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20 August 2018

Frasers Property Australia
Level 9, 484 St Kilda Road
MELBOURNE, VIC, 3004

Attention: Mr. Mark Cleveland

Dear Mark,

RE: EASTERN CREEK BUSINESS HUB
ROOTY HILL ROAD SOUTH, EASTERN CREEK
STORMWATER AND ROAD DESIGN REPORT FOR S96 APPLICATION

PROJECT OVERVIEW

To the east of Rooty Hill Road South and to the west of the M7 Motorway is a 35 hectare green field site that is proposed to be developed into an area with mixed uses of commercial, retail and bulky goods. The overall subdivision site is known as the Eastern Creek Quarter (ECQ) Business Hub. The land is currently owned by the Western Sydney Parklands Trust (WSPT), but will be developed by Frasers Property. The development of this area will include a private access road, communal On Site Detention (OSD) and Water Quality (WQ) basins as well as associated stormwater infrastructure. Figure 1 shows the location of the subdivision site. It is the design and documentation of these items that are the focus of this report.

A previous Development Application submission for these works was completed and submitted by Costing Roe (CR) Engineers in 2015, and prior to this, the original submission for the subdivision area was prepared and submitted by J. Wyndham Prince (JWP) Engineers in 2013. These two reports that have been used as a reference and basis for this S96 submission are;

- *Costin Roe – Co12693.00-04b.rpt (August 2015)*
- *J.Wyndhan Prince – 2014-04-23 Appendix 13_Stormwater report 8801Rpt1F (March 2013)*

Key stormwater elements of these previous designs have been reviewed and changed. As a result, a S96 submission has been prepared. The main changes that are occurring as part of this S96 submission are;

- The main overland flow channel has been adjusted to accommodate the proposed widening of Rooty Hill Road South as well as internal lot configurations and constraints.
- The 30 hectare upstream urban catchment will not be routed through the southern OSD/Bio basin and will instead be directed to the existing creek that is located downstream of the proposed main overland flow channel.
- The procedure for calculating the OSD basin size and outlet controls is to be undertaken using Council's latest *deemed to comply calculation spreadsheet.*

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There are proposed to be amplifications of the Rooty Hill Road South and the Great Western Highway as a result of the ECQ subdivision development. The Rooty Hill Road South/Cable Place amplifications are shown as a background to the overall site layout plans. These are currently being documented to a standard to obtain a Works Authorisation Deed (WAD) with RMS. As such, this layout is provided on our drawings for information purposes only. The RMS approved concept plans for these surrounding road works are attached as an appendix to this report.

The above changes were discussed with Council's stormwater Engineer, Tony Merrilees and he agreed to these changes so long as the design calculations and documentation reflects Blacktown Council's latest design policies on Water Sensitive Urban Design (WSUD). The reason for not routing the upstream 30 hectare catchment through the southern detention basin is because it is a separate catchment that is remaining unchanged. The proposed development is not to be responsible for the improvement of water quality of water quantity of this upstream catchment and flows should be able to flow through the development site, unmitigated towards the M7 discharge culverts.

There are two existing culverts that are located at the far eastern boundary of the site. Both culverts pass underneath the M7 motorway and flow eastwards towards Eastern Creek. These culverts are the outlets that define the two catchment areas of the subdivision site. The northern culvert drains the catchments to the north of the proposed subdivision Access Road. The areas to the south of the Access Road will drain towards the southern culvert. The overall catchment areas for the subdivision site are shown on the drawing 17D83_S96_C250. There is approximately 30 hectares of upstream urban catchment that is currently directed to a low point in Rooty Hill Road South. The catchment currently discharges underneath Rooty Hill Road and into an existing creek that traverses the subdivision site in an easterly direction to the southern culvert. The previous stormwater report and study by J. Wyndham Prince (JWP) (2013), calculated the flows off this area to be 12.90m^3/s. According to the report, these flows will enter the subdivision area via the existing twin 750mm pipes as well as via overflows over the low point. In accordance with the original report by JWP, a new proposed channel will need to be created that caters for these flows to be conveyed around the proposed Lot 1 site area. The design and calculation of this channel is described in the following sections of this report.

The existing topography of the site is that the majority falls in an easterly direction at approximately 5%. Runoff from the site currently is directed overland to two sets of culverts located at the far eastern edge of the overall precinct site. These culverts discharge to the east and eventually to Eastern Creek. The proposed stormwater from the developed stage 1 site will ultimately follow this same path to Eastern Creek.

Figure 1: Location of proposed site

PREVIOUS STORMWATER AND ROAD DESIGN STRATEGY AND SUBMISSIONS

The overall subdivision area is intended to become part of a commercial/retail precinct. This overall precinct area requires the installation of appropriate access roads and downstream stormwater infrastructure for the site to connect in to. In addition to this, there are proposed upgrades and amplifications of the adjoining Rooty Hill Road/Cable Place intersection and Rooty Hill Road South/Great Western Highway intersection.

The original subdivision access road and stormwater infrastructure design for the precinct area was carried out and approved under the following application and development consent.

- Application no. SSD 5175 MOD 1
- Applicant: Western Sydney Parklands Trust
- Consent Authority: Minister for Planning
- Approval date: 28th April 2016

The civil infrastructure design and drawings that formed part of this consent have been used as the basis for this S96 submission. However, some key components of the stormwater design are proposed to be amended and are discussed in detail in the later sections of this report

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STORMWATER STRATEGY

Access Road Drainage design:

The proposed access road drainage has been designed to accommodate up to the 1:20ARI storm event with the piped system. The 1:100ARI storm event has also been checked to ensure that there is not excessive overflow through the access road that causes dangerous velocities or flow depths.

The proposed piped stormwater drainage network for the access road can be seen on the detail plans 17D83_S96_C101-C107. The access road drainage network discharges into a 2.7m x 0.6m RCBC that runs underneath the low point of the Access Road. This culvert then directs all flows (up to and including the 100ARI) to the designated channel towards Basin 2 (Northern Bio/OSD basin). As well as catering for the Access Road piped drainage, this culvert has been sized to accommodate the flows from the 4.187Ha Lot 2 catchment with an assumed impervious percentage of 90%. Lot 2's site drainage connection point has been assumed to be at the upstream end of the culvert at headwall L-4.

In addition to the culvert under the low point of the road, there is a second culvert that is positioned approximately 90m to the north, and this culvert also passes underneath the Access Road. This culvert has been designed to accommodate flows up to the 100ARI from the future Lot 3 site as well as from the "Beggs Road" catchment area. The culvert size required is a 1.5m x 0.45m RCBC.

Refer to drawings 17D83_S96_C255 and C250 for the Access Road drainage and culvert stormwater catchment areas.

The DRAINS modelling software has been used to assess and design the Access Road piped drainage as well the two culverts. As mentioned above, the 20ARI flows have been contained within the piped system and only safe, minor overflows occur in the 100ARI event. The two culverts have been designed to accommodate the 100ARI flows without any overflow or excessively high Hydraulic losses. The DRAINS model prepared and submitted is;

- *17D83 Road rev 3 – option to flatten pipes.drn*

The stormwater longsections for the road drainage and culverts have been documented on drawings 17D83_S96_C220-221. Refer to appendix G for the DRAINS model.

Channels to Northern Basin:

As can be seen on drawings 17D83_S96_C105 and C111, there will be two trapezoidal channels to convey the flows from each of the two culverts towards the northern Bio/OSD basin. These two separate channels will converge to one channel approximately 90m to the east of the Access Road. From this point, the single channel will be directed towards the Bio retention basin via a low flow-bunded channel with flows over and above the treatable flow rates diverted to the main OSD.

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Both the two separate channels and the combined channel have a 5m wide base with 1:4 side batters/slopes and a longitudinal grade of approximately 0.3%. To model this channel area, a conservative estimate has been input to the above mentioned DRAINS model. The model has conservatively represented these channel as one overall channel with a 5m base and 1:4 side slopes. The entire catchment area from both the channels has been modelled to flow through this one channel in the DRAINS model. This is conservative because the flows would actually be split between each of the channels from the upstream culverts, both of which have dimensions of a 5m base and 1:4 side slopes. By modelling these channels conservatively as one, a conservative estimate of the flow depths within each channel can be calculated. It should be noted that the invert levels and length of the channel modelled in DRAINS closely represents the inverts of the actual channels as they both will have very similar upstream and downstream inverts as each other. This makes the DRAINS model a conservative representation of the channels. The channel as modelled is named as *DS CHANNEL – COMBINED* in the DRAINS model.

The top water level in the channels has been calculated to be RL39.87 (100ARI) and RL39.81 (20ARI), with a downstream/tail water level of 39.48. The tail water level of 39.48 has been conservatively assumed to be at 178mm above the top of the low flow bund (RL39.30) at its upstream end. This is the depth of flow that will occur over the 55m long diversion bund once the treatable flows rates are exceeded. It has been assumed that this overflow will act as weir flow and the depth of flow has been calculated accordingly.

Drains Modelling Data

For the above mentioned model, the IFD data used for the rainfall generation is;

Table 1

	2ARI	50ARI		
1hr	30.7(mm/hr)	59.6(mm/hr)	**G**	0.01
12hr	6.63(mm/hr)	13.1(mm/hr)	**F2**	4.30
72hr	1.99(mm/hr)	4.37(mm/hr)	**F50**	15.81

The standard parameters used in the DRAINS model are as follows;

Table 2

Description	Value
Model for Design and Analysis Run	Rational Method
Rational Method Procedure	ARR87
Soil Type - Normal	3.0
Paved (Impervious) Are Depression Storage	1mm
Supplementary Area Depression Storage	1mm
Grassed (Pervious) Area Depression Storage	5mm
Antecedent Moisture Condition (ARI = 1-5 years)	2.5
Antecedent Moisture Condition (ARI = 10-20 years)	3.0
Antecedent Moisture Condition (ARI = 50-100 years)	3.5
Sag Pit Blocking Factor	0.5
On Grade Pit Blocking Factor	0.2

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Main overflow channel from Rooty Hill Road South to M7 Culvert:

In accordance with the original development proposal by JWP and subsequent proposal by CR, a channel capable of accommodating the flows from approximately 30 hectares of urban upstream catchment needs to be conveyed through the subdivision site and to the existing culvert(s) that run underneath the M7 motorway at the far eastern boundary of the site. As discussed above, this catchment will not be routed through the southern detention/water quality basin. This is a significant change from the previously submitted subdivision stormwater strategy presented by Costin Roe.

Based on discussions with Council's stormwater Engineer, Tony Merriless, the following was agreed upon;

- The downstream water levels for the 100ARI event at the M7 Culvert entrance to be adopted is RL39.20
- The upstream urban catchment of approximately 30 hectares is not to be routed through the proposed southern Bio/Detention Basin.
- The new overland flow channel next to Rooty Hill Road is to be designed to accommodate the full 100ARI flows from the upstream urban catchment as previously calculated by JWP. This flow is 12.90m^3/s.
- HEC-RAS modelling is required to assess the depth of flow from the existing creek all the way through and into the proposed new channel that is adjacent to Rooty Hill Road South and the new Access Road.

In response to the above requirements, we have designed the channel, using the HEC-RAS software, to accommodate the 12.90m^3/s flow as well as a conservative allowance of 350L/s. This 352L/s the maximum runoff generated from the Rooty Hill Road widening. This increased area equates to 6070m^2. Therefore, the overall flow to be modelled and designed for this channel is <u>13.25m^3/s.</u>

The HEC-RAS model prepared and submitted is;

- *HEC RAS 10_04_2018.prj*

Refer to Appendix G for the HEC-RAS model.

The HEC-RAS modelling shows that the proposed channel adjacent to the new Access Road and Rooty Hill Road South will have be able to convey the flows and provide a minimum of 300mm to any surrounding pedestrian accessible areas. The top water level in the channel at the upstream end is approximately RL41.50 which is over 1m below the Rooty Hill Road top of the proposed top of kerb levels and over 300mm below the lowest point along the retaining wall adjacent to the channel along the new estate Access Road.

In terms of the Lot 1 side of the channel, there will be a future vertical wall at the top of the bank. This will be part of the future Lot 1 design. For this reason, we have assumed a vertical wall in the cross sections of the HEC RAS model along the Lot 1 side of the channel to obtain the most conservative and ultimate water levels within the channel. What we have shown on these S96 earthworks stage drawings is a 1:3 batter that extends into Lot 1 to ensure no water from the channel spills into the Lot 1 sediment and erosion works. It would be unnecessary to build a wall along the top of the batter in this temporary stage as there is negligible risk of any public pedestrian activity on this side of the channel until Lot 1 is fully developed.

As discussed with Council's Engineer, Tony Merrilees, appropriate scour protection will be required at the major bend in the channel and at the connection to the existing creek. Based on the flows and channel size, a D_{50} stone of 400mm will be required at these locations. This stone sizing is in accordance with the requirements of the *Landcom – Managing Urban Stormwater (Blue Book)* standard scour protection tables.

The drawings 17D83_S96_C102, C103 and C105 show the layout of the proposed channel and its connection into the existing creek downstream through the subdivision site. Drawings 17D83_S96_C110 and C302 show sections through critical locations for this channel.

ON-SITE DETENTION DESIGN

As discussed in the Pre-DA meeting with council's drainage engineer, Tony Merrilees, the development should comply with the BCC's on-site detention (OSD) policy. In this case, it was deemed that OSD shall be provided to control the peak flow of stormwater generated from the development in accordance with the BCC Development Control Plan (DCP) Part J 2015, and with BCCs Deemed to Comply OSD spreadsheet tool.

In order to mitigate the increased stormwater runoff and pollutants generated by the development, a water management basin for each of the two existing catchments, north and south, is proposed to be constructed to satisfy the water quality and quantity requirements of the development. Each of the water management basins will store the required detention volume for its given catchment as calculated by the BBC Deemed to Comply OSD spreadsheet tool. The required detention volume for each catchment is listed below, and is based on the developable catchment area draining to each basin (refer to Water Quantity Catchment Plan 17D83_96_C250 in Appendix E for details):

- North basin detention volume = 7106.0m^3 (14.986ha in area)
- South basin detention volume = 3218.6m^3 (4.435ha in area)

OSD spreadsheet calculations are available in Appendix E.

Several assumptions were made when using the spreadsheet tool to calculate the detention volumes for each basin. These include:

- Point 4 "RL of invert of Discharge to Council Drainage Pit", being taken as the invert of the pipe which discharges into the open channel leading to the M7 culverts.
- Inundation of the headwalls of the downstream M7 culverts will affect the discharge rate through the culverts, increasing the head required to drive the flow through the system. This

increase in head has the potential to affect the operation of the developments stormwater management system, particularly the on-site detention systems. For this reason, a downstream water level was included in the design of the downstream of the OSD. This water level is represented by Point 5 “RL of obvert of pit outlet pipe” in BCC’s deemed to comply spreadsheet. Following discussion with Council’s stormwater Engineer, Tony Merrilees, the downstream water level for the onsite detention basin, point 5, has been taken as 150mm below the flood level.

Where possible and within site constrains, the design of the on-site detention storage area in water management basins was designed in accordance with, and to fulfill the intent of BCCs Water Sensitive Urban Design (WSUD) Standard Drawings, with particular reference to:

- Surface of bioretention filter system elevated above estimated 2-year water level.
- 1.5-year ARI detention volumes retarded with orifice and weir arrangement which later drains through the 100-year ARI sized orifice (sized with deemed to comply spreadsheet).
- Appropriate access for maintenance purposes.
- Appropriate sized emergency overflow weir with rip rap scour protection designed in accordance with *Landcom – Managing Urban Stormwater - Soils and Construction, Volume 1, 4th Edition March 2004*.

The design of the composite water management basins is detailed on engineering drawings 17D83_96_C230-C231 (north basin) and 17D83_96_C240-C241 (south basin).

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WATER QUALITY STRATEGY

In accordance with the original stormwater management strategy outlined by JWP consulting engineers, water treatment is to be managed by a water quality treatment train consisting of tertiary treatment within dual communal composite water management basins and individual on-lot primary treatment.

Tertiary treatment is proposed to be managed by a bioretention filter system which will reduce total suspended solids and nutrient loads, which in-turn is protected from the influx of sediments and gross pollutants by the individual on-lot primary treatment and communal swales. Primary on-lot treatment is proposed to be managed by a combination of Enviropod pit baskets and gross pollutant traps (GPT's). In addition to the individual lots, the access road will be primarily treated in a similar manner. As such, all surface inlet pits within the access road (24 in total) have been nominated to be fitted with Enviropod pit baskets. In areas of vehicular traffic, suitable practices to manage the run-off of hydrocarbons will be implemented, taking the form of oilsorbs within pit baskets and oil baffles in GPTs. To ensure the treatment train remains functional and operational, the treatment measures must be regularly maintained. A maintenance schedule that outlines the specific maintenance requirement of each of treatment devices is provided in appendix x.

In order to meet WSUD goals outlined by BCC, all developments are required to achieve a minimum percentage reduction of the post development average annual load of pollutants in accordance with of BCC's DCP Part J 2017, shown in Table 3 below. The water quality pollutants modelled in MUSIC and specific to water quality outcomes for the development as a whole are Gross pollutants (GPs), Total Suspended Solids (TSS), Total Phosphorous (TP), Total Nitrogen (TN) and Total Hydrocarbons.

Table 3: Post development average annual pollutant load reduction target. Source: BCCs DCP Part J 2017

Pollutant	% post development reduction target
Gross Pollutants	90
Total Suspended Solids	85
Total Phosphorous	65
Total Nitrogen	45
Total Hydrocarbons	90

In order to better determine the conceptual design of the water quality treatment trains and to ensure the treatment trains satisfy the reduction parameters outlined in table 3, a preliminary Model for Urban Stormwater Improvement Conceptualisation (MUSIC) was developed. The MUSIC model prepared and presented is;

- *BCC STD Music Model_17D83 – S96 SUBMISSION.SQZ*

The MUSIC model was set up with the in-built rainfall station, time period data, evapotranspiration data, source node data and run-off parameters of BCC's MUSIC Link model. A schematic of the MUSIC model can be viewed below in figure 2, in conjunction with the resultant post developed pollutants calculated by the simulation. The resultant post developed pollutant loads have been reduced below the reduction target for all pollutants. The schematic illustrates the interrelationship between source nodes (catchments) and treatment nodes (water quality treatment measures) for each catchment (north and south). An in-depth analysis of the specific catchments and their spatial distribution is also detailed on engineering drawing 17D83_S96_C251 and a short summary is provided in the following subsection of this report. Additionally, the design of key individual treatment systems is further elaborated on.

	Sources	Residual Load	% Reduction
Flow (ML/yr)	97.8	88	10
Total Suspended Solids (kg/yr)	19100	2820	85.3
Total Phosphorus (kg/yr)	37.1	12.2	67.1
Total Nitrogen (kg/yr)	222	112	49.5
Gross Pollutants (kg/yr)	2380	17.5	99.3

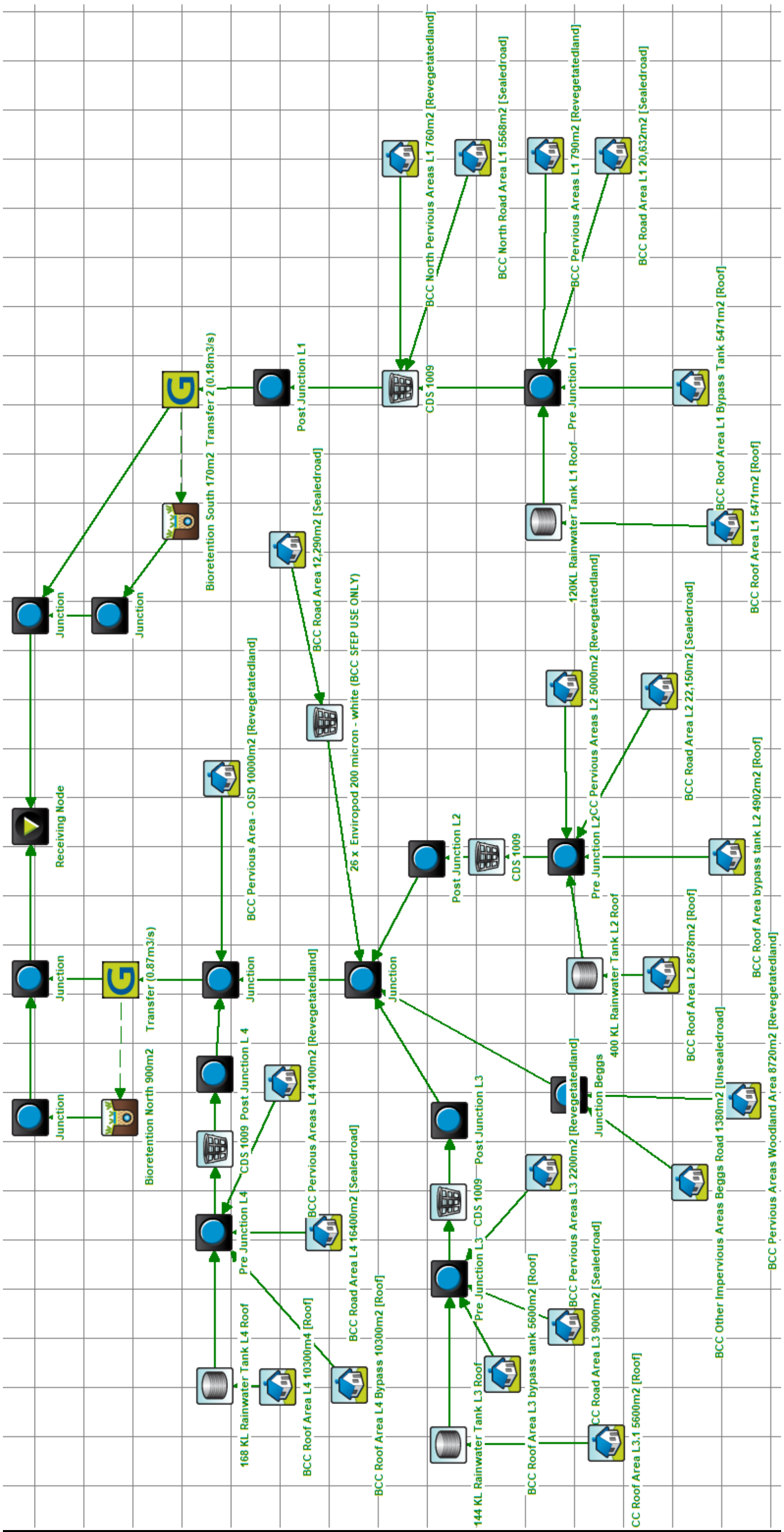

Figure 2: Schematic of Music model and resultant pollutant load reductions.

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Catchments – Water Quality

In terms of water quality, the proposed development is divided into two catchments, North and South, each of which drain to a separate water management basin. Each catchment's surface area break down is listed below as well as key assumptions incorporated into the modelling methodology.

South Catchment

The south catchment is comprised of the following areas:

Lot 1			**Source of Information / assumption**
Hardstand Area	2.62	ha	Engineering Drawings DA_17B42
Roof Area	1.094	ha	Engineering Drawings DA_17B42
Landscape Area	0.155	ha	Engineering Drawings DA_17B42
Total Area	3.869	ha	

North Catchment

The north catchment is comprised of the following areas:

Lot 2			**Source of Information / assumption**
Hardstand Area	2.215	ha	Engineering Drawings DA_17570
Roof Area	1.348	ha	Engineering Drawings DA_17570
Landscape Area	0.5	ha	Engineering Drawings DA_17570
Total Area	4.063	ha	
Lot 3			
Hardstand Area	0.9	ha	Same Distribution as Costin Roe
Roof Area	1.12	ha	S96 submission
Landscape Area	0.22	ha	10% LS Roof 50% HS 40%
Total Area	2.24	ha	
Lot 4			
Hardstand Area	1.64	ha	Same Distribution as Costin Roe
Roof Area	2.06	ha	S96 submission
Landscape Area	0.41	ha	10% LS Roof 50% HS 40%
Total Area	4.11	ha	
New Estate Road			

Hardstand Area	1.229	ha	
Swale area draining to North Bio-retention			
Landscape Area	0.523	ha	Conservatively modelled as 1ha
Beggs Road Catchment & Woodland Reserve			
Landscape	0.872	ha	
Unsealed Road	0.138	ha	
Total Area	1.01	ha	1.307ha for OSD calculations

BIORETENTION SYSTEMS

Modelling of Bioretention in MUSIC

The bioretention filter system was modelled in MUSIC, adopting the principles outlined in BCC's Handbook Part 4: Modelling Guide Draft June 2013. A screenshot of the modelling and design parameters of the north bioretention system is provided in figure 3 below.

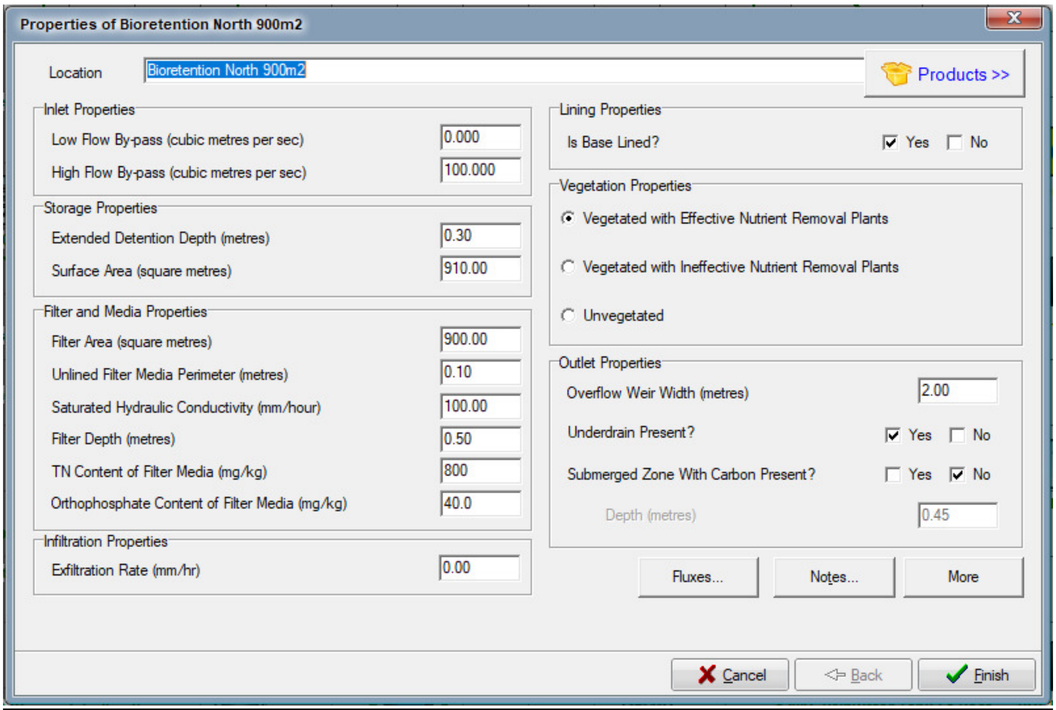

Figure 3: Screenshot of Bioretention properties of north basin

Low flow diversion systems

To ensure the bioretention filter systems are protected from the scour of extreme storm events, the filter systems are designed with a low flow diversion system. The diversion system splits the flows from upstream catchment, only allowing flows at or below the treatable flow rate to enter the treatment device. The treatable flow rate of the bioretention system was determined by configuring a transfer function in MUSIC, as shown in figure 4 below.

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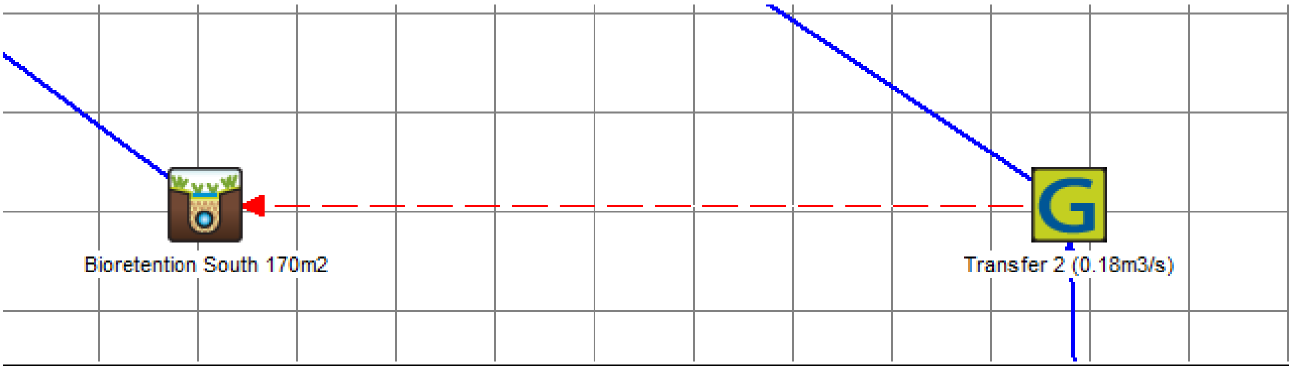

Figure 4: Sample of transfer function in MUSIC, South Basin

The transfer function is configured with a low-flow bypass, which routes all flows below a certain flow rate to the bioretention system. Under an iterative process, the low-flow bypass is reduced and the treatment performance is reviewed. The process is repeated, and the low-flow bypass is continually lowered until the treatment performance of the bioretention is noticeably impacted. In this manner, MUSIC is effectively removing more extreme storm events (high flows above the low-flow bypass) until the performance of the bioretention system is impacted, thus determining the flow rate at which a bio-retention system remains functional, or in other terms, the treatable flow rate of a given system under specific climatic conditions. For each bioretention system (north and south) this iterative process was applied and a transfer function employed to determine and divert low-flows. The resultant low-flow bypass for each basin is listed below:

- Treatable flow rate of north basin = $0.87m^3/s$
- Treatable flow rate of south basin = $0.18m^3/s$

With a treatable flow rate for each system having been determined, a low-flow diversion system could be designed. As stormwater run-off enters these systems under different flow conditions, different types of diversion systems are required.

For the south basin, flows contained within the pipe network originating from lot 1 are proposed to be diverted by the use of an offtake pit. This pit contains a small weir that is appropriately sized to divert flows under a certain magnitude by controlling the head which drives the diversion pipe. The calculations for the south offtake pit are available in appendix F.

A more complex design is required to divert low flows for the north basin, as the flow is much larger and the potential for a possible detrimental backwater effect is much greater. Stormwater draining down open channels 1 & 2 flow into a channel formed by a small bund that runs longitudinally with the channel. This bund directs the water over a series of on-grade pits culminating in a low point located adjacent to the entrance of the bioretention area. The height of the bund is specifically designed to control ponding over the pit network, with the head produced by the ponding driving all stormwater flows up to the treatable flow rate into the bioretention distribution system. The bund in the channel is graded in such a way as to mimic the hydraulic grade line from the ponding over the pit. At the point where the treatable flow rate is exceeded, the total bund length acts as an overflow weir, distributing the backwater effect of the weir flow over a greater distance. Hydraulic calculations for bund and pit arrangement are submitted in the form of drains model *Diversion Drainage System.drn*. Refer to appendix H for modelling of this low flow channel.

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Bioretention design

Where possible and within site constrains, the design of the bioretention filter system within the water management basins was designed in accordance with, and to fulfill the intent of BCC's Water Sensitive Urban Design Standard Drawings, with particular reference to:

- Surface of bioretention filter system elevated above estimated 2-year water level.
- Flows directed to the bioretention limited to the treatable flow rate of the treatment system (aforementioned)
- Partially permanently saturated transition zone to increased the longevity and establishment of biofilm, in addition to ensuring adequate water sources for planted macrophilic plant species
- Appropriate depth of filter media, transition and drainage layers as outlined in typical bioretention filter detail in BCC's Water Sensitive Urban Design Standard Drawings (refer to figure 5). Filter media is to be tested as Measurement of Hydraulic Conductivity manual in appendix C.
- Appropriate access and maintenance paths (min 4m), refer to standard drawings and maintenance schedule.
- Adequate dispersal and retarding distribution systems in the form of a system of up-flow pits, as well as, hydrocon permeable concrete pipes, where required.

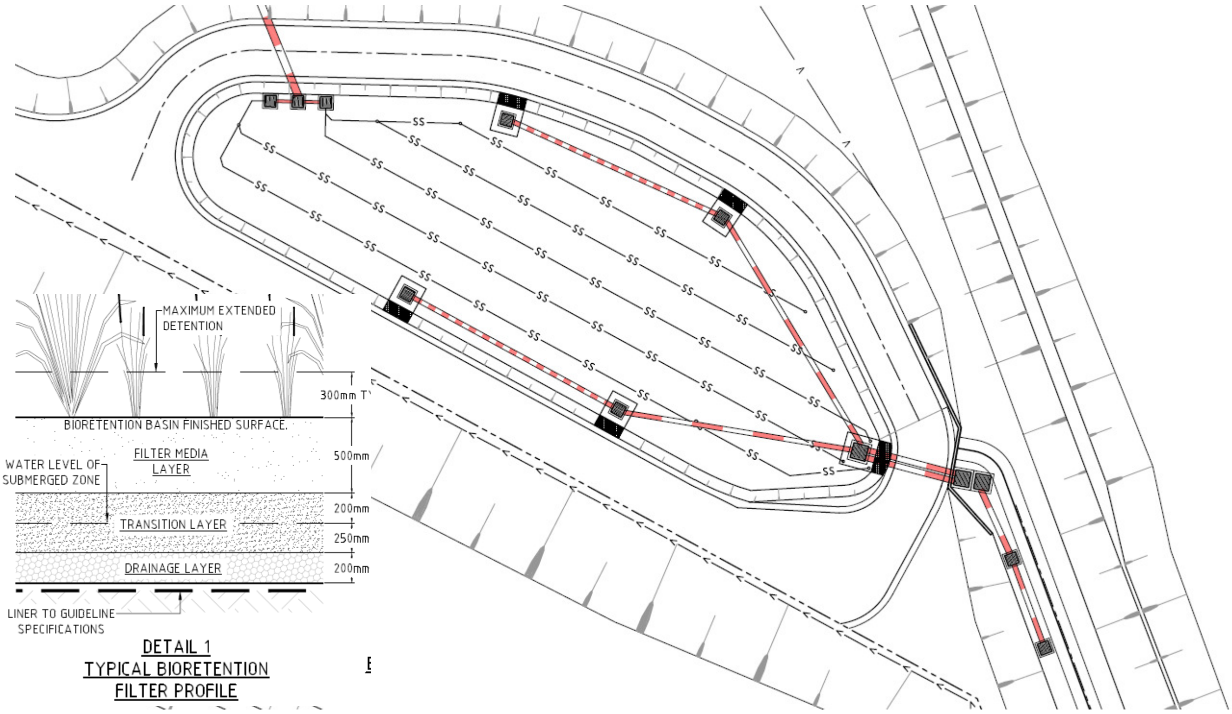

Figure 5: Design of north bio-retention filter system

Additional information and details regarding the bioretention systems is detailed on engineering drawings 17D83_96_C230-C231 (north basin) and 17D83_96_C240-C241 (south basin).

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WATER CONSERVATION

To assist with water conservation, and assuming each individual lot is developed in accordance with BCC's DCP Part J 2017, each lot is nominated and modelled with a rainwater tank which meets a significant portion of the non-potable demands. Using MUSIC water quality modelling software, preliminary rainwater tank sizing that satisfies 80% of the non-potable water demand of each of the developments was estimated.

Several assumptions were made when sizing the rainwater tanks. These assumptions are fundamental for determining the water demand of each building layout concept, and thus the tank volume. These assumptions, as well as the corresponding tank volume for each individual lot are presented in tabular form below;

Lot 1				**Source of Information**
Roof area draining to tank		0.547	ha	Engineering Drawings DA_17B42
Internal daily demand	28 Toilets X (0.1kl/toilet/day)	2.8	kL	BCA Report 074716-04BCA Report-Stage 2
External annual demand (0.3kL/m2/year)	Landscape Area x	465	kL	Engineering Drawings DA_17B42
Tank size volume	Including 20% loss in	**125**	kL	

Lot 2				**Source of Information**
Roof area draining to tank		0.8578	ha	Engineering Drawings DA_17570
Internal daily demand	56 Toilets X (0.1kl/toilet/day)	5.6	kL	Engineering Drawings DA_17570
External annual demand (0.3kL/m2/year)	Landscape Area x	1500	kL	Engineering Drawings DA_17570
Tank size volume	Including 20% loss in	**400**	kL	

Lot 3				**Source of Information**
Roof area draining to tank		0.56	ha	50% - Same Dist. as Costin Roe S96
Internal daily demand	28 Toilets X (0.1kl/toilet/day)	2.8	kL	'Like' development to lot 1
External annual demand (0.3kL/m2/year)	Landscape Area x	660	kL	Same Dist. as Costin Roe S96
Tank size volume	Including 20% loss in	**150**	kL	

Lot 3				**Source of Information**
Roof area draining to tank		1.03	ha	50% - Dist. as Costin Roe S96
Internal daily demand	28 Toilets X (0.1kl/toilet/day)	2.8	kL	'Like' development to lot 1

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External annual demand (0.3kL/m2/year)	Landscape Area x	1230	kL	Same Dist. as Costin Roe S96
Tank size volume	Including 20% loss in	**175**	kL	

FLOODING

An investigation of Blacktown Council's online flooding maps system showed that the subdivision site is not within a high, medium or low risk flood area. The proposed lot pad levels higher than the lowest potential access points to the proposed access road. Figure 3 shows the flooding zone extents in relation to the site. The maximum level that the furthest flood zone extends to is below RL39.25. Therefore all Pad levels have been set higher than RL40.00 which achieves in excess of 500mm freeboard.

In accordance with the NSW Floodplain Development Manual (2005), the pad levels of the development have been set so that it is not impacted by surrounding flood levels. In future DA designs for each individual Lot, safe evacuation paths of egress to Rooty Hill Road South will need to be designed. Based on the proposed pad levels and levels of the proposed Access Road, there will be sufficient freeboard to allow this to occur.

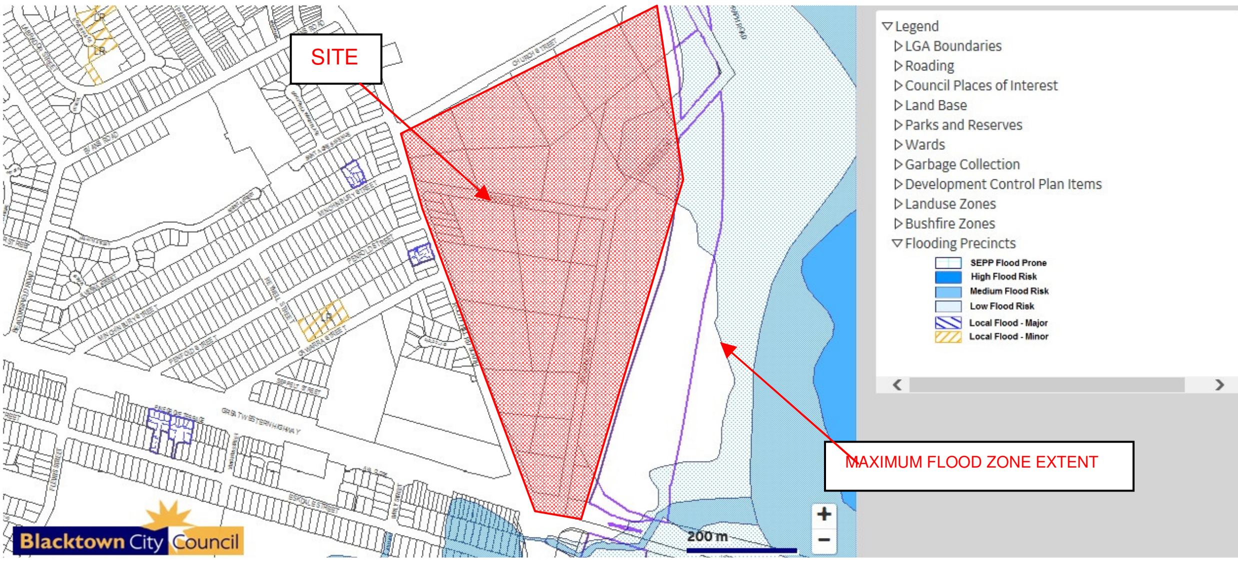

Figure 5: Flooding extents as shown by BCC.

EROSION AND SEDIMENT CONTROL

During construction, appropriate sediment and erosion control measures need to be implemented to ensure that downstream receiving waters are not adversely impacted. Our drawings 17D83_S96_SE01 – SE02 have detailed the required measures. These have been designed in accordance with the requirements of the *Landcom – Managing Urban Stormwater - Soils and Construction, Volume 1, 4th Edition March 2004*.

EARLY STAGE ACCESS ROAD OPTION – STAGE 1

As part of this submission, we have prepared a series of drawings that show an early works staging for the internal access road, referred to as *STAGE 1.* This option would only construct the access road up until the northern driveway of the Lot 2 development site. As part of this staging

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option, there would need to be alterations and allowances made to the stormwater channels and drainage strategy. This option assumes that Lot 3 and 4 would not be benched and as such stormwater measures have been shown to allow existing runoff to pass around the permanent channels and northern BIO/OSD basin.

DRAWING LIST

The Civil DA drawings provided for submission and to be read in conjunction with this report are;

Drawing No.	Drawing Name
17D83_S96_BE01	CUT AND FILL PLAN
17D83_S96_C000	COVER SHEET, DRAWING SCHEDULE, NOTES AND LOCALITY SKETCH
17D83_S96_C100	GENERAL ARRANGEMENT PLAN
17D83_S96_C101	DETAIL CIVIL PLAN, SHEET 1 OF 7
17D83_S96_C102	DETAIL CIVIL PLAN, SHEET 2 OF 7
17D83_S96_C103	DETAIL CIVIL PLAN, SHEET 3 OF 7
17D83_S96_C104	DETAIL CIVIL PLAN, SHEET 4 OF 7
17D83_S96_C105	DETAIL CIVIL PLAN, SHEET 5 OF 7
17D83_S96_C106	DETAIL CIVIL PLAN, SHEET 6 OF 7
17D83_S96_C107	DETAIL CIVIL PLAN, SHEET 7 OF 7
17D83_S96_C110	TYPICAL SITE SECTIONS, SHEET 1 OF 2
17D83_S96_C111	TYPICAL SITE SECTIONS, SHEET 2 OF 2
17D83_S96_C115	STORMWATER CHANNELS TYPICAL SECTIONS
17D83_S96_C130	ACCESS ROAD CL 1 LONG SECTION AND CHAINAGES PLAN
17D83_S96_C131	ACCESS ROAD CL 2 LONGSECTION AND CHAINAGES PLAN
17D83_S96_C200	STORMWATER MISCELLANEOUS DETAILS AND PIT LID SCHEDULE
17D83_S96_C220	STORMWATER LONGITUDINAL SECTIONS SHEET 1 OF 2
17D83_S96_C221	STORMWATER LONGITUDINAL SECTIONS SHEET 2 OF 2
17D83_S96_C230	NORTH BASIN PLAN AND SECTIONS
17D83_S96_C231	NORTH BASIN DETAILS
17D83_S96_C240	SOUTH BASIN PLAN AND SECTIONS
17D83_S96_C241	SOUTH BASIN DETAILS
17D83_S96_C250	CATCHMENT PLAN - WATER QUANTITY
17D83_S96_C251	CATCHMENT PLAN - WATER QUALITY
17D83_S96_C255	ACCESS ROAD CATCHMENT PLAN
17D83_S96_C300	RETAINING WALL OVERALL PLAN
17D83_S96_C301	RETAINING WALL LONG SECTIONS
17D83_S96_C302	RETAINING WALL SECTIONS
17D83_S96_C700	GENERAL ARRANGEMENT PLAN – STAGE 1
17D83_S96_C701	DETAIL CIVIL PLAN – STAGE 1, SHEET 1 OF 7
17D83_S96_C702	DETAIL CIVIL PLAN – STAGE 1, SHEET 2 OF 7
17D83_S96_C703	DETAIL CIVIL PLAN – STAGE 1, SHEET 3 OF 7
17D83_S96_C704	DETAIL CIVIL PLAN – STAGE 1, SHEET 4 OF 7
17D83_S96_C705	DETAIL CIVIL PLAN – STAGE 1, SHEET 5 OF 7

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17D83_S96_C706	DETAIL CIVIL PLAN – STAGE 1, SHEET 6 OF 7
17D83_S96_C707	DETAIL CIVIL PLAN – STAGE 1, SHEET 7 OF 7
17D83_S96_C710	TYPICAL SITE SECTIONS – STAGE 1, SHEE 1 OF 2
17D83_S96_C711	TYPICAL SITE SECTIONS – STAGE 1, SHEE 2 OF 2
17D83_S96_C720	STORMWATER LONGSECTIONS, SHEET 1 OF 2, STAGE 1
17D83_S96_C721	STORMWATER LONGSECTIONS, SHEET 2 OF 2, STAGE 1
17D83_S96_C730	ACCESS ROAD CL1 LONG SECTION AND CHAINAGES PLAN, STAGE 1
17D83_S96_C731	ACCESS ROAD CL2 LONG SECTION AND CHAINAGES PLAN, STAGE 1
17D83_S96_C770	RETAINING WALL OVERALL PLAN, STAGE 1
17D83_S96_C771	RETAINING WALL LONG SECTIONS, STAGE 1
17D83_S96_SE01	SEDIMENT AND EROSION CONTROL PLAN
17D83_S96_SE02	SEDIMENT AND EROSION CONTROL DETAILS

We trust this serves as an adequate summary and explanation for the complex nature of the storm water and grading issues related to this site.

Yours faithfully,

TOM DEMPSEY (Senior Civil Engineer)
For, and on behalf of,
H & H Consulting Engineers Pty Ltd

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APPENDIX A:
CIVIL DEVELOPMENT APPLICATION PLANS

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APPENDIX B:
STORMWATER MAINTENANCE MANUALS

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APPENDIX C:
HYDRAULIC TESTING OF BIO-RETENTION FILTER MEDIA

APPENDIX D:
FLOOD LEVELS DISCUSSIONS

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APPENDIX E:
BCCs DEEMED TO COMPLY SPREADSHEET PRINTOUTS

APPENDIX F:
OFFTAKE WEIR CALCULATION (SOUTH)

APPENDIX G:
HYDRAULIC AND WATER QUALITY MODELS

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APPENDIX H:
NORTH BASIN LOW FLOW CHANNEL CALCUALTION MODELS