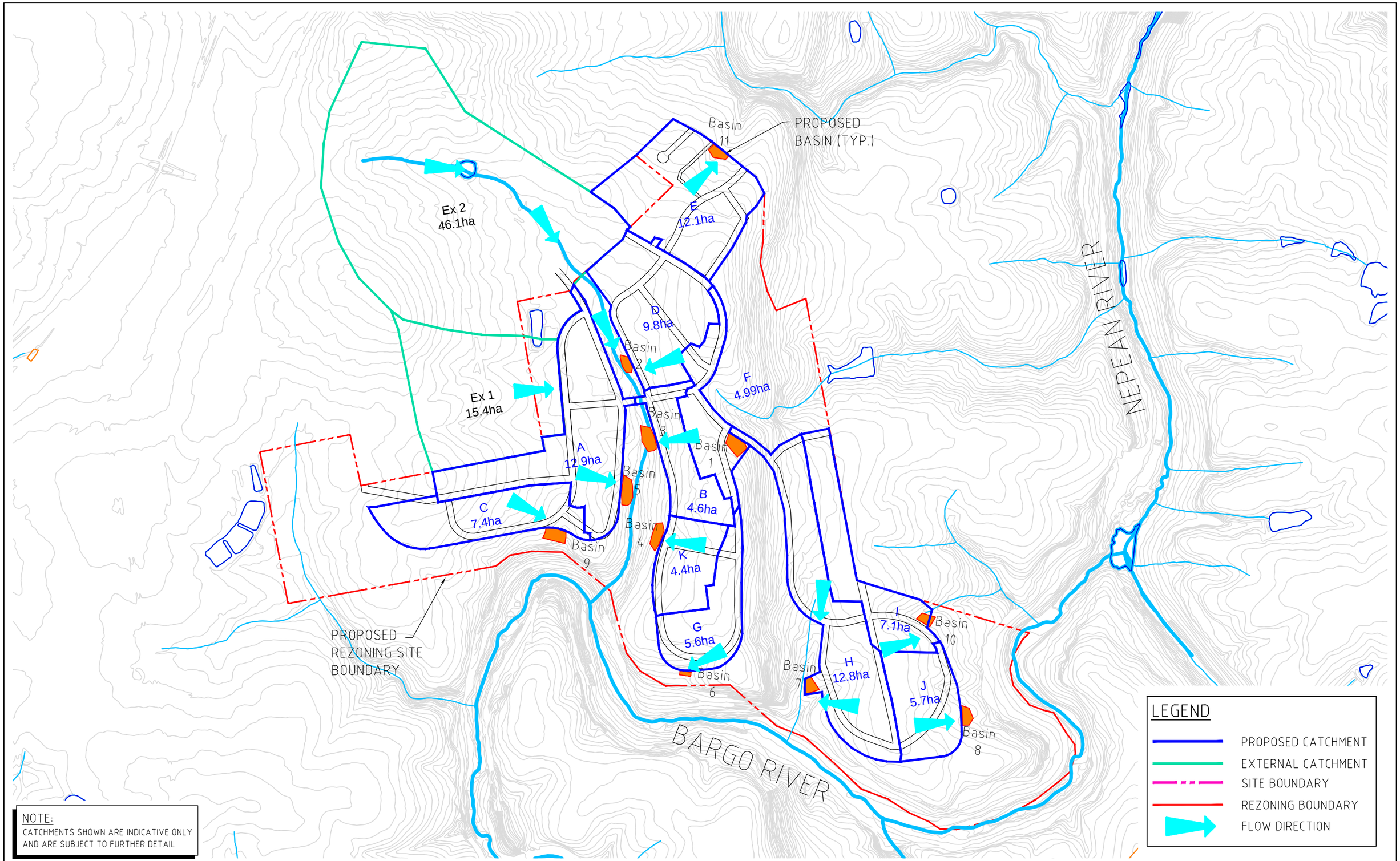
Project: INGHAMS, TAHMOOR

Title: EXISTING SUB CATCHMENT PLAN

HYDER CONSULTING PTY LTD
ABN 76 104 485 289
Level 5, 141 Walker St
North Sydney NSW 2060
Australia
Tel: +61 (0)2 8907 9000
Fax: +61 (0)2 8907 9001
www.hyderconsulting.com

Drawing No.	Project No.	Issue
SW001	AA005014	P2

Date Plotted: 29 May 2013 - 01:30PM File Name: \\HC-AUS-NS-FS-01\jobs\AA005014\E-CAD\C-Civil\B-Sketches\SW001-Existing_Sub_Catchment_Plan.dwg V1



Issue	Description	Date
P2	ISSUE FOR INFORMATION	29.05.2013
P1	ISSUE FOR INFORMATION	20.02.2013

100mm on Original

0 150 300 450 600m

1 : 6000

Client: INGHAM PROPERTY DEVELOPMENT PTY. LTD.

Status: **PRELIMINARY** NOT TO BE USED FOR CONSTRUCTION

Scales	1 : 6000	Current Issue Signatures	
		Drawn	B.CHISWELL
Original Size	A1	Designed	C.McCLELLAND
Height Datum	AHD	Checked	
Grid		Approved	

Filename:

Project: INGHAMS, TAHMOOR

Title: PROPOSED CATCHMENT PLAN

HYDER CONSULTING PTY LTD
ABN 76 104 485 289
Level 5, 141 Walker St
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www.hyderconsulting.com

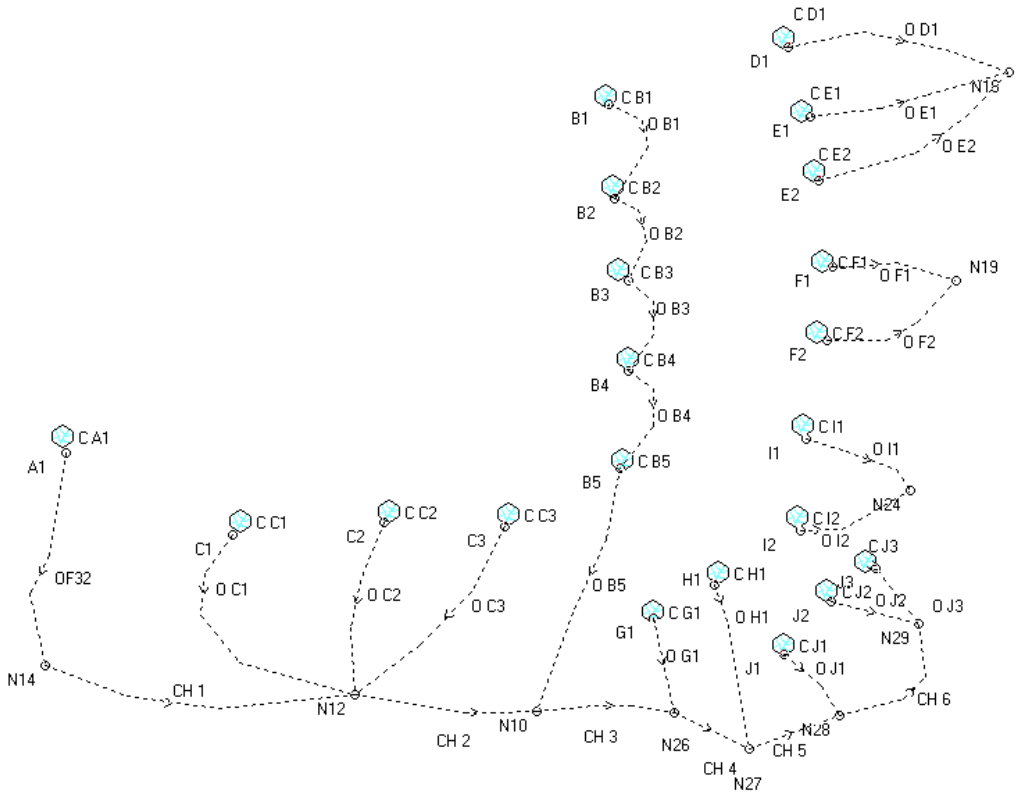
Drawing No.	Project No.	Issue
SW002	AA005014	P2

Date Plotted: 29 May 2013 - 02:03PM File Name: \\HC-AUS-NS-FS-01\jobs\AA005014\E-CAD\C-Civil\B-Sketches\SW002-Proposed_Catchment_Plan1.dwg V1

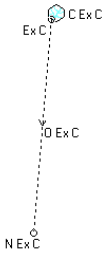
APPENDIX B

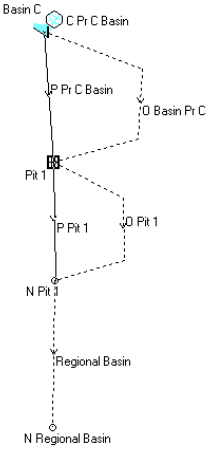
DRAINS OUTPUT

EXISTING SITE



PROPOSED REGIONAL BASIN (REPRESENTATION CATCHMENT C)





DRAINS Model Name and File Path:		F:\AA005014\D-Calculations\C-Civil\D-DRAINS\E-Results											**DATA**		
DRAINS Version:		Version 2012.06													
Modeller's Name:		Alavy Nishat Islam													
Description:		Data for existing catchments													
	PIT / NODE DETAILS			Version 10											
	Name	Type	Family	Size	Ponding Volume (cu.m)	Pressure Change Coeff. Ku	Surface Elev (m)	Max Pond Depth (m)	Base Inflow (cu.m/s)	Blocking Factor	x	y	Bolt-down lid	id
	B1	Node							0		355	-70		21
	B2	Node							0		358	-117		22
	B3	Node							0		365	-158		23
	B4	Node							0		365	-203		24
	B5	Node							0		361	-252		25
	A1	Node							0		84	-244		26
	C1	Node							0		167	-285		27
	C2	Node							0		243	-279		28
	C3	Node							0		303	-281		29
	N10	Node							0		319.213	-373.032		34
	N12	Node							0		227.778	-364.931		58
	N14	Node							0		73.333	-350		65
	D1	Node							0		445	-41		76
	E1	Node							0		456	-76		77
	E2	Node							0		460	-108		78
	N18	Node							0		555	-54		79
	N19	Node							0		528.704	-157.755		85
	F1	Node							0		466.782	-151.389		86
	F2	Node							0		463.889	-187.847		87
	I1	Node							0		453.472	-237.037		92
	I2	Node							0		451.157	-282.755		93
	N24	Node							0		505.556	-262.5		94
	N26	Node							0		388.079	-373.611		111
	N27	Node							0		425.116	-392.13		112
	N28	Node							0		470.255	-375.347		113
	N29	Node							0		510.378	-329.533		114
	G1	Node							0		377.083	-326.736		120
	H1	Node							0		407.755	-309.954		121
	J1	Node							0		443.056	-344.676		122
	J2	Node							0		466.204	-318.634		123
	J3	Node							0		488.194	-301.852		124
	DETENTION BASIN DETAILS													
	Name	Elev	Surf. Area	Init Vol. (cu.m)	Outlet Type	K	Dia(mm)	Centre RL	Pit Family	Pit Type	x	y	HED	Crest RL
	SUB-CATCHMENT DETAILS													
	Name	Pit or Node	Total Area	Impervious Area	Avg Slope(%)	Hydrological Model								
	C B1	B1	40.27	20	4	Tahmoor - RAFTS								
	C B2	B2	15.49	8	6	Tahmoor - RAFTS								
	C B3	B3	25.09	5	5	Tahmoor - RAFTS								
	C B4	B4	5.07	5	5	Tahmoor - RAFTS								
	C B5	B5	17.09	4	11	Tahmoor - RAFTS								
	C A1	A1	3.64	3	3	Tahmoor - RAFTS								

	C C1	C1	0.46	3	2	Tahmoor - RAFTS								
	C C2	C2	8.98	1	10	Tahmoor - RAFTS								
	C C3	C3	5.35	0	8	Tahmoor - RAFTS								
	C D1	D1	5.21	7	6	Tahmoor - RAFTS								
	C E1	E1	5.75	7	7	Tahmoor - RAFTS								
	C E2	E2	0.35	11	9	Tahmoor - RAFTS								
	C F1	F1	7.47	3	19	Tahmoor - RAFTS								
	C F2	F2	12.2	5	14	Tahmoor - RAFTS								
	C I1	I1	6.6	1	15	Tahmoor - RAFTS								
	C I2	I2	5.12	0	9	Tahmoor - RAFTS								
	C G1	G1	8.51	0	30	Tahmoor - RAFTS								
	C H1	H1	19.52	0	10	Tahmoor - RAFTS								
	C J1	J1	4.63	0	20	Tahmoor - RAFTS								
	C J2	J2	5.06	0	11	Tahmoor - RAFTS								
	C J3	J3	5.58	0	20	Tahmoor - RAFTS								
	PIPE DETAILS													
	Name	From	To	Length	U/S IL	D/S IL	Slope	Type	Dia	I.D.	Rough	Pipe Is	No. Pipes	Chg From
				(m)	(m)	(m)	(%)		(mm)	(mm)				
	DETAILS of SERVICES CROSSING PIPES													
	Pipe	Chg	Bottom	Height of Service	Chg	Bottom	Height of Service	Chg	Bottom	leight of Servic	etc			
		(m)	Elev (m)	(m)	(m)	Elev (m)	(m)	(m)	Elev (m)	(m)	etc			
	CHANNEL DETAILS													
	Name	From	To	Type	Length	U/S IL	D/S IL	Slope	Base Width	L.B. Slope	R.B. Slope	Manning	Depth	Roofed
					(m)	(m)	(m)	(%)	(m)	(1:?)	(1:?)	n	(m)	
	OVERFLOW ROUTE DETAILS													
	Name	From	To	Travel	Spill	Crest	Weir	Cross	Safe Depth	SafeDepth	Safe	Bed	D/S Area	
				Time	Level	Length	Coeff. C	Section	Major Storms	Minor Storms	DxV	Slope	Contributing	
				(min)	(m)	(m)			(m)	(m)	(sq.m/sec)	(%)	%	
	O B1	B1	B2	0.1			Dummy used to model flow acros		0.2	0.05	0.6	1	0	
	O B2	B2	B3	0.1			Dummy used to model flow acros		0.2	0.05	0.6	1	0	
	O B3	B3	B4	0.1			Dummy used to model flow acros		0.2	0.05	0.6	1	0	
	O B4	B4	B5	0.1			Dummy used to model flow acros		0.2	0.05	0.6	1	0	
	O B5	B5	N10	0.1			Dummy used to model flow acros		0.2	0.05	0.6	1	0	
	OF32	A1	N14	0.1			Dummy used to model flow acros		0.2	0.05	0.6	1	0	
	O C1	C1	N12	0.1			Dummy used to model flow acros		0.2	0.05	0.6	1	0	
	O C2	C2	N12	0.1			Dummy used to model flow acros		0.2	0.05	0.6	1	0	
	O C3	C3	N12	0.1			Dummy used to model flow acros		0.2	0.05	0.6	1	0	
	CH 3	N10	N26	0.1			Dummy used to model flow acros		0.2	0.05	0.6	1	0	
	CH 2	N12	N10	0.1			Dummy used to model flow acros		**0.2**	**0.05**	**0.6**	**1**	0	
	CH 1	N14	N12	0.1			Dummy used to model flow acros		**0.2**	**0.05**	**0.6**	**1**	0	
	O D1	D1	N18	0.1			Dummy used to model flow acros		0.2	0.05	0.6	1	0	
	O E1	E1	N18	0.1			Dummy used to model flow acros		0.2	0.05	0.6	1	0	
	O E2	E2	N18	0.1			Dummy used to model flow acros		0.2	0.05	0.6	1	0	
	O F1	F1	N19	0.1			Dummy used to model flow acros		0.2	0.05	0.6	1	0	
	O F2	F2	N19	0.1			Dummy used to model flow acros		0.2	0.05	0.6	1	0	
	O I1	I1	N24	0.1			Dummy used to model flow acros		0.2	0.05	0.6	1	0	
	O I2	I2	N24	0.1			Dummy used to model flow acros		0.2	0.05	0.6	1	0	
	CH 4	N26	N27	0.1			Dummy used to model flow acros		0.2	0.05	0.6	1	0	
	CH 5	N27	N28	0.1			Dummy used to model flow acros		0.2	0.05	0.6	1	0	
	CH 6	N28	N29	0.1			Dummy used to model flow acros		0.2	0.05	0.6	1	0	
	O G1	G1	N26	0.1			Dummy used to model flow acros		0.2	0.05	0.6	1	0	
	O H1	H1	N27	0.1			Dummy used to model flow acros		0.2	0.05	0.6	1	0	

	O J1	J1	N28	0.1			Dummy used to model flow acros	0.2	0.05	0.6	1	0	
	O J2	J2	N29	0.1			Dummy used to model flow acros	0.2	0.05	0.6	1	0	
	O J3	J3	N29	0.1			Dummy used to model flow acros	0.2	0.05	0.6	1	0	

DRAINS Model Name and File Path:	F:\AA005014\D-Calculations\C-Civil\D-DRAINS\E-Results	RESULTS 5 YEAR ARI
DRAINS Version:	Version 2012.06	
Modeller's Name:	Alavy Nishat Islam	
Description:	5 year flows for existing catchments	

DRAINS results prepared 13 February, 2013 from Version 2012.06							
PIT / NODE DETAILS				Version 8			
Name	Max HGL	Max Pond	Max Surface	Max Pond	Min	Overflow	Constraint
		HGL	Flow Arriving	Volume	Freeboard	(cu.m/s)	
			(cu.m/s)	(cu.m)	(m)		
SUB-CATCHMENT DETAILS							
Name	Max	Due to Storm					
	Flow						
	(cu.m/s)						
C B1	4.698	AR&R 5 year, 4.5 hours storm, average 16.6 mm/h, Zone 1					
C B2	1.802	AR&R 5 year, 4.5 hours storm, average 16.6 mm/h, Zone 1					
C B3	2.606	AR&R 5 year, 4.5 hours storm, average 16.6 mm/h, Zone 1					
C B4	0.687	AR&R 5 year, 2 hours storm, average 26.7 mm/h, Zone 1					
C B5	2.703	AR&R 5 year, 2 hours storm, average 26.7 mm/h, Zone 1					
C A1	0.401	AR&R 5 year, 1.5 hours storm, average 31.6 mm/h, Zone 1					
C C1	0	AR&R 5 year, 5 minutes storm, average 129 mm/h, Zone 1					
C C2	1.14	AR&R 5 year, 2 hours storm, average 26.7 mm/h, Zone 1					
C C3	0.657	AR&R 5 year, 2 hours storm, average 26.7 mm/h, Zone 1					
C D1	0.99	AR&R 5 year, 2 hours storm, average 26.7 mm/h, Zone 1					
C E1	1.141	AR&R 5 year, 2 hours storm, average 26.7 mm/h, Zone 1					
C E2	0.099	AR&R 5 year, 25 minutes storm, average 64.3 mm/h, Zone 1					
C F1	0.847	AR&R 5 year, 2 hours storm, average 26.7 mm/h, Zone 1					
C F2	1.183	AR&R 5 year, 2 hours storm, average 26.7 mm/h, Zone 1					
C I1	0.8	AR&R 5 year, 2 hours storm, average 26.7 mm/h, Zone 1					
C I2	0.675	AR&R 5 year, 2 hours storm, average 26.7 mm/h, Zone 1					
C G1	1.027	AR&R 5 year, 2 hours storm, average 26.7 mm/h, Zone 1					
C H1	1.29	AR&R 5 year, 2 hours storm, average 26.7 mm/h, Zone 1					
C J1	0.875	AR&R 5 year, 2 hours storm, average 26.7 mm/h, Zone 1					
C J2	0.516	AR&R 5 year, 1.5 hours storm, average 31.6 mm/h, Zone 1					
C J3	0.61	AR&R 5 year, 2 hours storm, average 26.7 mm/h, Zone 1					
Outflow Volumes for Total Catchment (13.4 impervious + 194 pervious = 207 total ha)							
Storm	Total Rainfall	Total Runoff	Impervious Runoff	Pervious Runoff			
	cu.m	cu.m (Runoff %)	cu.m (Runoff %)	cu.m (Runoff %)			
AR&R 5 year, 5 minutes storm, average 129 mm/h, Zone 1	22299.8	1272.25 (5.7%)	-68.32 (-4.7%)	1340.58 (6.4%)			
AR&R 5 year, 10 minutes storm, average 98.9 mm/h, Zone 1	34193.03	11822.66 (34.6%)	-519.94 (-23.6%)	12342.60 (38.6%)			
AR&R 5 year, 15 minutes storm, average 82.6 mm/h, Zone 1	42836.36	19885.15 (46.4%)	-447.03 (-16.2%)	20332.18 (50.7%)			
AR&R 5 year, 20 minutes storm, average 72 mm/h, Zone 1	49785.6	26186.82 (52.6%)	-536.13 (-16.7%)	26722.95 (57.4%)			
AR&R 5 year, 25 minutes storm, average 64.3 mm/h, Zone 1	55576.64	31484.46 (56.7%)	-525.84 (-14.7%)	32010.30 (61.6%)			
AR&R 5 year, 30 minutes storm, average 58.4 mm/h, Zone 1	60572.48	35912.68 (59.3%)	-608.63 (-15.6%)	36521.30 (64.5%)			
AR&R 5 year, 45 minutes storm, average 46.9 mm/h, Zone 1	72967.02	47885.41 (65.6%)	121.02 (2.6%)	47764.40 (70.0%)			
AR&R 5 year, 1 hour storm, average 39.9 mm/h, Zone 1	82768.55	57771.69 (69.8%)	1249.61 (23.4%)	56522.08 (73.0%)			
AR&R 5 year, 1.5 hours storm, average 31.6 mm/h, Zone 1	98326.57	72755.73 (74.0%)	2648.87 (41.7%)	70106.87 (76.2%)			
AR&R 5 year, 2 hours storm, average 26.7 mm/h, Zone 1	110772.95	83639.37 (75.5%)	2611.85 (36.5%)	81027.52 (78.2%)			
AR&R 5 year, 3 hours storm, average 21 mm/h, Zone 1	130687.21	95814.48 (73.3%)	-1985.64 (-23.5%)	97800.12 (80.0%)			
AR&R 5 year, 4.5 hours storm, average 16.6 mm/h, Zone 1	154957.69	108093.04 (69.8%)	-9984.78 (-99.8%)	118077.82 (81.5%)			
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)			
CHANNEL DETAILS							
Name	Max Q	Max V	Chainage	Max	Due to Storm		
	(cu.m/s)	(m/s)	(m)	HGL (m)			
OVERFLOW ROUTE DETAILS							
Name	Max Q U/S	Max Q D/S	Safe Q	Max D	Max DxV	Max Width	Max V
O B1	4.698	4.698	0.256	0.164	0.23	36.78	1.43
O B2	6.499	6.499	0.256	0.187	0.29	41.45	1.55
O B3	9.103	9.103	0.256	0.214	0.36	46.84	1.69
O B4	9.661	9.661	0.256	0.22	0.38	47.91	1.71
O B5	11.831	11.831	0.256	0.23	0.44	49.99	1.92
OF32	0.401	0.401	0.256	0.06	0.04	15.94	0.75
O C1	0	0	0.256	0	0	0	0
O C2	1.14	1.14	0.256	0.092	0.09	22.41	0.99

O C3	0.657	0.657	0.256	0.073	0.06	18.64	0.85
CH 3	13.925	13.925	0.256	0.23	0.52	49.99	2.27
CH 2	2.096	2.096	0.256	0.118	0.14	27.62	1.16
CH 1	0.401	0.401	0.256	0.06	0.04	15.94	0.75
O D1	0.99	0.99	0.256	0.087	0.08	21.33	0.95
O E1	1.141	1.141	0.256	0.092	0.09	22.41	0.99
O E2	0.099	0.099	0.256	0.035	0.02	10.91	0.5
O F1	0.847	0.847	0.256	0.081	0.07	20.25	0.91
O F2	1.183	1.183	0.256	0.093	0.09	22.59	1.01
O I1	0.8	0.8	0.256	0.079	0.07	19.9	0.9
O I2	0.675	0.675	0.256	0.074	0.06	18.82	0.86
CH 4	14.951	14.951	0.256	0.23	0.56	49.99	2.43
CH 5	15.834	15.834	0.256	0.23	0.59	49.99	2.58
CH 6	16.554	16.554	0.256	0.23	0.62	49.99	2.69
O G1	1.027	1.027	0.256	0.088	0.08	21.69	0.95
O H1	1.29	1.29	0.256	0.097	0.1	23.31	1.03
O J1	0.875	0.875	0.256	0.082	0.08	20.43	0.93
O J2	0.516	0.516	0.256	0.066	0.05	17.2	0.81
O J3	0.61	0.61	0.256	0.071	0.06	18.28	0.83
DETENTION BASIN DETAILS							
Name	Max WL	MaxVol	Max Q	Max Q	Max Q		
			Total	Low Level	High Level		
CONTINUITY CHECK for AR&R 5 year, 4.5 hours storm, average 16.6 mm/h, Zone 1							
Node	Inflow	Outflow	Storage Change	Difference			
	(cu.m)	(cu.m)	(cu.m)	%			
B1	24496.05	24496.05	0	0			
B2	33865.46	33865.21	0	0			
B3	48882.49	48882.58	0	0			
B4	51540.91	51541.86	0	0			
B5	61920.52	61920.27	0	0			
A1	0	0	0	0			
C1	0	0	0	0			
C2	4700.26	4700.26	0	0			
C3	2796.55	2796.55	0	0			
N10	69415.45	69415.53	0	0			

N12	7496.78	7496.72	0	0			
N14	0	0	0	0			
D1	2748.93	2748.93	0	0			
E1	3035.83	3035.83	0	0			
E2	0	0	0	0			
N18	5784.6	5784.6	0	0			
N19	10241.33	10241.33	0	0			
F1	3908.02	3908.02	0	0			
F2	6333.67	6333.67	0	0			
I1	3454.18	3454.18	0	0			
I2	2677.11	2677.11	0	0			
N24	6131.21	6131.21	0	0			
N26	73861.7	73861.8	0	0			
N27	83517.25	83517.23	0	0			

N28	85942.17	85942.3	0	0			
N29	85939.73	85939.73	0	0			
G1	4447.82	4447.82	0	0			
H1	9658	9658	0	0			
J1	2427.47	2427.47	0	0			
J2	0	0	0	0			
J3	0	0	0	0			
Run Log for AA005014 run at 15:53:00 on 13/2/2013							
The maximum flow exceeded the safe value in the following overflow routes: O J3, O J2, O J1, O H1, O G1, CH 6, CH 5, CH 4, CH 3, O I2, O I1, O F2, O F1, O E1, O D1, CH 1, OF32, CH 2, O C2, O C3, O B5, O B4, O B3, O B2, O B1							

DRAINS Model Name and File Path:	F:\AA005014\D-Calculations\C-Civil\D-DRAINS\E-Results				RESULTS 20 YEAR ARI		
DRAINS Version:	Version 2012.06						
Modeller's Name:	Alavy Nishat Islam						
Description:	20 year flows for existing catchments						
DRAINS results prepared 13 February, 2013 from Version 2012.06							
PIT / NODE DETAILS				Version 8			
Name	Max HGL	Max Pond	Max Surface	Max Pond	Min	Overflow	Constraint
		HGL	Flow Arriving	Volume	Freeboard	(cu.m/s)	
			(cu.m/s)	(cu.m)	(m)		
SUB-CATCHMENT DETAILS							
Name	Max	Due to Storm					
	Flow						
	(cu.m/s)						
C B1	7.316	AR&R 20 year, 2 hours storm, average 35.3 mm/h, Zone 1					
C B2	2.839	AR&R 20 year, 2 hours storm, average 35.3 mm/h, Zone 1					
C B3	3.715	AR&R 20 year, 4.5 hours storm, average 21.8 mm/h, Zone 1					
C B4	1.036	AR&R 20 year, 2 hours storm, average 35.3 mm/h, Zone 1					
C B5	4.095	AR&R 20 year, 2 hours storm, average 35.3 mm/h, Zone 1					
C A1	0.651	AR&R 20 year, 2 hours storm, average 35.3 mm/h, Zone 1					
C C1	0	AR&R 20 year, 5 minutes storm, average 170 mm/h, Zone 1					
C C2	1.782	AR&R 20 year, 2 hours storm, average 35.3 mm/h, Zone 1					
C C3	1.009	AR&R 20 year, 2 hours storm, average 35.3 mm/h, Zone 1					
C D1	1.459	AR&R 20 year, 2 hours storm, average 35.3 mm/h, Zone 1					
C E1	1.654	AR&R 20 year, 2 hours storm, average 35.3 mm/h, Zone 1					
C E2	0.15	AR&R 20 year, 25 minutes storm, average 85.1 mm/h, Zone 1					
C F1	1.3	AR&R 20 year, 2 hours storm, average 35.3 mm/h, Zone 1					
C F2	1.813	AR&R 20 year, 2 hours storm, average 35.3 mm/h, Zone 1					
C I1	1.229	AR&R 20 year, 2 hours storm, average 35.3 mm/h, Zone 1					
C I2	1.025	AR&R 20 year, 2 hours storm, average 35.3 mm/h, Zone 1					
C G1	1.615	AR&R 20 year, 2 hours storm, average 35.3 mm/h, Zone 1					
C H1	1.909	AR&R 20 year, 2 hours storm, average 35.3 mm/h, Zone 1					
C J1	1.293	AR&R 20 year, 2 hours storm, average 35.3 mm/h, Zone 1					
C J2	0.82	AR&R 20 year, 2 hours storm, average 35.3 mm/h, Zone 1					
C J3	0.934	AR&R 20 year, 2 hours storm, average 35.3 mm/h, Zone 1					
Outflow Volumes for Total Catchment (13.4 impervious + 194 pervious = 207 total ha)							
Storm	Total Rainfall	Total Runoff	Impervious Runoff	Pervious Runoff			
	cu.m	cu.m (Runoff %)	cu.m (Runoff %)	cu.m (Runoff %)			
AR&R 20 year, 5 minutes storm, average 170 mm/h, Zone 1	29387.33	7513.29 (25.6%)	-387.78 (-20.4%)	7901.08 (28.7%)			
AR&R 20 year, 10 minutes storm, average 131 mm/h, Zone 1	45291.07	22423.76 (49.5%)	-224.58 (-7.7%)	22648.34 (53.5%)			
AR&R 20 year, 15 minutes storm, average 109 mm/h, Zone 1	56527.4	33117.51 (58.6%)	36.12 (1.0%)	33081.39 (62.6%)			
AR&R 20 year, 20 minutes storm, average 95.2 mm/h, Zone 1	65827.62	41918.40 (63.7%)	242.20 (5.7%)	41676.20 (67.7%)			
AR&R 20 year, 25 minutes storm, average 85.1 mm/h, Zone 1	73554.76	49139.43 (66.8%)	377.66 (8.0%)	48761.77 (70.9%)			
AR&R 20 year, 30 minutes storm, average 77.5 mm/h, Zone 1	80382.99	55387.50 (68.9%)	400.94 (7.7%)	54986.56 (73.1%)			
AR&R 20 year, 45 minutes storm, average 62.2 mm/h, Zone 1	96770.76	71548.36 (73.9%)	1566.92 (25.1%)	69981.44 (77.3%)			
AR&R 20 year, 1 hour storm, average 52.9 mm/h, Zone 1	109735.76	84184.91 (76.7%)	2499.09 (35.3%)	81685.82 (79.6%)			
AR&R 20 year, 1.5 hours storm, average 41.8 mm/h, Zone 1	130064.89	103968.49 (79.9%)	4231.35 (50.4%)	99737.13 (82.0%)			
AR&R 20 year, 2 hours storm, average 35.3 mm/h, Zone 1	146452.64	118747.87 (81.1%)	4452.43 (47.1%)	114295.45 (83.4%)			
AR&R 20 year, 3 hours storm, average 27.7 mm/h, Zone 1	172382.64	142333.17 (82.6%)	5652.51 (50.8%)	136680.66 (84.8%)			
AR&R 20 year, 4.5 hours storm, average 21.8 mm/h, Zone 1	203498.66	158099.26 (77.7%)	-5260.52 (-40.0%)	163359.78 (85.8%)			
PIPE DETAILS							
Name	Max Q	Max V	Max U/S	Max D/S	Due to Storm		
	(cu.m/s)	(m/s)	HGL (m)	HGL (m)			
CHANNEL DETAILS							
Name	Max Q	Max V	Chainage	Max	Due to Storm		
	(cu.m/s)	(m/s)	(m)	HGL (m)			
OVERFLOW ROUTE DETAILS							
Name	Max Q U/S	Max Q D/S	Safe Q	Max D	Max DxV	Max Width	Max V
O B1	7.316	7.316	0.256	0.196	0.31	43.24	1.6
O B2	10.154	10.154	0.256	0.224	0.39	48.81	1.73
O B3	13.717	13.717	0.256	0.23	0.51	49.99	2.23
O B4	14.744	14.744	0.256	0.23	0.55	49.99	2.4
O B5	18.581	18.581	0.256	0.23	0.7	49.99	3.02
OF32	0.651	0.651	0.256	0.073	0.06	18.64	0.85
O C1	0	0	0.256	0	0	0	0
O C2	1.782	1.782	0.256	0.111	0.12	26.18	1.1

O C3	1.009	1.009	0.256	0.088	0.08	21.51	0.95
CH 3	22.02	22.02	0.256	0.23	0.82	49.99	3.58
CH 2	3.441	3.441	0.256	0.145	0.19	33.01	1.31
CH 1	0.651	0.651	0.256	0.073	0.06	18.64	0.85
O D1	1.459	1.459	0.256	0.102	0.11	24.39	1.05
O E1	1.654	1.654	0.256	0.107	0.12	25.46	1.09
O E2	0.15	0.15	0.256	0.041	0.02	12.17	0.55
O F1	1.3	1.3	0.256	0.097	0.1	23.49	1.02
O F2	1.813	1.813	0.256	0.111	0.12	26.18	1.12
O I1	1.229	1.229	0.256	0.095	0.1	22.95	1.01
O I2	1.025	1.025	0.256	0.088	0.08	21.51	0.97
CH 4	23.632	23.632	0.256	0.23	0.88	49.99	3.84
CH 5	25.024	25.024	0.256	0.23	0.94	49.99	4.07
CH 6	26.072	26.072	0.256	0.23	0.98	49.99	4.24
O G1	1.615	1.615	0.256	0.106	0.11	25.28	1.08
O H1	1.909	1.909	0.256	0.114	0.13	26.72	1.13
O J1	1.293	1.293	0.256	0.097	0.1	23.31	1.03
O J2	0.82	0.82	0.256	0.08	0.07	20.08	0.9
O J3	0.934	0.934	0.256	0.085	0.08	20.97	0.93
DETENTION BASIN DETAILS							
Name	Max WL	MaxVol	Max Q	Max Q	Max Q		
			Total	Low Level	High Level		
CONTINUITY CHECK for AR&R 20 year, 4.5 hours storm, average 21.8 mm/h, Zone 1							
Node	Inflow	Outflow	Storage Change	Difference			
	(cu.m)	(cu.m)	(cu.m)	%			
B1	33861.46	33861.46	0	0			
B2	46834.75	46834.71	0	0			
B3	67645.94	67646.13	0	0			
B4	71197.7	71198.16	0	0			
B5	85552.13	85552.54	0	0			
A1	0	0	0	0			
C1	0	0	0	0			
C2	7516.63	7516.63	0	0			
C3	3737.23	3737.23	0	0			
N10	96804.52	96804.46	0	0			
N12	11253.71	11253.75	0	0			
N14	0	0	0	0			
D1	4392.08	4392.08	0	0			
E1	4847.69	4847.69	0	0			
E2	0	0	0	0			
N18	9240.1	9240.1	0	0			
N19	13663.61	13663.61	0	0			
F1	5215.02	5215.02	0	0			
F2	8449.06	8449.06	0	0			
I1	4610.69	4610.69	0	0			
I2	3578.9	3578.9	0	0			
N24	8189.45	8189.45	0	0			
N26	102737.62	102737.48	0	0			
N27	115679.31	115680.07	0	0			
N28	119568.32	119567.38	0	0			
N29	126980.11	126980.11	0	0			
G1	5935.23	5935.23	0	0			

H1	12945.09	12945.09	0	0			
J1	3891.2	3891.2	0	0			
J2	3525.97	3525.97	0	0			
J3	3889.97	3889.97	0	0			
Run Log for AA005014 run at 15:54:13 on 13/2/2013							
The maximum flow exceeded the safe value in the following overflow routes: O J3, O J2, O J1, O H1, O G1, CH 6, CH 5, CH 4, CH 3, O I2, O I1, O F2, O F1, O E1, O D1, CH 1, OF32, CH 2, O C2, O C3, O B5, O B4, O B3, O B2, O B1							

DRAINS Model Name and File Path:	F:\AA005014\D-Calculations\C-Civil\D-DRAINS\E-Results	RESULTS 100 YEAR ARI
DRAINS Version:	Version 2012.06	
Modeller's Name:	Alavy Nishat Islam	
Description:	100 year flows for existing catchments	

DRAINS results prepared 19 February, 2013 from Version 2012.06

PIT / NODE DETAILS				Version 8			
Name	Max HGL	Max Pond HGL	Max Surface Flow Arriving (cu.m/s)	Max Pond Volume (cu.m)	Min Freeboard (m)	Overflow (cu.m/s)	Constraint
SUB-CATCHMENT DETAILS							
Name	Max Flow (cu.m/s)	Due to Storm					
C B1	10.35	AR&R 100 year, 2 hours storm, average 46.7 mm/h, Zone 1					
C B2	4.004	AR&R 100 year, 2 hours storm, average 46.7 mm/h, Zone 1					
C B3	5.305	AR&R 100 year, 2 hours storm, average 46.7 mm/h, Zone 1					
C B4	1.463	AR&R 100 year, 2 hours storm, average 46.7 mm/h, Zone 1					
C B5	5.649	AR&R 100 year, 2 hours storm, average 46.7 mm/h, Zone 1					
C A1	0.879	AR&R 100 year, 1 hour storm, average 70.1 mm/h, Zone 1					
C C1	0.022	AR&R 100 year, 5 minutes storm, average 225 mm/h, Zone 1					
C C2	2.479	AR&R 100 year, 2 hours storm, average 46.7 mm/h, Zone 1					
C C3	1.344	AR&R 100 year, 1.5 hours storm, average 55.4 mm/h, Zone 1					
C D1	1.917	AR&R 100 year, 2 hours storm, average 46.7 mm/h, Zone 1					
C E1	2.167	AR&R 100 year, 1.5 hours storm, average 55.4 mm/h, Zone 1					
C E2	0.185	AR&R 100 year, 25 minutes storm, average 113 mm/h, Zone 1					
C F1	1.892	AR&R 100 year, 2 hours storm, average 46.7 mm/h, Zone 1					
C F2	2.617	AR&R 100 year, 2 hours storm, average 46.7 mm/h, Zone 1					
C I1	1.754	AR&R 100 year, 2 hours storm, average 46.7 mm/h, Zone 1					
C I2	1.447	AR&R 100 year, 2 hours storm, average 46.7 mm/h, Zone 1					
C G1	2.263	AR&R 100 year, 2 hours storm, average 46.7 mm/h, Zone 1					
C H1	2.876	AR&R 100 year, 2 hours storm, average 46.7 mm/h, Zone 1					
C J1	1.697	AR&R 100 year, 2 hours storm, average 46.7 mm/h, Zone 1					
C J2	1.135	AR&R 100 year, 1.5 hours storm, average 55.4 mm/h, Zone 1					
C J3	1.28	AR&R 100 year, 1.5 hours storm, average 55.4 mm/h, Zone 1					

Outflow Volumes for Total Catchment (13.4 impervious + 194 pervious = 207 total ha)

Storm	Total Rainfall cu.m	Total Runoff cu.m (Runoff %)	Impervious Runoff cu.m (Runoff %)	Pervious Runoff cu.m (Runoff %)
AR&R 100 year, 5 minutes storm, average 225 mm/h, Zone 1	38895	16503.32 (42.4%)	-217.97 (-8.7%)	16721.29 (46.0%)
AR&R 100 year, 10 minutes storm, average 173 mm/h, Zone 1	59811.87	36505.32 (61.0%)	331.04 (8.6%)	36174.28 (64.7%)
AR&R 100 year, 15 minutes storm, average 145 mm/h, Zone 1	75197	51343.15 (68.3%)	874.45 (18.0%)	50468.70 (71.8%)
AR&R 100 year, 20 minutes storm, average 126 mm/h, Zone 1	87124.8	62753.15 (72.0%)	1211.73 (21.5%)	61541.42 (75.5%)
AR&R 100 year, 25 minutes storm, average 113 mm/h, Zone 1	97669.66	72670.64 (74.4%)	1424.35 (22.6%)	71246.29 (78.0%)
AR&R 100 year, 30 minutes storm, average 103 mm/h, Zone 1	106831.6	81194.95 (76.0%)	1533.73 (22.2%)	79661.22 (79.7%)
AR&R 100 year, 45 minutes storm, average 82.5 mm/h, Zone 1	128353.52	102576.27 (79.9%)	3119.55 (37.6%)	99456.73 (82.8%)
AR&R 100 year, 1 hour storm, average 70.1 mm/h, Zone 1	145415.44	119226.76 (82.0%)	4229.36 (45.0%)	114997.40 (84.5%)
AR&R 100 year, 1.5 hours storm, average 55.4 mm/h, Zone 1	172382.64	145669.86 (84.5%)	6404.41 (57.5%)	139265.45 (86.4%)
AR&R 100 year, 2 hours storm, average 46.7 mm/h, Zone 1	193748.97	165079.33 (85.2%)	6670.56 (53.3%)	158408.77 (87.4%)
AR&R 100 year, 3 hours storm, average 36.5 mm/h, Zone 1	227146.8	197744.93 (87.1%)	9930.55 (67.7%)	187814.38 (88.4%)
AR&R 100 year, 4.5 hours storm, average 28.6 mm/h, Zone 1	266975.28	229046.98 (85.8%)	6515.28 (37.8%)	222531.70 (89.1%)

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)			
CHANNEL DETAILS							
Name	Max Q	Max V	Chainage	Max	Due to Storm		
	(cu.m/s)	(m/s)	(m)	HGL (m)			
OVERFLOW ROUTE DETAILS							
Name	Max Q U/S	Max Q D/S	Safe Q	Max D	Max DxV	Max Width	Max V
O B1	10.35	10.35	7.665	0.226	0.39	49.17	1.74
O B2	14.353	14.353	7.665	0.23	0.54	49.99	2.33
O B3	19.623	19.623	7.665	0.23	0.73	49.99	3.19
O B4	21.036	21.036	7.665	0.23	0.79	49.99	3.42
O B5	26.094	26.094	7.665	0.23	0.98	49.99	4.24
OF32	0.879	0.879	7.665	0.082	0.08	20.43	0.93
O C1	0.022	0.022	7.665	0.02	0.01	6.74	0.32
O C2	2.479	2.479	7.665	0.126	0.15	29.24	1.22
O C3	1.344	1.344	7.665	0.098	0.1	23.67	1.03
CH 3	30.76	30.76	7.665	0.23	1.15	49.99	5
CH 2	4.668	4.668	7.665	0.164	0.23	36.78	1.42
CH 1	0.879	0.879	7.665	0.082	0.08	20.43	0.93
O D1	1.917	1.917	7.665	0.114	0.13	26.72	1.14
O E1	2.167	2.167	7.665	0.12	0.14	27.98	1.17
O E2	0.185	0.185	7.665	0.044	0.03	12.71	0.61
O F1	1.892	1.892	7.665	0.114	0.13	26.72	1.12
O F2	2.617	2.617	7.665	0.13	0.16	29.95	1.22
O I1	1.754	1.754	7.665	0.11	0.12	26	1.1
O I2	1.447	1.447	7.665	0.101	0.11	24.21	1.06
CH 4	33.022	33.022	7.665	0.23	1.24	49.99	5.37
CH 5	35.186	35.186	7.665	0.23	1.32	49.99	5.72
CH 6	36.563	36.563	7.665	0.23	1.37	49.99	5.95
O G1	2.263	2.263	7.665	0.122	0.14	28.34	1.19
O H1	2.876	2.876	7.665	0.134	0.17	30.85	1.26
O J1	1.697	1.697	7.665	0.108	0.12	25.64	1.1
O J2	1.135	1.135	7.665	0.092	0.09	22.41	0.98
O J3	1.28	1.28	7.665	0.097	0.1	23.31	1.02
DETENTION BASIN DETAILS							
Name	Max WL	MaxVol	Max Q	Max Q	Max Q		
			Total	Low Level	High Level		
CONTINUITY CHECK for AR&R 100 year, 2 hours storm, average 46.7 mm/h, Zone 1							
Node	Inflow	Outflow	Storage Change	Difference			
	(cu.m)	(cu.m)	(cu.m)	%			
B1	32587.02	32587.02	0	0			
B2	45088.34	45088.29	0	0			
B3	65123.13	65123.13	0	0			
B4	69222.2	69222.34	0	0			
B5	83104.92	83104.76	0	0			
A1	2773.79	2773.79	0	0			
C1	0	0	0	0			
C2	7246.12	7246.12	0	0			
C3	4073.05	4073.05	0	0			
N10	97194.2	97194.3	0	0			
N12	14092.49	14092.5	0	0			
N14	2773.71	2773.71	0	0			
D1	4244.64	4244.64	0	0			
E1	4687.14	4687.14	0	0			
E2	276.63	276.63	0	0			
N18	9208.53	9208.53	0	0			
N19	15739.07	15739.07	0	0			
F1	6005.65	6005.65	0	0			
F2	9734.1	9734.1	0	0			
I1	5316.19	5316.19	0	0			

I2	4135.13	4135.13	0	0			
N24	9451.1	9451.1	0	0			
N26	104045.74	104045.7	0	0			
N27	118826.22	118826.48	0	0			
N28	122579.46	122579.46	0	0			
N29	130640.53	130640.53	0	0			
G1	6854.97	6854.97	0	0			
H1	14785.88	14785.88	0	0			
J1	3758.28	3758.28	0	0			
J2	3834.94	3834.94	0	0			
J3	4231.86	4231.86	0	0			
Run Log for AA005014 run at 17:43:38 on 19/2/2013							
The maximum flow exceeded the safe value in the following overflow routes: CH 6, CH 5, CH 4, CH 3, O B5, O B4, O B3, O B2, O B1							

DRAINS Model Name and File Path:		F:\AA005014\D-Calculations\C-Civil\D-DRAINS\E-Results											**DATA**		
DRAINS Version:	Version 2012.06														
Modeller's Name:	Alavy Nishat Islam														
Description:	Proposed regional basin data														
	PIT / NODE DETAILS			Version 10											
	Name	Type	Family	Size	Ponding	Pressure	Surface	Max Pond	Base	Blocking	x	y	Bolt-down		
					Volume	Change	Elev (m)	Depth (m)	Inflow	Factor			lid		
					(cu.m)	Coeff. Ku			(cu.m/s)						
	Ex C	Node							0		231.314	-429.44			
	Pr C	Node							0		319.727	-431.449			
	N Ex C	Node							0		227.296	-476.46			
	N Pr C	Node							0		319.325	-475.656			
	Pit 1	OnGrade	Standard Pits	1.8m lintel		1.5	248		0	0	401.275	-460.719	No		
	N Pit 1	Node					247.95		0		401.554	-486.953			
	N Regional Basin	Node							0		400.996	-519.327			
	DETENTION BASIN DETAILS														
	Name	Elev	Surf. Area	Init Vol. (cu.m)	Outlet Type	K	Dia(mm)	Centre RL	Pit Family	Pit Type	x	y	HED		
	Basin C	246.6	1	0	Orifice		225	248.85			399.042	-431.974	No		
		248.6	2												
		248.61	1300												
		250.1	2000												
	SUB-CATCHMENT DETAILS														
	Name	Pit or	Total	Paved	Grass	Supp	Paved	Grass	Supp	Paved	Grass	Supp	Paved		
		Node	Area	Area	Area	Area	Time	Time	Time	Length	Length	Length	Slope(%)		
			(ha)	%	%	%	(min)	(min)	(min)	(m)	(m)	(m)	%		
	C Pr C	Pr C	7.348	30	70	0	5.5	7.5	0						
	C Pr C Basin	Basin C	7.348	30	70	0	5.5	7.5	0						
	Name	Pit or	Total	Impervious	Avg	Hydrological									
		Node	Area	Area	Slope(%)	Model									
	C Ex C	Ex C	7.348	2	8	Tahmoor - RAFTS									
	PIPE DETAILS														
	Name	From	To	Length	U/S IL	D/S IL	Slope	Type	Dia	I.D.	Rough	Pipe Is	No. Pipes		
				(m)	(m)	(m)	(%)		(mm)	(mm)					
	P Pr C Basin	Basin C	Pit 1	10	246.6	246.5	1	RCP Class 2	750	750	0.3	NewFixed	1		
	P Pit 1	Pit 1	N Pit 1	5	246.5	246.45	1	RCP Class 2	750	750	0.3	New	1		
	OVERFLOW ROUTE DETAILS														
	Name	From	To	Travel	Spill	Crest	Weir	Cross	Safe Depth	SafeDepth	Safe	Bed	D/S Area		
				Time	Level	Length	Coeff. C	Section	Major Storms	Minor Storms	DxV	Slope	Contributing		
				(min)	(m)	(m)			(m)	(m)	(sq.m/sec)	(%)	%		
	O Ex C	Ex C	N Ex C	0.1			Dummy used to model flow acros		0.2	0.05	0.6	1	0		
	O Pr C	Pr C	N Pr C	0.1			Dummy used to model flow acros		0.2	0.05	0.6	1	0		
	O Basin Pr C	Basin C	Pit 1	0.1	249.2	2.2	1.6	model flow acros	0.2	0.05	0.6	1	0		
	O Pit 1	Pit 1	N Pit 1	0.1			Dummy used to model flow acros		0.2	0.05	0.6	1	0		
	Regional Basin	N Pit 1	N Regional Basin	0.1			Dummy used to model flow acros		0.2	0.05	0.6	1	0		

DRAINS Model Name and File Path:	F:\AA005014\D-Calculations\C-Civil\D-DRAINS\E-Results				RESULTS 5 YEAR ARI		
DRAINS Version:	Version 2012.06						
Modeller's Name:	Alavy Nishat Islam						
Description:	Proposed regional basin 5 year						
results prepared 13 February, 2013 from Version 2012.06							
PIT / NODE DETAILS				Version 8			
Name	Max HGL	Max Pond	Max Surface	Max Pond	Min	Overflow	Constraint
		HGL	Flow Arriving	Volume	Freeboard	(cu.m/s)	
			(cu.m/s)	(cu.m)	(m)		
Pit 1	246.93		0.502		1.07	0.372	Inlet Capacity
N Pit 1	246.65		0.372				
SUB-CATCHMENT DETAILS							
Name	Max	Paved	Grassed	Paved	Grassed	Supp.	Due to Storm
	Flow Q	Max Q	Max Q	Tc	Tc	Tc	
	(cu.m/s)	(cu.m/s)	(cu.m/s)	(min)	(min)	(min)	
C Pr C	1.954	0.748	1.211	5.5	7.5	0	AR&R 5 year, 25 minutes storm, average 64.3 mm/h, Zone 1
C Pr C Basin	1.954	0.748	1.211	5.5	7.5	0	AR&R 5 year, 25 minutes storm, average 64.3 mm/h, Zone 1
Name	Max	Due to Storm					
	Flow						
	(cu.m/s)						
C Ex C	1.238	AR&R 5 year, 2 hours storm, average 26.7 mm/h, Zone 1					
Outflow Volumes for Total Catchment (4.56 impervious + 17.5 pervious = 22.0 total ha)							
Storm	Total Rainfall	Total Runoff	Impervious Runoff	Pervious Runoff			
	cu.m	cu.m (Runoff %)	cu.m (Runoff %)	cu.m (Runoff %)			
AR&R 5 year, 5 minutes storm, average 129 mm/h	2369.73	695.53 (29.4%)	465.15 (95.0%)	230.37 (12.3%)			
AR&R 5 year, 10 minutes storm, average 98.9 mm	3633.59	1718.48 (47.3%)	698.39 (93.0%)	1020.09 (35.4%)			
AR&R 5 year, 15 minutes storm, average 82.6 mm	4552.09	2461.98 (54.1%)	882.58 (93.8%)	1579.40 (43.7%)			
AR&R 5 year, 20 minutes storm, average 72 mm/h	5290.56	3060.23 (57.8%)	1031.40 (94.3%)	2028.83 (48.3%)			
AR&R 5 year, 25 minutes storm, average 64.3 mm	5905.96	3501.70 (59.3%)	1156.05 (94.7%)	2345.64 (50.1%)			
AR&R 5 year, 30 minutes storm, average 58.4 mm	6436.85	3874.57 (60.2%)	1262.46 (94.9%)	2612.12 (51.2%)			
AR&R 5 year, 45 minutes storm, average 46.9 mm	7753.98	4873.29 (62.8%)	1536.40 (95.9%)	3336.90 (54.2%)			
AR&R 5 year, 1 hour storm, average 39.9 mm/h, Z	8795.55	5633.87 (64.1%)	1754.79 (96.5%)	3879.08 (55.6%)			
AR&R 5 year, 1.5 hours storm, average 31.6 mm/h	10448.86	6819.64 (65.3%)	2106.35 (97.5%)	4713.29 (56.9%)			
AR&R 5 year, 2 hours storm, average 26.7 mm/h,	11771.49	7785.38 (66.1%)	2387.85 (98.2%)	5397.53 (57.8%)			
AR&R 5 year, 3 hours storm, average 21 mm/h, Zo	13887.72	9320.17 (67.1%)	2848.20 (99.2%)	6471.97 (58.7%)			
AR&R 5 year, 4.5 hours storm, average 16.6 mm/h	16466.87	11029.10 (67.0%)	3396.31 (99.8%)	7632.80 (58.4%)			
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 Pr C Basin	0.085	0.45	246.929	246.929	AR&R 5 year, 4.5 hours storm, average 16.6 mm/h, Zone 1		
P Pit 1	0.215	2.34	246.696	246.646	AR&R 5 year, 4.5 hours storm, average 16.6 mm/h, Zone 1		
CHANNEL DETAILS							
Name	Max Q	Max V	Chainage	Max	Due to Storm		
	(cu.m/s)	(m/s)	(m)	HGL (m)			
OVERFLOW ROUTE DETAILS							
Name	Max Q U/S	Max Q D/S	Safe Q	Max D	Max DxV	Max Width	Max V
O Ex C	1.238	1.238	0.256	0.095	0.1	22.95	1.02
O Pr C	1.954	1.954	0.256	0.115	0.13	26.9	1.14
O Basin Pr C	0.502	0.502	0.256	0.066	0.05	17.2	0.78
O Pit 1	0.372	0.372	0.256	0.058	0.04	15.58	0.73
Regional Basin	0.586	0.586	0.256	0.07	0.06	17.92	0.83
DETENTION BASIN DETAILS							
Name	Max WL	MaxVol	Max Q	Max Q	Max Q		
			Total	Low Level	High Level		
Basin C	249.47	1297.2	0.586	0.085	0.502		
HECK for AR&R 5 year, 2 hours storm, average 26.7 mm/h, Zone 1							
Node	Inflow	Outflow	Storage Change	Difference			

	(cu.m)	(cu.m)	(cu.m)	%			
Ex C	3084.36	3084.36	0	0			
Pr C	2350.39	2350.39	0	0			
N Ex C	3084.27	3084.27	0	0			
N Pr C	2350.39	2350.39	0	0			
Basin C	2350.39	1665.15	685.28	0			
Pit 1	1665.15	1664.99	0	0			
N Pit 1	1664.98	1664.91	0	0			
N Regional Basin	1664.59	1664.59	0	0			
Run Log for 130212_Regional Basin.drn run at 15:32:33 on 13/2/2013							
No water upwelling from any pit. Freeboard was adequate at all pits.							
To see more detailed results select the Edit/Copy Results to Spreadsheet menu item, and paste them into a spreadsheet.							
The maximum flow exceeded the safe value in the following overflow routes: Regional Basin, O Pit 1, O Basin Pr C, O Pr C, O Ex C							

DRAINS Model Name and File Path:		F:\AA005014\D-Calculations\C-Civil\D-DRAINS\E-Results			RESULTS 20 YEAR ARI		
DRAINS Version:	Version 2012.06						
Modeller's Name:	Alavy Nishat Islam						
Description:	Proposed regional basin 20 year						
DRAINS results prepared 13 February, 2013 from Version 2012.06							
PIT / NODE DETAILS				Version 8			
Name	Max HGL	Max Pond	Max Surface	Max Pond	Min	Overflow	Constraint
		HGL	Flow Arriving	Volume	Freeboard	(cu.m/s)	
			(cu.m/s)	(cu.m)	(m)		
Pit 1	246.95		1.161		1.05	1.026	Inlet Capacity
N Pit 1	246.66		1.026				
SUB-CATCHMENT DETAILS							
Name	Max	Paved	Grassed	Paved	Grassed	Supp.	Due to Storm
	Flow Q	Max Q	Max Q	Tc	Tc	Tc	
	(cu.m/s)	(cu.m/s)	(cu.m/s)	(min)	(min)	(min)	
C Pr C	2.779	0.99	1.789	5.5	7.5	0	AR&R 20 year, 25 minutes storm, average 85.1 mm/h, Zone 1
C Pr C Basin	2.779	0.99	1.789	5.5	7.5	0	AR&R 20 year, 25 minutes storm, average 85.1 mm/h, Zone 1
Name	Max	Due to Storm					
	Flow						
	(cu.m/s)						
C Ex C	1.878	AR&R 20 year, 2 hours storm, average 35.3 mm/h, Zone 1					
olumes for Total Catchment (4.56 impervious + 17.5 pervious = 22.0 total ha)							
Storm	Total Rainfall	Total Runoff	Impervious Runoff	Pervious Runoff			
	cu.m	cu.m (Runoff %)	cu.m (Runoff %)	cu.m (Runoff %)			
AR&R 20 year, 5 minutes storm, average 170 mm/h, Zone 1	3122.9	1414.37 (45.3%)	598.34 (92.7%)	816.03 (32.9%)			
AR&R 20 year, 10 minutes storm, average 131 mm/h, Zone 1	4812.94	2881.25 (59.9%)	939.67 (94.5%)	1941.58 (50.8%)			
AR&R 20 year, 15 minutes storm, average 109 mm/h, Zone 1	6006.99	3894.41 (64.8%)	1180.85 (95.1%)	2713.55 (56.9%)			
AR&R 20 year, 20 minutes storm, average 95.2 mm/h, Zone 1	6995.29	4736.77 (67.7%)	1381.02 (95.5%)	3355.75 (60.5%)			
AR&R 20 year, 25 minutes storm, average 85.1 mm/h, Zone 1	7816.43	5382.44 (68.9%)	1547.32 (95.8%)	3835.13 (61.8%)			
AR&R 20 year, 30 minutes storm, average 77.5 mm/h, Zone 1	8542.05	5952.28 (69.7%)	1692.53 (95.9%)	4259.76 (62.9%)			
AR&R 20 year, 45 minutes storm, average 62.2 mm/h, Zone 1	10283.52	7356.47 (71.5%)	2054.85 (96.7%)	5301.62 (65.0%)			
AR&R 20 year, 1 hour storm, average 52.9 mm/h, Zone 1	11661.27	8461.24 (72.6%)	2344.97 (97.3%)	6116.27 (66.1%)			
AR&R 20 year, 1.5 hours storm, average 41.8 mm/h, Zone 1	13821.59	10158.49 (73.5%)	2798.65 (98.0%)	7359.84 (67.1%)			
AR&R 20 year, 2 hours storm, average 35.3 mm/h, Zone 1	15563.06	11521.01 (74.0%)	3160.67 (98.3%)	8360.34 (67.7%)			
AR&R 20 year, 3 hours storm, average 27.7 mm/h, Zone 1	18318.56	13676.80 (74.7%)	3755.39 (99.2%)	9921.41 (68.3%)			
AR&R 20 year, 4.5 hours storm, average 21.8 mm/h, Zone 1	21625.16	16066.78 (74.3%)	4454.29 (99.7%)	11612.49 (67.7%)			
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 Pr C Basin	0.098	0.49	246.948	246.948	urs storm, average 35.3 mm/h, Zone 1		
P Pit 1	0.233	2.36	246.706	246.656	urs storm, average 35.3 mm/h, Zone 1		
CHANNEL DETAILS							
Name	Max Q	Max V	Chainage	Max	Due to Storm		
	(cu.m/s)	(m/s)	(m)	HGL (m)			
OVERFLOW ROUTE DETAILS							
Name	Max Q U/S	Max Q D/S	Safe Q	Max D	Max DxV	Max Width	Max V
O Ex C	1.878	1.878	0.256	0.113	0.13	26.54	1.13
O Pr C	2.779	2.779	0.256	0.132	0.17	30.49	1.25
O Basin Pr C	1.161	1.161	0.256	0.093	0.09	22.59	0.99
O Pit 1	1.026	1.026	0.256	0.088	0.08	21.69	0.95
Regional Basin	1.259	1.259	0.256	0.096	0.1	23.13	1.02

DETENTION BASIN DETAILS							
Name	Max WL	MaxVol	Max Q	Max Q	Max Q		
			Total	Low Level	High Level		
Basin C	249.68	1652.4	1.259	0.098	1.161		
UITY CHECK for AR&R 20 year, 2 hours storm, average 35.3 mm/h, Zone 1							
Node	Inflow	Outflow	Storage Change	Difference			
	(cu.m)	(cu.m)	(cu.m)	%			
Ex C	4333.74	4333.74	0	0			
Pr C	3593.62	3593.62	0	0			
N Ex C	4333.65	4333.65	0	0			
N Pr C	3593.62	3593.62	0	0			
Basin C	3593.62	2881.78	711.88	0			
Pit 1	2881.78	2881.65	0	0			
N Pit 1	2881.64	2881.56	0	0			
N Regional Basin	2881.23	2881.23	0	0			
Run Log for 130212_Regional Basin.drn run at 15:32:10 on 13/2/2013							
No water upwelling from any pit. Freeboard was adequate at all pits.							
To see more detailed results select the Edit/Copy Results to Spreadsheet menu item, and paste them into a spreadsheet.							
The maximum flow exceeded the safe value in the following overflow routes: Regional Basin, O Pit 1, O Basin Pr C, O Pr C, O Ex C							

DRAINS Model Name and File Path:	F:\AA005014\D-Calculations\C-Civil\D-DRAINS\E-Results	RESULTS 100 YEAR ARI
DRAINS Version:	Version 2012.06	
Modeller's Name:	Alavy Nishat Islam	
Description:	Proposed regional basin 100 year	

DRAINS results prepared 13 February, 2013 from Version 2012.06

PIT / NODE DETAILS				Version 8			
Name	Max HGL	Max Pond	Max Surface	Max Pond	Min	Overflow	Constraint
		HGL	Flow Arriving	Volume	Freeboard	(cu.m/s)	
			(cu.m/s)	(cu.m)	(m)		
Pit 1	246.96		1.892		1.04	1.757	Inlet Capacity
N Pit 1	246.66		1.757				

SUB-CATCHMENT DETAILS							
Name	Max	Paved	Grassed	Paved	Grassed	Supp.	Due to Storm
	Flow Q	Max Q	Max Q	Tc	Tc	Tc	
	(cu.m/s)	(cu.m/s)	(cu.m/s)	(min)	(min)	(min)	
C Pr C	3.408	1.218	2.203	5.5	7.5	0	AR&R 100 year, 15 minutes storm, average 145 mm/h, Zone 1
C Pr C Basin	3.408	1.218	2.203	5.5	7.5	0	AR&R 100 year, 15 minutes storm, average 145 mm/h, Zone 1

Name	Max	Due to Storm
	Flow	
	(cu.m/s)	
C Ex C	2.54	AR&R 100 year, 2 hours storm, average 46.7 mm/h, Zone 1

olumes for Total Catchment (4.56 impervious + 17.5 pervious = 22.0 total ha)

Storm	Total Rainfall	Total Runoff	Impervious Runoff	Pervious Runoff
	cu.m	cu.m (Runoff %)	cu.m (Runoff %)	cu.m (Runoff %)
AR&R 100 year, 5 minutes storm, average 225 mm/h, Zone 1	4133.25	2403.27 (58.1%)	795.40 (93.1%)	1607.87 (49.0%)
AR&R 100 year, 10 minutes storm, average 173 mm/h, Zone 1	6356.02	4408.19 (69.4%)	1254.44 (95.5%)	3153.75 (62.5%)
AR&R 100 year, 15 minutes storm, average 145 mm/h, Zone 1	7990.95	5856.08 (73.3%)	1588.56 (96.2%)	4267.52 (67.3%)
AR&R 100 year, 20 minutes storm, average 126 mm/h, Zone 1	9258.48	6960.74 (75.2%)	1846.35 (96.5%)	5114.38 (69.6%)
AR&R 100 year, 25 minutes storm, average 113 mm/h, Zone 1	10379.05	7907.65 (76.2%)	2075.03 (96.7%)	5832.62 (70.8%)
AR&R 100 year, 30 minutes storm, average 103 mm/h, Zone 1	11352.66	8732.16 (76.9%)	2271.11 (96.8%)	6461.05 (71.7%)
AR&R 100 year, 45 minutes storm, average 82.5 mm/h, Zone 1	13639.73	10672.60 (78.2%)	2746.58 (97.4%)	7926.02 (73.2%)
AR&R 100 year, 1 hour storm, average 70.1 mm/h, Zone 1	15452.84	12207.73 (79.0%)	3124.50 (97.8%)	9083.23 (74.1%)
AR&R 100 year, 1.5 hours storm, average 55.4 mm/h, Zone 1	18318.56	14619.37 (79.8%)	3722.49 (98.3%)	10896.88 (75.0%)
AR&R 100 year, 2 hours storm, average 46.7 mm/h, Zone 1	20589.1	16519.71 (80.2%)	4198.04 (98.7%)	12321.68 (75.4%)
AR&R 100 year, 3 hours storm, average 36.5 mm/h, Zone 1	24138.18	19399.60 (80.4%)	4945.49 (99.1%)	14454.11 (75.5%)
AR&R 100 year, 4.5 hours storm, average 28.6 mm/h, Zone 1	28370.63	22723.69 (80.1%)	5836.29 (99.5%)	16887.41 (75.0%)

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 Pr C Basin	0.108	0.52	246.959	246.959	AR&R 100 year, 2 hours storm, average 46.7 mm/h, Zone 1
P Pit 1	0.243	2.37	246.712	246.662	AR&R 100 year, 2 hours storm, average 46.7 mm/h, Zone 1

OVERFLOW ROUTE DETAILS							
Name	Max Q U/S	Max Q D/S	Safe Q	Max D	Max DxV	Max Width	Max V
O Ex C	2.54	2.54	7.665	0.128	0.16	29.59	1.22
O Pr C	3.408	3.408	7.665	0.144	0.19	32.83	1.31
O Basin Pr C	1.892	1.892	7.665	0.114	0.13	26.72	1.12
O Pit 1	1.757	1.757	7.665	0.11	0.12	26	1.11
Regional Basin	2	2	7.665	0.116	0.13	27.26	1.14

DETENTION BASIN DETAILS					
Name	Max WL	MaxVol	Max Q	Max Q	Max Q
			Total	Low Level	High Level
Basin C	249.86	1989	2	0.108	1.892

JITY CHECK for AR&R 100 year, 2 hours storm, average 46.7 mm/h, Zone 1

Node	Inflow	Outflow	Storage Change	Difference			
	(cu.m)	(cu.m)	(cu.m)	%			
Ex C	6002.83	6002.83	0	0			
Pr C	5258.41	5258.41	0	0			
N Ex C	6002.73	6002.73	0	0			
N Pr C	5258.41	5258.41	0	0			
Basin C	5258.41	4520.55	737.9	0			
Pit 1	4520.56	4520.39	0	0			
N Pit 1	4520.43	4520.34	0	0			
N Regional Basin	4520	4520	0	0			
Run Log for 130212_Regional Basin.drn run at 14:16:27 on 13/2/2013							
No water upwelling from any pit. Freeboard was adequate at all pits.							
To see more detailed results select the Edit/Copy Results to Spreadsheet menu item, and paste them into a spreadsheet.							
Flows were safe in all overflow routes.							

APPENDIX C

MUSIC INPUT - CATCHMENT SPLIT REPORTING TABLES

Table 1 Catchment F Basin 1 Split reporting table

Land Use	Area (ha)	Impervious Area (ha) (percentage of area)	Comments
Lot Roof Area	0.73	0.73 (100%)	Assumed roof area is 25% of lot area
Lot Ground Level	2.18	0.33 (15%)	Allowed for driveway
Roads	1.54	1.38 (90%)	Including road reserve
Area of lumped public open space area (Park)	0.10	0.02 (20%)	
Area of lumped public open space area (Basin)	0.32	0.02 (5%)	
TOTAL (ha)	**4.86**	**2.48**	

Table 2 Catchment D Basin 2 Split reporting table

Land Use	Area (ha)	Impervious Area (ha) (percentage of area)	Comments
Lot Roof Area	1.95	1.95 (100%)	Assumed roof area is 25% of lot area
Lot Ground Level	5.84	0.88 (15%)	Allowed for driveway
Roads	2.02	1.81 (90%)	Including road reserve
Area of lumped public open space area (Basin)	0.47	0.02 (5%)	
TOTAL (ha)	**10.28**	**4.66**	

Table 3 Catchment B Basin 2 Split reporting table

Land Use	Area (ha)	Impervious Area (ha) (percentage of area)	Comments
Lot Roof Area	0.9	0.9 (100%)	Assumed roof area is 25 % of lot area
Lot Ground Level	2.69	0.4 (15%)	Allowed for driveway
Roads	1.02	0.92 (90%)	Including road reserve
Area of lumped public open space area (Basin)	0.31	0.015 (5%)	
TOTAL (ha)	**4.92**	**2.24**	

Table 4 Catchment K Basin 4 Split reporting table

Land Use	Area (ha)	Impervious Area (ha) (percentage of area)	Comments
Lot Roof Area	0.89	0.89 (100%)	Assumed roof area is 25 % of lot area
Lot Ground Level	2.66	0.4 (15%)	Allowed for driveway
Roads	0.86	0.77 (90%)	Including road reserve
Area of lumped public open space area (Basin)	0.3	0.015 (5%)	
TOTAL (ha)	**4.71**	**2.08**	

Table 5 Catchment A Basin 5 Split reporting table

Land Use	Area (ha)	Impervious Area (ha)	Comments
Lot Roof Area	1.91	1.91 (100%)	Assumed roof area is 25 % of lot area
Lot Ground Level	5.72	0.86 (15%)	Allowed for driveway
Roads	5.3	4.76 (90%)	Including road reserve
Area of lumped public open space area (Basin)	0.56	0.03 (5%)	
TOTAL (ha)	**13.49**	**7.56**	

Table 6 Catchment G Basin 6 Split reporting table

Land Use	Area (ha)	Impervious Area (ha)	Comments
Lot Roof Area	0.89	0.89 (100%)	Assumed roof area is 25 % of lot area
Lot Ground Level	2.66	0.40 (15%)	Allowed for driveway
Roads	2	1.8 (90%)	Including road reserve
Area of lumped public open space area (Basin)	0.34	0.02 (5%)	
TOTAL (ha)	**5.89**	**3.11**	

Table 7 catchment H Basin 7 Split reporting table

Land Use	Area (ha)	Impervious Area (ha)	Comments
Lot Roof Area	1.37	1.37 (100%)	Assumed roof area is 15 % of lot area
Lot Ground Level	7.76	1.16 (15%)	Allowed for driveway
Roads	3.45	3.11 (90%)	Including road reserve
Area of lumped public open space area (Basin)	0.56	0.03 (5%)	
TOTAL (ha)	**13.14**	**5.67**	

Table 8 Catchment J Basin 8 Split Reporting table

Land Use	Area (ha)	Impervious Area (ha)	Comments
Lot Roof Area	0.71	0.71 (100%)	Assumed roof area is 15 % of lot area
Lot Ground Level	4.03	0.6 (15%)	Allowed for driveway
Roads	0.94	0.85 (90%)	Including road reserve
Area of lumped public open space area (Basin)	0.34	0.02 (5%)	
TOTAL (ha)	**6.02**	**2.16**	

Table 9 Catchment C Basin 9 Split reporting table

Land Use	Area (ha)	Impervious Area (ha)	Comments
Lot Roof Area	1.11	1.11 (100%)	Assumed roof area is 25 % of lot area
Lot Ground Level	3.32	0.5 (15%)	Allowed for driveway
Roads	1.71	1.54 (90%)	Including road reserve
Area of lumped public open space area (Park)	1.21	0.24 (20%)	
Area of lumped public open space area (Basin)	0.4	0.02 (5%)	
TOTAL (ha)	**7.75**	**3.41**	

Table 10 Catchment I Basin 10 Split reporting table

Land Use	Area (ha)	Impervious Area (ha)	Comments
Lot Roof Area	0.91	0.91 (100%)	Assumed roof area is 15 % of lot area
Lot Ground Level	5.15	0.77 (15%)	Allowed for driveway
Roads	0.97	0.87 (90%)	Including road reserve
Area of lumped public open space area (Basin)	0.39	0.02 (5%)	
TOTAL (ha)	**7.42**	**2.59**	

Table 11 Catchment E Basin 11 Split reporting table

Land Use	Area (ha)	Impervious Area (ha)	Comments
Lot Roof Area	1.66	1.66 (100%)	Assumed roof area is 25 % of lot area
Lot Ground Level	4.98	0.75 (15%)	Allowed for driveway
Roads	1.66	1.49 (90%)	Including road reserve
Area of lumped public open space area (Park)	3.27	0.65 (20%)	
Area of lumped public open space area (Basin)	0.54	0.03 (5%)	
TOTAL (ha)	**12.11**	**4.58**	