

ENDORSEMENT PAGE

This structure plan is prepared under the provisions of the Shire of Beverley Town
Planning Scheme No. 2

IT IS CERTIFIED THAT THIS STRUCTURE PLAN WAS APPROVED BY RESOLUTION OF THE
WESTERN AUSTRALIAN PLANNING COMMISSION ON:

20 JUNE 2011

In accordance with Schedule 2, Part 4, Clause 28 (2) and refer to Part 1, 2. (b) of the
Planning and Development (Local Planning Schemes) Regulations 2015.

Date of Expiry:

19 OCTOBER 2035

Figure 3 Outline Development Plan



LEGEND



Proposed Outline Development Plan Area



Existing Lot Boundaries & Lot Numbers



Contours (2m interval)



Indicative Lots (subject to redesign at subdivision stage)



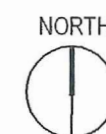
Proposed Road (Only constructed if landowner subdivides)

Notes

1. Landowners only need to construct roads if they wish to subdivide and where proposed lots do not have a road frontage.
2. Subdividing landowners are responsible for all costs associated with road construction (s158 Planning & Development Act 2005) and as per WAPC standard condition (D11) which states:

"The land being filled and/or drained at the subdividers cost to the satisfaction of the Western Australian Planning Commission and any easements and/or reserves necessary for the implementation thereof being provided free of cost.(LG)"

3. Construction of drainage swales, bunds and crossovers adjacent to each lot is to be in accordance with the approved Drainage Management Plan to the satisfaction of the Local Authority.
4. The proposed road is to have a minimum reserve width of 20 metres.
5. The Lot Layout is indicative only. The number and size of lots is to be determined at subdivision stage. Lot sizes and shape must be designed in accordance with the the Residential Design Codes.



Scale 1:2500(A3)

June 2011

Country Planning Services

ABN 90 261 896 767

PROPOSED OUTLINE DEVELOPMENT PLAN

LOTS 151 & 152, 160 - 163 BROOKING & RICHARDSON STREETS, BEVERLEY

ENDORSEMENT OF OUTLINE DEVELOPMENT PLAN FOR LOTS 152, 160 & 161 BROOKING STREET AND LOTS 151, 162 & 163 RICHARDSON STREET, BEVERLEY

The Western Australian Planning Commission resolved on 14 October 2011 to endorse the Outline Development Plan, as a guide for future subdivision within the locality.

Signed for and on behalf of the Western Australian Planning Commission

M. Thomas

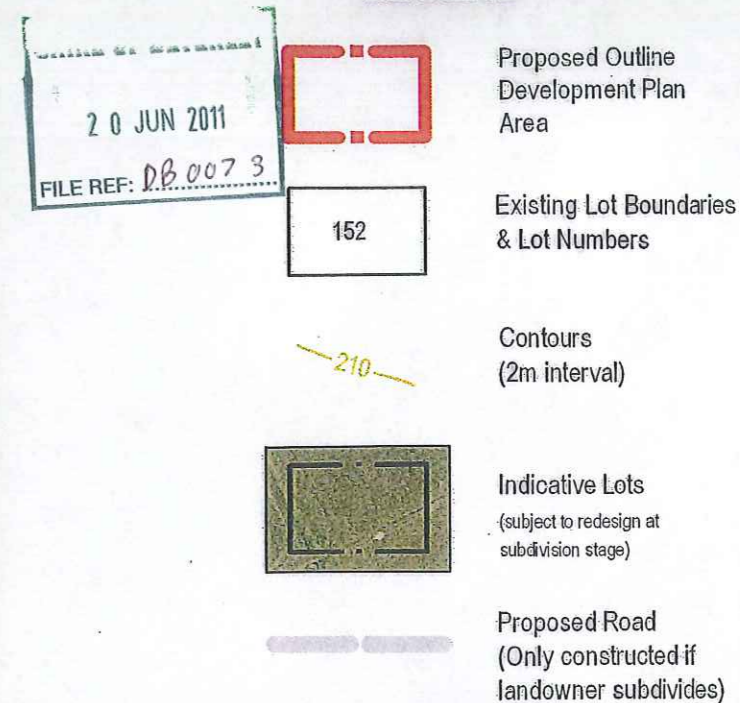
an officer of the Commission duly authorised by the Commission pursuant to section 24 of the Planning and Development Act 2005 for that purpose in the presence of

M. Wrecla Witness

18.10.2011 Date



LEGEND



Notes

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June 2011

**Country
Planning
Services**

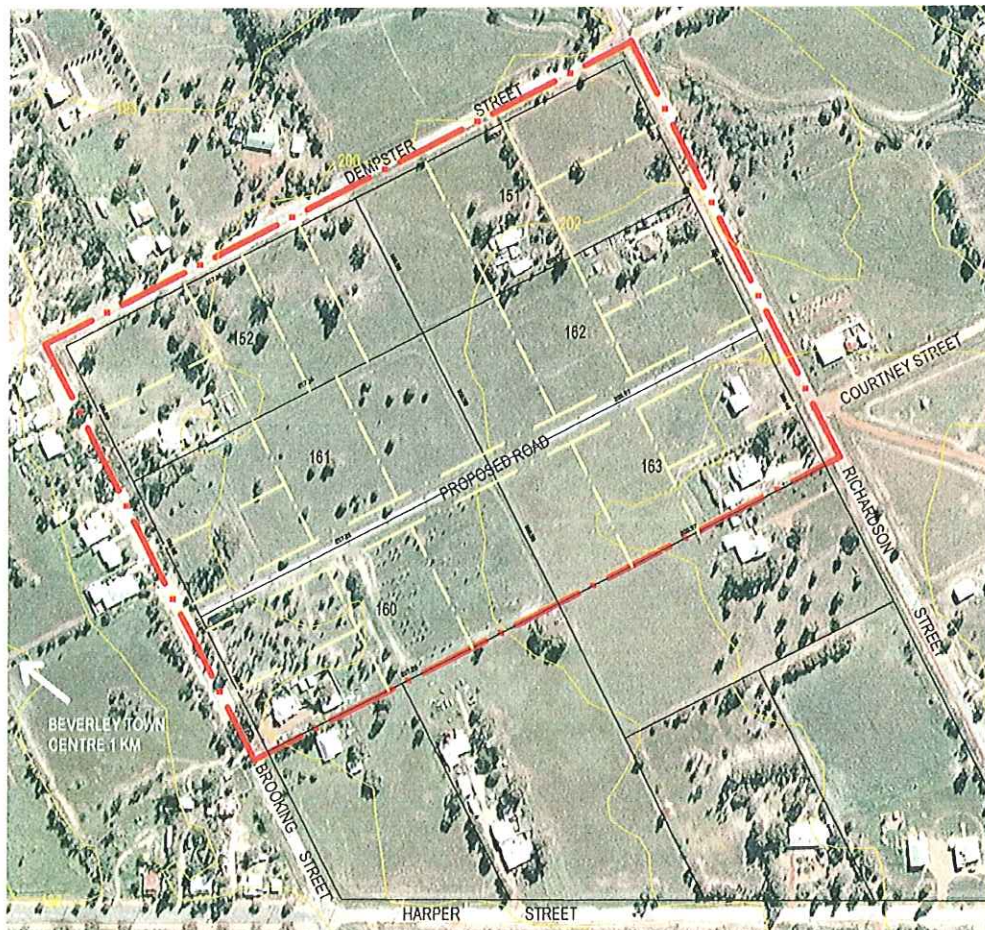
ABN 90 261 896 767

PROPOSED OUTLINE DEVELOPMENT PLAN

LOTS 151 & 152, 160 - 163 BROOKING & RICHARDSON STREETS, BEVERLEY

Outline Development Plan

Lots 152, 160 & 161 Brooking Street & Lots 151, 162 & 163 Richardson Streets, Beverley



June 2011

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Summary Information

Introduction

This Outline Development Plan (ODP) relates to land currently occupied by six lots of approximately 2 hectares each in size and seeks to provide guidance for an eventual subdivision into 26 lots (subject to application for subdivision) of a minimum size of 4,000m² each. The land is zoned Residential R2.5. Under section 4.11 of the Shire of Beverley Town Planning Scheme No. 2 it is stated that "in the Residential Zone the Council may require the preparation of an Outline Development Plan" before subdivision can be permitted. In previous correspondence with the Shire it has been indicated that an ODP will be required in this instance. Section 4.11.1 sets out the requirements and procedures required for the ODP.

Following correspondence with the Shire submitted in August 2009 it has been established that an ODP covering the area indicated in this report would be supported by Shire staff (see copy of letter dated 19 September 2009 in Appendix 1 of this report). This is subject to:

- "1. A comprehensive drainage plan by a suitably qualified person, with costings would be required. This is to allow for adequate drainage of the areas and for the drainage infrastructure cost to be allocated on a per hectare basis when lots area subdivided.
2. The width of the proposed road reserve would need to be nominated. A 20m width road reserve is suggested to match surrounding roads, and;
3. It would need to be made very explicit in the text that the proposed road is to be constructed at the subdividers cost. The shire has had some difficulty in relation to this matter with other subdivisions."

In regard to point 1 comprehensive drainage plan has been submitted by Thompson McRobert Edgeloe. A copy of the drainage plan has been submitted to the Shire separate to this report. In relation to point 2 a 20 metre width road reserve has been indicated on the ODP map. Point 3 is addressed by the inclusion of text on the ODP map.

Location of Subject Land

The townsite of Beverley lies within the central wheatbelt area, east of the Perth metropolitan area and being approximately 129 kms from Perth by road. The subject land is located about 1 kms south east of the Beverley town centre and covers an area of about 12 hectares.

Figure 1 illustrates the location of the subject land in relation to the Beverley townsite.

Figure 1. Location of subject land.

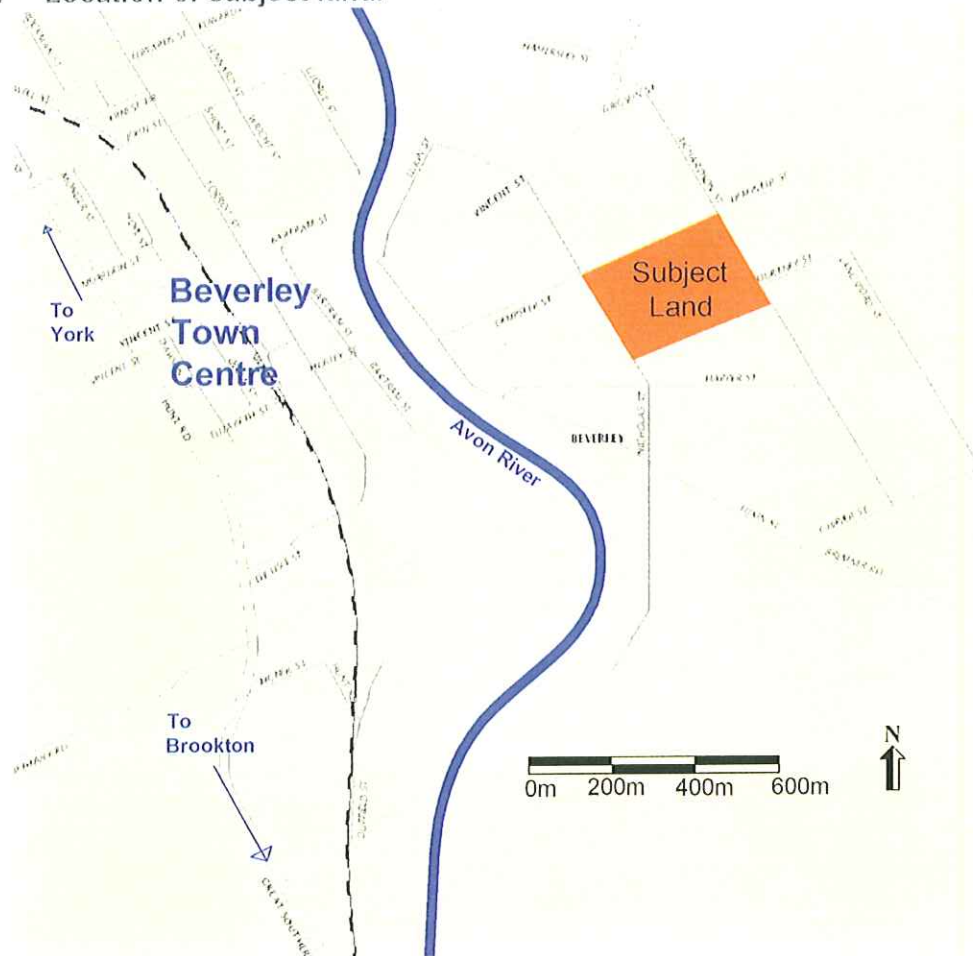
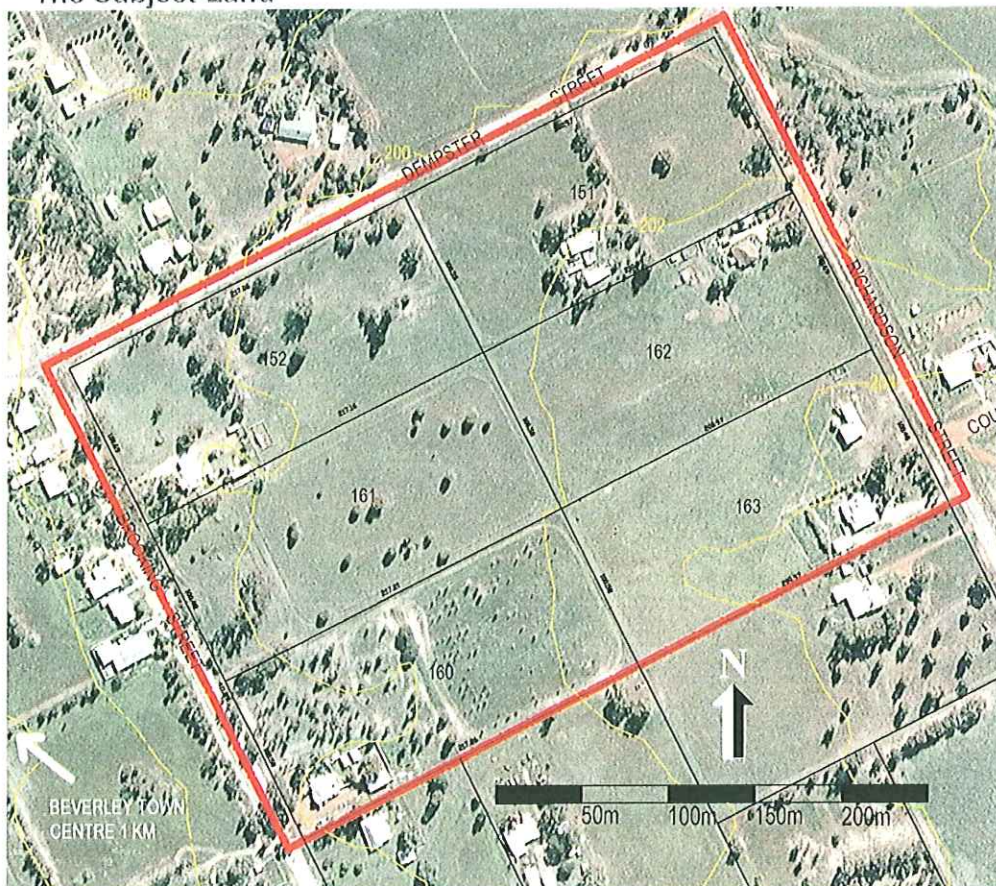


Figure 2. The Subject Land



Ownership Details

Table 1 below provides a summary of the land ownership details at the time of preparing this Local Scheme Amendment Report.

Table 1. Lot Numbers, Landowners & Areas

Lot & Street Address	Landowner	Total Lot Area
Lot 152 Brooking Street	Guy Slingerland	2.1828ha
Lot 151 Richardson Street	David Porter	2.0209ha
Lot 162 Richardson Street	Bruce & Margaret Peck	2.0209ha
Lot 163 Richardson Street	Sheldon & Jennifer Petchell	2.0209ha
Lot 160 Brooking Street	Rick & Sue Hall	2.1853ha
Lot 161 Brooking Street	Beverley Langford	2.1853ha
Total		12.6161ha

Planning Controls

State Planning Framework

State Planning Strategy:	
State Planning Policies:	<p>Policy 3.1 – Residential Design Codes (Variation 1)</p> <p>As the subject land is zoned Residential R2.5 the Residential Design Codes apply. In this instance the main requirements of the codes are found in Table 1 – General Site Requirements which given the R2.5 coding requires that each proposed lot has a minimum area of 4000m² and a minimum frontage of 40 m. Primary street setback is 15m and other boundary setbacks are 7.5m.</p> <p>Policy 3.6 - Development Contributions for Infrastructure (November 2009)</p> <p>This policy is mainly to ensure that contributions are necessary and relevant to the development and lists in Appendix 1 the standard development contributions that can be applied at the subdivision stage. Local Authorities may not apply additional costs for items not indicated in Appendix 1 without having an adopted Development Contribution Plan. It is also understood however that this policy is currently under review.</p>
Development Control Policies:	<p>Policy 1.1 – Subdivision of Land – General Principles (June 2004)</p> <p>Provides the general principles for the WAPC to determine applications for subdivision. The policy objectives in brief area as follows:</p> <ul style="list-style-type: none"> • the proposal being in conformity with the local planning scheme, • has a coordinated approach, • is responsive to the local characteristics of the area, • achieves appropriate standards of health, safety and amenity, • facilitates appropriate access, • ensures constructed vehicle from the gazetted road system to each new lot, • to create lots that are capable of lawful development, • to secure appropriate public utility services to each new lot • to make appropriate arrangements for development contributions, and • to make appropriate arrangements, where necessary for the ceding or transfer of land.

	<p>The policy also outlines the requirements for structure plans (or outline development plan in this case) and their role in guiding subdivision and development.</p>
<p>Wheatbelt Regional Strategy – Directions Paper, August 2009</p>	<p>The WRS directions paper generally predicts a decline in rural activity related populations in the wheatbelt area. For this reason and to support local economies residential subdivisions within or close to town sites should be encouraged in order to assist in boosting local economies.</p> <p>It is stated in Section 5 on page 29 in relation to Land Supply as follows:</p> <p>Possible measures to secure an appropriate land supply in the Wheatbelt include the following statements:</p> <ul style="list-style-type: none"> • “Ensuring an adequate supply of greenfield land is identified in local planning strategies, based on demand assessment and realistic expectations of infrastructure capacity”, and • “Establishing structure planning areas to facilitate re-subdivision of existing urban land based on workable urban cells and developer intentions.” <p>This proposal is in conformity with the above measures and presents an opportunity to facilitate urban land supply.</p>
<p>Avon Arc Sub-Regional Strategy - September 2005 (AASRS)</p>	<p>The Avon Arc Sub-Regional Strategy covers the wheatbelt area extending between Gingin and Brookton and hence forms a large arc extending out north and east of the metropolitan area. In relation to this proposal the AASRS generally supports subdivision and development of areas close to towns that will not interfere with areas of agricultural production. Given that the subject land is zoned residential and that the lots are already of a size too small for productive agriculture then the subdivision is not in conflict with any of the objectives of the AASRS.</p>
<p>Other:</p>	<p>Nil applicable.</p>

Local Planning Framework

<p>Local Planning Scheme:</p>	<p>Shire of Beverley Town Planning Scheme No.2</p>
<p>Scheme Text:</p>	<p>Section 4.11.1 outlines the requirements for subdivision in the Residential Zone and that Council may require an Outline Development Plan before permitting subdivision. In this case it is understood that an ODP is required.</p> <p>4.11.1 a) – e) outlines the requirements for the preparation</p>

		of the ODP and the process for assessment and adoption of the ODP.
Map	Zone:	"Residential"
	Reserves:	NA
	R-Coding:	R2.5
Local Planning Policy (Strategies, Local Area Plans, etc):		None Applicable

Topography, Soils and Vegetation

The subject land consists mostly of cleared pasture and has a gentle slope from between the 204m AHD contour in the east down to the 198m AHD contour at the north western corner of Lot 152 Brooking Street. The soil texture generally consists of moderately well drained sandy loam surface soils overlying clay loam sub surface soils (CSIRO). Vegetation coverage is sparse and is mainly located adjacent to fence lines and around the areas occupied by dwellings. Native vegetation consists mostly of eucalypts located in scattered stands with no understorey.

Drainage

Existing drainage of the site is generally catered for in the adjoining streets by well defined road side swales with culverts operating effectively. A non-perennial creek line provides the major outfall to the west. Information from the Department of Water indicates that there are no flooding implications over the site and none of the land is within the 100 Year Floodplain associated with the Avon River approximately 750 metres to the west of the site.

In response to correspondence from the Shire dated 18 September 2009 a comprehensive drainage plan was prepared by TME and submitted to the shire for review. The drainage plan includes estimates of predevelopment and post development flows, proposals for drainage infrastructure and the allocation of drainage infrastructure costs. Also groundwater investigation of the site has been in progress by the installation of 12 monitoring bores at locations specified by the drainage engineer. Monitoring of the bores has been conducted from April 2010 and continues on a 3 monthly basis. The drainage study has been submitted to the Shire of Beverley under separate cover to this report.

Environmental Considerations

Vegetation

Much of the vegetation on the site is planted by landowners however isolated stands of eucalypts occupy parts of the site. Given the lot sizes proposed and that vegetation is scattered and that it mainly occupies areas associated with houses or along fence lines there will be minimal need for vegetation removal once the land has been subdivided and developed in accordance with the ODP.

Acid Sulphate Soils

Information from the CSIRO indicates that the majority of the site is rated as "low probability" for acid sulphate soils. A small section of the north eastern corner is rated as "No known occurrence". It is therefore considered that given the nature of the low density residential development and the low probability of acid sulphate soils in the site that this will not be an issue.

Servicing

Roads

The site is bounded by Brooking, Dempster and Richardson Roads. These are all sealed and drained and occupy 20 metre width road reserves.

Water Supply

The site is serviced by a Water Corporation reticulated water supply with 150, 100 and 58mm diameter mains in Dempster, Brooking and Richardson Streets respectively.

Sewerage

There is no reticulated sewerage service in the vicinity of the subject land. The proposed lots will all be over 4,000m² therefore well over the 2000m² lot size under which require reticulated sewerage by the Department of Health/ Water Corporation's Country Sewerage Policy. On site effluent disposal will therefore be acceptable subject to leach drains being above the minimum separation from groundwater requirements as specified by the Shires Health Department and in accordance with the requirements of the Department of Health.

Power

Standard Western Power electricity services are available to the site.

Telecommunications

Standard Telstra telecommunication services are available to the site.

Proposal

Layout

The Outline Development Plan proposes to guide subdivision of the subject land to allow subdivision of lots of a minimum lot size of 4,000m² in accordance with the requirements of the Residential Design Codes for lots coded R2.5. Each lot must also have a minimum road frontage of 40 metres. In order to provide appropriate road frontage an access road is proposed between Lots 162 & 163 and Lots 161 & 160. As requested by the Shire a 20 metre road reserve width is specified to provide continuity with existing road reserve widths and also to allow ample room for swale drains as proposed by the TME Drainage Plan. Another consideration for placement of the road reserve is that each end of the road does not place a T intersection directly in front of any existing houses.

Road Construction

The proposed road and its associated infrastructure is to be constructed at the subdividers cost. Involved landowners have been notified of this requirement. This is a standard requirement of all subdivision proposals within the state (via the provisions of Section 158 of the Planning and Development Act 2005). Also the ODP includes a notation that the WAPC standard condition regarding construction and draining of roads will apply and that works will need to be in accordance with the approved Drainage Management Plan (see notes 2 & 3 on the ODP).

Variations to the ODP

It is also to be noted that the ODP is for guidance purposes only and that landowners should be able to vary the lot layouts on their properties if they wish to do so. This is providing any rearrangement of lots does not interfere with the overall access layout of the plan and is in keeping with the requirements of the Shire of Beverley Town Planning Scheme No.2 and the Residential Design Codes.

Conclusion

The ODP provides a simple and efficient mechanism for guiding subdivision of the existing six lots. It is also understood that the eventual subdivision of the lots will allow for low density residential lots that will appeal to many metropolitan dwellers looking for a change in lifestyle. In conclusion it is believed that the subdivision of the land will be of benefit to the town and for the following reasons should be supported:

- The ODP provides well defined road access to all proposed lots whilst allowing for the minimum 40 metre lot frontage requirement.
- The ODP provides for an efficient and connective street layout that allows for ready vehicle access to each new lot which is also effective for safety considerations (ie there are no cul de sacs and all lots can be accessed from two directions).
- The ODP provides a simple and effective layout that is in keeping with the character of the surrounding area and is complementary to the overall character of the Beverley townsite.

For the above reasons it is hoped that Council will look favourably on this plan as a positive step forward for the future economy and wellbeing of the Beverley community.

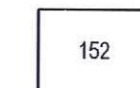
Figure 3 Outline Development Plan



LEGEND



Proposed Outline
Development Plan
Area



Existing Lot Boundaries
& Lot Numbers



Contours
(2m interval)



Indicative Lots
(subject to redesign at
subdivision stage)



Proposed Road
(Only constructed if
landowner subdivides)

Notes

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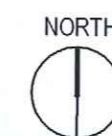
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LOTS 151 & 152, 160 - 163 BROOKING & RICHARDSON STREETS, BEVERLEY

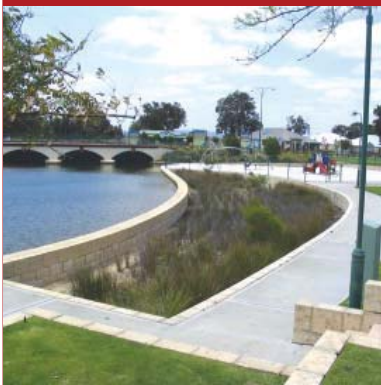


Thompson McRobert Edgeloe
Group

Beverley Drainage Study

Lots 151, 152 and 160 to 163

Brooking and Richardson Streets, Beverley



Research, Design & Delivery of
Sustainable Development

10141
August 2010

DOCUMENT QUALITY CONTROL

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DATE
12.08.2010

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DATE
12.08.2010

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REVISION TABLE

No.	PURPOSE	DATE

THOMPSON McROBERT EDGELOE
PO BOX 733, BUNBURY
PH: (08) 9791 4411



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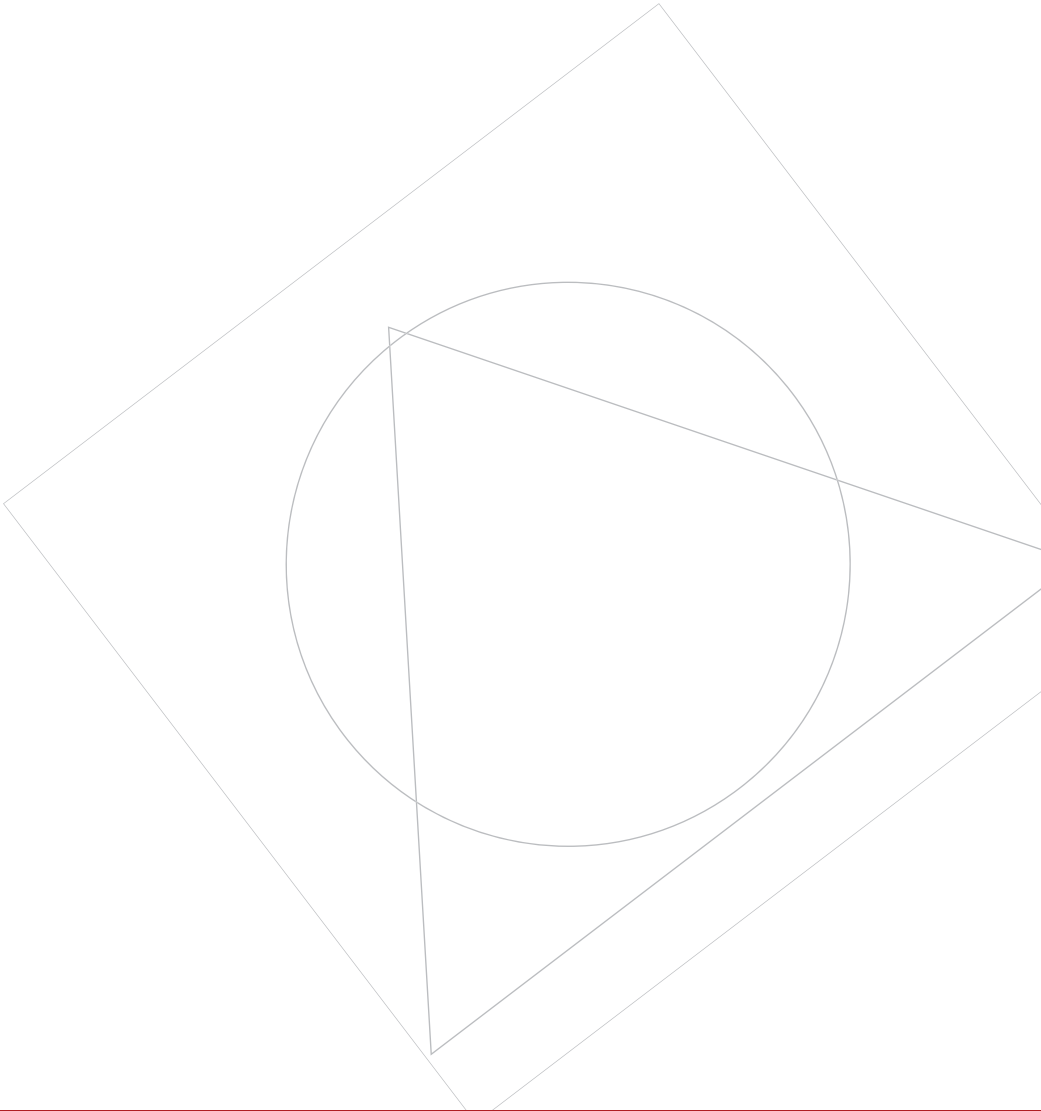


LIST OF ATTACHMENTS

Attachment A	1:5year Peak Flow Analysis (2 Pages)
Attachment B	1:100year Peak Flow Analysis (2 Pages)
Attachment C	Attenuation Calculations (9 Pages)
Attachment D	Swale Drain Calculations
Attachment E	Design Summary Sheet
Attachment F	Preliminary Cost Estimate

LIST OF PLANS

10141E-CK01	Predevelopment Drainage 1:5yr and 1:100yr (Sheet 1)
10141E-CK02	Predevelopment Drainage 1:5yr and 1:100yr (Sheet 2)
10141E-CK03	Post Development Drainage 1:1yr, 1:5yr and 1:100yr (Sheet 1)
10141E-CK04	Post Development Drainage 1:1yr, 1:5yr and 1:100yr (Sheet 2)





1.0 INTRODUCTION

Thompson McRobert Edgeloe Group Pty Ltd were engaged by Mr Guy Slingerland to undertake a Drainage Study (DS) of the Beverley ODP area, located between Brooking and Richardson Streets. The area is as depicted in Figure 1, below.



Figure 1: Beverley ODP area (ex Country Planning Services)

This engagement is in response to a letter to Country Planning Services (acting as Mr Slingerland's planning consultant) from the Shire of Beverley (dated 18 September 2009) following a preliminary review of the ODP. The Shire requested that a comprehensive drainage plan be prepared.



2.0 STUDY OBJECTIVES AND METHODOLOGY

The key objectives of the DS were to provide a clear understanding of the catchment/s in terms of existing drainage conditions and develop a preliminary treatment and disposal system in order to meet current design parameters in terms of volume and quality. This was achieved by:

1. Determining predevelopment runoff parameters;
2. Calculating post-development detention volumes for the 1year, 5year and 100year storm events and developing drainage concepts for drainage management for the area; and
3. Determining land requirements for drainage management structures.

The study was conducted using the following methodology:

- o Preparation of base plans.
- o Verifying visible drainage infrastructure, runoff directions and ascertain catchment parameters on site.
- o Overlaying the ODP, developing post-development catchments and analysing runoff for the 1year, 5year and 100year storm events.
- o Determination of allowable runoff from the proposed development into the existing downstream drainage network.
- o Determining attenuation and treatment areas (volume and area) for the 1year, 5year and 100year storm events to ensure allowable runoff is not exceeded.
- o Determining attenuated accumulative runoff from networked catchments to outfall areas.
- o Preparation of recommendations to adequately dispose of minor and major storm events as well as Water Sensitive Urban Design considerations.



3.0 PREDEVELOPMENT CONDITIONS

Refer to drawings CK01 and CK02.

The catchment boundary was well defined. Geometrical in shape and bounded by Dempster, Richardson, Harper and Brooking Streets. Three sub-catchments were identified (PD 1 to PD3) with outfall nodes by way of culverts (225mm dia under Harper Street and 300mm dia under both Dempster Street crossings (west and east of the catchment)). Average grade across the site are gentle and in the order of 1.0% to 1.3%.

Generally road swales are well defined with culverts operating effectively. There is no sign of scour and very little surface water was noted. There appeared to be some perching on the verge on Harper Street (mid-way along as the grade flattens).



Photo 1: Minor inundation mid-way along Harper Street

A non-perennial creekline provides the major outfall to the west. No water was flowing on the date of the site inspection (2 August 2010). According to DoW mapping there are no flood implications over the site.



Photo 2: Non-perennial creekline (taken at Dempster Street looking west)

The ODP area consists generally of well grassed paddocks



Photo 3: General appearance of ODP runoff area



4.0 GEOLOGY AND GROUNDWATER

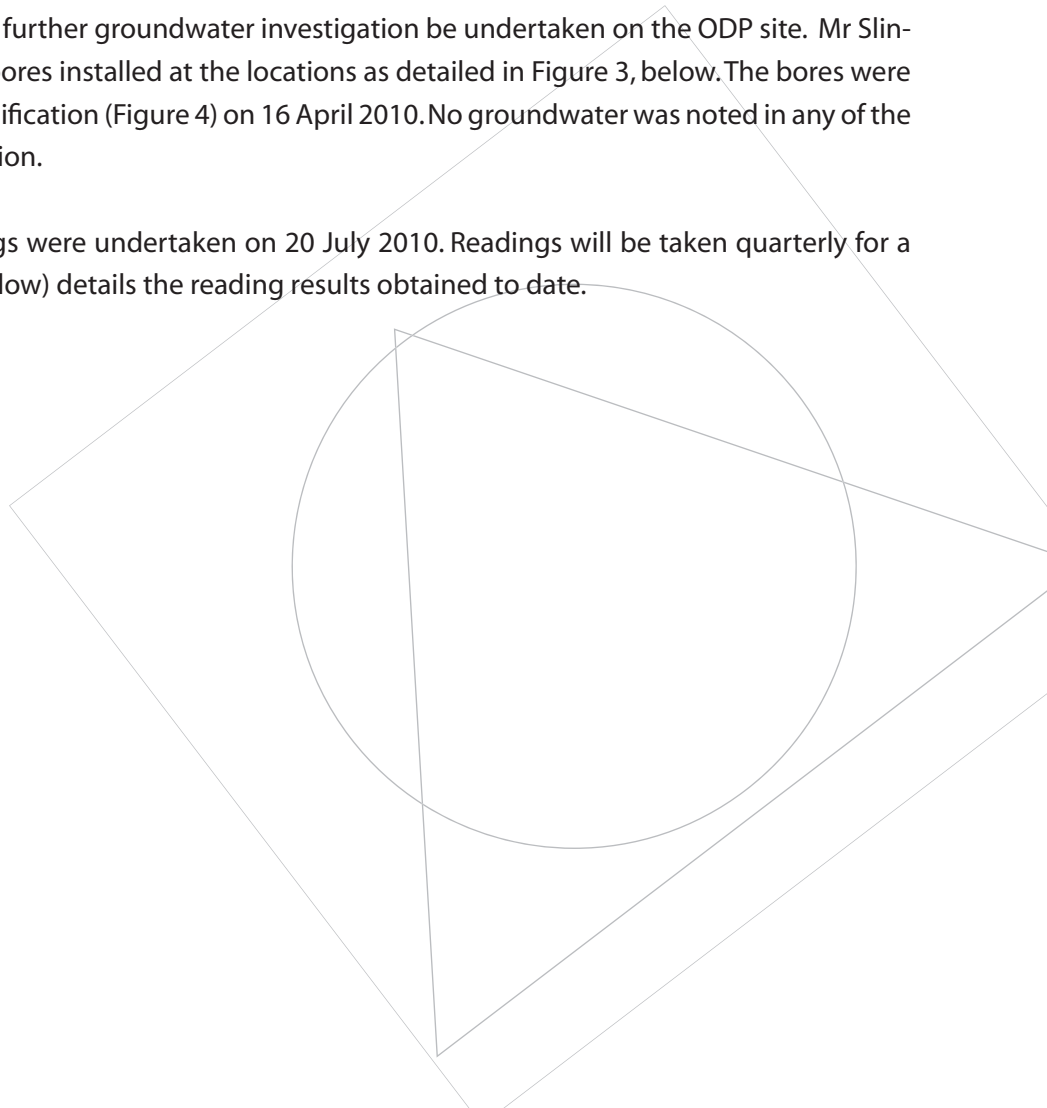
The Department of Agriculture and Food's preliminary groundwater investigation of the Beverley townsite (May 2006 – Ned Crossley) states that 7 shallow monitoring bores were drilled to 3m depth. One of these bores is located near the intersection of Brooking and Dempster Streets (ref# 05BE05S). No groundwater was intersected on any of the bores. The report also notes "the well incised creeklines flowing through the town and the readily drainable soils ...". In conclusion a low salinity risk is provided for the townsite.

Figure 2 (below) – Drillers Field Log for the Brooking/Dempster bore details yellow sand/clay sand to 3m depth and brown sandy clay to 4m. Static Water Level (SWL) at completion (7/09/2005) was dry. On 10/04/2006 the bore was again dry.

Regarding Acid Sulphate Soils, a desktop study has found that in accordance with the CSIRO's nation database the main portion of the site is classified as "low probability" with the northeastern corner deemed to have "no known occurrence".

The Shire has requested that further groundwater investigation be undertaken on the ODP site. Mr Slingerland had 12 monitoring bores installed at the locations as detailed in Figure 3, below. The bores were installed to the supplied specification (Figure 4) on 16 April 2010. No groundwater was noted in any of the bores on the date of installation.

The second round of readings were undertaken on 20 July 2010. Readings will be taken quarterly for a two-year period. Figure 5 (below) details the reading results obtained to date.





Catchment Hydrology Group: Drillers Field Log

Site Details	
Date : 7/9/05	Landform/Unit : Break of slope/valley floor
Catchment/Project/Owner: Beverley Rural Towns Program	Year Cleared : Location: South side of Dempster St Reserve
Local Bore #: 05BE05S	AMG Easting (m): 493945
W+R Bore #	AMG Northing (m): 6447599
Driller: Fred Bremner	AHD (m) :

Depth (m)	Sample Description and Drilling Comments	Geology
0	Yellow sand – clay sand	3° Sediments
3	Brown sandy clay	3° Sediments
4	Bottom of hole	

Bore Completion Details		
Depth Drilled (m) :	4 m	Water Injected at 3 m
Casing Total Length (m) :	4.3	Est. Watertable during drilling (m): none
A.G.L.(m) :	0.3	Casing Installation: GOOD/O.K./FORCED
Screen Length (m) :	2 m	Estimated Yield:
Material Screened:	clay sand	S.W.L. at Completion (m): DRY
Drill Method/Bit Size (Diam. mm):	Auger 90 mm	
Casing Type & Diam. (mm):	PVC 50 mm	First SWL (m) : DRY on _10/04/06

Figure 2: Drillers Field Log (05BE05S).



Figure 3: Piezometer Locations

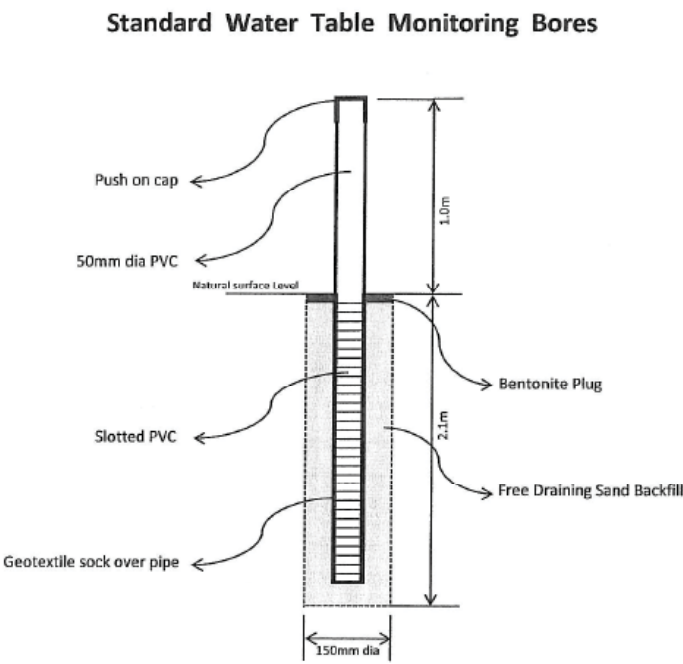


Figure 4: Piezometer Specification



10141 - Brooking Street ODP Groundwater Monitoring

Piezo Number	Reading Date and Depth To Groundwater (m)								
	16/04/2010	20/07/2010	Oct-10	Jan-11	Apr-11	Jul-11	Oct-11	Jan-12	Apr-12
1	Dry	+2							
2	Dry	0.6							
3	Dry	+2							
4	Dry	+2							
5	Dry	+2							
6	Dry	1.1							
7	Dry	+2							
8	Dry	1.4							
9	Dry	1.2							
10	Dry	+2							
11	Dry	+2							
12	Dry	1.5							

Notes

Piezometers installed 16 April 2010

Figure 5: Piezometer reading on ODP area to date



Photo 4: Piezometer 3 (adjacent to Dempster Street)

For the purposes of the Drainage Study it is assumed that there will be nominal infiltration (although this is not included in the drainage calculations) and that groundwater will be generally 1.0m to 1.5m below natural ground level.



5.0 DRAINAGE CONCEPT

Refer to Drawings CK02 and CK03.

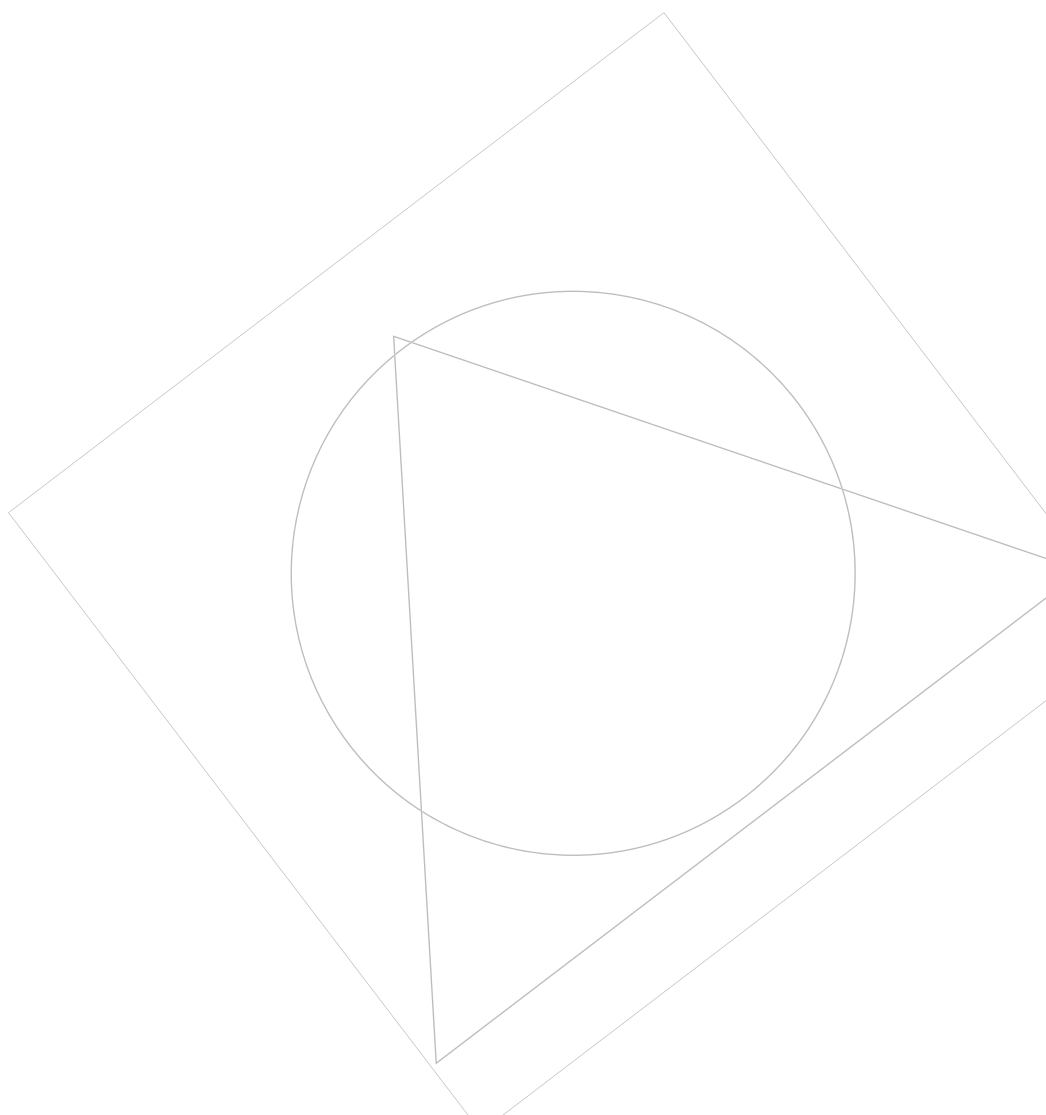
1:1year 1hour Event

The 1year 1hour volume is to be treated/stored at source in the roadside swales by way of infiltration through a bioretention medium consisting of sand mixed 30/70 with sawdust/free draining sand. Property crossover culverts would be set 0.3m above the swale invert to ensure infiltration.

1:5year and 1:100year events

The balance of the available swale volume (maximum depth of 0.6m) will attenuate runoff peak flows to the capacity of the existing culverts (Nodes PD 1 and PD2). This rate of peak runoff is less than the pre-development flow and ensures no uncontrolled breakout over roads.

The combined effect of attenuation areas provides a throttled outflow which will minimise impact on downstream drainage infrastructure.





6.0 DRAINAGE DESIGN PARAMETERS

To model the drainage catchments Rational Method calculations were utilised. Attenuation (where required) was analysed (in accordance with Australian Rainfall and Runoff) up to 72hours.

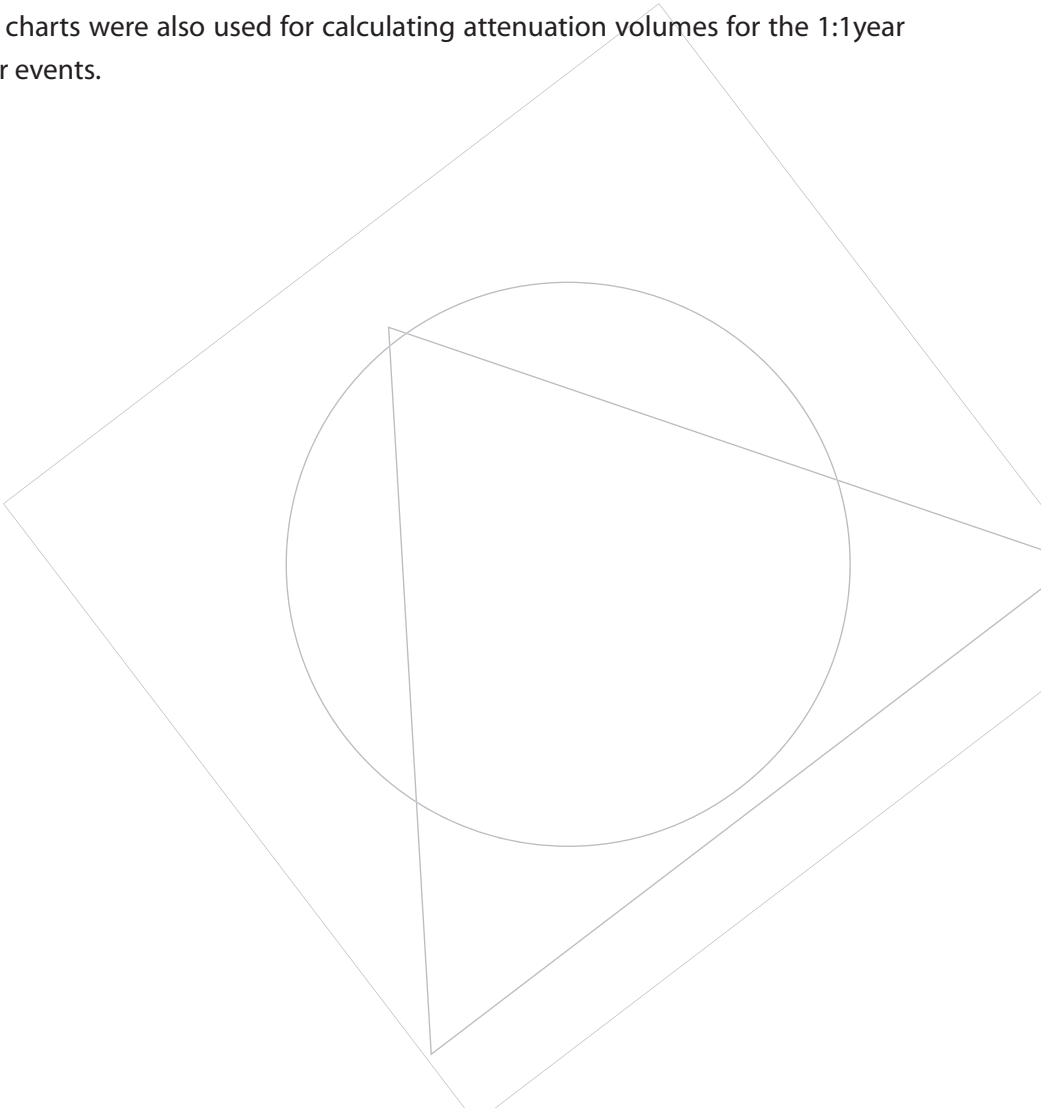
The post development runoff coefficients selected therefore were:

1:5year and 1:100year	
C (Road Reserves):	0.8
C (Lot Area - Developed):	1.0 (assuming 800m ² of impervious area per lot)
C (Lot Area – Balance):	0.4

A Horton’s Roughness Coefficient (retardance factor) of 0.1 (short grass paddock) was selected.

Local IFD Charts for Beverley were calculated using ARR and the 1,5 and 100year ARI events used in determining runoff volumes.

Intensity values from the IFD charts were also used for calculating attenuation volumes for the 1:1year (1hour), 1:5year and 1:100year events.





7.0 HYDROLOGICAL ANALYSIS

The developed ODP area was divided into 3 catchments. Drawing CK03 and CK04 details the proposed 1:1year (1hour); 1:5year and 1:100year infrastructure.

The Rational Method was utilised to determine runoff from each catchment node for the 1:5year and 1:100year peak events.

Storage calculations make use of the relevant storm intensities and conservatively assume no soakage. Storage is assessed up to 72hours for each catchment.

7.1 1:1year System

To determine the 1year 1hour storage/treatment volumes the Equivalent Impervious Areas (from Attachment A) were applied to the Storage calculation spreadsheets (Attachment C – pages 1,4 and 7). For each catchment a storage volume was determined (with zero outflow) to attenuate the 1hour storm event.

This ephemeral zone would be 0.3m deep and equal 25% of the roadside swale volume. Attachment D details the available volume (42m³ per 40m length (ie 1m³ per linear metre) – being 50% of the overall swale volume at a depth of 0.6m). Property crossover culverts would be set 0.3m above the swale invert to ensure infiltration (required to be 50% of the total storage volume – Attachment E) through the medium.

The Shire of Beverley is to be encouraged to upgrade road swales and install a similar treatment chain on Richardson Street upstream of the ODP area (some 300m in length).

The 1:1year 1hour volumes results are summarised in Attachment F and on Drawings CK03 and CK04.

At detailed design stage the swales would be designed to meet the storage requirements per catchment.

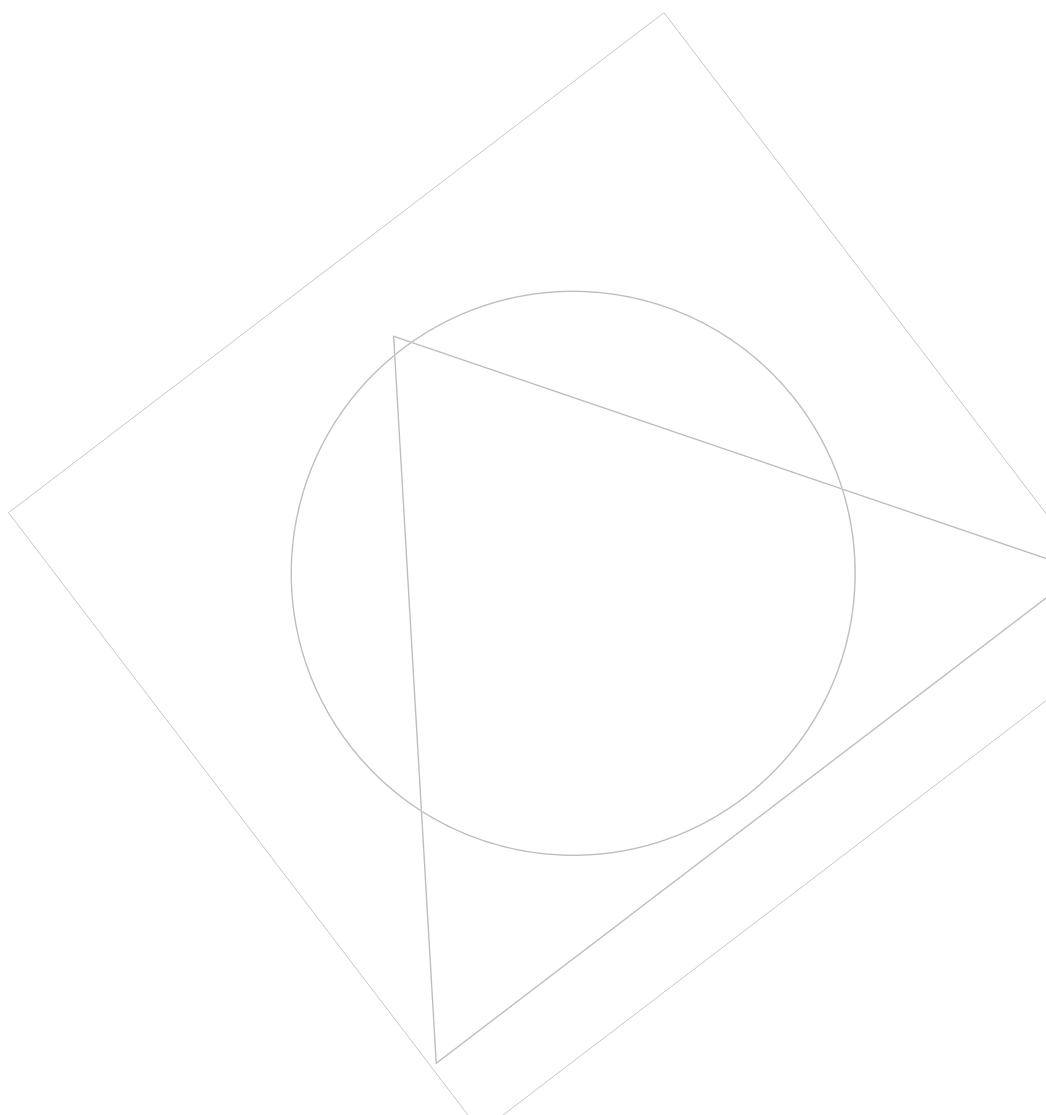
7.2 1:5year System

Applying the attenuation volume from the 1:1year 1hour event to each catchment (Attachment C – pages 2,5 and 8) revealed that peak runoff was already less than predevelopment. Therefore no further attenuation is required for the 1:5year peak event. The outflow cell on each of the 1:5year catchment spreadsheets was adjusted to reflect the predicted peak flow. These peak flows are summarised in Attachment E and on Drawings CK03 and CK04.



7.3 1:100year System

Applying further attenuation to augment the 1:1year 1hour storage (Attachment C – pages 3, 6 and 9) the peak flows from each catchment were reduced to achieve predicted practical culvert outflows (based on actual HW/D). These peak flows and attenuation volumes are summarised in Attachment E and on Drawings CK03 and CK04.





8.0 ROADSIDE SWALES

Attachment D provides a Mannings calculation confirming that the swale profile (depth 0.6m, side slopes 1:5 side slopes and maximum grade of 1.3%):

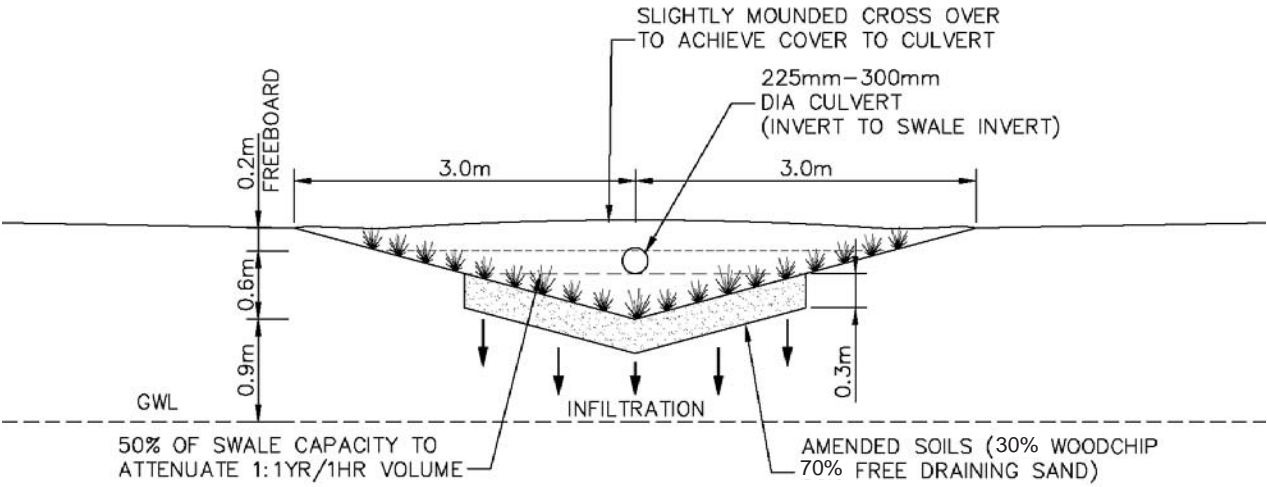
1. Has adequate conveyance potential (max 3.95m³/s); and
2. At this grade 50% of its capacity (approx 1m³/m) is available for attenuation.

Therefore over a 40m length (the approximate distance between property crossovers, culverts could be set 0.3m above the swale invert level to ensure adequate infiltration of the 1year 1hour event (totaling approximately 50% of the runoff volume (Attachment E). Crossovers will be required to be slightly mounded to achieve cover over crossover pipes.

The section of Richardson Street upstream of the ODP area should be reshaped and bunded every 40m with a trickle pipe 0.3m above invert in order to achieve attenuation.

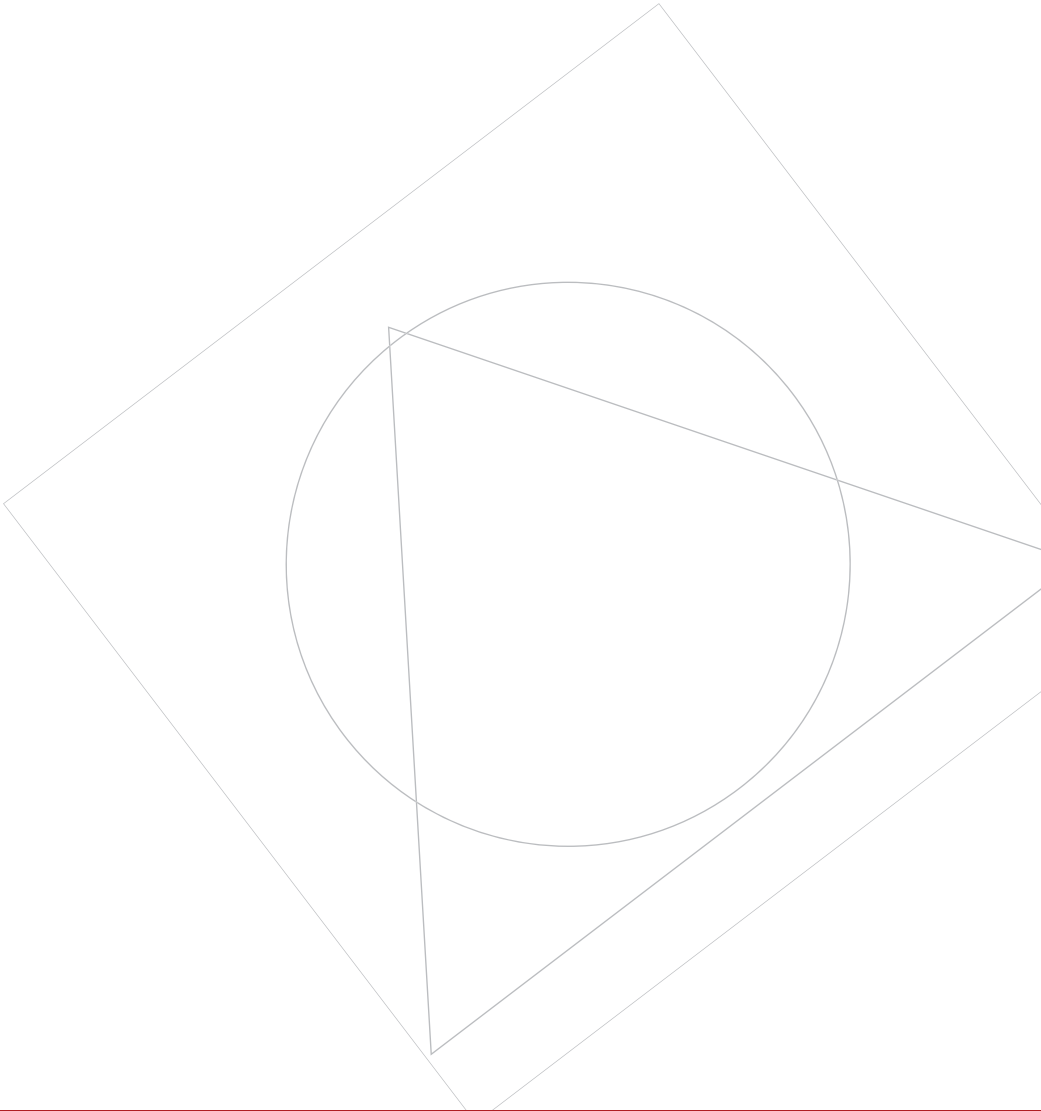


Photo 5: Richardson Street swale upstream of ODP area.



TYPICAL SWALE CROSS SECTION
1:50

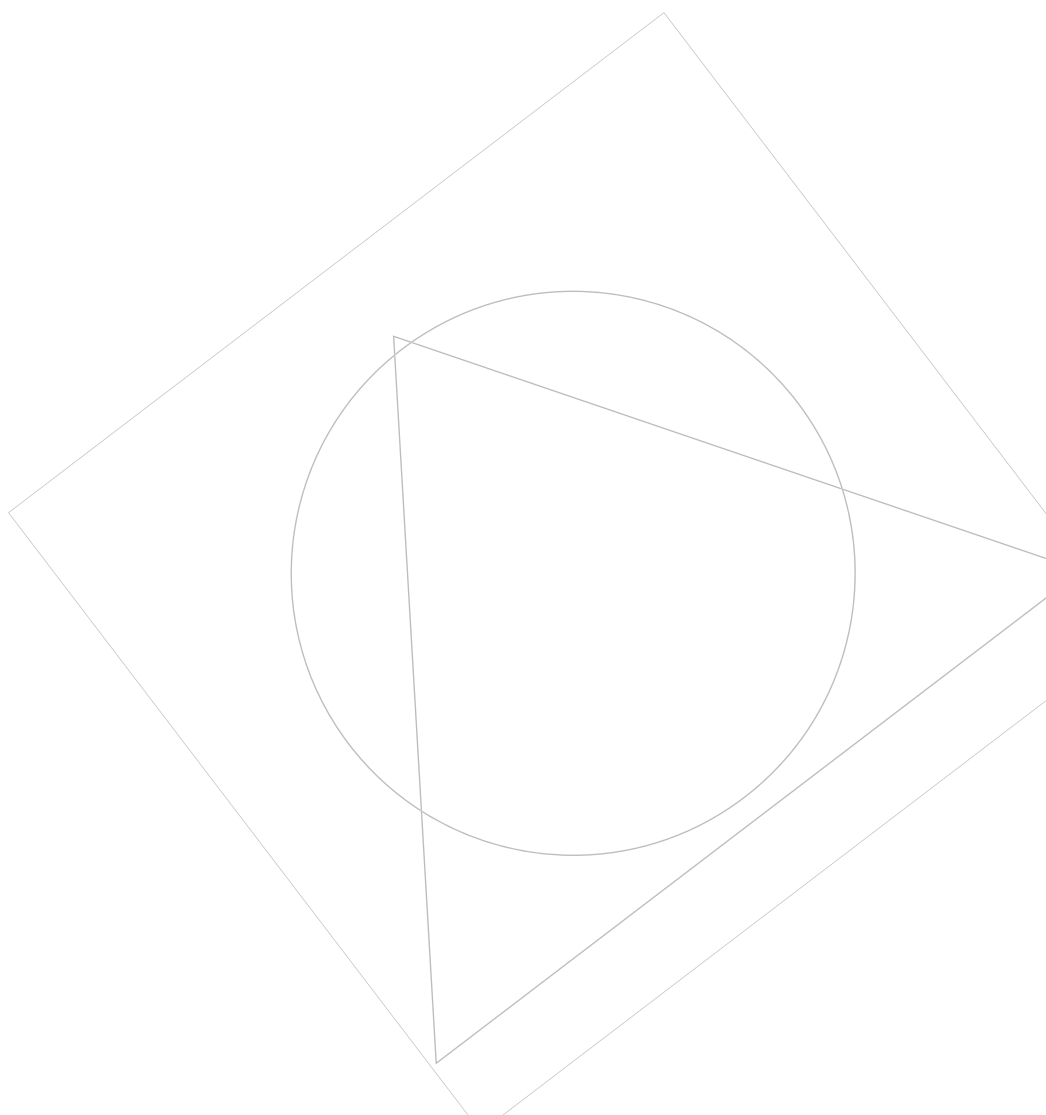
Figure 6: Typical swale and crossover detail





9.0 PRELIMINARY ESTIMATE

Attachment F provides detailed quantities and rates to construct the drainage swales and crossover pipes within the ODP area. This estimate does not include base course and sealing of crossovers (this would be covered under roadworks). The preliminary estimate does however include all bund works, culvert pipe installation, amended soils and respread of topsoil.





ATTACHMENT A



1:5YEAR DRAINAGE DESIGN

Job: Brooking Str Beverley
Job No: 10141E

Table 4.06.4 Surface roughness or retardance factors

Surface Type	Horton's Roughness Coefficient <i>n</i> *
Concrete or Asphalt	0.010 – 0.013
Bare Sand	0.010 – 0.016
Gravelled Surface	0.012 – 0.030
Bare Clay-Loam Soil (eroded)	0.012 – 0.033
Sparse Vegetation	0.053 – 0.130
Short Grass Paddock	0.100 0.200
LAWNS	0.170 – 0.480

Notes (Table 4.06.4):

1. The surface roughness/retardance coefficient *n** is similar but not identical to Manning's "n" value for surface roughness.

change to
suit ARI

Road Reserve C=
Lots (developed) C=
Lots (balance) C=

0.80
1.00
0.40

Beverley coefs for 5 yr storm

A
B
C
D
E
F
G

2.93368
-0.6589847
0.0015754
0.0074902
-0.0025913
3.272E-06
2.683E-05

n value source QUDM
pasture use 0.035
bush 0.05 - 0.075
trees 0.15

1	2	3	4	5	6	7	8	9	10	11	12	13		
Pit	Chainage	Flow Length (m)	road Slope (%)	catchment Slope (%)	catchment Slope (m/m)	"n"	Time by Kinematic Wave equation (min)	Total Time (min)	Intensity I (mm/hr)	Road Reserve Area (ha)	Lot Area (dev) (ha)	Lot Area (balance) (ha)	sum CA (ha)	(8)*12/0.36 Q=CIA/0.36
PD1	0	450	1	0.01	0.014	0.1	82.0	82.0	15.31	0.60	0.25	8.78	4.242	180.35
PD2	0	515	0.6	0.006	0.014	0.1	91.0	91.0	14.30	0.47	0.13	5.93	2.878	114.28
PD3	0	620	1.2	0.012	0.011	0.1	117.0	117.0	12.13	0.90	0.30	6.18	3.492	117.70
1	0	480	1.2	0.012	0.014	0.1	86.0	86.0	14.83	0.46	0.64	2.84	2.144	88.35
2	0	590	0.6	0.006	0.014	0.1	102.0	102.0	13.27	0.75	0.64	2.88	2.392	88.16
3	0	620	1.2	0.012	0.011	0.1	117.0	117.0	12.13	0.99	0.80	3.71	3.076	103.68

NETWORKED FLOWS

Job: Brooking Str Beverley
Job No: 10141E

DRAINAGE DESIGN 1 IN 5 YEAR STORM

based on 1m/sec																										
1a				1b	1c		1d		U/S node maximum Tc for pipe B		U/S node maximum Tc for pipe C		travel time in U/S pipe		travel time in U/S pipe		1e		2		3	4a	4b	4c	5	
Pipe	Pipe Number (must be in ascending order)	U/s pipe A (insert 0 if no pipe)	U/s pipe B (insert 0 if no pipe)	U/s pipe C (insert 0 if no pipe)	Pipe Length	Travel time in pipe	(min)	(min)	(min)	(min)	(min)	(min)	(min)	(min)	(min)	(min)	(min)	from column 1c for upstream pipe A	from column 1c for upstream pipe B	from column 1c for upstream pipe C	Time tc	Intensity I	Local Catchment to Node (from step 1)	Other Upstream catchments to node	Sum C.A. = 4a + 4b	Q=CIA/0.36
					(m)	(min)	(min)	(min)	(min)	(min)	(min)	(min)	(min)	(min)	(min)	(min)	(min)						(ha)	(ha)	(ha)	(l/s)
start	0	0	0	0			0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00								0	
1-2	1	0	0	0	210	3.50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	86.00				86.00	14.83	2.14	0.00	2.14	88.35
2-Outlet1	2	1	0	0	10	0.17	86.00	0.00	0.00	0.00	3.50	0.00	0.00	0.00	0.00	3.50	105.50	3.50	0.00	0.00	105.50	12.98	2.39	2.14	4.54	163.54



ATTACHMENT B



1:100YEAR DRAINAGE DESIGN

Job: Brooking Str Beverley
Job No: 10141E

Table 4.06.4 Surface roughness or retardance factors

Surface Type	Horton's Roughness Coefficient <i>n</i> *
Concrete or Asphalt	0.010 – 0.013
Bare Sand	0.010 – 0.016
Gravelled Surface	0.012 – 0.030
Bare Clay-Loam Soil (eroded)	0.012 – 0.033
Sparse Vegetation	0.053 – 0.130
Short Grass Paddock	0.100 0.200
LAWNS	0.170 – 0.480

Notes (Table 4.06.4):

1. The surface roughness/retardance coefficient *n** is similar but not identical to Manning's "n" value for surface roughness.

change to
suit ARI

Road Reserve C=
Lots (developed) C=
Lots (balance) C=

0.80
1.00
0.40

Beverley coeffs for 100 yr storm

A
B
C
D
E
F
G

3.6421799
-0.7169594
0.0158204
0.0055151
-0.0032008
0.00046
-3.242E-05

n value source QUDM
pasture use 0.035
bush 0.05 - 0.075
trees 0.15

1	2	3	4	5	6	7	8	9	10	11	12	13			
Pit	Chainage	Flow Length (m)	road Slope (%)	road Slope (m/m)	catchment Slope (%)	catchment Slope (m/m)	"n"	Time by Kinematic Wave equation (min)	Total Time (min)	Intensity I (mm/hr)	Road Reserve Area (ha)	Lot Area (dev) (ha)	Lot Area (balance) (ha)	sum CA (ha)	(8)*120.36 Q=CIA/0.36
PD1	0	450	1	0.01	1.40	0.014	0.1	55.0	55.0	40.64	0.60	0.25	8.78	4.242	478.84
PD2	0	515	0.6	0.006	1.40	0.014	0.1	62.0	62.0	37.29	0.47	0.13	5.93	2.878	298.10
PD3	0	620	1.2	0.012	1.10	0.011	0.1	81.0	81.0	30.83	0.90	0.30	6.18	3.492	299.07
1	0	480	1.2	0.012	1.40	0.014	0.1	59.0	59.0	38.64	0.46	0.64	2.84	2.144	230.11
2	0	590	0.6	0.006	1.40	0.014	0.1	70.0	70.0	34.19	0.75	0.64	2.88	2.392	227.20
3	0	620	1.2	0.012	1.10	0.011	0.1	81.0	81.0	30.83	0.99	0.80	3.71	3.076	263.45

NETWORKED FLOWS

Job: Brooking Str Beverley
Job No: 10141E

DRAINAGE DESIGN 1 IN 100 YEAR STORM

based on 1m/sec																										
1a				1b	1c		1d		U/S node maximum Tc for pipe B		U/S node maximum Tc for pipe C		travel time in U/S pipe		travel time in U/S pipe		travel time in U/S pipe		1e	2		3	4a	4b	4c	5
Pipe	Pipe Number (must be in ascending order)	U/s pipe A (insert 0 if no pipe)	U/s pipe B (insert 0 if no pipe)	U/s pipe C (insert 0 if no pipe)	Pipe Length	Travel time in pipe	U/S node maximum Tc from column 2	U/S node maximum Tc for pipe A	U/S node maximum Tc for pipe B	U/S node maximum Tc for pipe C	travel time in U/S pipe	travel time in U/S pipe	travel time in U/S pipe	travel time in U/S pipe	from column 1c for upstream pipe A	from column 1c for upstream pipe B	from column 1c for upstream pipe C	Time tc	Intensity I	Local Catchment to Node (from step 1)	Other Upstream catchments to node	Sum C.A. = 4a + 4b	(ha)	(l/s)		
start	0	0	0	0			0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00					0			
1-2	1	0	0	0	210	3.50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	59.00	38.64	2.14		2.14	2.14	230.11		
2-Ualet1	2	1	0	0	10	0.17	59.00	0.00	0.00	0.00	3.50	0.00	0.00	0.00	3.50	0.00	0.00	73.50	33.03	2.39	2.14	4.54	416.16			



ATTACHMENT C



CATCHMENT NO: Beverley Drainage Study - Catchment:

1

STORM FREQUENCY: 1

Sum (CA) (ha) : 2.144 Equivalent Impervious Area - from Developed Hyro SHEET 1)

1yr 1hr detention: 234

5yr detention: 0

100yr detention: 0

No. : 1

Outflow:

m3/s

Volume (m3) : 234.00

Soakage (l/s/m2): 0

t min&hr	i mm/hr	Runoff m3	Storage m3	Soakage m3	Outflow	Total m3	Excess m3
6	38.2	81.90	234.00	0.00	0.00	234.00	152.10
10	30.5	108.99	234.00	0.00	0.00	234.00	125.01
15	25.9	138.82	234.00	0.00	0.00	234.00	95.18
20	21.2	151.51	234.00	0.00	0.00	234.00	82.49
30	16.7	179.02	234.00	0.00	0.00	234.00	54.98
1	10.9	233.70	234.00	0.00	0.00	234.00	0.30

CATCHMENT NO:
Beverley Drainage Study - Catchment:

1

STORM FREQUENCY:
5

Sum (CA) (ha) :
2.144
Equivalent Impervious Area - from Developed Hyro SHEET 1)

1yr 1hr detention:
234

5yr detention:
0

100yr detention:
1

No. :

Outflow:
0.047
m3/s

Culvert capacity
0.08m3/s

225mm dia

Volume (m3) :
234

Soakage (l/s/m2):

t min&hr	i mm/hr	Runoff m3	Storage m3	Soakage m3	Outflow	Total m3	Excess m3
6	73.6	157.80	234.00	0.00	16.92	250.92	93.12
10	57.4	205.11	234.00	0.00	28.20	262.20	57.09
15	47.9	256.74	234.00	0.00	42.30	276.30	19.56
20	38.3	273.72	234.00	0.00	56.40	290.40	16.68
30	29.6	317.31	234.00	0.00	84.60	318.60	1.29
1	18.8	403.07	234.00	0.00	169.20	403.20	0.13
2	11.9	510.27	234.00	0.00	338.40	572.40	62.13
3	9.2	591.10	234.00	0.00	507.60	741.60	150.50
4	8.1	694.66	234.00	0.00	676.80	910.80	216.14
6	5.9	758.98	234.00	0.00	1015.20	1249.20	490.22
8	5.2	891.90	234.00	0.00	1353.60	1587.60	695.70
10	4.5	964.80	234.00	0.00	1692.00	1926.00	961.20
12	3.8	972.52	234.00	0.00	2030.40	2264.40	1291.88
24	2.4	1214.36	234.00	0.00	4060.80	4294.80	3080.44
72	1.0	1589.99	234.00	0.00	12182.40	12416.40	10826.41

CATCHMENT NO:
Beverley Drainage Study - Catchment:

1

STORM FREQUENCY:
100

Sum (CA) (ha) :
2.144
Equivalent Impervious Area - from Developed Hyro SHEET 1)

1yr detention:
234

5yr detention:
0

100yr detention:
299

No. :
1

Outflow:
0.080
m3/s

Culvert capacity
0.08m3/s

225mm dia

Total volume (m3) :
533.00

Soakage (l/s/m2):
0

t min&hr	i mm/hr	Runoff m3	Storage m3	Soakage m3	Outflow	Total m3	Excess m3
6	179.0	383.78	533.00	0.00	28.80	561.80	178.02
10	135.0	482.40	533.00	0.00	48.00	581.00	98.60
15	109.8	588.53	533.00	0.00	72.00	605.00	16.47
20	84.5	603.89	533.00	0.00	96.00	629.00	25.11
30	63.1	676.43	533.00	0.00	144.00	677.00	0.57
1	38.2	819.01	533.00	0.00	288.00	821.00	1.99
2	23.4	1003.39	533.00	0.00	576.00	1109.00	105.61
3	17.8	1144.90	533.00	0.00	864.00	1397.00	252.10
4	15.6	1337.86	533.00	0.00	1152.00	1685.00	347.14
6	11.2	1440.77	533.00	0.00	1728.00	2261.00	820.23
8	9.8	1686.04	533.00	0.00	2304.00	2837.00	1150.96
10	8.5	1813.82	533.00	0.00	2880.00	3413.00	1599.18
12	7.1	1821.54	533.00	0.00	3456.00	3989.00	2167.46
24	4.4	2284.65	533.00	0.00	6912.00	7445.00	5160.35
72	2.0	3071.92	533.00	0.00	20736.00	21269.00	18197.08

CATCHMENT NO: Beverley Drainage Study - Catchment:

2

STORM FREQUENCY:

1

Sum (CA) (ha) :

2.392 Equivalent Impervious Area - from Developed Hyro SHEET 1)

1yr 1hr detention:

261

5yr detention:

0

100yr detention:

0

No. :

1

Outflow:

m3/s

Volume (m3) :

261.00

Soakage (l/s/m2):

0

t min&hr	i mm/hr	Runoff m3	Storage m3	Soakage m3	Outflow	Total m3	Excess m3
6	38.2	91.37	261.00	0.00	0.00	261.00	169.63
10	30.5	121.59	261.00	0.00	0.00	261.00	139.41
15	25.9	154.88	261.00	0.00	0.00	261.00	106.12
20	21.2	169.03	261.00	0.00	0.00	261.00	91.97
30	16.7	199.73	261.00	0.00	0.00	261.00	61.27
1	10.9	260.73	261.00	0.00	0.00	261.00	0.27

CATCHMENT NO:
Beverley Drainage Study - Catchment:

1 and 2

STORM FREQUENCY:
5

Sum (CA) (ha) :
4.536
Equivalent Impervious Area - from Developed Hyro SHEET 1)

1yr 1hr detention:
495

5yr detention:
0

100yr detention:
1

No. :

Outflow:
0.100
m3/s

Culvert capacity
0.15m3/s

Volume (m3) :
495

Soakage (l/s/m2):

t min&hr	i mm/hr	Runoff m3	Storage m3	Soakage m3	Outflow	Total m3	Excess m3
6	73.6	333.85	495.00	0.00	36.00	531.00	197.15
10	57.4	433.94	495.00	0.00	60.00	555.00	121.06
15	47.9	543.19	495.00	0.00	90.00	585.00	41.81
20	38.3	579.10	495.00	0.00	120.00	615.00	35.90
30	29.6	671.33	495.00	0.00	180.00	675.00	3.67
1	18.8	852.77	495.00	0.00	360.00	855.00	2.23
2	11.9	1079.57	495.00	0.00	720.00	1215.00	135.43
3	9.2	1250.58	495.00	0.00	1080.00	1575.00	324.42
4	8.1	1469.66	495.00	0.00	1440.00	1935.00	465.34
6	5.9	1605.74	495.00	0.00	2160.00	2655.00	1049.26
8	5.2	1886.98	495.00	0.00	2880.00	3375.00	1488.02
10	4.5	2041.20	495.00	0.00	3600.00	4095.00	2053.80
12	3.8	2057.53	495.00	0.00	4320.00	4815.00	2757.47
24	2.4	2569.19	495.00	0.00	8640.00	9135.00	6565.81
72	1.0	3363.90	495.00	0.00	25920.00	26415.00	23051.10

CATCHMENT NO:
Beverley Drainage Study - Catchment:

1 and 2

STORM FREQUENCY:
100

Sum (CA) (ha) :
4.536
Equivalent Impervious Area - from Developed Hyro SHEET 1)

1yr detention:
495

5yr detention:
0

100yr detention:
698

No. :
1

Outflow:

0.150

m3/s

300 dia culvert HW/D 2.5

= 0.15m3/s

Total volume (m3) :
1193.00

Soakage (l/s/m2):

0

t min&hr	i mm/hr	Runoff m3	Storage m3	Soakage m3	Outflow	Total m3	Excess m3
6	179.0	811.94	1193.00	0.00	54.00	1247.00	435.06
10	135.0	1020.60	1193.00	0.00	90.00	1283.00	262.40
15	109.8	1245.13	1193.00	0.00	135.00	1328.00	82.87
20	84.5	1277.64	1193.00	0.00	180.00	1373.00	95.36
30	63.1	1431.11	1193.00	0.00	270.00	1463.00	31.89
1	38.2	1732.75	1193.00	0.00	540.00	1733.00	0.25
2	23.4	2122.85	1193.00	0.00	1080.00	2273.00	150.15
3	17.8	2422.22	1193.00	0.00	1620.00	2813.00	390.78
4	15.6	2830.46	1193.00	0.00	2160.00	3353.00	522.54
6	11.2	3048.19	1193.00	0.00	3240.00	4433.00	1384.81
8	9.8	3567.11	1193.00	0.00	4320.00	5513.00	1945.89
10	8.5	3837.46	1193.00	0.00	5400.00	6593.00	2755.54
12	7.1	3853.79	1193.00	0.00	6480.00	7673.00	3819.21
24	4.4	4833.56	1193.00	0.00	12960.00	14153.00	9319.44
72	2.0	6499.18	1193.00	0.00	38880.00	40073.00	33573.82

CATCHMENT NO: Beverley Drainage Study - Catchment:

3

STORM FREQUENCY:

1

Sum (CA) (ha) :

3.076 Equivalent Impervious Area - from Developed Hyro SHEET 1)

1yr 1hr detention:

336

10yr detention:

0

100yr detention:

0

No. :

1

Outflow:

m3/s

Volume (m3) :

336.00

Soakage (l/s/m2):

0

t min&hr	i mm/hr	Runoff m3	Storage m3	Soakage m3	Outflow	Total m3	Excess m3
6	38.2	117.50	336.00	0.00	0.00	336.00	218.50
10	30.5	156.36	336.00	0.00	0.00	336.00	179.64
15	25.9	199.17	336.00	0.00	0.00	336.00	136.83
20	21.2	217.37	336.00	0.00	0.00	336.00	118.63
30	16.7	256.85	336.00	0.00	0.00	336.00	79.15
1	10.9	335.28	336.00	0.00	0.00	336.00	0.72

CATCHMENT NO:
Beverley Drainage Study - Catchment:

3

STORM FREQUENCY:
5

Sum (CA) (ha) :
3.076
Equivalent Impervious Area - from Developed Hyro SHEET 1)

1yr 1hr detention:
336

5yr detention:
0

100yr detention:
1

No. :

Outflow:
0.068
m3/s

300 dia culvert HW/D 3.5
= 0.20m3/s

Volume (m3) :
336

Soakage (l/s/m2):

t min&hr	i mm/hr	Runoff m3	Storage m3	Soakage m3	Outflow m3	Total m3	Excess m3
6	73.6	226.39	336.00	0.00	24.48	360.48	134.09
10	57.4	294.27	336.00	0.00	40.80	376.80	82.53
15	47.9	368.35	336.00	0.00	61.20	397.20	28.85
20	38.3	392.70	336.00	0.00	81.60	417.60	24.90
30	29.6	455.25	336.00	0.00	122.40	458.40	3.15
1	18.8	578.29	336.00	0.00	244.80	580.80	2.51
2	11.9	732.09	336.00	0.00	489.60	825.60	93.51
3	9.2	848.05	336.00	0.00	734.40	1070.40	222.35
4	8.1	996.62	336.00	0.00	979.20	1315.20	318.58
6	5.9	1088.90	336.00	0.00	1468.80	1804.80	715.90
8	5.2	1279.62	336.00	0.00	1958.40	2294.40	1014.78
10	4.5	1384.20	336.00	0.00	2448.00	2784.00	1399.80
12	3.8	1395.27	336.00	0.00	2937.60	3273.60	1878.33
24	2.4	1742.25	336.00	0.00	5875.20	6211.20	4468.95
72	1.0	2281.16	336.00	0.00	17625.60	17961.60	15680.44

CATCHMENT NO: Beverley Drainage Study - Catchment:

3

STORM FREQUENCY:

100

Sum (CA) (ha) :

3.076 Equivalent Impervious Area - from Developed Hyro SHEET 1)

1yr detention:

336

5yr detention:

0

100yr detention:

329

No. :

1

Outflow:

0.200 m3/s

300 dia culvert HW/D 3.5

= 0.20m3/s

Total volume (m3) :

665.00

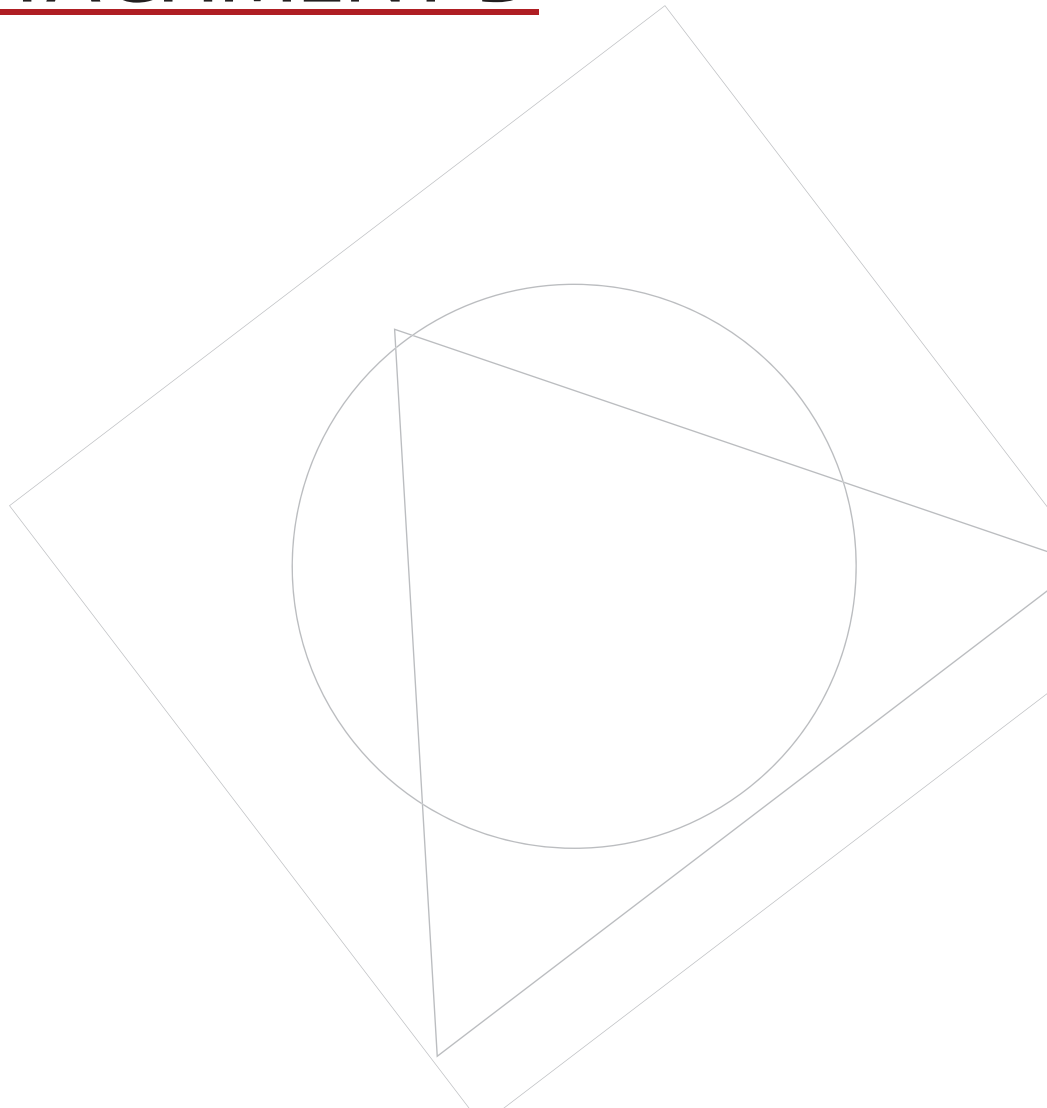
Soakage (l/s/m2):

0

t min&hr	i mm/hr	Runoff m3	Storage m3	Soakage m3	Outflow	Total m3	Excess m3
6	179.0	550.60	665.00	0.00	72.00	737.00	186.40
10	135.0	692.10	665.00	0.00	120.00	785.00	92.90
15	109.8	844.36	665.00	0.00	180.00	845.00	0.64
20	84.5	866.41	665.00	0.00	240.00	905.00	38.59
30	63.1	970.48	665.00	0.00	360.00	1025.00	54.52
1	38.2	1175.03	665.00	0.00	720.00	1385.00	209.97
2	23.4	1439.57	665.00	0.00	1440.00	2105.00	665.43
3	17.8	1642.58	665.00	0.00	2160.00	2825.00	1182.42
4	15.6	1919.42	665.00	0.00	2880.00	3545.00	1625.58
6	11.2	2067.07	665.00	0.00	4320.00	4985.00	2917.93
8	9.8	2418.97	665.00	0.00	5760.00	6425.00	4006.03
10	8.5	2602.30	665.00	0.00	7200.00	7865.00	5262.70
12	7.1	2613.37	665.00	0.00	8640.00	9305.00	6691.63
24	4.4	3277.79	665.00	0.00	17280.00	17945.00	14667.21
72	2.0	4407.29	665.00	0.00	51840.00	52505.00	48097.71



ATTACHMENT D



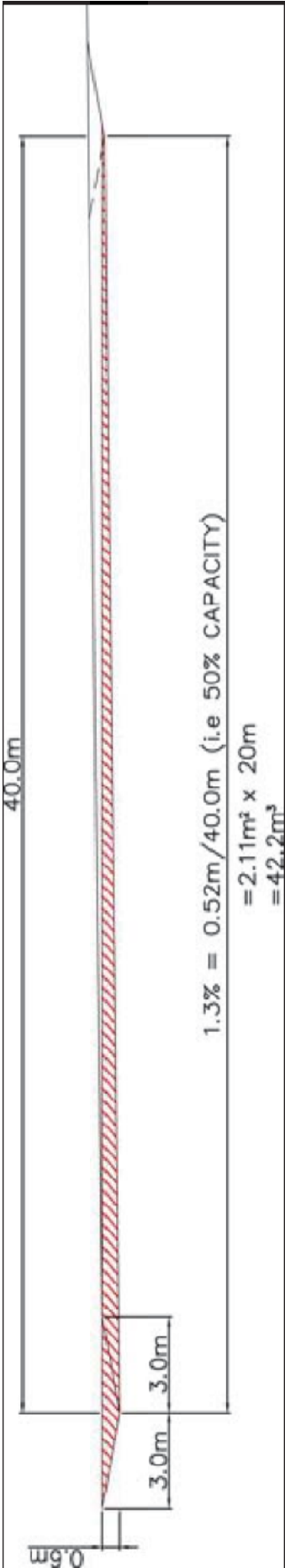
10141E Brooking Str Beverley Drainage Study

Swale Drain Calculations

Drain	Base		Sides			P (m)	R (A/P)	S _o (m/m)	n	Swale Drain Capacity $Q = AR^{2/3} S_o^{0.5} / n$ (m ³ /s)	Overall Width (m)
	Depth (m)	Base Width (m)	Base Area (m ²)	Vert (m)	Horiz (m)						
1.3% grade	0.60	0.00	6E-04	0.60	3.00	1.80	0.29	0.013	0.023	3.95	6.00

Note:

Swale drain flow capacity adequate for all storm events. Profile's main function is to attenuate flows. 1.3% is the steepest grade on the project - and therefore provides the least storage per m
Diagram below details how approx 1m³/m storage is arrived at
Cross over and road culverts to be set up min 300mm above swale invert to ensure 1:1yr infiltration





ATTACHMENT E

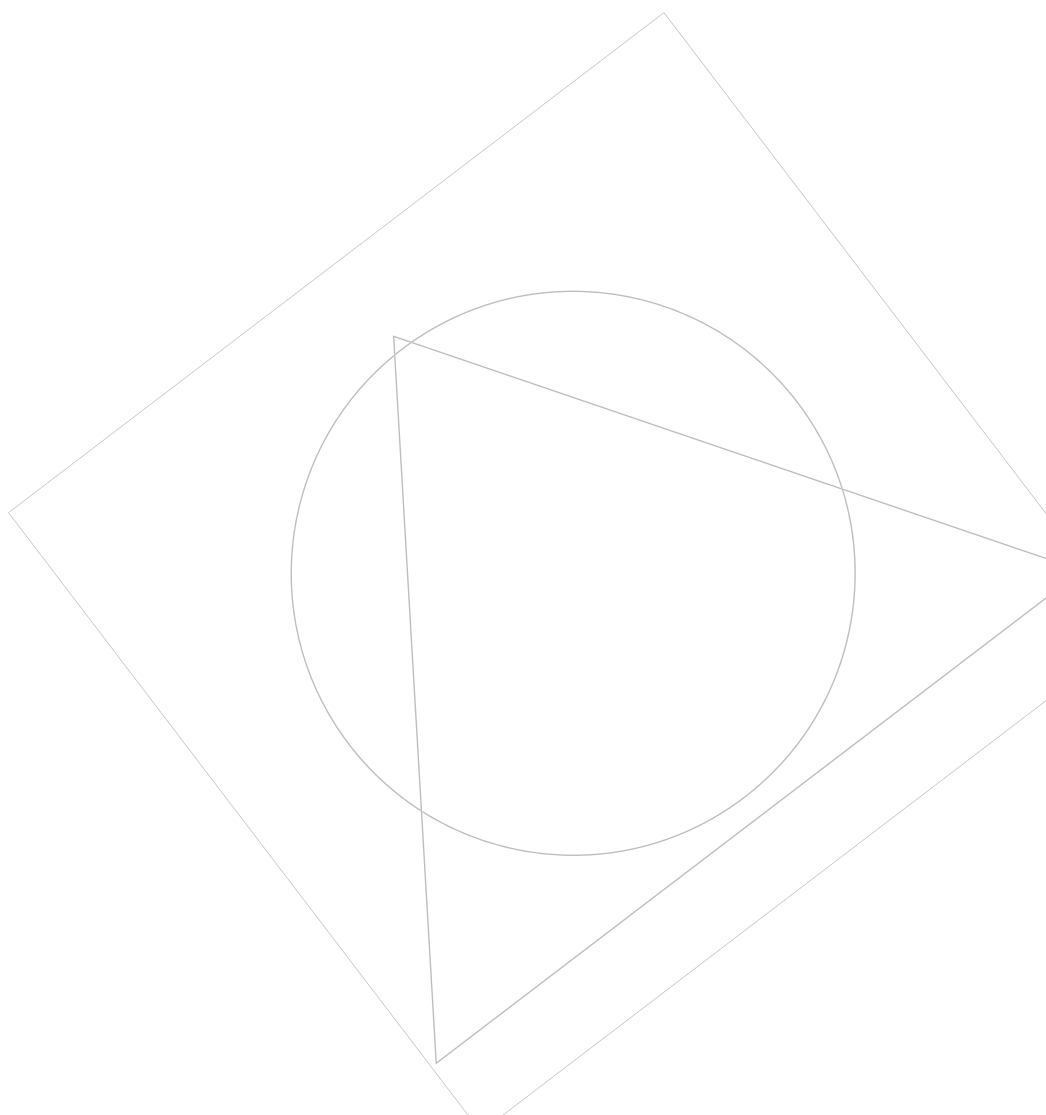


10141E Brooking Street, Beverley Drainage Study
Design Summary Sheet
Retention Structure Sizing and Peak Outflows

Catchment	1:1yr - 1hr (Roads and lots) - 0.3m deep		1:5yr Storage 0.6m deep		1:100yr Storage 0.6m deep		Total Storage Vol (m3)	Road Length (m)	Attenuation in Rd 1m3 per m	5yr Outflow m3/s	100yr Outflow m3/s	Remarks
	Volume	Approx Area	Volume	Area	Volume	Area						
1	234	803	-	-	299	329	533	480	480.00	0.05	0.08	Culvert under new road - 225mm dia. Set invert level to ensure 1:1yr storage. During 1:100yr event some minor overflow to swales in Catchment 2 will occur (53m3)
2	261	896	-	-	399	439	660	750	750.00	0.10	0.15	Existing 300mm culver adequate with attenuation volumes installed.
3	336	1,154	-	-	329	362						Existing 300mm culver adequate with attenuation volumes installed. Shire to install 1m3 attenuation per metre on Richardson Street upstream of ODP area.
Totals:	831	2,853	-	-	1,027	1,130		990	990.00	0.07	0.20	



ATTACHMENT F





Thompson McRobert Edgeloe Group

BEVELEY BROOKING STREET ODP AREA
PRELIMINARY BUDGET ESTIMATE - DRAINAGE ONLY
JOB NUMBER: 10141E

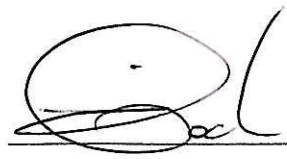
ITEM	DESCRIPTION	UNIT	ESTIMATED QTY	ESTIMATED RATE	ESTIMATED TOTAL
PRELIMINARIES					
ESTABLISHMENT					
	Mobilisation / Demobilisation	Item	1	\$ 2,500.00	\$ 2,500.00
	Insurances	Item	1	\$ 1,500.00	\$ 1,500.00
	Traffic Management	Item	1	\$ 650.00	\$ 650.00
OTHER					
	Final Cleanup	Item	1	\$ 850.00	\$ 850.00
SUBTOTAL PRELIMINARIES					\$ 5,500.00
STORMWATER DRAINAGE					
SITEWORKS					
EARTHWORKS					
	Strip and Stockpile Topsoil	m ²	9480	\$ 0.38	\$ 3,602.40
	Respread Topsoil	m ²	9480	\$ 0.50	\$ 4,740.00
CULVERTS EXCAVATE / SUPPLY / LAY					
	225 Dia Class 2 (17No)	m	76.5	\$ 85.00	\$ 6,502.50
	300 Dia Class 2 (8no.)	m	36	\$ 100.00	\$ 3,600.00
	Rock Pitched headwalls	No.	50	\$ 120.00	\$ 6,000.00
SWALES					
	Form Graded Drains to levels	m	1580	\$ 5.00	\$ 7,900.00
	Form earthwork bunds (approx 40m c/c)	No.	25	\$ 85.00	\$ 2,125.00
	Supply , Import and Spread Filter Media 300mm Thick	m2	4740	\$ 16.00	\$ 75,840.00
SUB TOTAL STORMWATER DRAINAGE					\$ 95,465.00
SUBTOTAL					\$ 100,965.00
CONTINGENCY 20%					\$ 20,193.00
TOTAL					\$ 121,158.00
TOTAL (INCLUDING GST)					\$ 133,273.80

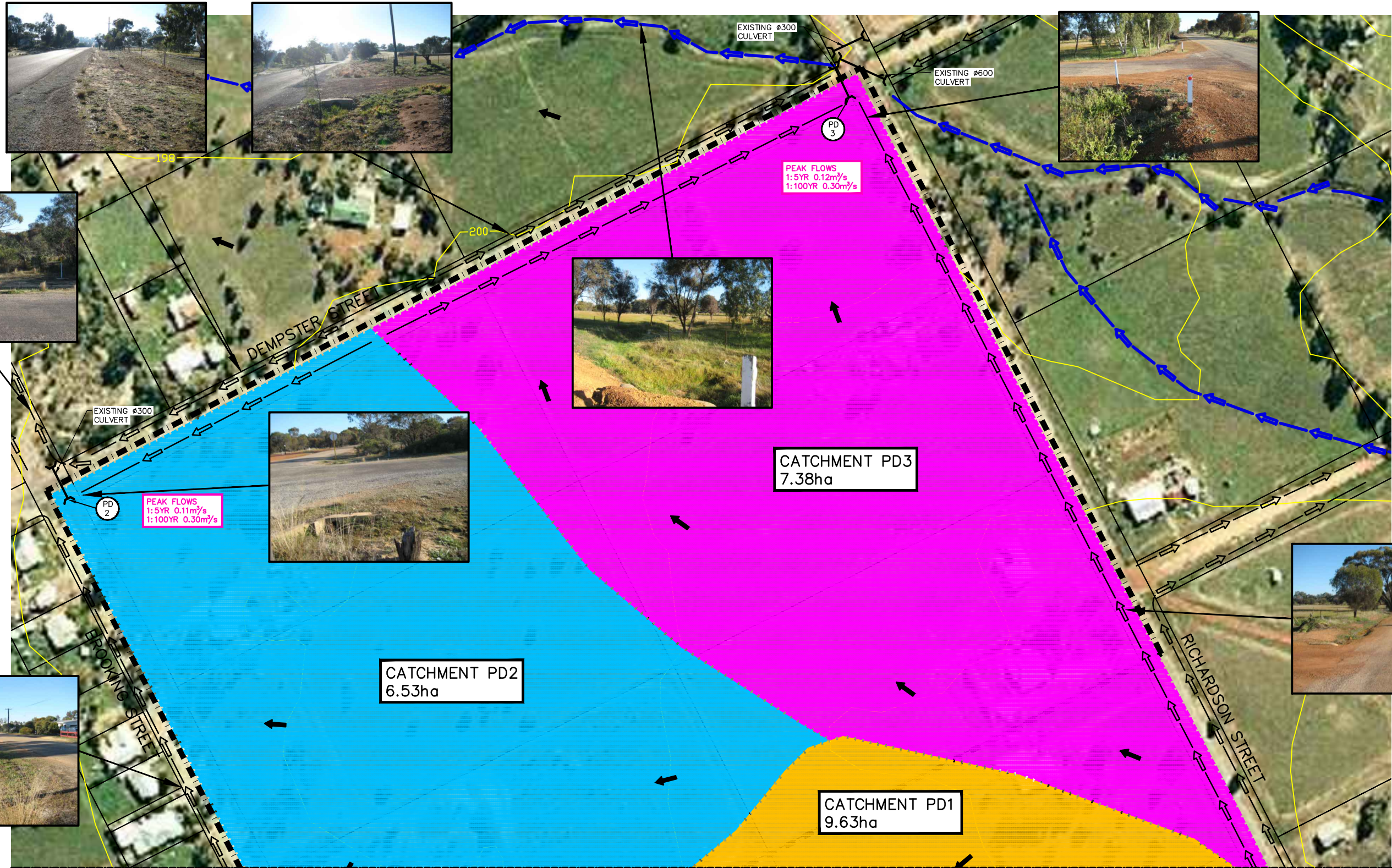
This estimate includes drainage installation only. It does not cover extraordinary unforeseen costs such lowering of services, removal of unsuitable material etc

DISCLAIMER

The information provided in this estimate expresses the results of preliminary investigations only. Detail design has not been undertaken in preparation of this estimate. It is provided to the reader as background material and to provide general assessment on possible project costs. No information in this estimate should be regarded as final or conclusive and the reader should not use this report as the basis for budgeting or investment decisions without obtaining independent analysis or detailed studies from the authors. The reader must acknowledge the underlying premise on which the information has been prepared may change significantly as a result of changes in State or Local Government or Departmental Policy, changing advice of officers in the bodies consulted, unforeseen geotechnical problems and latent conditions during the construction phase of the project, changes in market demands and variations in the wider Australian or world economies.

SIGNATURE OF DESIGNATED OFFICER OF TME

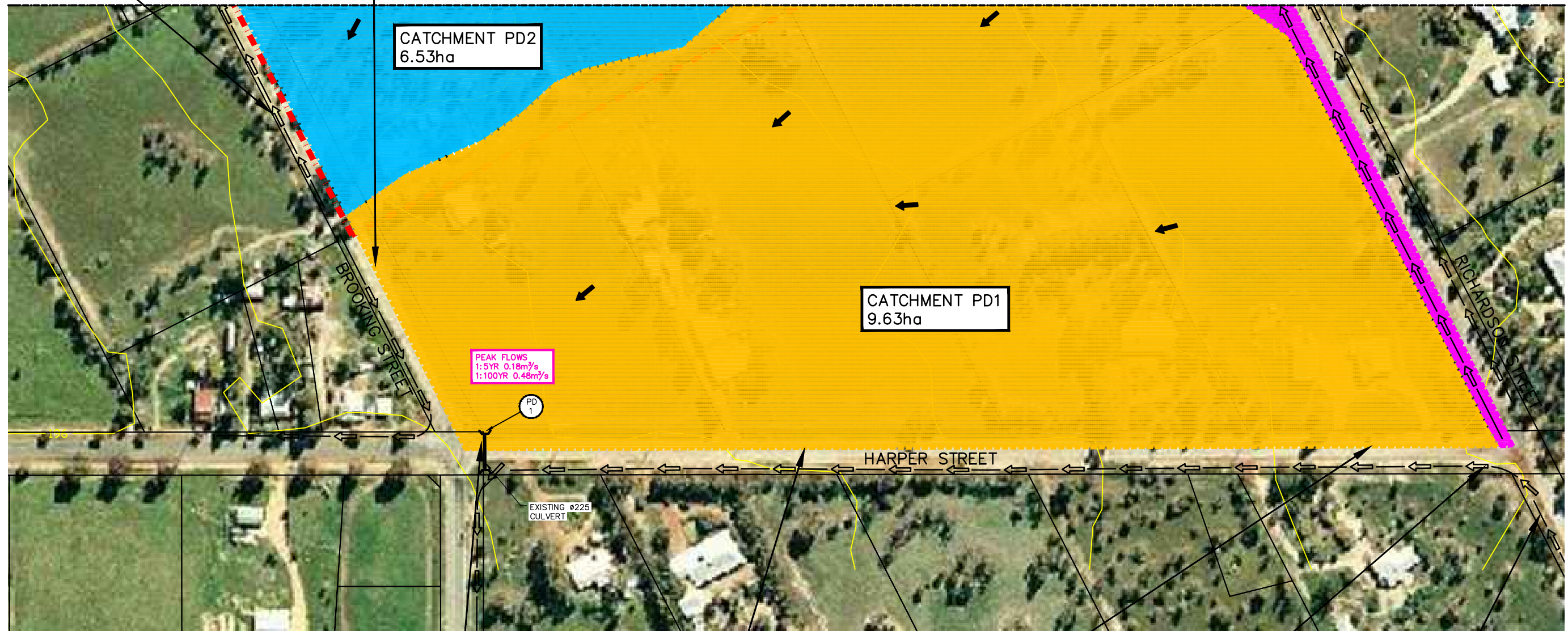
 12/08/2010



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ADJOINS DWG 10141E-C302



PEAK FLOWS
1:5YR 0.18m³/s
1:100YR 0.46m³/s

PD 1

EXISTING Ø225 CULVERT

LEGEND

- NON PERENIAL WATER COURSE
- RUNOFF DIRECTION
- EXISTING SWALE
- CATCHMENT BOUNDARY
- POST DEVELOPMENT CATCHMENT NODE
- OUTLINE PREDEVELOPMENT PLAN AREA



* DENOTES SIGNATURES ON ORIGINAL OR PREVIOUS ISSUE OF DRAWING

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A		ISSUED FOR APPROVAL		



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ENVIRONMENTAL • CIVIL/STRUCTURAL

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KJB 5/8/10	IDC 5/8/10	
DRAFT CHECKER AND DATE	DESIGN CHECKER AND DATE	
SCALE:	1:1000	

CLIENT and JOB NAME	BROOKING AND RICHARDSON STREET ODP AREA, BEVERLEY – DRAINAGE STUDY
TITLE	1:1YR, 1:5YR & 1:100YR PRE DEVELOPMENT DRAINAGE STUDY SHEET 2 OF 2
DRAWING NOT TO BE SCALED	DWG No. 10141E-C301





ADJOINS DWG 10141E-C302

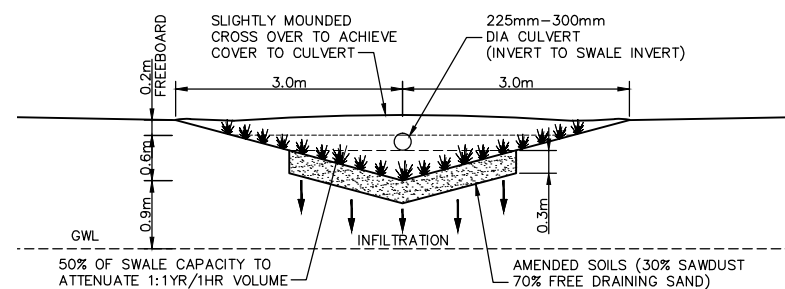


NOTES:

1. ALL SWALES TO BE UPGRADED AS PER DETAIL BUNDING (CROSSOVER AND CULVERT) APPROXIMATELY EVERY 40m.

LEGEND

- NON PERENIAL WATER COURSE
- RUNOFF DIRECTION
- SWALE (AS PER DETAIL)
- EXISTING SWALE
- CATCHMENT BOUNDARY
- POST DEVELOPMENT CATCHMENT NODE
- OUTLINE PREDEVELOPMENT PLAN AREA



TYPICAL SWALE CROSS SECTION
1:50

10141E BROOKING STREET, BEVERLEY DRAINAGE STUDY DESIGN SUMMARY SHEET RETENTION STRUCTURE SIZING AND PEAK FLOWS

Catchment	1:1yr - 1hr (Roads and lots) - 0.3m deep		1:5yr Storage 0.6m deep		1:100yr Storage 0.6m deep		Total Storage Vol (m3)	Road Length (m)	Attenuation In Rd 1m3 per m	5yr Outflow m3/s	100yr Outflow m3/s	Remarks
	Volume	Approx Area	Volume	Area	Volume	Area						
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3	336	1,154	-	-	329	362	665	990	990.00	0.07	0.20	Existing 300mm culvert adequate with attenuation volumes installed. Shire to install 1m3 attenuation per metre on Richardson Street upstream of ODP area.
Total:	831	2,853	-	-	1,027	1,130						

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DRAFT CHECKER AND DATE		DESIGN CHECKER AND DATE	
SCALE:	1:1000		

CLIENT and JOB NAME	
BROOKING AND RICHARDSON STREET ODP AREA, BEVERLEY - DRAINAGE STUDY	
TITLE	
1:1YR, 1:5YR & 1:100YR POST DEVELOPMENT DRAINAGE STUDY SHEET 2 OF 2	
DRAWING NOT TO BE SCALED	DWG No.
	10141E-C303
REV	A

