161 SANDMERE ROAD, PINKENBA

CONCEPTUAL STORMWATER MANAGEMENT PLAN

Prepared for LAGC CAVA Pty Ltd
July 2026

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PROJECT MANAGEMENT
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Document Control

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Version Register

Version #	Date of Revision	Prepared by	Reviewed by	Reason for revision	Authorised by
1	MARCH 2026	SF	AR	DA SUBMISSION	AR
2	JULY 2026	SF	AR	DA RFI RESPONSE	AR

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1. INTRODUCTION

LAGC CAVA Pty Ltd have commissioned Civil360 to prepare this Conceptual Stormwater Management Plan (CSMP) for a proposed industrial development at 161 Sandmere Road, Pinkenba (the site).

This report has been prepared to address and demonstrate compliance with:

- *Environmental Protection Act 1994* – Queensland Government
- *Environmental protection (Water) Policy 2009* – Queensland Government
- *State Planning Policy (Water Quality) 2016* - Department of Local Government and Infrastructure (DILGP)
- Brisbane City Council *Water Sensitive Urban Design (WSUD) Guidelines*
- *Queensland Urban Drainage Manual (QUDM)*
- Healthy Waterways – *Water by Design Guidelines*
- *Best Practice in Erosion and sediment Control* - IECA

The objectives of this stormwater management plan are to:

1. Ensure the development appropriately manages stormwater quality to:

    (a) Protect natural ecosystems
    (b) Integrate stormwater treatment into the urban landscape;
    (c) Protect water quality;
    (d) Meet the water quality objectives and environmental values for Queensland waters.

2. Ensure development does not cause erosion or allow sediments to leave the site during construction

2. DEVELOPMENT SITE

2.1. Existing Site

The site is located within Pinkenba, which is an industrial locality within the Brisbane City Council Region. It is approximately 11km east of Brisbane Airport and 21km northeast of Brisbane CBD.

The site details are shown below in Table 1:

TABLE 2.1: EXISTING PROPERTY INFORMATION

Address	Description	Area (m^2)
161 Sandmere Road, Pinkenba	Lot 482 on M3321	17,497m^2

Figure 1 (below) includes a recent aerial image of the subject site. This CSMP outlines the stormwater quality measures for the subject site.

FIGURE 1: AERIAL IMAGE OF THE SUBJECT SITE (SOURCE NEARMAPS 2025)

The site in its current state is a relatively flat pad, with grades ranging from 0.0% to 0.7%, over most of the site with batters around the northwest, northeast and southeast boundaries ranging from 10% to 50%. Levels on the site range from RL 2.982 to RL 3.984. The site compacted gravel hardstand with an existing demountable building with sheds. The site fronts Sandmere Road to the northwest and Marine Road to the northeast.

2.2. Proposed Development

The proposed development will consist of a gravel hardstand area graded to allow surface flow discharge into a stormwater management area along the northeast boundary which will include a bioretention basin for water quality treatment. A 7.5m road dedication will be made along the

Marine Road frontage to allow for the construction of a formalized 8m wide trunk drainage concrete lined channel and 3.5m wide verge with footpath.

Sandmere Road along the site frontage will be upgraded to include a 7m wide paved road replacing the existing gravel road with a 3m wide formalized concrete lined drainage swale, with a 1.2m wide footpath adjacent to the site's northwest boundary.

The existing demountable building and accompanying sheds will be retained, as well as an existing concrete hardstand area approximately 430m^2 in area located on the western side of the site.

Retaining walls are proposed around the frontage of Sandmere Road and Marine Road with the existing driveway access on Sandmere reinstated with a new concrete driveway access ramping up to the hardstand area.

Refer to Appendix A for JW Surveys and Plansur Detail and Level Survey Plan.

3. STORMWATER QUALITY ASSESSMENT

3.1. Design Intent and Description of the Devices

Bioretention systems are designed to collect and treat urban stormwater. This stormwater is then filtered through a densely vegetated, biologically active sand and loam filter media. As the stormwater permeates through the filter media, pollutants (such as Suspended Solids, Nitrogen and Phosphorus) are captured via fine filtration, absorption and biological processes by soil microbes and plants.

These systems can be in the form of a bioretention basin in a designated open space/stormwater management area, or tree pits located within the road verge.

Treated water is then discharged through the outlet to the proposed trunk drainage channel on Marine Road.

3.2. Device Location, Design and Size

The proposed stormwater quality treatment train consists of a proposed bioretention basin located in along the northeast boundary of the site adjacent to the trunk drainage channel.

The location of the proposed device is shown on the Civil360 drawings 2025077 SK100 & SK300 in Appendix C.

The bio basin has a filter media area of 235m^2 at a surface level of RL2.685. The inflow and outflow locations are to be located as close as possible to each other to ensure high flows can reach the outlet without scouring vegetation.

The planting for the bioretention basin will be detailed by the developer's landscape consultant at detailed design stage.

A checklist has also been completed for the bioretention basin that contains detailed information such as catchment areas, design flows, depth profile, layout and inlet design. The Water by Design Bioretention Technical Design Guideline (Version 1.1) postdates the WSUD TDG by eight (8) years and has therefore been utilised for this document.

A completed copy of the Water by Design Bioretention Technical Design Guideline Design Assessment Checklist for the bioretention basin is included in Appendix D.

3.3. Construction Phase Water Quality Management

The intent of the erosion and sediment control plan is to ensure construction activities for the development avoid adverse impacts on stormwater quality and downstream water environments. It is noted that the Contractor will assume responsibility and liability under the construction contract for monitoring and control of construction activities to ensure sediment and other prescribed contaminants are not released from the site.

Erosion and sediment control will be managed in accordance with the *Best Practice Erosion and Sediment Control (IECA) Guidelines* for construction sites.

The following erosion and sediment controls are considered appropriate for this site:

- Stabilised entry/exit locations
- Type 3 sediment controls – Sediment Fence
- Silt fence downstream of any stockpiled material or bund
- Locate stockpiles away from concentrated stormwater or natural flow paths

- Remove any contaminated stockpiles from site upon excavation
- Control of water movement through site and away from excavation
- Minimise extent and duration of disturbance – stabilise isolated areas when practicable
- Maintain all ESC measures in proper working order at all times
- Monitor the site and adjust ESC practices during construction phasing
- Provide appropriate environmental induction and training to all site personnel

The following minimum inspection measures are recommended:

- Inspect erosion and sediment control measures weekly and following runoff events until the site is stabilised
- Inspect drainage control measures daily to ensure they have not been damaged by construction machinery
- Complete non-conformance reports
- Compile and retain at the site office monthly ESC performance summary

3.4. Operational Phase Water Quality Management

The intent of the local government stormwater quality objectives is to protect receiving water quality by limiting the quantity (loads) of stormwater pollutants discharged into receiving waters from development. The stormwater quality objectives are as follows:

TABLE 3.1: STORMWATER QUALITY OBJECTIVES

Pollutant	Reduction Target
Gross Pollutants	90% reduction in mean annual load
Total Suspended Solids (TSS)	80% reduction in mean annual load
Total Phosphorus (TP)	60% reduction in mean annual load
Total Nitrogen (TN)	45% reduction in mean annual load

3.5. Meteorological Data

Rainfall and evapotranspiration data was obtained from the Bureau of Meteorology (BOM) rainfall station (ID 040842_Brisbane Aero QLD) for the climate period of 9/02/2000 to 28/02/2011 and using 6-minute time step recorded rainfall data.

3.6. Catchment Parameters

The developed site discharging to the bioretention basin has been broken up into five (5) catchment node types using the “Split Catchment Approach” as outlined in Water by Design MUSIC Modelling Guidelines. Refer to MUSIC Catchment Plan in Appendix B. The catchment node information is summarised in Table 3.2 below:

TABLE 3.2: MUSIC CATCHMENT NODES TO BIORETENTION BASIN

Catchment Type	Area (ha)	Total Impervious (%)
Urban Industrial – Roof	0.0148	100
Urban Industrial – Hardstand	1.4875	100
Urban Industrial - Landscape	0.0788	0
Urban Industrial – Hardstand Bypassing	0.0056	100
Urban Industrial – Landscape Bypassing	0.0433	0

Runoff Parameters and Pollutant Export Parameters for the source nodes where taken from the recommended values suggested in Water by Design MUSIC Modelling Guidelines and are summarised below in Tables 3.3 and 3.4 respectively:

TABLE 3.3: RAINFALL RUNOFF PARAMETERS - INDUSTRIAL

Parameter	Residential
Rainfall Threshold (mm)	1
Soil Storage Capacity (mm)	18
Initial Storage (% capacity)	10
Field Capacity (mm)	80
Infiltration Capacity coefficient a	243
Infiltration Capacity coefficient b	0.6
Initial Depth (mm)	50
Daily Recharge Rate (%)	0
Daily Baseflow Rate (%)	31
Daily Deep Seepage Rate (%)	0

TABLE 3.4: POLLUTANT EXPORT PARAMETERS – URBAN RESIDENTIAL

Flow Type	Surface type	TSS log^{10} values		TP log^{10} values		TN log^{10} values	
		Mean	St. dev.	Mean	St. dev.	Mean	St. dev.
Base Flow Parameters	Roof	N/A	N/A	N/A	N/A	N/A	N/A
	Hardstand	0.78	0.45	-1.11	0.48	0.14	0.20
	Ground Level	0.78	0.45	-1.11	0.48	0.14	0.20
Storm Flow Parameters	Roof	1.30	0.44	-0.89	0.36	0.25	0.32
	Hardstand	2.43	0.44	-0.30	0.36	0.25	0.32
	Ground Level	1.92	0.44	-0.59	0.36	0.25	0.32

3.7. Treatment Nodes

The MUSIC model was run using a Bioretention Node to represent the filter media in the bioretention basin. The bioretention node input parameters are summarised in Table 3.5 below and on the following page:

TABLE 3.5: BIORETENTION PARAMETERS

Parameter	Bioretention Basin Input
Storage Properties	
Extended Detention Depth (metres)	0.20
Surface Area (square metres)	310
Filter and Media Properties	
Filter Area (square metres)	235
Unlined Filter Media Perimeter (metres)	0.01
Saturated Hydraulic Conductivity (mm/hour)	200
Filter Depth (metres)	0.40
TN Content of Filter Media (mg/kg)	550
Orthophosphate Content of Filter Media (mg/kg)	55
Infiltration Properties	
Exfiltration Rate (mm/hour)	0.00
Lining Properties	
Is Base Lined?	No

Parameter	Bioretention Basin Input
Vegetation properties	
Vegetation Properties	Vegetated with Effective Nutrient Removal Plants
Outlet Properties	
Outlet Weir Width (metres)	2
Underdrain Present?	Yes
Submerged Zone with Carbon Present?	No

The total catchment area discharging to the basin is 1.5607ha which is below the 2ha limit, meaning there is no requirement for a coarse sediment forebay.

3.8. Modelling Results

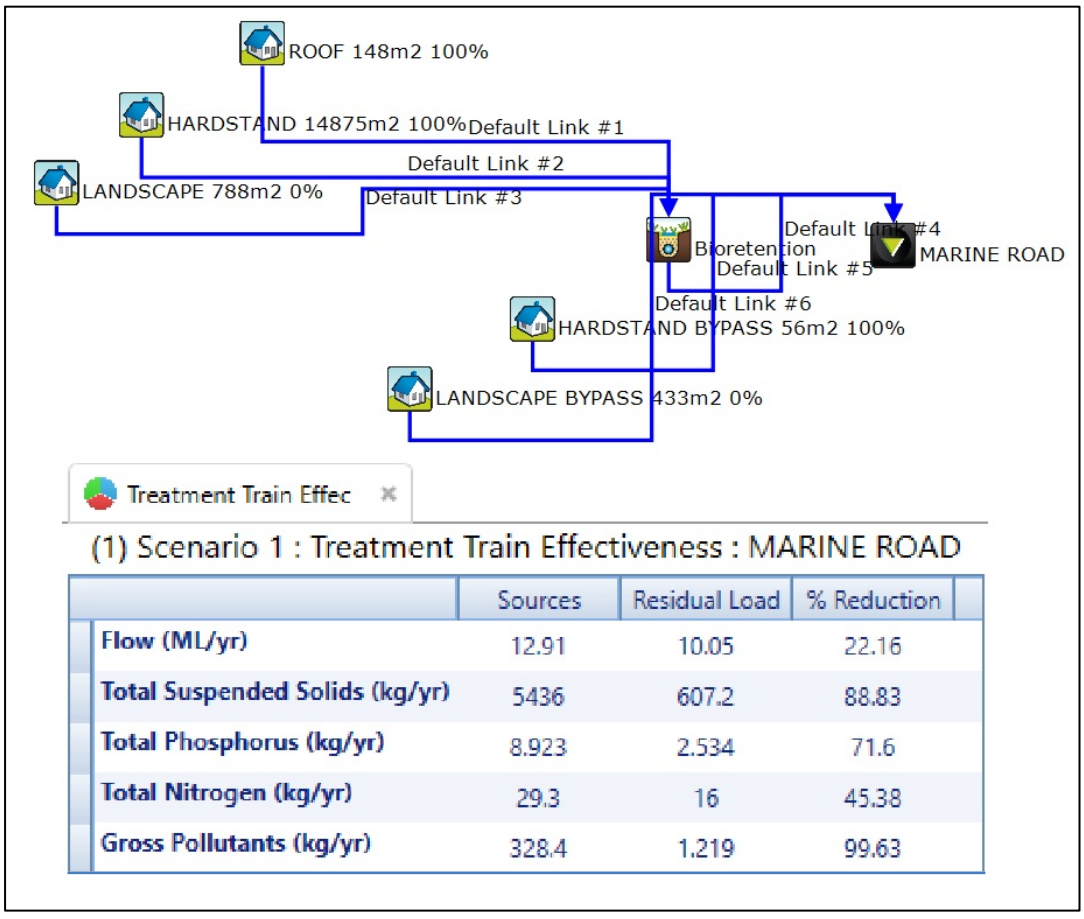
Table 3.6 below summarises the MUSIC modelling results:

TABLE 3.6: MUSIC MODEL RESULTS – TREATMENT TRAIN EFFECTIVENESS AT BIORETENTION BASIN OUTLET

Pollutant	Sources	Residual Load	% Reduction	Objectives (%)
Total Suspended Solids (kg/yr)	5436	607.2	88.83	80
Total Phosphorous (kg/yr)	8.923	2.534	71.6	60
Total Nitrogen (kg/yr)	29.3	16	45.38	45
Gross Pollutants (kg/yr)	328.4	1.219	99.63	90

Table 3.6 indicates that the bioretention basin filter media is achieving the required pollutant removal percentages for all pollutants.

The nodal layout and results for the MUSIC model is shown below:



4. OPERATIONAL MANAGEMENT AND MAINTENANCE – BIORETENTION BASIN AND TREE PITS

In order to minimise long term maintenance of bioretention systems, the Facility for Advancing Water Biofiltration (FAWB) have identified three key elements in the design and construction of bioretention systems:

1. Correct filter media specification and installation (light compaction)
2. Dense vegetation cover – the most efficient pollutant removal occurs where plants have dense fibrous roots.
3. Protection during construction phase (including building phase) – to protect the filter media from scour and heavy sediment loads, or other wash off, and to allow good establishment of plants.

4.1. Establishment Phase

The establishment phase is defined as the period up to where:

- The bio-retention system's catchment is no longer under construction.
- Plants no longer require irrigation and are close to their mature height (typically 18 to 24 months)

Protect the filter media during construction

- Delay final landscaping and protect/cover the filter media (using geofabric and turf) until construction is completed. In accordance with Water By Design Construction Establishment Guidelines (Appendix E) Step 26, the bio-retention system will be protected during the building phase with geofabric, 25mm topsoil and turf until minimum 80% catchment build out.

Irrigation

Plants and trees in bioretention basins and tree pits generally require irrigation during the establishment phase. The frequency of watering is dependent on rainfall, maturity of planting stick and the water holding capacity of the filter media. Generally, the following watering program is required but advice should be sought from the Landscape Architect and may need to be adjusted to suit the site conditions:

- Week 1-6 5 waterings per week
- Week 7-10 3 waterings per week
- Week 11-15 2 waterings per week

If there is no rain, each plant should receive 2.5 – 5.0 litres of water per week in the first six weeks (40mm per week)

After this initial 15-week period, watering may still be required, particular during the dry winter period. Advice should again be sought from the Landscape Architect.

Tree stake removal

Once trees are adequately established support stakes should be removed and holes filled with filter media.

4.2. Long Term maintenance (Post Establishment Phase)

The long-term maintenance tasks identified by FAWB are recommended for this Site.

Three monthly inspection and maintenance checks should be carried out during the initial period of operation of the bio-retention system to ensure it is functioning as designed. Once the system has been established a less frequent schedule may be appropriate.

This maintenance should verify proper functioning of:

Filter Media

TASK	FREQUENCY
Remove sediment deposition and build up from sediment forebays and filter surfaces	**3 monthly after rain**
Infill any holes in the filter media, check for erosion or scour and repair. Provide energy dissipation (e.g. rocks) if required	**3 monthly after rain**
Check for ponding of water on the surface of the media. Remove any accumulation of oily or clayey sediment that may have formed on the surface of the media by raking away any surface mulch and scarifying the surface of the media between plants.	**3 monthly after rain**
Remove any anthropogenic or organic litter to ensure flow paths and infiltration through the media are not hindered.	**3 monthly after rain or as desired for aesthetics**

Horticulture

TASK	FREQUENCY
Treat plants for disease, pest infection, stunted growth or senescence	**3 monthly after rain or as desired for aesthetics**
Provide infill planting to maintain original plant densities	**3 monthly after rain or as desired for aesthetics**
Manually remove weed species using herbicide applied with a wand or restrictive spot spray.	**3 monthly after rain or as desired for aesthetics**
Remove any anthropogenic or organic litter to ensure flow paths and infiltration through the media are not hindered.	**3 monthly after rain or as desired for aesthetics**

Drainage

TASK	FREQUENCY
Check to ensure underdrainage is not blocked. Place a hose with low flow down the pipes and observe outlet. CCTV may also be used if feasible.	**6 monthly after rain**
Ensure inflow pits and grates over pits are clear of litter and debris and are in good and safe condition (not dislodged or damaged). Remove any sediment within pits and inlet areas.	**Monthly and occasionally after rain**

Other

TASK	FREQUENCY
Occasionally observe tree pit or bioretention raingarden after a rainfall event to check infiltration. Identify signs of poor drainage (extended ponding on the filter media surface). If poor drainage is identified, check landuse and assess whether is has altered from design capacity (e.g. unusually high sediment loads may require installation of a sediment forebay).	**Twice a year after rain**

FAWB's inspection and maintenance form has been included in Appendix F.

Vegetation plays a key role in maintaining the porosity of the filter media of a bioretention system and a strong healthy growth of vegetation is critical to its performance. Therefore the most intensive period of maintenance is during the plant establishment period (24 months) when weed removal and replanting may be required.

Repair any damage to the profile resulting from scour, rill erosion or vehicle damage by replacement of appropriate fill (to match onsite soils) and revegetating.

Till the bioretention system surface, or remove the surface layer, if there is evidence of clogging.

Resetting (i.e. complete reconstruction) of the bioretention system will be required if it fails to drain adequately after tilling of the surface. Maintenance should only occur after a reasonably rain free period when the soil in the bioretention system is dry. Inspections are also recommended following large storm events to check for scour and other damage.

5. CONCLUSION

This CSMP outlines measures to treat stormwater during the construction and operation phases of the proposed development in order to meet the requirements of Brisbane City Council for water quality.

It has been demonstrated via MUSIC modelling that a treatment train consisting of a bioretention basin utilising bioretention filter media achieves the Brisbane City Council water quality objectives for Gross Pollutants, Total Suspended Solids, Total Phosphorus and Total Nitrogen during the ongoing operational phase of this development.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Anthony Rickert – RPEQ 24958

DIRECTOR

CIVIL360

APPENDIX A DETAIL & LEVEL SURVEY PLANS

JW SURVEYS DETAIL & LEVEL SURVEY PLAN

PLANSUR DETAIL & LEVEL SURVEY PLAN

Title boundaries were not marked at the time of survey and have been determined from the original survey plan dimensions only. For accurate locations of boundaries, an Identification survey is recommended.

Issue	Amendment / Notation	Date
1	Original Issue	17/01/2026

Location of Services Table

Service	Above Ground Services	Invert Levels Measured	DBYD Records	Service Locator	Vacuum Potholing	Other
Sewer	No	No	Yes	No	Yes	
Drainage	Yes	Yes	No	No	No	
Water	Yes	No	Yes	Yes	Yes	
Elect	Yes	No	No	No	No	
Comms	Yes	No	Yes	Yes	No	
Gas	No	No	No	No	No	

Disclaimer: The underground services have been compiled from a combination of field surveys, service locators and "Dial Before You Dig" records as per the Location of Services Table. Where pipe details have been obtained from Utility records, the plan has been noted accordingly.

The accuracy of service alignments shown on this plan may vary depending on the source of the data. Pot holing should always be undertaken to verify the exact position prior to construction. Whilst all care has been taken to represent the location of all underground services, further services may exist.

Legend - Kerb Profiles

Field Shot Taken Here — Typical Box Kerb
Field Shot Taken Here, Pavement — Typical Traffic Island Kerb
Field Shot Taken Here, Pavement — Typical Mountable Kerb

LEGEND

Electricity Box
Electricity Light Pole
Electricity Pit
Electricity Pole
Fire Hydrant
Gas
Gully Pit (Backstone)
Gully Pit (Centre of Grate)
Inspection Opening
Post
Sewerage MH Lid
Stormwater MH Lid
Telstra Pit
Tree
Valve
Water Meter

Crown of Road
Edge of Concrete
Edge of Bitumen
Fence
Top of Bank
Bottom of Bank
Sewerage
Stormwater
Water
Electrical
Overhead Wires
Comms
Gas

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Cadastral Land Surveyors
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Client: LAGC CAVA

Project / Location: **161 Sandmere Road Pinkenba**

Real Property Description
Lot 482 on M3321

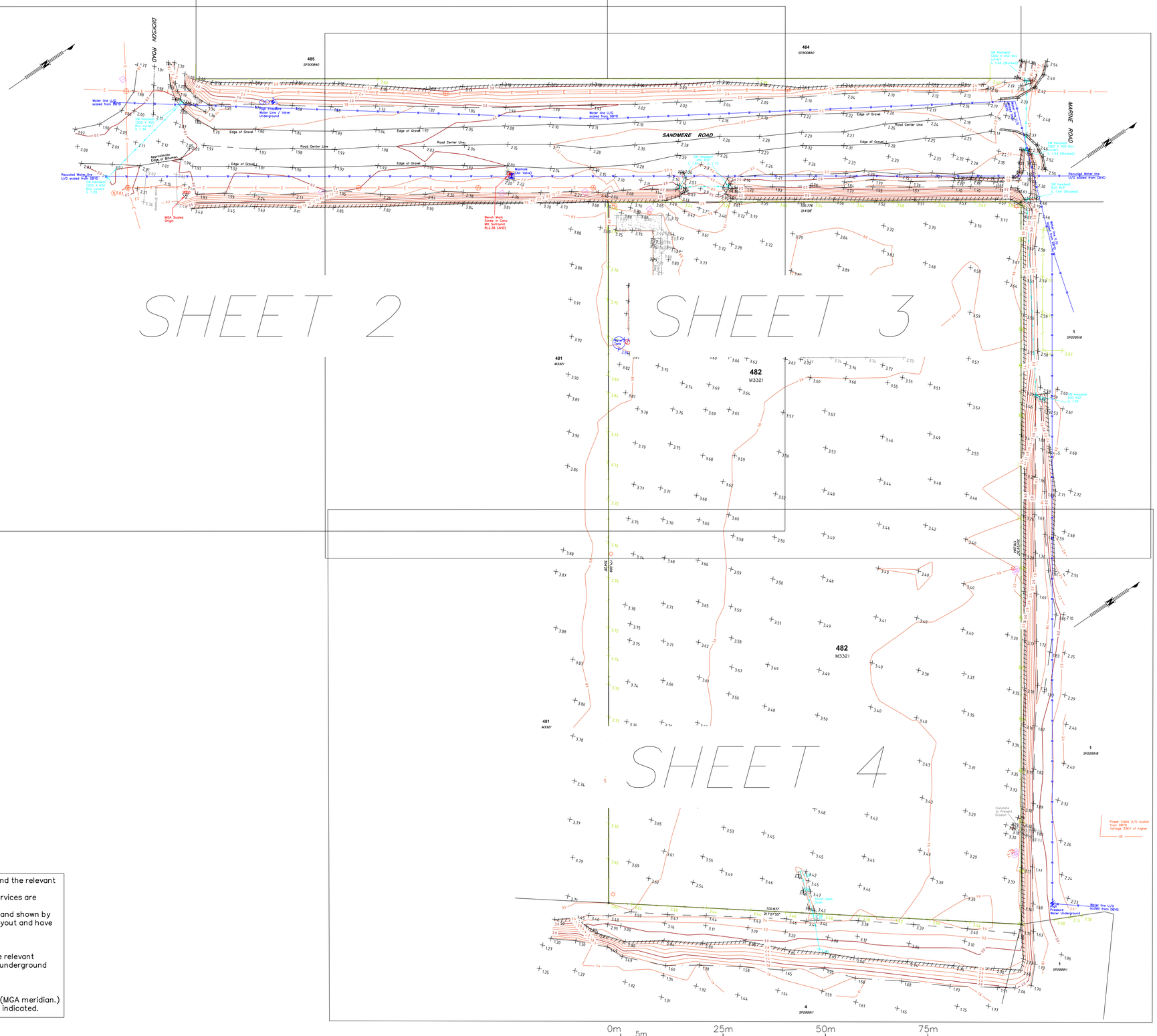
Datum for Levels - AHD via GNSS

Detail & Level Survey

Scale 1:500
Date - 23/12/2025 When plotted at A1

Job No.	Drawing No.	Issue
25145	JW 991	1

Received
03/10/2018
BCC DS



Symbol Legend

- Bench Mark
- Control Station
- Setout Point
- Water Meter
- Water Stop Valve
- Water Marker Plaque
- Water tap
- Fire Hydrant
- Stormwater manhole triangular
- Stormwater manhole square
- Stormwater manhole round
- Rain water outlet
- Grid Inlet
- Sewer manhole triangular
- Sewer manhole square
- Sewer manhole round
- Electrical Pit
- Power Box
- Light Pole
- Power Pole with Light
- Power Pole
- Stay Anchor Post
- Traffic Light
- Electric Marker Plaque
- Telstra Pit
- Telstra Marker Plaque
- Telstra Pillar
- Cable Marker
- Comms Pit
- Fibre Optic Pit
- Comms Telephone Post
- Gate
- Sign Post
- Bollard
- Tree and trunk (symbol indicates size)

Line Legend

- Kerb back,invert and lip
- Powerline under ground
- Powerline above ground
- Fence line
- Edge of vegetation
- Edge of building
- Major contour 1.0m
- Minor contour 0.2m
- Sewer Line
- Water line
- Telecomms line under ground
- Telecomms line above ground
- Fiber optic line
- Gas line
- Stormwater line
- Change of Grade
- Bottom of Bank
- Top of bank
- Top Retaining Wall

Services have been plotted from records obtained through DBYD and the relevant council.
These records are schematic in nature and therefore all plotted services are approximate only.
Surface features have been located by field survey where possible and shown by appropriate symbols, lines joining symbols follow the schematic layout and have not been physically located.

The information may have omissions.
Prior to any Demolition,Construction or Excavation on the site, the relevant Authority should be contacted for the possible location of further underground services.

The Real Property Boundaries have not been defined by
this survey and have been compiled from IS201378 and SP229518 (MGA meridian.)
Coordinate system is MGA Scaled with 1.0004 about point 9000 as indicated.

REVISIONS

REV	BY	DATE	DESCRIPTION
A	JVR	20/07/18	Original Copy

NOTES

LEVEL DATUM: AHD Derived			
REF BM No: GPS CORS Network			
REDUCED LEVEL:			
LOCATION:			
AZIMUTH: MGA (Scaled)			
SURVEYOR: JVR			
FIELD BOOK		DRAWN	JVR
LEVEL BOOK		CHECKED	

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SCALE 1:500 @ A1

LOCALITY PLANNING & CONSULTING

CONTOUR & DETAIL PLAN

161 Sandmere Road, Pinkenba
Lot 482 on M3321

PASSED

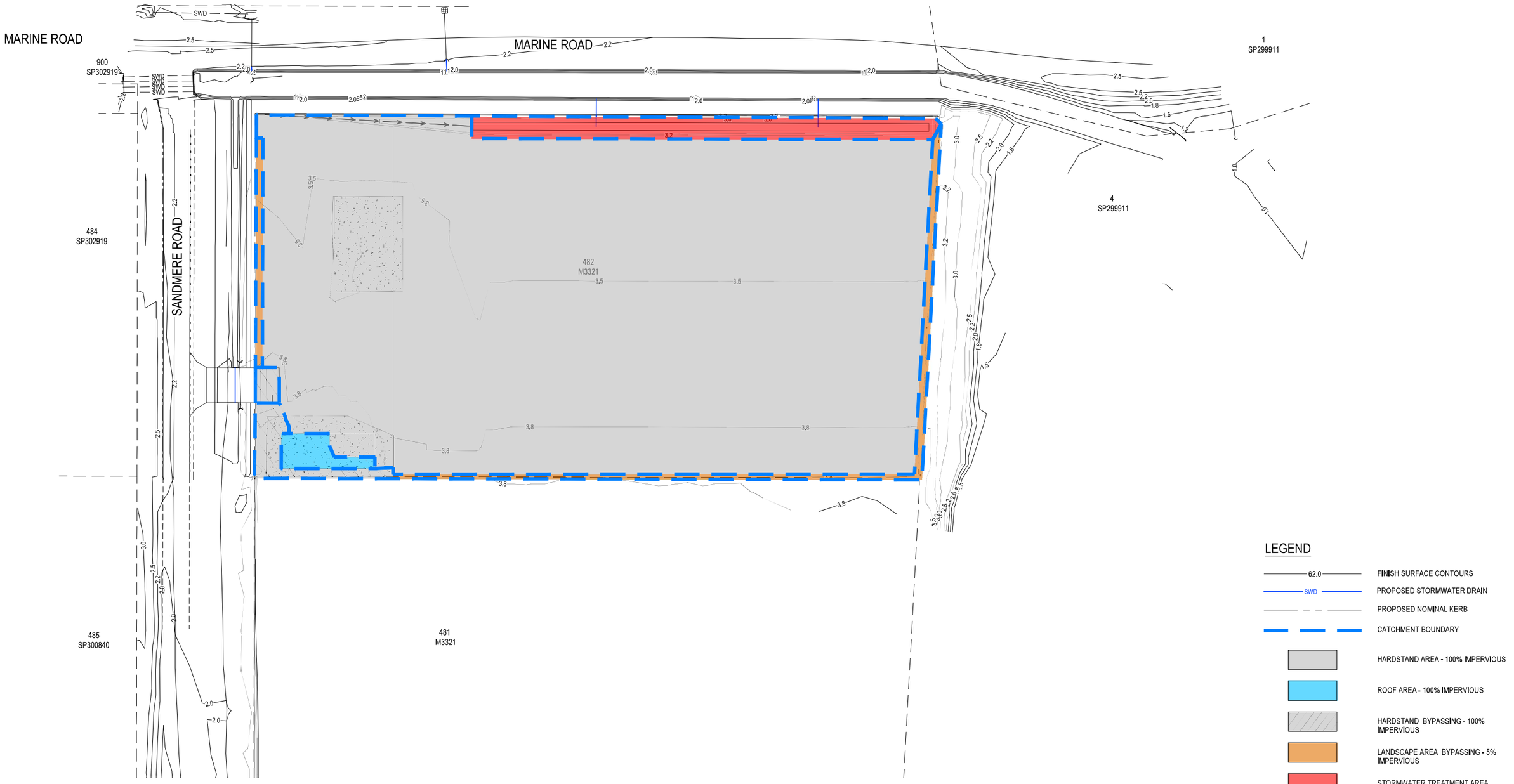
DATE

SHEET 1 OF 4

0412-01 | A

APPENDIX B MUSIC CATCHMENT PLAN

CIVIL360 MUSIC MODELLING CATCHMENT PLAN



BEFORE YOU DIG www.byda.com.au

REV	REVISION DESCRIPTION	DESIGN	DRAWN	DATE
A	ISSUE FOR APPROVAL	AR	ED	26.03.26
B	BRISBANE CITY COUNCIL RFI AMENDMENTS	SF	SF	14.07.26

SCALE
1 : 500 5 0 5 10 15 20 25m A1
1 : 1000 A3

COUNCIL
BRISBANE CITY COUNCIL

APPROVED ANTHONY RICKERT(RPEQ 24958)
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FOR AND ON BEHALF OF CIVIL360 ENGINEERING PTY LTD.

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ASSOCIATED CONSULTANTS
TPA.

PROJECT
161 SANDMERE ROAD
161 SANDMERE ROAD, PINKENBA
LOT 482 ON M3321

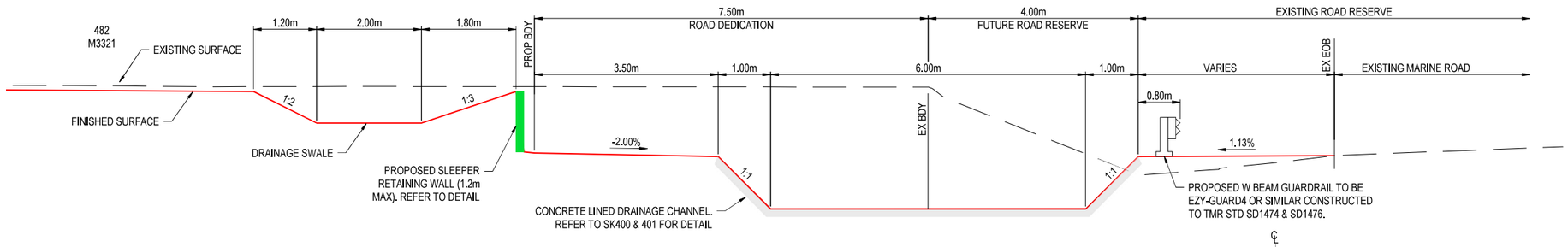
STATUS
ISSUE FOR APPROVAL

DRAWING TITLE
MUSIC CATCHMENT PLAN

PROJECT No.	DRAWING No.	REVISION
2025077	SK410	B

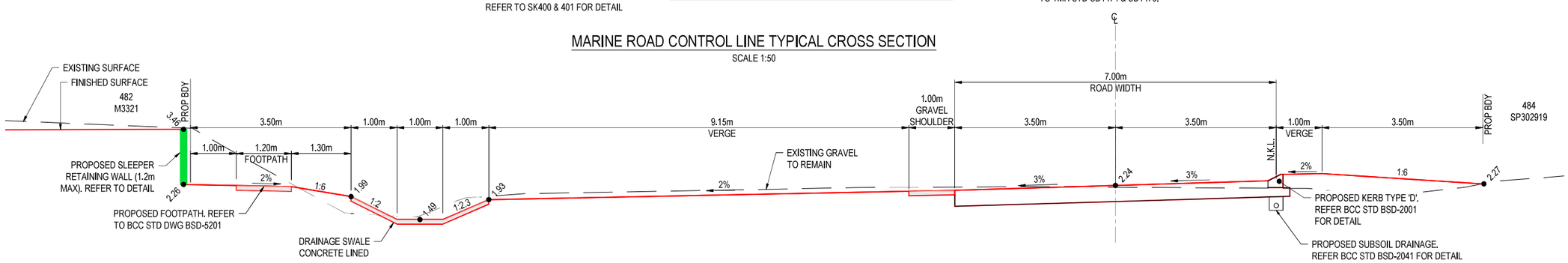
APPENDIX C STORMWATER MANAGEMENT DRAWING

BIORETENTION BASIN (QUALITY TREATMENT) DETAILS



MARINE ROAD CONTROL LINE TYPICAL CROSS SECTION

SCALE 1:50



DATUM 0.0

MARINE ROAD CONTROL LINE CROSS SECTION CH 20.000

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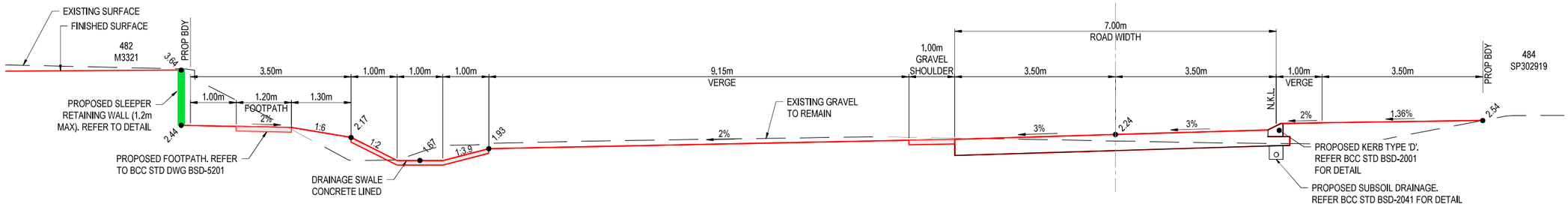

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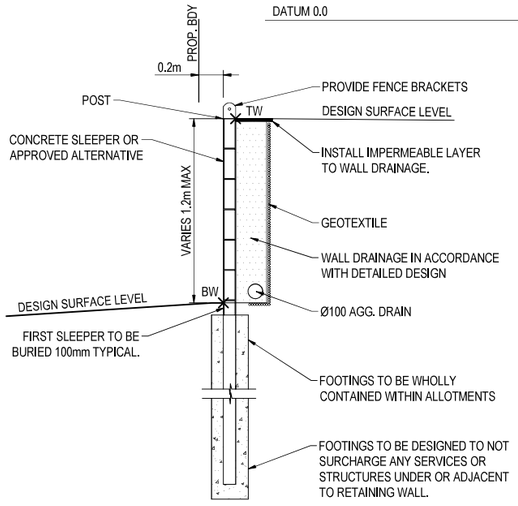
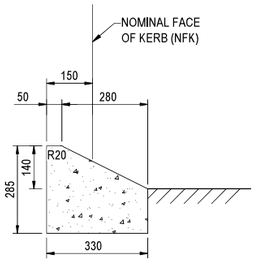


TYPICAL SLEEPER RETAINING WALL SECTION

SCALE: NTS

SLEEPER WALL DESIGN AND CONSTRUCTION TO BE CERTIFIED BY A STRUCTURAL ENGINEER

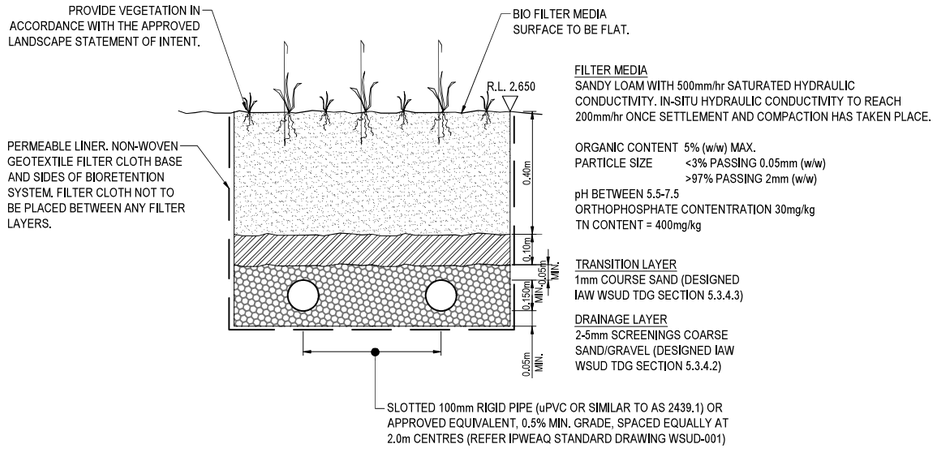


BARRIER TYPE 'D'

SCALE 1:10

MARINE ROAD CONTROL CROSS SECTION CH 60.000

SCALE 1:50



FILTER MEDIA
SANDY LOAM WITH 500mm/hr SATURATED HYDRAULIC CONDUCTIVITY. IN-SITU HYDRAULIC CONDUCTIVITY TO REACH 200mm/hr ONCE SETTLEMENT AND COMPACTION HAS TAKEN PLACE.

ORGANIC CONTENT 5% (w/w) MAX.
PARTICLE SIZE <3% PASSING 0.05mm (w/w)
>97% PASSING 2mm (w/w)
pH BETWEEN 5.5-7.5
ORTHOPHOSPHATE CONTENTRATION 30mg/kg
TN CONTENT = 400mg/kg

TRANSITION LAYER
1mm COURSE SAND (DESIGNED IAW WSUD TDG SECTION 5.3.4.3)

DRAINAGE LAYER
2-5mm SCREENINGS COARSE SAND/GRAVEL (DESIGNED IAW WSUD TDG SECTION 5.3.4.2)

INDICATIVE BIORETENTION MEDIA CROSS SECTION

SCALE 1:100

NOTES:

1. KERB PROFILES ARE TO BE IN ACCORDANCE WITH BCC STD DRG BSD-2001.
2. SUB SURFACE DRAINAGE IN ACCORDANCE WITH BCC STD DRG BSD-2041.
3. REFER TO BCC STD DRGS BSD-5201 & 5203 FOR CONCRETE FOOTPATH DETAILS.
4. VERGE PROFILE TO BE IN ACCORDANCE WITH B.C.C. STANDARD DRAWINGS.

PAVEMENT NOTES:

1. THE COMPACTED DEPTHS OF PAVEMENT SHOWN ON THE DRAWINGS ARE DESIGN DEPTHS ONLY AND MAY BE VARIED AFTER SUBGRADE TESTS ARE TAKEN. PAVEMENT DEPTHS SHALL BE SUBJECT TO APPROVAL BY B.C.C.
2. PAVEMENT MATERIAL SHALL CONFORM TO B.C.C. SPECIFICATION.

REV	REVISION DESCRIPTION	DESIGN	DRAWN	DATE
A	ISSUE FOR APPROVAL	AR	ED	26.03.26
B	BRISBANE CITY COUNCIL RFI AMENDMENTS	SF	SF	14.07.26

SCALE
1 : 100 1 0 1 2 3 4 5m A1
1 : 200 A3

COUNCIL
BRISBANE CITY COUNCIL

APPROVED ANTHONY RICKERT(RPEQ 24958)
2026.07.20 11:46:29+10'00'

FOR AND ON BEHALF OF CIVIL360 ENGINEERING PTY LTD.

CIVIL 360 ENGINEERING
PROJECT MANAGEMENT
CIVIL ENGINEERING
LAND DEVELOPMENT
0406 424 223 / 0423 593 058
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CLIENT: LAGC CAVA PTY LTD

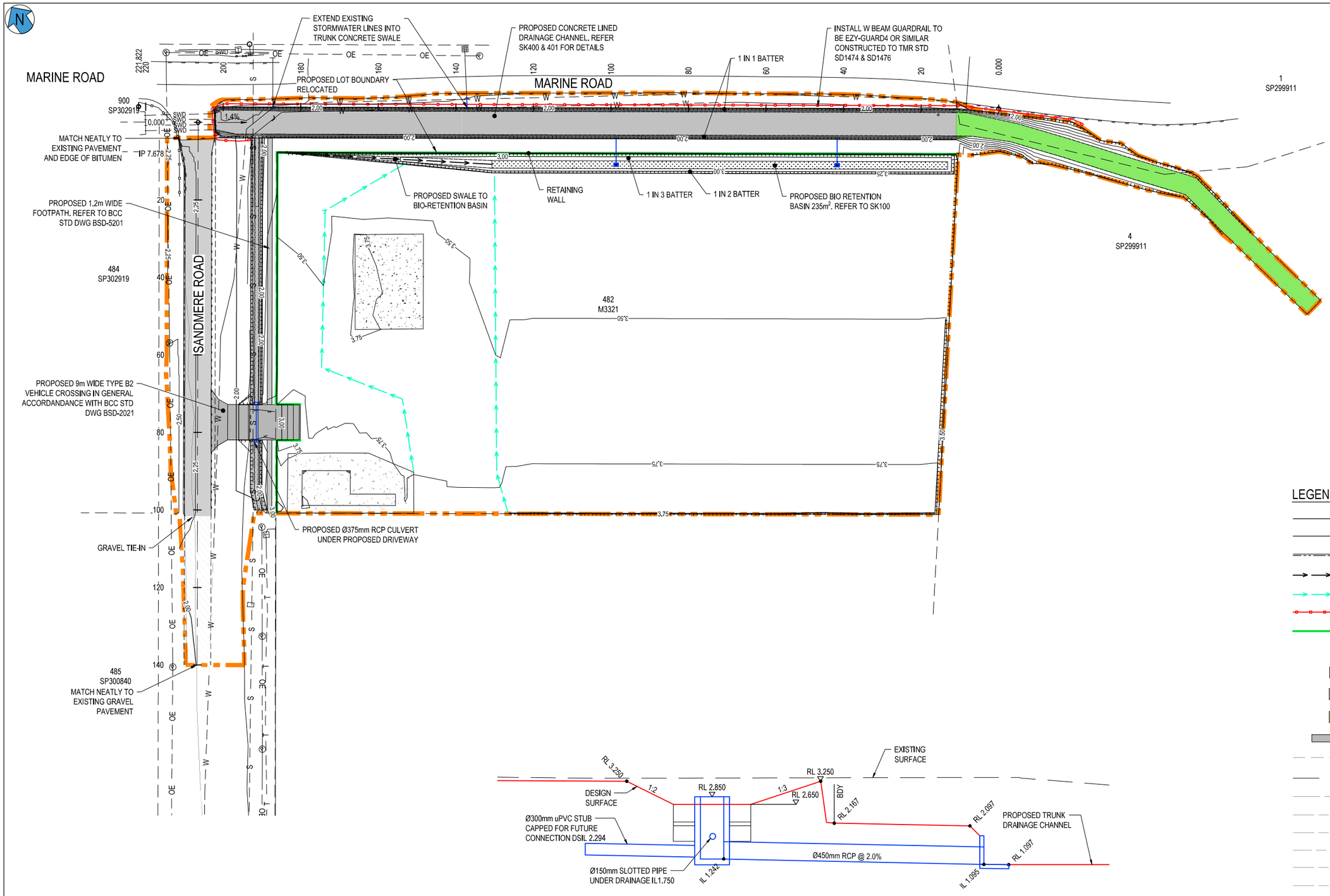
ASSOCIATED CONSULTANTS: TPA.

PROJECT: 161 SANDMERE ROAD
161 SANDMERE ROAD, PINKENBA
LOT 482 ON M3321

STATUS: ISSUE FOR APPROVAL

DRAWING TITLE: TYPICAL DETAILS

PROJECT No.	DRAWING No.	REVISION
2025077	SK100	B



TYPICAL BIORETENTION PIPE OUTLET DETAIL

SCALE 1:50 (A1)

BEFORE YOU DIG www.byda.com.au

REV	REVISION DESCRIPTION	DESIGN	DRAWN	DATE
A	ISSUE FOR APPROVAL	AR	ED	26.03.26
B	BRISBANE CITY COUNCIL RFI AMENDMENTS	SF	SF	14.07.26

SCALE
1 : 500 5 0 5 10 15 20 25m A1
1 : 1000 A3

COUNCIL
BRISBANE CITY COUNCIL

APPROVED ANTHONY RICKERT(RPEQ 24958)
2026.07.20 11:46:30+10'00'

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PROJECT
161 SANDMERE ROAD
161 SANDMERE ROAD, PINKENBA
LOT 482 ON M3321

STATUS
ISSUE FOR APPROVAL

DRAWING TITLE
ROADWORKS AND DRAINAGE PLAN

PROJECT No.	DRAWING No.	REVISION
2025077	SK300	B

APPENDIX D DESIGN ASSESSMENT CHECKLIST

WATER BY DESIGN BIO-RETENTION TECHNICAL GUIDELINES VERSION 1.1

TABLE 22 DESIGN CHECK AND SUMMARY - COMPLETED BY CIVIL360

Item	Description	Detail	Recommendation
1. Treatment			
(a)	Catchment area (ha)	1.5811	
(b)	Filter media area (excluding batters) (m^2)	235	*Floor area minus forebay area*
(c)	Confirm water quality performance meets the design objectives	Design objectives have been met.	
(d)	Confirm hydrologic performance meets relevant frequent flow objectives	N/A	
2. Design inflows			
(a)	Minor design storm entering system	39.3% AEP	
(b)	Minor storm peak flow rate (m^3/s)	0.479	
(c)	Major design storm entering system	1% AEP	
(d)	Major storm peak flow rate (m^3/s)	1.37	
3. Depth profile			
(a)	Bioretention drainage profile type	3	
(b)	Minimum drainage layer depth (m)	0.200	*Minimum 50mm of material above 150mm diameter pipe.*
(c)	Maximum drainage layer depth (m)	0.333	*underdrain grade = 0%*
(d)	Transition layer depth (m)	0.100	
(e)	Saturated zone depth for Type 1 bioretention systems (m)	N/A	
(f)	Filter media layer depth (m)	0.400	
(g)	Extended detention depth (m)	0.200	
(h)	Maximum water level depth above extended detention for major storm event (m)	0.575	*Major storm = 1% AEP*
(i)	Freeboard to top of embankment (m)	-0.175	
(j)	Total system profile depth [3(c)+3(d)+3(f)+3(g)+3(h)+3(i)] (m)	1.433	
(k)	Liner type (i)Permeable(ii)Impermeable(iii)None to base	Permeable	*refer to drawing IPWEAQ DSD-504*
(l)	AASS/PASS assessed and appropriately managed	N/A	
(m)	Presence of dispersive soils assessed and appropriately managed	N/A	
4. Design levels			
(a)	Outlet invert level (mAHD)	1.28	
(b)	Overflow pit invert level (mAHD)	2.88	
(c)	Minimum drainage layer level (mAHD)	1.82	
(d)	Filter media surface level (mAHD)	2.65	
(e)	Overflow pit crest level (mAHD)	2.88	
(f)	Overflow weir level (mAHD)	3.08	
(g)	Maximum design water level (mAHD)	3.43	
(h)	Top of embankment/batter level (mAHD)	3.05	
(i)	Inlet/inflow invert level (mAHD)	2.65	
(j)	Total level difference [4(h)-4(c)] (mAHD)	1.233	
(k)	Highest astronomical tide level (mAHD)	Non-tidal m AHD	
(l)	Groundwater level (mAHD)	N/A	
5. Layout			
(a)	Maximum filter media length (m)	28.5	*≤ 40 m*
(b)	Maximum filter media width (m)	2	*≤ 20 m (preferred ≤ 15m*
(c)	Maximum batter slope	1 in 3	*V:H*
(d)	Maximum wall height (where applicable) (m)	N/A	*Max 0.8m tiers, up to 50% of perimeter*
(e)	Provision for services (water, sewer, gas, telecommunications, stormwater)	N/A	
(f)	Maintenance access provided	Y	
(g)	Flood storage volume above extended detention (where bioretention combined with flood storage) (m^3)	N/A	

6. Inlet design			
(a)	Inlet/inflow type (i)pipe (ii)channel (iii)sheet flow (iv)other	sheet flow	
(b)	Diversion/surcharge type (where applicable)	N/A	
(c)	Coarse sediment removal (i)forebay (ii)inlet pond (iii)swale (iv)other	N/A	*Catchment Area less than 2ha*
(d)	Coarse sediment removal area (m^2)	N/A	
(e)	Coarse sediment removal depth (m)	N/A	
(f)	Coarse sediment clean-out frequency (yrs)	N/A	
(g)	Flow distribution type	N/A	*Required if filter media area > 400 m2*
(h)	Confirm scour protection at inflow locations	NO	*all inflow is sheet flow over 174m (velocity = 0.28m/s)*
(i)	Minor storm flow velocity over filter (m/s)	0.60	*< 1.0 m/s*
(j)	Major storm flow velocity over filter (m/s)	0.88	*< 1.0 m/s*
7. Underdrainage (outlet design)			
(a)	Filter media saturated hydraulic conductivity (mm/hr)	200	*100 – 300 mm/hr*
(b)	Maximum filter infiltration capacity (m^3/s)	0.017	
(c)	Underdrain capacity (m^3/s)	0.047	*Pipe flow at outlet = 0.017 cumecs*
8. Overflow design (outlet design)			
(a)	Overflow pit type	FIELD INLET	
(b)	Overflow pit dimensions	2 x 900mm x 600mm	*refer to civil drawngs for locations*
(c)	Overflow weir length (m)	2	
(d)	Overflow pit capacity (taking into account blockage factors) (m^3/s)	0.561	
(e)	Overflow pit plus overflow weir capacity (taking into account blockage factors) (m^3/s)	1.401	*Total weir depth is not reached in Q100 event (remaining depth is for emergency overflow in extreme flood events)*
(f)	Outlet pipe size (m)	0.450	
(g)	Appropriate outlet scour protection provided	Y	
9. Vegetation design			
(a)	Planting style (i)small scale urban (ii)med-large scale urban (iii)bushland	Medium-large scale urban	
(b)	Trees and shrubs to be included (Y/N)	N	*groundcover, plants & shrubs*
(c)	Species diversity (number of species)	6	
(d)	Species selection	refer to Landscape Plans	
(e)	Planting density	6-8 plants/m^2 ,1 shrub per 2 -20m^2	*no trees*
(f)	Mulch type and depth	Sugar Cane Mulch	*50 to 75mm depth*

Areas			
Catchment Area Treated =	1.5811	*ha*	*Measured from CAD*
Total Catchment Area =	1.581	*ha*	
Design Filter Area - Basin A =	235	m^2	*Refer to MUSIC model or SBSMP*
Depths/ILs			
Profile Type =	3		*Figure 16 WBD TDG 2014*
Extended Detention Depth =	0.2	*m*	*Refer to MUSIC model*
Filter Media Invert Level *IL* =	2.65	*m*	*from earthworks model*
Filter Media Depth =	0.4	*m*	*Refer to MUSIC model*
Transition Layer Depth =	0.1	*m*	*recommended minimum*
Minimum Drainage Layer Depth =	0.200	*m*	*50mm cover above underdrainage pipes*
Maximum Underdrain Centres =	2.5	*m*	*Figure 41 WBD TDG 2014*
Collector Pipe Diameter =	0.100	*m*	*refer to "Under Drainage Friction Loss - Collector" below*
Maximum Collector Pipe Length =		*m*	*refer to "Under Drainage Friction Loss - Collector" below*
Minimum Collector Longitudinal Grade =		*m/m*	*= 0%*
Branch Pipe Diameter =	0.150	*m*	*refer to "Under Drainage Friction Loss - Branch" below*
Maximum Branch Pipe Length =	31.5	*m*	*refer to "Under Drainage Friction Loss - Branch" below*
Minimum Branch Longitudinal Grade =	0.005	*m/m*	*= 0.5%*
Underdrain fall =	0.133	*m*	
Maximum Drainage Layer Depth =	0.333	*m*	*min depth + length x grade*
Basin Depth for Major Storm Event =	0.575	*m*	*from DRAINS model*
Minimum Adjacent Allotment Level =	3.250	*m*	*from earthworks model*
Depth to Top of Embankment =	0.400	*m*	*Minimum adj lot level - filter media IL*
Overflow Pit FSL =	2.875	*m*	
Overflow Weir IL =	3.075	*m*	
Forebay Sizing	N/A		*Catchment Area less than 2ha*
Inlet 1:			
Catchment Area =		*ha*	*Measured from CAD*
Capture Efficiency *R* =	0.8		*WDB TDG 2014 recommended page 71*
Sediment Loading Rate L_o =	0.6	m^3*/ha/year*	*Paragraph 1 page 72 WBD TDG 2014*
Cleanout Frequency F_c =	N/A	*year*	*Section 3.4.3.2 page 71 WBD TDG 2014*
Forebay Storage V_s =	0.0	m^3	*minimum forebay volume*
Turbulence Parameter *n* =	0.5		*WDB TDG 2014 recommended page 72*
Settling Velocity v_s =	0.1	*m/s*	*for 1mm particle WDB TDG 2014 page 72*
3month Flow Q =		m^3*/s*	*from DRAINS model*
Forebay Area A_f =	N/A	m^2	*minimum forebay area*
Forebay Depth D_s =	N/A	*m*	*Between 0.2m and 0.3m (can be 0.1m for smaller basins)*
Minimum Forebay Storage Check V_s =	0.000	m^3	*VS = Af x DS (must be > 0)*
Flow Velocity over Filter Media			*Eq 6 WBD TDG 2014*
Minor AEP =	39.3	*%*	
Major ARI =	1	*%*	
39.3% AEP Flow =	0.479	m^3*/s*	*from DRAINS model*
Basin Width at outlet *w* =	2	*m*	*from earthworks model*
Detention Depth d_2 =	0.400	*m*	*Depth of water in basin from Q39.3 inflows*
V_2 =	0.60	*m/s*	*v =Q/(w x d)*

2nd Inlet (if applicable):			
Maximum Infiltration Rate			*Eq 7 WBD TDG 2014*
Hydraulic Conductivity =	200	*mm/hr*	*Refer to MUSIC model*
Saturated Hydraulic Conductivity K_{sat} =	0.0001	*m/s*	
Filter Media Area *A* =	235	m^2	*Refer to MUSIC model*
Extended Detention Depth h_{max} =	0.2	*m*	*Refer to MUSIC model*
Filter Media Depth *d* =	0.6	*m*	*Refer to MUSIC model*
Max Infiltration Rate Q_{max} =	0.017	m^3/s	$Q_{max} = k_{sat} \times A \times (h_{max} + d)/d$
Under Drainage Friction Loss - Branch			*Eq 8 WBD TDG 2014*
Pipe Section Length *L* =	28.5	*m*	*Longest branch - measured from CAD*
Area captured by Longest Branch =	57	m^2	*Measured from CAD*
Flow Q_a =	0.004	m^3/s	Q_{max} *x (Capture Area/Total Filter Area)*
Roughness Coefficient *C* =	150		
Pipe Diameter *D* =	0.150	*m*	
Pipe Friction Loss h_f =	0.012	*m*	$hf = L \times (10.67 \times Qa^{1.85})/(C^{1.85} \times D^{4.87})$
Under Drainage Friction Loss - Collector			*Eq 8 WBD TDG 2014*
Pipe Section Length *L* =		*m*	*Measured from CAD*
Flow at outlet Q_a =	0.017	m^3/s	Q_{max}
Roughness Coefficient *C* =	150		
Pipe Diameter *D* =	0.100	*m*	
Pipe Friction Loss h_f =	0.000	*m*	$hf = L \times (10.67 \times Qa^{1.85})/(C^{1.85} \times D^{4.87})$
Under Drainage Friction Loss - Fittings			
Pipe Flow Velocity *V* =	0.239	*m/s*	$V = Q_a$*/Pipe Area*
Number of 11.25° Bends =		*No.*	*Measured from CAD*
11.25° Pressure Change Coefficient *K* =	0.05		*recommended by manufacturer*
11.25° Friction Loss in each Bend H_s =	0.0000	*m*	$H_s = K \times V^2/2g$
Number of 22.5° Bends =		*No.*	*Measured from CAD*
22.5° Pressure Change Coefficient *K* =	0.15		*recommended by manufacturer*
22.5° Friction Loss in each Bend H_s =	0.0004	*m*	$H_s = K \times V^2/2g$
Number of 45° Bends =		*No.*	*Measured from CAD*
45° Pressure Change Coefficient *K* =	0.45		*recommended by manufacturer*
45° Friction Loss in each Bend H_s =	0.0013	*m*	$H_s = K \times V^2/2g$
Number of 90° Bends =	1	*No.*	*Measured from CAD*
90° Pressure Change Coefficient *K* =	0.75		*recommended by manufacturer*
90° Friction Loss in each Bend H_s =	0.0022	*m*	$H_s = K \times V^2/2g$
Total Friction Loss in Bends H_b =	0.002	*m*	$H_b = H_s$ *x No. bends*
Number of Tees =		*No.*	*Measured from CAD*
Pressure Change Coefficient *K* =	0.9		*recommeded by manufacturer*
Friction Loss in each Tee H_s =	0.003	*m*	$H_s = K \times V^2/2g$
Total Friction Loss in Tees H_t =	0.000	*m*	$H_t = H_s$ *x No. tees*
Under Drainage Friction Loss - Total			
Sum of Losses H_{TOTAL} =	0.014	*m*	*Eq 10 WBD TDG 2014*
Overflow Orifice (if applicable)			
Minor Outflow =		m^3/s	*from DRAINS model*
Number of Orifices =		*No.*	*refer to bio-basin layout for locations*
Orifice Height (or Diameter) =		*m*	
Orifice Width (if applicable) =		*m*	
Orifice Area =	0.000	m^2	
Orifice Coefficient C_d =	0.60		
WSL Depth Above Orifice IL =		*m*	
Orifice Flow Capacity $Q_{orifice}$ =	0.000	m^3/s	$Q_{orifice} = C_d \times A \times (2gh)^{1/2}$

Overflow Pit			
39.3% AEP Outflow =	0.479	m^3/s	*from DRAINS model*
Major Outflow =	1.37	m^3/s	*from DRAINS model*
Number of Pits =	2	*No.*	*refer to bio-basin layout for locations*
Blockage Factor B =	0.5		
Weir Coefficient C_w =	1.66		
Pit Opening length *L* =	0.900	*m*	
Pit Opening width *W* =	0.600	*m*	
Weir Length =	3.780	*m*	*excluding grate*
Available Depth Below Overflow Weir *H* =	0.200	*m*	*Overflow weir IL - overflow pit grate level*
Total Pit Capacity for Weir Flow Q_{weir} =	0.561	m^3/s	$Q_{weir} = B \times C_w \times L \times h^{3/2}$
Orifice Flow Capacity at weir level $Q_{orifice}$ =	0.642	m^3/s	$Q_{orifice} = C_d \times A \times (2gh)^{1/2}$
Clear Opening Area of Grate A_g =	0.972	m^2	*excluding grate area*
Available Depth Below Overflow Weir *H* =	0.200	*m*	*Overflow weir IL - overflow pit grate level*
Orifice Flow Pit Capacity $Q_{orifice}$ =	0.578	m^3/s	$Q_{orifice} = B \times C_d \times A \times (2gh)^{1/2}$
Therefore Overflow Pit Capacity =	1.203	m^3/s	*Remaining flow passes over weir*
Overflow Weir			
1% AEP Flow =	1.370	m^3/s	*from DRAINS model*
Overflow Pit Capacity Q_{pit} =	0.561	m^3/s	*From Overflow Pit Calculations above*
Weir Capacity Required =	0.809	m^3/s	$Q_{100} - Q_{pit}$
Weir Length =	2.000	*m*	*Measured from CAD*
Available Depth in Overflow Weir *H* =	0.400	*m*	*to maintain 0.3m freeboard to lowest lot*
Weir Coefficient C_w =	1.66		
Capacity for Weir Flow Q_{weir} =	0.840	m^3/s	$Q_{weir} = C_w \times L \times h^{3/2}$
Overflow Pipe			
Outlet Pipe Diameter *D* =	0.450	*m*	
Number of conduits =	2		
Pipe Length *L* =	7.284	*m*	
Pipe Invert Upstream *USIL* =	1.277	*m*	*Lowest invert in the drainage layer*
Pipe Invert Downstream *DSIL* =	1.131	*m*	
Pipe Length Grade *S* =	0.020	*m/m*	*= 2%*
Pipe Fall L_s =	0.146	*m*	
Outlet Pipe Obvert Level =	1.581	*m*	
1% AEP WSL at Outlet Downstream =	2.101	*m*	*from DRAINS model*
Outlet WSL/HGL *TW* =	2.101	*m*	*maximum of OL and WSL*
1% AEP Detention Basin WSL =	3.250	*m*	*from DRAINS model*
Available Friction Head H_f =	1.149	*m*	*Overflow weir - TWL*
Available Friction Slope S_f =	0.158	*m/m*	H_f/L
Therefore Pipe Capacity Q_{pipe} =	2.265	m^3/s	*therefore pit inflow is not limited by pipe capacity*

APPENDIX E WATER BY DESIGN FORMS

CONSTRUCTION AND ESTABLISHMENT SIGN OFF FORMS - BIORETENTION SYSTEMS

Construction and Establishment Sign-off Forms: Bioretention Systems

Version 1.1, April 2010

The *Construction and Establishment Sign-Off Forms: Bioretention Systems* outline the key items to be reviewed when delivering and inspecting bioretention systems.

The Sign-Off Forms follow the construction step-by-step sequences provided in Sections 3.9 and 3.10 of the *Construction and Establishment Guidelines: Swales, Bioretention Systems and Wetlands* (Water by Design, 2010, accessible from www.waterbydesign.com.au).

The Sign-off Forms are to be used by contractors, construction site superintendents, designers and local authority compliance inspectors to ensure all the elements of the bioretention system have been constructed in accordance with the design. It is the responsibility of the site superintendent and contractor to ensure the most recent version of the forms are being used.

The Sign-Off Forms provide the basis of the certification and compliance requirements for bioretention systems. They are designed for easy incorporation into asset databases managed by Councils or private organisations such as body corporates.

The following Construction and Establishment Sign-Off Forms are provided in this document:

- Bioretention System Construction and Establishment
- Pre-Start Meeting Sign-Off Form
- FORM A — Earthworks and Functional Structures
- FORM B — Under-drainage
- FORM C — Bioretention Media
- FORM D — Finished Levels
- FORM E — Coarse Sediment Forebay
- FORM F — Protective Measures
- FORM G — Landscape Installation
- FORM H — Landscape Establishment

If an item receives an 'N' in the 'Satisfactory Criteria', indicating that an element is 'not satisfactory', appropriate actions must be specified to rectify the construction issue before final inspection sign-off is given.

Disclaimer

The material contained in this publication is produced for general information only. It is not intended as professional advice on specific applications. It is the responsibility of the user to determine the suitability and appropriateness of the material contained in this publication to specific applications. No person should act or fail to act on the basis of any material contained in this publication without first obtaining specific independent professional advice. The South East Queensland Healthy Waterways Partnership (SEQHWP) expressly disclaim all and any liability to any person in respect of anything done by any such person in reliance, whether in whole or in part, on this publication. The information contained in this publication does not necessarily represent those of the funding partners.

Asset I.D.		DA No.	
System location:			
Area:	Catchment Area (ha):	Bioretention Area (ha):	
Civil drawing no.			
Landscape drawing no.			

Role/Stakeholder	**Company**	**Contact Name**	**Contact Details**
Developer			
Site superintendent (civil)			
Site superintendent (landscape)			
Bioretention designer			
Civil engineer			
Landscape architect			
Civil contractor			
Landscape contractor			
Council compliance officer			

Checklist of Sign-Off Forms

Sign-Off Form	**Date Completed**	**Name of Signatory & Role (e.g. Superintendent)**	**Signature**
Pre-Start Meeting			
Form A — Earthworks & Functional Structures			
Form B — Under-Drainage			
Form C — Bioretention Media			
Form D — Finished Levels			
Form E — Coarse Sediment Forebay			
Form F — Protective Measures			
Form G — Landscape Installation			
Form H — Landscape Establishment			

Pre-Start Meeting List pre-start meeting attendees who are to sign indicating they have attended the meeting and understand the design intent, construction and establishment process.			
Location			
Date			
Role/Stakeholder	**Company**	**Contact Name**	**Sign**
Developer			
Site superintendent (civil)			
Site superintendent (landscape)			
Bioretention designer			
Civil engineer			
Landscape architect			
Civil contractor			
Landscape contractor			
Other			
Other			
Other			
Comments (attach and refer to additional pages if necessary)			
Actions (attach and refer to additional pages if necessary)			
FORM A — Earthworks and Functional (Hydraulic) Structures			

Purpose: To ensure earthworks bulking out, trimming and profiling and the key levels of functional (hydraulic) structures are in accordance with design drawings and specifications. The earthworks and structures dictate the movement of stormwater through the bioretention system and are a critical element in the function of the system.				
Items	**Checked**	**Satisfactory**	**Action (if unsatisfactory)**	**Initial**
As constructed survey completed and attached to this form				
Photos taken and attached to this form				
Set-out of system is correct				
Base levels are at correct elevation (±50 mm)				
Base at correct grading (0.5%)				
Punch out holes in overflow pit are correct size, correct level and above invert level of outlet pipe (±25 mm)				
Overflow pit is correct size and crest and invert is at correct level (±25 mm)				
Outlet pipe invert levels are correct (upstream and downstream) (±25 mm)				
Outlet pipe is free draining				
Overflow weir (if required) is correct length and at correct level (±25 mm)				
Overflow weir (if required) is keyed into bund				
Bunds/embankments surrounding the system are at correct levels or above				
HOLD POINT: Superintendent and bioretention designer inspection and sign-off before proceeding.				
Comments (attach and refer to additional pages if necessary)				

NB: As constructed survey and drawings and photos attached.

Signed by superintendent: _____

Print name: _____

Date: _____

AND

Signed by bioretention designer: _____

Print name: _____

Date: _____

FORM B — Under-drainage
Purpose: To ensure under-drainage is installed correctly before the bioretention media is installed.

Items	Checked	Satisfactory	Action (if unsatisfactory)	Initial
Base of system free from debris				
Liner (typically filter cloth) correctly installed				
There is no fabric 'sock' around the under-drainage				
Correct under-drainage has been supplied and slotted at 2 mm or smaller				
Under-drainage pipes are laid at the correct spacing (small bioretention system 1.5 m, large system 2 m) Required grade (verified using level or string line)				
Under-drainage pipes laid at required grade (verified using level or string line to achieve design level ±25 mm and 0.5% grade)				
All junctions and connections have been appropriately sealed				
Top of clean out points at design level (i.e. approximately 50–150 mm above filter media surface)				
HOLD POINT: Superintendent or bioretention designer inspection and sign-off before proceeding.				
Comments (attach and refer to additional pages if necessary)				

NB: As constructed survey and drawings and photos attached.

Signed by superintendent: _____

Print name: _____

Date: _____

AND

Signed by bioretention designer: _____

Print name: _____

Date: _____

FORM C — Bioretention Media
Purpose: To ensure that the media placed in the system meets the required specifications and that there is a record of the media being delivered to site. To ensure media layers are installed correctly and meet the design and specification requirements.

SOURCING, TESTING AND SUPPLYING BIORETENTION MEDIA				
Drainage layer	**Checked**	**Satisfactory**	**Action (if unsatisfactory)**	**Initial**
Meets the specifications				
Meets the required hydraulic conductivity (4,000 mm/hr)				
Delivery supply docket certifies that the material delivered is the material tested (delivery docket attached)				
Transition layer supply				
Meets the specifications				
Supplier certification provided (certification attached)				
Delivery supply docket certifies that the material delivered is the material tested (delivery docket attached)				
Filter media supply				
Meets the FAWB's *Guideline Specifications for Soil Media in Bioretention Systems* (2008)				
Meets the required hydraulic conductivity (100–500 mm/hr, 750 mm/hr maximum)				
Frequency of laboratory testing completed in accordance with Section 3.5 (results of testing attached)				
Supplier certification provided (certification attached)				
Delivery supply docket certifies that the material delivered is the material tested (delivery docket attached)				
HOLD POINT: Superintendent or bioretention designer inspection and review of test results and certifications before proceeding.				
Comments (attach and refer to additional pages if necessary)				

FORM C — Bioretention Media (cont.)				
INSTALLATION OF BIORETENTION MEDIA				
	Checked	**Satisfactory**	**Action (if unsatisfactory)**	**Initial**
Base of system free from debris				

Drainage layer (fine gravel) installed to correct depth (± 25 mm)				
Transition layer (coarse sand) installed to correct depth (± 25 mm)				
Placement of filter media completed to avoid compaction of media and using at least two lifts				
Filter media installed to correct depth				
Light, even compaction applied to remove air gaps (e.g. light roller or single pass with a 'pozitrack' bobcat)				
Spreader bar used to flatten surface of filter media				
Sediment fences in place				
INSPECTION: Superintendent and bioretention designer inspection and sign-off to occur while installation of media is occurring. Photos must be taken by the superintendent, the bioretention designer or the contractor.				
Comments (attach and refer to additional pages if necessary)				

NB: Laboratory test results, certification, delivery dockets and photos attached.

Signed by superintendent: _____

Print name: _____

Date: _____

AND

Signed by bioretention designer: _____

Print name: _____

Date: _____

FORM D — Finished Levels				
Purpose: To ensure finished levels of system surface and bunds are correct and meet the design.				
Items	**Checked**	**Satisfactory**	**Action (if unsatisfactory)**	**Initial**
Landscaping topsoil applied to surrounding bunds to achieve design levels				

As-constructed survey of system surface and surrounding bunds completed				
Final constructed levels are consistent with design levels				
Under-drainage clean-outs extended 50–150 mm above filter media				
Under-drainage pipes flushed to remove initial ingress of material				
HOLD POINT: Superintendent and bioretention designer inspection and sign-off before proceeding.				
Comments (attach and refer to additional pages if necessary)				

NB: As constructed survey and drawings and photos attached.

Signed by superintendent: _____

Print name: _____

Date: _____

AND

Signed by bioretention designer: _____

Print name: _____

Date: _____

FORM E — Coarse Sediment Forebay				
Purpose: To ensure the coarse sediment forebay is constructed correctly.				
Items	**Checked**	**Satisfactory**	**Action (if unsatisfactory)**	**Initial**
Extent of coarse sediment forebay correctly set out				
Rocks to be used to line base of forebay are correct size and shape				

Base of constructed forebay is flat and set at the correct level below the surface of the filter media				
Rocks placed for energy dissipation are of appropriate size and are in correct location				
Interface between forebay and filter media is structurally sound and not prone to collapse				
HOLD POINT: Superintendent or bioretention designer inspection and sign-off before proceeding.				
Comments (attach and refer to additional pages if necessary)				

NB: As constructed survey and drawings and photos attached.

Signed by superintendent: _____

Print name: _____

Date: _____

AND

Signed by bioretention designer: _____

Print name: _____

Date: _____

FORM F — Protective Measures				
Purpose: To ensure protective measures are correctly installed to protect the bioretention system while building is occurring in the catchment.				
Protection option adopted (Option 1, 2 or 3)				
Option 1 — Surface protection during building phase	**Checked**	**Satisfactory**	**Action (if unsatisfactory)**	**Initial**
Continuous sediment fences installed around perimeter of filter media and top of batter.				
Where landscape works are not to commence immediately then cover batters with filter cloth.				

Protective covering (filter cloth + 25 mm topsoil + turf) installed across entire filter media area of system.				
Option 2 — Bypass and early establishment	**Checked**	**Satisfactory**	**Action (if unsatisfactory)**	**Initial**
Continuous sediment fences installed around perimeter of filter media and top of batter.				
Where landscape works are not to commence immediately then cover batters with filter cloth.				
Temporary bund installed (where required) to prevent stormwater runoff from entering bulk of system. Bund keyed into batters of bioretention and crest level higher than pits and weirs.				
Temporary protective covering (filter cloth + 25 mm topsoil + turf) installed within bunded area.				
Option 3 – Sediment Basin and Bioretention Function	**Checked**	**Satisfactory**	**Action (if unsatisfactory)**	**Initial**
Continuous sediment fences installed around perimeter of filter media and top of batter.				
Sediment basin installed upstream of bioretention in accordance with either (hydraulic structure): • WSUD Technical Design Guidelines for SEQ (SEQHWP, 2006) • Local erosion and sediment control guidelines or Best Practice Erosion and Sediment Control (IECA, 2008).				
Suitable access provided to sediment basin for clean out.				
Bioretention system installed downstream of sediment basin.				
Protective covering (filter cloth, 25mm top soil and turf) installed across entire filter media area of basin.				
HOLD POINT: Superintendent and bioretention designer inspection and sign-off before proceeding.				
Comments (attach and refer to additional pages if necessary)				

NB: Photos attached.

Signed by superintendent: _____

Print name: _____

Date: _____

AND

Signed by bioretention designer: _____

Print name: _____

Date: _____

FORM G — Landscape Installation				
Purpose: To ensure the correct plants are supplied, installed and established.				
Items	**Checked**	**Satisfactory**	**Action (if unsatisfactory)**	**Initial**
Correct mulch has been supplied				
Mulch applied to correct depth and secured				
Supplied plants are correct species				
Supplied plants are in correct pot sizes and maturity (300 mm min)				
Plants have been installed at correct planting density (min 6 plants/m^2)				
As constructed drawings marked up with final plant species and densities				

Mulch is clear of plant stems by approximately 50 mm				
HOLD POINT: Superintendent AND bioretention designer inspection and sign-off before proceeding.				
Comments (attach and refer to additional pages if necessary)				

NB: As constructed drawings and photos attached.

Signed by superintendent: _____

Print name: _____

Date: _____

AND

Signed by bioretention designer: _____

Print name: _____

Date: _____

FORM H — Landscape Establishment				
Purpose: To ensure the correct plants are supplied, installed and established.				
Items	**Checked**	**Satisfactory**	**Action (if unsatisfactory)**	**Initial**
PLANT ESTABLISHMENT				
Weeds being removed as required				
Watering occurring as required				
Replanting occurred as required to replace failed plants				

Plants successfully established plants propagation is occurring. Measure of successful establishment 1. Survivorship greater than 90% 2. 80% coverage of system 3. Preferably more than one species per macrophyte zone 4. At least 5 plants/m^2 (preferably 6–10 plants/m^2) 5. Plant height of at least 50%. This can be measures through the use of marker or stakes through the bioretention 6. Propagation is occurring (more than 2–3 stems, seeding) 7. No weeds. Growth and maturity should be recorded through three-monthly photo logs every 500 m^2.				
HOLD POINT: Superintendent AND bioretention designer inspection and sign-off.				
Comments (attach and refer to additional pages if necessary)				

NB: As constructed drawings and photos attached.

Signed by superintendent: _____

Print name: _____

Date: _____

AND

Signed by bioretention designer: _____

Print name: _____

Date: _____

3.9 Step-by-step sequence — Options 1, 2 and 3

The following sections provide a step-by-step sequence for civil construction, building phase protection and landscape establishment for the Staged Construction and Establishment Options 1, 2 and 3. Detailed descriptions and, where available, photos are provided for each step in tabular format. It is envisaged the tables will be laminated and used as an on-site reference during construction and establishment.

3.9.1 Stage 1 – Civil construction

The recommended civil construction sequence for bioretention systems is summarised in Table 3.7. The construction sequence should be read in combination with the Bioretention Construction and Establishment Sign-Off Forms.

Table 3.7: Civil construction (Stage 1) step-by-step sequence — Options 1, 2 and 3

CONSTRUCTION STEP	ACTIVITY	PHOTOS (SMALL BIORETENTION SYSTEM)	PHOTOS (LARGE BIORETENTION SYSTEM)
STEP 1: Pre-start meeting	Hold a pre-start meeting with the bioretention designer, civil engineer, landscape architect, site superintendent, civil contractor, landscape contractor and, where required, the Council compliance officer to: - explain the function of the bioretention system - highlight issues and risks associated with construction and establishment - talk through a preferred construction and establishment approach for the site - explain the as-constructed survey or drawing, inspection and sign-off requirements - confirm sources of bioretention media and certification requirements.		
STEP 2: Preparation	Prepare for construction at least 10 days before starting on site. Preparation includes organising the correct equipment to achieve required tolerances (Section 3.4.2), sourcing the bioretention media, ensuring the supplier of the filter media is completing the correct testing (Section 3.5), ordering materials and identifying construction timing and rain contingency plans (Section 3.3).		

CONSTRUCTION STEP	ACTIVITY	PHOTOS (SMALL BIORETENTION SYSTEM)	PHOTOS (LARGE BIORETENTION SYSTEM)
STEP 3: Install overflow pit and outlet pipe	Install the overflow pit and ensure the crest of the pit is at design level. The crest of the pit can be used as a datum from which other levels within the system are measured. The pit requires holes for under-drainage pipe connections. These holes should be drilled at this stage or plastic stubs should be installed at the time of casting the pit. Construct outflow headwalls and install sections of stormwater outlet pipe. If the outlet pipe is below the receiving environment levels (Section 3.3.4) consult the superintendent and designers to resolve a change in the design. Design levels and tolerances (+25 mm) must be achieved (Section 3.4.2).		
STEP 4: Bulking out	Undertake bulk earthworks, including construction of bunds surrounding system. The bunds and batters surrounding the system should have 200 mm of topsoil applied following earthworks. Design levels for the top of the bund are inclusive of this 200 mm layer of topsoil, so that bulk earthworks should leave the top of bund 200 mm below the design level. Excavate the surrounding landform to design subsoil levels. This will reduce the need for earthworks adjacent to the systems after they have been constructed. If adopting Construction and Establishment Method Option 3, the upstream sediment basin should be constructed and commissioned prior to bulking out the bioretention system.		

CONSTRUCTION STEP	ACTIVITY	PHOTOS (SMALL BIORETENTION SYSTEM)	PHOTOS (LARGE BIORETENTION SYSTEM)
STEP 5: Trimming and profiling	Undertake detailed excavation, trimming and profiling of bunds, embankments, batters, sides and base of system, ensuring the base has a minimum 0.5% grade towards pit, unless the design specifies a flat base and design levels achieve (+ 50 mm). If the design has a flat base and does not contain the 0.5% grade, confirm with the designer and refer to these guidelines or the *WSUD Technical Design Guidelines for SEQ* (SEQHWP, 2006). Ensure base of system is free from debris and meets the tolerances (Section 3.4.2).		
STEP 6: Construct overflow weir if required	Where an overflow weir is part of the system design, it should be constructed at this stage and appropriately 'keyed' into the bunds to avoid potential scour at the edges of the weir. Design levels and tolerances must be achieved (+25 mm).		
STEP 7: As-constructed survey	Undertake an as-constructed survey of the system at this stage to confirm design and tolerances (Section 3.4.2) are achieved, including: - overflow pit crest level, invert level and under-drainage connections invert and diameter - outlet pipe upstream and downstream invert levels - overflow weir - base of bioretention system to illustrate the level and the 0.5% grade.		

CONSTRUCTION STEP	ACTIVITY	PHOTOS (SMALL BIORETENTION SYSTEM)	PHOTOS (LARGE BIORETENTION SYSTEM)
STEP 8: HOLD POINT Inspection and sign-off (Form A)	Following collection of the as-constructed survey, the site superintendent and bioretention designer will inspect the system with the contractor, review the as-constructed survey and take photos. If the construction meets the tolerances outlined Section 3.4.2 and conforms with the design, complete Sign-Off Form A attaching the as-constructed survey and photos.		
STEP 9: Filter cloth Lining	Line system with filter cloth, ensuring the filter cloth extends a minimum of 500 mm beyond the top of the bioretention system side walls.		
STEP 10: Install under-drainage	Install slotted rigid under-drainage pipes and ag-pipes and rigid collector pipes in the specified layout outlined in Section 3.3.6. Ensure all pipes are laid at a minimum 0.5% slope with no localised depressions verified using levels or string lines. Ensure levels are achieved (+25 mm). Seal junctions and connections using sufficient sealant to prevent sand, gravel or soil passing into drainage network. The same drainage layer material (aggregate) may be required to raise pipe in section to adhere to design grade (0.5%).		
STEP 11: Install cleanouts	Connect clean-out points ensuring top of clean-out points will ultimately sit at least 50 mm (preferably 150 mm) above the bioretention surface. The caps on the clean-out points should be screwed in place to secure against vandalism.		

CONSTRUCTION STEP	ACTIVITY	PHOTOS (SMALL BIORETENTION SYSTEM)	PHOTOS (LARGE BIORETENTION SYSTEM)
STEP 12: HOLD POINT Inspection and sign-off (Form B)	Following installation of the liner and under-drainage, either the site superintendent or bioretention designer will inspect the system with the contractor and take photos. If the lining and under-drainage meets the design and construction requirements, they will complete Sign-Off Form B and attach photos.		
STEP 13: Source drainage layer, transition layer and filter media material	Testing and sourcing the drainage, transition and filter media layers should have commenced as part of Step 2. By Step13, the material can be delivered and stockpiled on site ready for installation.	 2	 4
STEP 14: Install drainage layer	Install 200–250 mm deep gravel drainage layer to cover the slotted under-drainage pipe network. The preferred approach is to use an excavator (long-arm if required) or conveyor belt (see Section 3.4.7) positioned on the edge of the system to place gravel into the system. Contractors can then spread and flatten the gravel to the specified depth using spreader bars. The exact procedure for constructing the drainage layer is determined through consultation with the contractor. It may differ from the procedure described in Section 3.4.7. The site superintendent or bioretention designer should inspect the drainage layer to ensure the correct depth (200–250 mm) and tolerances (+25 mm) have been achieved and that the surface is flat.		
STEP 15: HOLD POINT Inspection of drainage layer	The site superintendent or bioretention designer should inspect the drainage layer to ensure the correct depths (200–250 mm) and grades (typically 0.5%) have been achieved and the surface is flat. The relevant sections of Sign-Off Form C must be completed and photos taken. There is no need to stop construction for this inspection unless specifically required. The site superintendent or designer should undertake the inspection as construction occurs.		

CONSTRUCTION STEP	ACTIVITY	PHOTOS (SMALL BIORETENTION SYSTEM)	PHOTOS (LARGE BIORETENTION SYSTEM)
STEP 16: Install transition layer	Install a 100 mm deep coarse sand transition layer on top of the gravel drainage layer using the same approach outlined in Step 14 to achieve the correct tolerances (+25 mm) and to ensure the surface is flat.		
STEP 17: Inspection of transition layer	The site superintendent or bioretention designer should inspect the transition layer to ensure the correct depths (100 mm) and grade (typically 0.5%) have been achieved and that the surface is flat. The relevant sections of Sign-Off Form C should be completed and photos taken. The site superintendent or designer can undertake the inspection as construction occurs.		
STEP 18: Install filter media	Place the bioretention filter media to the designed the surface level of the bioretention system in two separate lifts, where required, with each lift lightly compacted as outlined in Section 3.4.6. At the completion of the section lift and compaction, use a spreader bar to flatten the surface of the filter media. Ultimately, the surface of the filter media must be at the design level (+25 mm) and free from local depressions.		
STEP 19: Install sediment fences	Immediately after installing the filter media, install sediment fences around the filter media and at the top of the batter to prevent sediment from entering the batters and to keep construction vehicles off the system.		
STEP 20: Lay protective filter cloth, where required	If there is a delay between Step 18 and Steps 25 and 29, the surface and batters of the bioretention system should be covered with a temporary layer of filter cloth to protect against sediment-laden runoff. Some or all of this filter cloth will be left in place as part of Steps 25 to 28.		

CONSTRUCTION STEP	ACTIVITY	PHOTOS (SMALL BIORETENTION SYSTEM)	PHOTOS (LARGE BIORETENTION SYSTEM)
STEP 21: As constructed survey	Undertake an as-constructed survey of the system surface and surrounding bunds, picking at least four spots on the surface of the small bioretention systems (<100 m²), one spot level per 100 m² on the surface of large bioretention systems and at least one spot level every 10 m along the top of the bunds as well as any low points.		
STEP 22: HOLD POINT Inspection and sign-off (Forms C and D)	Following collection of the as-constructed survey, the site superintendent and bioretention designer will inspect the system, review the as-constructed survey and take photos. If the construction meets the tolerances outlined in Section 3.4.2 and conforms to the design, Sign-Off Forms C and D will be completed and signed and the as-constructed survey and photos attached.		
STEP 23: Install coarse sediment forebay	Construct the coarse sediment forebay in accordance with the design and advice provided in Section 3.4.9. Concrete is preferred with surface treatment as directed by the design.		
STEP 24: Inspection and sign-off (Form E) PRACTICAL COMPLETION	The site superintendent or bioretention designer should inspect the coarse sediment forebay to ensure consistency with design. The relevant sections of Sign-Off Form E should be completed and photos are taken before either Building Phase Protection works or Landscape Works start.		
CONTINUE TO STEP 25 (Building Phase Protection) if there is building or works in the catchment that will cause damage to the bioretention system or the accumulation of sediment in the system. CONTINUE TO STEP 29 (Landscape Works) if there is no building or works proposed in the catchment that are likely to cause damage to the bioretention system or the accumulation of sediment in the system.			

3.9.2 Stage 2 — Building phase protection

Steps 25–28 provide the construction and establishment sequence for the Building Phase Protection (Stage 2) for Option 1, 2 and 3.

Table 3.8: Building phase protection (Stage 2) step-by-step sequence — Options 1 and 3

CONSTRUCTION STEP	ACTIVITY	PHOTOS (SMALL BIORETENTION SYSTEM)	PHOTOS (LARGE BIORETENTION SYSTEM)
STEP 25: Install sediment fences	If not installed as part of Step 19, sediment fences should be installed around the filter media and at the top of the batter to prevent sediment entering from the batters and to keep construction vehicles off the system.		
STEP 26: Install protective layers on surface of filter media (filter cloth and turf)	Cover the surface of filter media with filter cloth or 25–50 mm of coarse sand and place 25 mm topsoil and turf over the filter cloth or coarse sand. Filter cloth has been known to block in some situations. Coarse sand (25–50 mm) can be used if there is concern with the filter cloth.		
STEP 27: HOLD POINT Inspection and sign-off (Form F)	Following installation of protective layers, the site superintendent and bioretention designer will inspect the system with the contractor. If approved, Sign-Off Form F can be completed and signed and photos attached.		
STEP 28: Building phase operation	During the building phase, which may be as long as 2–4 years, the bioretention system will operate as a shallow sediment basin, and protect the filter media from sediment and clogging. When 80–90% of the building in the catchment is complete, Stage 3: Landscape Works can start (Step 29).		

CONSTRUCTION STEP	ACTIVITY	PHOTOS (SMALL BIORETENTION SYSTEM)	PHOTOS (LARGE BIORETENTION SYSTEM)
STEP 25: Install sediment fences	If not already installed as part of STEP 19, sediment fences should be installed around the filter media and at the top of the batter to prevent sediment entering from the batters and to keep construction vehicles off the system.		
STEP 26A: Install bypass system (temporary protective bunds)	The majority of the bioretention system should be isolated from sediment-laden inflows. This can be achieved by: - completely bypassing pipe flows during the building phase and connecting the pipe system to the bioretention system following the building phase - partitioning (bunding) the majority of the bioretention system to isolate flows to the outlet and inlet of the system. Where partitioning (bunding) is used: - it should be designed so that flows are directed into either the overflow pit or overflow weir rather than entering the bioretention system preventing sediment-laden runoff from spreading across the bioretention surface - in small bioretention systems, the protective bund can be created using form ply with all joints overlaid and sealed - in larger bioretention system, the protective bunds can be created using the filter media wrapped in filter cloth - the crest of the bund should be higher than both the overflow pit and the surrounding embankments to ensure no sediment-laden flow enters the bioretention system and the bund should be keyed into the batters to avoid scouring around the edges causing water to enter the system.		

CONSTRUCTION STEP	ACTIVITY	PHOTOS (SMALL BIORETENTION SYSTEM)	PHOTOS (LARGE BIORETENTION SYSTEM)
STEP 26B: Install protective layers on surface of filter media (filter cloth and turf)	Install temporary protective covering over the bioretention surface located within bunded area adjacent to the coarse sediment forebay. Cover the surface of filtration media with filter cloth (or coarse sand) and place 25 mm topsoil and turf over the filter cloth.		
STEP 27: HOLD POINT Inspection and sign-off (Form F)	Following collection of the as-constructed survey, the site superintendent and bioretention designer will inspect the system, review the as-constructed survey and take photos. If the construction meets the tolerances outlined in Section 3.4.2 and conforms to the design, Sign-Off Forms C and D will be completed and signed and the as-constructed survey and photos attached.		
STEP 28: Building phase operation	During the building phase, which may be up to 2–4 years, landscape can be established on the majority of the bioretention system surfaces in accordance with Stage 3: Landscape Works (Step 29 onwards). The small, protected part of the bioretention system will operate as a sediment basin, while protecting the filter media from sediment and clogging. When 80–90% of the building in the catchment is complete, the bund and protective layers can be removed and appropriate landscaping applied.		

3.9.3 Stage 3 — Landscape establishment

Once the building phase is finished, the protected portions of the bioretention system are cleaned and any accumulated is removed in readiness for establishing the landscape. The recommended landscape establishment sequence for the bioretention systems is shown in Table 3.10. The construction sequence should be read in combination with the Bioretention Construction and Establishment Sign-Off Forms.

Table 3.9: Landscape establishment (Stage 3) step-by-step sequence — Options 1, 2 and 3

CONSTRUCTION STEP	ACTIVITY	PHOTOS (SMALL BIORETENTION SYSTEM)	PHOTOS (LARGE BIORETENTION SYSTEM)
STEP 29: Pre-start and plant set-out meeting	Before starting landscape preparation, hold a pre-start and plant set-out meeting with the bioretention designers, including an ecologist, site superintendent and landscape contractors. The meeting should confirm design and planting establishment and set out the planting to ensure the correct plants are installed in the correct locations.		
STEP 30: Preparation	Prepare for the landscape establishment up to six months before starting, including ordering and inspecting plants at the nursery, ordering and receiving organic mulch and matting and organising a source of irrigation water.	 2	 3
STEP 31: Remove building phase protection and flushing of under-drainage (where required)	Remove the building phase protective measures such as bunds, filter cloth, coarse sand, turf and accumulated sediment. Care should be taken to avoid damaging the clean-out points for the under-drainage. The under-drainage should be flushed out with potable water to remove any accumulated sediment. If adopting Option 1, the protective measures will remain in place while landscape is being establishment. Protective measures are removed when building is 80–90% complete.		

CONSTRUCTION STEP	ACTIVITY	PHOTOS (SMALL BIORETENTION SYSTEM)	PHOTOS (LARGE BIORETENTION SYSTEM)
STEP 32: Flatten surface	After the protective layers are removed, flatten the surface of the filter media using a spreader bar. Additional filter media may be required to fill in any over-excavated zones. Care should be taken to not over-compact the filter media (refer Sections 3.4.6 and 3.4.7).		
STEP 33: Mulching	Mulch the filter media surface in accordance with Section 3.6.4. Create holes in the mulch for planting. Ensure the holes have 50 mm separation from stem of the plant to the mulch.		
STEP 34: Soil preparation	Dig planting holes by hand and apply the prescribed amount of slow-release native fertiliser detailed in Section 3.6.3. Pre-soaked wetting agents are recommended in this step.		
STEP 35: Planting	Plant tubestock ensuring the root ball is covered with filter media and the stem is sitting above the filter media. Clear away any mulch from the step to 50 mm (refer Section 3.6.5).	 	 

CONSTRUCTION STEP	ACTIVITY	PHOTOS (SMALL BIORETENTION SYSTEM)	PHOTOS (LARGE BIORETENTION SYSTEM)
STEP 36: Inspection and sign-off (Form G) PRACTICAL COMPLETION	After installing the mulch and plants, the site superintendent and bioretention designer will inspect the system and Sign-Off Form G is completed and photos attached.		
STEP 37: Watering	Water the plants according to Section 3.6.6: Week 1–6 5 waterings per week Week 6–103 waterings per week Week 11–152 waterings per week If there is no rain, each plant should receive 2.5–5.0 litres of water per week during establishment in the first six weeks (40 mm per week).	 	
STEP 38: Weeding	Inspect bioretention plants fortnightly during establishment,removing any weeds by hand.		

CONSTRUCTION STEP	ACTIVITY	PHOTOS (SMALL BIORETENTION SYSTEM)	PHOTOS (LARGE BIORETENTION SYSTEM)
STEP 39: On-going inspections and final landscape establishment	Monitor the establishment of plants until they are robust and self-sustaining. An established bioretention is measured by (Section 3.6.7): 1. survival of more than 90% of plants 2. 80% coverage of bioretention surface 3. more than one species per macrophyte zone 4. at least 5 plants per m2 and preferably 6–10 plants/m2 5. an increase in plant height of at least 50% measured through markers or stakes 6. propagation of more than 2–3 stems and there is seeding 7. no weeds. Record growth and maturity through three-monthly photo logs every 500m2.		 
STEP 40: Inspection and sign-off (Form H)	After plants are established, the site superintendent and bioretention designer will inspect the system and complete Sign-Off Form H with attached photos.		

3.10 Step-by-step sequence — Option 4

The following sections provide a step-by-step sequence for the civil construction, building phase protection and landscape establishment for Staged Construction and Establishment Option 4. Detailed descriptions and, where available, photos are provided for each step in tabular format. It is envisaged the tables will be laminated and used as an on-site reference during construction and establishment.

3.10.1 Stage 1 — Civil construction

Stage 1 involves the civil works to create the form of the bioretention system and install structures following which the system is allowed to operate as a sedimentation basin. The civil construction sequence for Stage 1 is summarised in the Table 3.11. The construction sequence should be read in combination with the Bioretention System Construction and Establishment Sign-Off Forms.

Table 3.10: Civil construction (Stage 1) step-by-step sequence — Option 4

CONSTRUCTION STEP	ACTIVITY	PHOTOS (SMALL BIORETENTION SYSTEM)	PHOTOS (LARGE BIORETENTION SYSTEM)
STEP 1: Pre-start meeting	Hold a pre-start meeting with the bioretention designer, civil engineer, landscape architect, site superintendent, civil contractor, landscape contractor and, where required, the Council compliance officer to: - explain the function of the bioretention system - highlight issues and risks associated with construction and establishment - talk through a preferred construction and establishment approach for the site explain the as-constructed survey or drawing, inspection and sign-off requirements.		
STEP 2: Preparation	Prepare for construction at least 10 days before starting on site. Preparation includes organising the correct equipment to achieve required tolerances (Section 3.4.2), ordering materials and identifying construction timing and rain contingency plans (Section 3.3).		

CONSTRUCTION STEP	ACTIVITY	PHOTOS (SMALL BIORETENTION SYSTEM)	PHOTOS (LARGE BIORETENTION SYSTEM)
STEP 3: Install overflow pit and outlet pipe	Install overflow pit and ensure the crest of the pit is at design level. The crest of the pit can be used as a datum from which other levels within the system are be measured. The pit requires holes for under-drainage pipe connections. These holes should be drilled at this stage or plastic stubs should be installed at the time of casting the pit. Construct outflow headwalls and install sections of stormwater outlet pipe. If the outlet pipe is below the receiving environment levels (Section 3.4.5) consult the superintendent and designers to resolve a change in the design. Design levels and tolerances (±25 mm) must be achieved (Section 3.4.2).	 2	 1
STEP 4: Bulking out	Undertake bulk earthworks, including construction of bunds surrounding the system. The bunds and batters surrounding the systems should have 200 mm of topsoil applied following earthworks. Design levels for the top of the bund are inclusive of this 200 mm layer of topsoil, so that bulk earthworks should leave the top of bund 200 mm below the design level. The bulked out bioretention system will operate as a sediment basin. Where required by the sediment basin design, for example the *Best Practice Erosion and Sediment Control* (IECA, 2008), the sediment basin may need to be larger than the 'bulked out' bioretention system. In this case, the bulking out will be dictated by the sediment basin design rather than the bioretention design.	 1	 1

CONSTRUCTION STEP	ACTIVITY	PHOTOS (SMALL BIORETENTION SYSTEM)	PHOTOS (LARGE BIORETENTION SYSTEM)
STEP 5: Install sediment basin flow controls	The various flow controls for the sediment basin should be installed in accordance with the sediment basin design, for example the *Best Practice Erosion and Sediment Control* (IECA, 2008).		
STEP 6: Stabilise base of sediment basin	The base of the sediment basin should be stabilised to avoid scour and re-suspension of sediment. This may involve installation of turf or filter cloth in the base of the system.		
PRACTICAL COMPLETION OF STAGE 1 CIVIL WORKS: The 'bulked out' bioretention system operates as a sedimentation basin during building phase of development. At the end of the building phase (80–90% completion of building) the bioretention system (sediment basin) is cleaned out and civil works completed and landscape established.			

3.10.2 Stage 2 — Building phase protection

The bioretention system is allowed to operate as a sedimentation basin during the building phase (Figure 3.15). Operation and management of the sedimentation basin is the responsibility of the developer and it is suggested a maintenance contract is established with the civil or landscape contractor to monitor the performance of the sedimentation basin, undertake regular inspections, clean the basin as required and complete rectification of the system as required, for example, in the *Best Practice Erosion and Sediment Control* (IECA, 2008).

Figure 3 15: Building basin operating as a sediment basin during the building phase

3.10.3 Stage 3 — Civil construction and landscape establishment

Once the building phase is complete, the bioretention system is cleaned out of accumulated sediment, civil works are finalised and landscape established in accordance with the sequence provided in Table 3.12. The construction and establishment sequence should be read in combination with the Bioretention System Construction and Establishment Sign-Off Forms.

Table 3.11: Civil construction and landscape establishment step-by-step sequence — Option 3

CONSTRUCTION STEP	ACTIVITY	PHOTOS (LARGE BIORETENTION SYSTEM)	PHOTOS (LARGE BIORETENTION SYSTEM)
STEP 7: Pre-start meeting	Hold a pre-start meeting with the bioretention designer, civil engineer, landscape architect, site superintendent, civil contractor, landscape contractor and, where required, the Council compliance officer to: - explain the function of the bioretention system - highlight issues and risks associated with construction and establishment - talk through a preferred construction and establishment approach for the site - explain the as-constructed survey or drawing, inspection and sign-off requirements - confirm sources of bioretention media and certification requirements.		
STEP 8: Preparation	Prepare for construction at least 10 days before starting on site. Preparation includes organising the correct equipment to achieve required tolerances (Section 3.4.2), sourcing the bioretention media ensuring the supplier of the filter media is completing the correct testing (Section 3.5), ordering materials and identifying construction timing and rain contingency plans (Section 3.3).		
STEP 9: Clean out the bioretention system	Drain the bioretention system and remove accumulated sediment, gross litter and any lining installed for sediment basin operation.		

CONSTRUCTION STEP	ACTIVITY	PHOTOS (SMALL BIORETENTION SYSTEM)	PHOTOS (LARGE BIORETENTION SYSTEM)
STEP 10: Check the hydraulic structures	The hydraulic structures should be inspected for damage or movement.		
STEP 11: Trimming and profiling	Undertake detailed excavation, trimming and profiling of bunds, embankments, batters, sides and base of system, ensuring base has minimum 0.5% grade towards pit, unless the design specifies a flat base and design levels achieve (+ 50 mm). If the design has a flat base, confirm with the designer and refer to these guidelines or the *WSUD Technical Guidelines for South East Queensland* (SEQHWP, 2006)if the designer does not understand the purposes of the 0.5% grade. Ensure base of system is free from debris and meets the tolerances (Section 3.4.2).		
STEP 12: Construct overflow weir if required	Where an overflow weir is part of the system design, it should be constructed at this stage and appropriately 'keyed' into the bunds to avoid potential scour at the edges of the weir. Design levels and tolerances must be achieved (+25 mm).		
STEP 13: As-constructed survey	An as-constructed survey of the system is required at this stage to confirm design and tolerances (Section 3.4.2) are achieved, including: - overflow pit crest level, invert level and under-drainage connections invert and diameter - outlet pipe upstream and downstream invert levels - overflow weir - base of bioretention system to illustrate the level and the 0.5% grade.		

CONSTRUCTION STEP	ACTIVITY	PHOTOS (SMALL BIORETENTION SYSTEM)	PHOTOS (LARGE BIORETENTION SYSTEM)
STEP 14: HOLD POINT Inspection and sign-off (Form A)	Following collection of the as-constructed survey, the site superintendent and bioretention designer will inspect the system with the contractor, review the as-constructed survey and take photos. If the construction meets the tolerances outlined Section 3.4.2 and conforms with the design, complete Sign-Off Form A attaching the as-constructed survey and photos.		
STEP 15: Filter cloth lining	Line system with filter cloth, ensuring filter cloth extends a minimum of 500 mm beyond the top of the bioretention system's side walls.		
STEP 16: Install under-drainage	Install slotted rigid under-drainage pipes or ag-pipe and rigid collector pipes in the specified layout outlined in Section 3.4.5. Ensure all pipes are laid at a minimum 0.5% slope with no localised depressions verified using levels or string lines. Ensure levels are achieved (+25 mm). Seal junctions and connections using sufficient sealant to prevent sand, gravel or soil passing into drainage network. The same drainage layer material (aggregate) can be used to adjust the under drainage grade of the pipe to 0.5%.		
STEP 17: Install cleanouts	Connect clean out points ensuring the top of clean out points will ultimately sit at least 50 mm (preferably 150 mm) above the bioretention surface. Clean out caps should be screwed in place to secure against vandalism.		

CONSTRUCTION STEP	ACTIVITY	PHOTOS (SMALL BIORETENTION SYSTEM)	PHOTOS (LARGE BIORETENTION SYSTEM)
STEP 18: HOLD POINT Inspection and sign-off (Form B)	Following collection of the as-constructed survey, the site superintendent and bioretention designer will inspect the system with the contractor, review the as-constructed survey and take photos. If the construction meets the tolerances outlined Section 3.4.2 and conforms with the design, complete Sign-Off Form A attaching the as-constructed survey and photos.		
STEP 19: Source drainage layer, transition layer and filter media material	Testing and sourcing of the drainage, transition and filter media layers should have commenced as part of Step 2. By Step 19, the material can be delivered and stockpiled on site ready for installation.		
STEP 20: Install drainage layer	Install 200–250 mm deep gravel drainage layer to cover the slotted under-drainage pipe network. The preferred approach is to use an excavator (long-arm if required) or conveyor belt (see Section 3.4.7) positioned on the edge of the system to place gravel into the system. Contractors can then spread and flatten the gravel to the specified depth using spreader bars. The exact procedure for constructing the drainage layer is determined through consultation with the contractor. It may differ from the procedure described in Section 3.4.7. The site superintendent or bioretention designer should inspect the drainage layer to ensure the correct depth (200–250 mm) and tolerances (+25 mm) have been achieved and that the surface is flat.		
STEP 21: HOLD POINT Inspection of drainage layer	The site superintendent or bioretention designer should inspect the drainage layer to ensure the correct depths (200–250 mm) and grade (typically 0.5%) have been achieved and the surface is flat. The relevant sections of Sign-Off Form C must completed and photos taken. There is no need to stop construction for this inspection unless specifically required. The site superintendent or designer should undertake the inspection as construction occurs.		

CONSTRUCTION STEP	ACTIVITY	PHOTOS (SMALL BIORETENTION SYSTEM)	PHOTOS (LARGE BIORETENTION SYSTEM)
STEP 22: Install transition layer	Install a 100 mm deep coarse sand transition layer on top of the gravel drainage layer using the same approach outlined in Step 14 to achieve the correct tolerances (+25 mm) and to ensure the surface is flat.		
STEP 23: Inspection of transition layer	The site superintendent or bioretention designer should inspect the transition layer to ensure the correct depths (100 mm) and grade (typically 0.5%) have been achieved and that the surface is flat. The relevant sections of Sign-Off Form C should be completed and photos taken. There is no need to stop construction for this inspection, unless specifically required. The site superintendent or designer should undertake the inspection as construction occurs.		
STEP 24: Install filter media	Place the bioretention filter media to the designed the surface level of the bioretention system, in two separate lifts where required, with each lift lightly compacted as outlined in Section 3.4.6. At the completion of the section lift and compaction, use a spreader bar to flatten the surface of the filter media. Ultimately, the surface of the filter media must be level at the design level (+25 mm) and free from local depressions.		
STEP 25: Install sediment fences	Immediately after installing the filter media, install sediment fences around filter media and at the top of the batter to prevent sediment from entering the batters and to keep construction vehicles off the system.		

CONSTRUCTION STEP	ACTIVITY	PHOTOS (SMALL BIORETENTION SYSTEM)	PHOTOS (LARGE BIORETENTION SYSTEM)
STEP 26: Lay protective filter cloth, where required	If there will be delay between Step 34 and Step 35 (handover from civil contractor to landscape contractor), the surface and batters of the bioretention system should be covered with a temporary layer of filter cloth to protect against sediment-laden runoff. The filter cloth will be removed prior to installation and establishment of the landscape.		 1
STEP 27: As constructed survey	Undertake an as-constructed survey of the system surface and surrounding bunds, choosing at least four spots on the surface of the small bioretention systems (<100 m^2), one spot level per 100 m^2 on the surface of large bioretention systems and at least one spot level every 10 m along the top of the bunds as well as any low points.		
STEP 28: HOLD POINT Inspection and sign-off (Forms C and D)	Following collection of the as-constructed survey, the site superintendent and bioretention designer will inspect the system, review the as-constructed survey and take photos. If the construction meets the tolerances outlined Section 3.4.2 and conforms with the design, Sign-Off Forms C and D will be completed and signed and the as-constructed survey and photos attached.		
STEP 29: Install coarse sediment forebay	Construct coarse sediment forebay in accordance with the design and advice provided in Section 3.4.9. Concrete is preferred with surface treatment as directed by the design.		
STEP 30: Inspection and sign-off (Form E) PRACTICAL COMPLETION	The site superintendent or bioretention designer should inspect the coarse sediment forebay to ensure consistency with design. The relevant sections of Sign-Off Form E should be completed and photos taken before either Building Phase Protection works or Landscape Works start.		

CONSTRUCTION STEP	ACTIVITY	PHOTOS (SMALL BIORETENTION SYSTEM)	PHOTOS (LARGE BIORETENTION SYSTEM)
CONTINUE TO STEP 31 (Landscape Works) immediately. This will involve a rapid handover from the civil contractor to the landscape contractor.			
Landscape works STEP 31: Pre-start and plant set-out meeting	Before starting landscape preparation, hold a pre-start and plant set-out meeting with the bioretention designers, including an ecologist, site superintendent and landscape contractors. The meeting should confirm design and planting establishment and set out the planting to ensure the correct plants are installed in the correct locations.		
STEP 32: Preparation	Prepare for the landscape establishment up to six months before starting, including ordering and inspecting plants at the nursery, ordering and receiving organic mulch and matting and organising a source of irrigation water. For bioretention systems, recycled water for irrigation is generally not recommended.	 3	 3
STEP 33: Remove temporary protection	If temporary protective filter cloth was installed at STEP 26, this should be removed at this stage. Care should be taken to avoid damaging the clean-out points for the under-drainage.		
STEP 34: Flatten surface	After the protective layers are removed, flatten the surface of the filter media using a spreader bar. Additional filter media may be required to fill in any over-excavated zones. Care should be taken to not over-compact the filter media (refer Sections 3.4.6 and 3.4.7).		

CONSTRUCTION STEP	ACTIVITY	PHOTOS (SMALL BIORETENTION SYSTEM)	PHOTOS (LARGE BIORETENTION SYSTEM)
STEP 35: Mulching	Mulch the filter media surface in accordance with Section 3.6.4. Create holes in the mulch for planting. Ensure the holes have 50 mm separation from stem of the plant to the mulch.		
STEP 36: Soil preparation	Dig planting holes by hand and apply the prescribed amount of slow-release native fertiliser detailed in Section 3.6.3. Pre-soaked wetting agents are recommended in this step.		
STEP 37: Planting	Plant tubestock ensuring the root ball is covered with filter media and the stem is sitting above the filter media. Clear away any mulch from the step to 50 mm (refer Section 3.6.5).	 	 
STEP 38: Inspection and sign-off (Form G) PRACTICAL COMPLETION	After installing the mulch and plants, the site superintendent and bioretention designer will inspect the system and Sign-Off Form G is completed and photos attached.		

CONSTRUCTION STEP	ACTIVITY	PHOTOS (SMALL BIORETENTION SYSTEM)	PHOTOS (LARGE BIORETENTION SYSTEM)
STEP 39: Watering	Water the plants according to Section 3.6.6: Week 1–6 5 waterings per week Week 6–10 3 waterings per week Week 11–15 2 waterings per week If there is no rain, each plant should receive 2.5–5.0 litres of water per week during establishment in the first six weeks (40 mm per week).		
STEP 40: Weeding	Inspect bioretention plants fortnightly during establishment, removing any weeds by hand.		
STEP 41: On-going inspections and final landscape establishment	Monitor the establishment of plants until they are robust and self-sustaining.An established bioretention is measured by (Section 3.6.7): 1. survival of more than 90% of plants 2. 80% coverage of bioretention surface 3. more than one species per macrophyte zone 4. at least 5 plants per m2 and preferably 6–10 plants/m2 5. an increase in plant height of at least 50% measured through markers or stakes 6. propagation of more than 2–3 stems and there is seeding 7. no weeds. Record growth and maturity through three-monthly photo logs every 500m^2.		 

CONSTRUCTION STEP	ACTIVITY	PHOTOS (SMALL BIORETENTION SYSTEM)	PHOTOS (LARGE BIORETENTION SYSTEM)
STEP 42: Inspection and sign-off (Form H)	After plants are established, the site superintendent and bioretention designer will inspect the system and complete Sign-Off Form H with photos attached.		

3.11 Potential failure and rectification

Constructing and establishing any civil or landscape asset requires refinement and repair of defects to ensure compliance with the design. Table 3.13 outlines potential construction and establishment failures or defects for bioretention systems and suggests ways to rectify the problems. The table focuses on construction and establishment defects and on functional failures that can occur following the completion of construction and provides rectification actions. The table is not exhaustive and will be updated in future revisions of this guideline. The bioretention designer or external expert should be consulted when the following failures occur to confirm rectification actions.

Table 3.12: Potential failure scenarios for bioretention systems and rectification actions

DEFECT OR FAILURE	CAUSES	RECTIFICATION
Ponding water on surface or reduce filtration rate	Blinding or blockage of filter media surface with sediment.  	Confirm surface blinding or blockage by scraping back the surface sediment to reach the bioretention filter media filling the void with water to see if the water drains. In-situ hydraulic conductivity testing should be undertaken at the surface, middle and bottom of the filter media profile in accordance with *Practice Note 1: In-Situ Measurement of Hydraulic Conductivity* (Hatt and Le Coustumer, 2008). More detailed assessment may be required by: - collecting samples at the surface and at depth at a number of locations in the system - testing samples for particle size distribution and saturated hydraulic conductivity in accordance with the *Guideline Specifications for Soil Media in Bioretention Systems* (FAWB, 2008). Rectification of the system is required if: - the in-situ hydraulic conductivity testing confirms low conductivity at the surface and high conductivity at depth - the particle distribution size analysis finds finer material at the surface.

APPENDIX F INSPECTION FORMS

FAWB GUIDELINES

4.2.5 FORM (REGULAR INSPECTION & MAINTENANCE)			
Location	**Raingarden/Tree Pit**		
Site Visit Date:		Site Visit By:	
Weather:			
Purpose of the Site Visit	Routine Inspection	☐	Complete section 1 (below)
	Routine Maintenance	☐	Complete sections 1 and 2 (below)

NOTE: Where maintenance is required ('yes' in Section 2), details should be recorded in the 'Additional Comments' section at the end of this document.

1. Filter media				
**In addition to regular inspections, it is recommended that inspection for damage and blockage is made after significant rainfall events that might occur once or twice a year.*	**Section 1**		**Section 2**	
	Maintenance Required?		Maintenance Performed	
	Yes	No	Yes	No
Filter media (*CIRCLE* – pooling water/accumulation of silt & clay layer/scour/holes/sediment build up)	☐	☐	☐	☐
Litter (*CIRCLE* – large debris/accumulated vegetation/anthropogenic)	☐	☐	☐	☐
2. Vegetation				
Vegetation health (*CIRCLE* – signs of disease/pests/poor growth)	☐	☐	☐	☐
Vegetation densities (*CIRCLE* – low densities– infill planting required)	☐	☐	☐	☐
Build up of organic matter, leaf litter (*CIRCLE* – requires removal) **BIORETENTION TREE PITS ONLY**	☐	☐	☐	☐
Weeds (*CIRCLE* – isolated plants/infestation) (*SPECIES* – .....)	☐	☐	☐	☐

3. Pits, pipes and inflow areas				
	Section 2		**Section 3**	
	Maintenance Required?		Maintenance Performed	
	Yes	No	Yes	No
Perforated pipes (*CIRCLE* – full blockage/partial blockade/damage)	☐	☐	☐	☐
Inflow areas (*CIRCLE* – scour/excessive sediment deposition/litter blockage)	☐	☐	☐	☐
Over flow grates (*CIRCLE* – damage/scour/blockage)	☐	☐	☐	☐
Pits (*CIRCLE* – poor general integrity/sediment build up/litter/blockage)	☐	☐	☐	☐
Other stormwater pipes and junction pits (*CIRCLE* – poor general integrity/sediment build up/litter/blockage)	☐	☐	☐	☐

4. Additional Comments