



# BIORETENTION SYSTEM 16A

MUNICIPAL  
INFRASTRUCTURE  
TECHNICAL  
SPECIFICATION  
**16 - STORMWATER**

Transport Canberra and  
City Services

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# 1 BIORETENTION SYSTEMS

## 1.1 General

General: This Specification comprises the supply and construction of Water Sensitive Urban Design (WSUD) bio-retention measures.

Requirement: Provide the following bio-retention systems:

- > Bioretention swales; or
- > Rain water gardens; or
- > Bioretention basins.

Exclusions: This Specification does not include other WSUD measures such as wetlands, ponds, gross pollutant traps etc. Preliminaries, Traffic Management, Earthworks, Drainage Structures and Landscaping required to construct Bioretention systems shall be included under the respective *MITS 00 Preliminaries*, *MITS 01 Traffic Management*, *MITS 02 Earthworks*, *MITS 03 Underground services*, *MITS 09 Landscape*.

### 1.1.1 Responsibilities

#### 1.1.1.1 Objectives

Requirement: Provide bio-retention systems, as documented and as follows:

- > Free of pollutants
- > Stormwater diverted off line until construction works upstream are complete or as agreed with TCCS.
- > Constructed in accordance with the detailed design plans
- > In accordance with the construction tolerances specified.

### 1.1.2 Cross references

General: The following documents are related to this Specification:

#### 1.1.2.1 Legislation

Environmental Protection Act

Lakes Act

Public Roads Act

Road Transport (General) Act

Road Transport (Safety and Traffic Management) Act

Road Transport (Mass, Dimensions and Loading) Act

Road Transport (Safety and Traffic Management) Regulation

Scaffolding and Lifts Act

Scaffolding and Lifts Regulation

Territory Plan 2008 and related Codes

Water Resources Act

Waste Minimisation Act

Work Health and Safety Act

### **1.1.2.2 Specifications**

Requirement: Conform to the following:

MITS 00	Preliminaries
MITS 01	Traffic Management
MITS 02	Earthworks
MITS 03	Underground services
MITS 06	Concrete kerbs, footpaths and minor works
MITS 09C	Planting
MITS 10	Concrete works
MITS 14	Road Signs
MITS 16B	Ponds
MITS 16C	Wetlands
MITS 16D	Gross Pollutant Traps

### **1.1.2.3 Design Standards**

General: The following Design Standards are related to this Specification:

Attachment B	Design acceptance requirements
Canberra Central Design Manual	

### **1.1.2.4 TCCS Reference Documents**

General: The following TCCS reference documents are related to this Specification:

Reference document 4	Protection of public landscape assets
Reference document 7	Operational acceptance submissions
Reference document 8	Works as executed quality records
Reference document 9	Final acceptance submissions
Reference document 10	Landscape consolidation
Reference document 11	Drafting Standard for Civil and Landscape works

## 1.1.3 Referenced documents

### 1.1.3.1 Standards

General: The following documents are incorporated into this Specification by reference:

#### Australian standards

AS 1141	Methods for sampling and testing aggregates
AS 1141.11.1	Particle size distribution - Sieving method
AS 1141.22	Wet/dry strength variation
AS 1289	Methods of testing soils for engineering purposes.
AS 1289 2.1.1	Moisture Content Tests
AS 1289 3.1.1	Plastic Limit Tests
AS 1289 3.1.2	Atterberg Limit Tests
AS 1289 3.2.1	Liquid Limit Tests
AS 1289 3.3.1	Plasticity Index Tests
AS 1289 3.6.1	Particle Size Distribution Tests
AS 1289 3.8.1	Emerson Class Number
AS 1289.5.2.1	Maximum Modified Dry Density Test
AS 1289.5.4.1	Optimum Moisture Content
AS 1289.5.5.1	Soil compaction and density tests - Determination of the minimum and maximum dry density of a cohesionless material - Standard method.
AS 1289 5.7.1	Optimum Moisture Content
AS 1289 6.7.3	Permeability (remoulded) on undisturbed tube samples collected from the completed pad liner
AS 2758.5	Filter Material Test
AS 3706.2	Geotextile Grab Tensile Strength
AS 3706.3	Geotextile Trapezoidal Tear Strength
AS 3706.7	Geotextile EOS – Pore Size
AS 3706.9	Geotextile Flow Rate
AS 4133.4.1	Rock Point Load Strength
AS 4419	Soils for landscaping and garden use
AS/NZS 5667.1	Sampling of Water

### 1.1.3.2 Standards

IPWEA (NSW) Specification for the supply of recycled materials for pavements, earthworks and drainage (Greenspec)

USEPA Calcium Carbonate content

Austrroads 90Geotextile G Rating

Austrroads AGPT04J Filter Material Testing

ASTM F1632-03 Filter Material Testing

Proprietary products: To *TCCS Products previously considered for use list*

## 1.1.4 Interpretation

### 1.1.4.1 Abbreviations

General: For the purposes of this Specification the following abbreviations apply:

<b>CCTV:</b>	Closed Circuit Television
<b>D:</b>	External diameter of the pipe.
<b>DN:</b>	Nominal Diameter of pipe.
<b>PAP:</b>	Principal Authorised Person (For use with GC-21 contracts).
<b>WSUD:</b>	Water Sensitive Urban Design.
<b>ITP:</b>	Inspection and Test Plan.
<b>NATA:</b>	National Association of Testing Authorities.
<b>RMS:</b>	NSW Roads and Maritime Services.
<b>TCCS:</b>	Transport Canberra and City Services, ACT Government and its successors.

### 1.1.4.2 Definitions

General: For the purposes of this Specification the definition given below applies:

- > Authorised person: PAP/Superintendent/Client of the works.
- > Inadequate foundation material: Material beneath or adjacent to the proposed drainage structures with insufficient strength to support the structure and loads on the structure, or material with characteristics that would adversely affect the performance or construction of the drainage structure.
- > Select fill: Backfill material with known properties and grading placed and compacted in layers.
- > Water Sensitive Urban Design (WSUD): The approach to urban planning and design that aims to integrate the management of the urban water cycle into the urban development process.

## 1.1.5 Submissions

### 1.1.5.1 General

Conform to **Hold points and witness points**.

Drawings: Prepare drawings or other documentation to record extent and constitution of final works in accordance with Requirements for Works as Executed quality records, TCCS.

### 1.1.5.2 Execution details

Survey: Submit set-out survey for temporary and permanent drainage system.

Set-out of stormwater drainage system (Temporary and Permanent): Submit details of any proposed changes to the location, length, design levels, strength, and conditions of installation or cover to suit construction procedures.

Temporary drainage during construction: Submit details of procedures/devices to maintain effective drainage of the works area and/or upstream diversions.

Soil type: Give notice if the soil type on site is not consistent with the soil type used for design.



### 1.1.5.3 Reports

Maintenance Report: A maintenance report shall be provided to the Authorised Person in accordance with this specification to achieve maintenance period completion.

### 1.1.5.4 Samples

General: Submit the following:

- > Components:
- > Bioretention/Mulch Materials
- > Samples:
- > Bioretention/Mulch Materials: Submit a minimum 5kg sample of each different type and/or source of material with conforming test results for approval by the Authorised Person prior to ordering. Samples are to be indicative of the material to be supplied for each different use.

### 1.1.5.5 Tests

Authority: A NATA or ASPAC registered laboratory and a qualified soil scientist / Certified Professional Soil Scientist / geotechnical engineer must be used to carry out all testing for, and verification of, the biofiltration media material. The Certified Professional Soil Scientist is qualified to review test results and advise acceptance or rejection if fitness-for-purpose is or is not impacted by non-compliances.

Lots: Sample all stockpiles in accordance with AS1141. Sample and test from supplier stockpiles at the minimum rate of 1 test/100m<sup>3</sup> of materials. A minimum of 1 test shall be provided per project and / or material source. Test results up to 3 months old on the same stockpile will be accepted.

Amendments for testing: Hydraulic conductivity and water holding capacity tests require amendments to the materials in order to simulate the material in the installed condition.

## 1.1.6 Hold points and witness points

### 1.1.6.1 Notice

General: Give notice so that the documented inspection and submissions may be made to the **Hold Point Table** and the **Witness Point Table**.

**Table 16A-1 Hold point table**

Item	Clause title	Requirement	Notice for inspection	Release by
<b>Materials</b>				
16A.1	Underdrainage pipes, lining material, Drainage, Transition, Filtration and Mulch Layer Materials	Provide documentation of conformity of drainage/transition/ filtration/mulch layer material and installation process, liner materials and Compliance certificates for drainage pipes	14 days before supplying materials	Authorised Person

Item	Clause title	Requirement	Notice for inspection	Release by
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### Execution

<b>16A.2</b>	Protection of Bioretention System from Pollutant Ingress and Upstream Drainage Established	The Contractor shall notify the Authorised Person that protection measures to prevent pollutants entering bioretention system works (including upstream diversions) are constructed in accordance with the specification and ready for inspection and approval.	3 days prior to commencement of excavation for bioretention system. Construction of large bioretention areas where protection measures are constructed in stages shall be subject to inspection on each stage of the works	Authorised Person
<b>16A.3</b>	Excavation - Trenches	Approval of completed trenches required.	1 working day prior to installation of liner materials.	Authorised Person
<b>16A.4</b>	Installation of Liner Material	Approval of completed liner material required.	1 working day prior to installation of drainage pipes.	Authorised Person
<b>16A.5</b>	Installation of Underdrainage	Approval of completed underdrainage pipe works required.	1 working day prior to installation of drainage layer materials.	Authorised Person

### Maintenance

<b>16A.6</b>	Maintenance of bioretention systems – Commencement	Submit request to commence maintenance period with proposed maintenance schedule in accordance with Clause 3.1 of this specification.	5 working days prior to proposed commencement of maintenance period upon operational acceptance by TCCS or as detailed in the contract.	Authorised Person
<b>16A.7</b>	Maintenance of bioretention systems – Decreased life/Damage to system functionality from upstream catchment outside contractor scope	The contractor shall provide a summary of the extent of damage occurred to WSUD and include a report on specific sources of pollution for further investigation by the Authorised Person. The Authorised person shall then determine and provide the contractor with a summary of activities required (if any) to rectify the damage to WSUD.	5 working days after damage has been identified to newly constructed WSUD measures.	Authorised Person

Item	Clause title	Requirement	Notice for inspection	Release by
<b>16A.8</b>	Maintenance of bioretention systems – Undertaking of maintenance works	The contractor shall provide all relevant approved TTM/Environmental documentation and proposed materials/methodologies for use in the rectification of WSUD infrastructure.	5 working days prior to commencing maintenance works on WSUD system.	Authorised Person
<b>16A.9</b>	Maintenance of bioretention systems - Completion	Submit request to complete maintenance period with submission of maintenance records completed in accordance with Clause 3.3 of this specification. Notify that the WSUD system is ready for flushing inspection.	5 working days prior to proposed completion of maintenance period.	Authorised Person

**Table 16A-2 Witness point table**

Item	Clause title	Requirement	Notice for inspection
<b>Execution</b>			
<b>16A.1</b>	Temporary drainage during construction	Locate materials and equipment clear of water courses and provide temporary drainage to protect area of works.	2 days prior to commencement of excavation for bioretention system.
<b>16A.2</b>	Establishment - Set out	Submit the proposed set-out for approval by the Authorised Person.	7 days before planned excavation.
<b>16A.3</b>	Backfilling with Drainage Layer	Witness completed drainage layer works.	1 working day prior to commencement of transition layer works.
<b>16A.4</b>	Backfilling with Transition Layer	Witness completed transition layer works.	1 working day prior to commencement of filtration materials work
<b>16A.5</b>	Backfilling with Filtration Layer	Witness completed filtration layer.	1 working day prior to construction of planting/final surface finish.

## 1.2 Preconstruction planning

### 1.2.1 Protection to bioretention system

Vegetated swales, buffer strips and bioretention systems: Do not allow construction traffic access to areas of bioretention systems. Provide fences if required to protect bioretention systems. Refer *MITS 01 Traffic Management* for protection of bioretention systems (Sensitive Areas) from traffic.

Temporary Protection: Install silt fences, filter rolls or other approved sediment and erosion protection measures to protect the bioretention system during all construction works.

## 1.3 Materials

### 1.3.1 General

Approval: Before supplying bioretention materials on site, submit compliance certificates demonstrating compliance to the relevant criteria within this specification.

#### 1.3.1.1 Materials and components

Stormwater Pipes and culverts: To *MITS 03B Pipe drainage*

Precast Stormwater Structures: To *MITS 03C Precast box culverts*

Other Drainage Structures: To *MITS 03D Drainage structures*

Recycled Material: To *MITS 03H Road openings and restorations*

### 1.3.2 Liner materials

#### 1.3.2.1 Impermeable Liner Materials

##### HDPE Liner

The HDPE liner shall be UV stabilised polypropylene or polyethylene of minimum 1.5mm thickness.

##### Clay Liner

General: The material used as a clay liner shall be well graded, of low permeability and conforms to the particle size distribution, plasticity index and other characteristics listed in the **Clay liner properties table**.

Variance: If proposed clay liner material fall outside the specification in the **Clay liner properties table**, a geotechnical engineer may review the test results and provide a report recommending the material as suitable for use for review and approval by the Authorised Person and Design Engineer.

Organic Materials Prohibited: The clay lining material shall be free of topsoil, tree roots and organic matter.

Manufactured Products: Geosynthetic Clay and HDPE liners may also be utilised with case by case approval required from TCCS.

**Table 16A-3 Clay liner properties table**

Property	Specification to be met	Test Method
<b>Particle Size Distribution (PSD)</b>	As below	AS 1289 3.6.1
<b>Particles passing 53-mm sieve</b>	>100%	AS 1289 3.6.1
<b>Particles passing 19-mm sieve</b>	>90%	AS 1289 3.6.1
<b>Particles passing 2.36-mm sieve</b>	>70%	AS 1289 3.6.1
<b>Particles passing 0.075-mm sieve</b>	>30%	AS 1289 3.6.1
<b>Maximum particle size</b>	40 mm	AS 1289 3.6.1
<b>Atterberg Limits</b>	As below	AS 1289 3.1.2, 3.2.1, 3.3.1, 3.4.1
<b>Plasticity Index</b>	≥15% and above Casagrande A line	AS 1289 3.3.1
<b>Liquid Limit</b>	35 - 60%	AS 1289 3.2.1
<b>Permeability (remoulded)</b>	≤ 1 x 10 <sup>-9</sup> m/sec (300-mm thick clay pad liner)	AS 1289 6.7.3
<b>Permeability on undisturbed tube samples collected from the completed pad liner</b>	≤ 1 x 10 <sup>-9</sup> m/sec (300-mm thick clay pad liner)	AS 1289 6.7.3
<b>Emerson Class Number</b>	> 4	AS 1289 3.8.1
<b>Calcium Carbonate content</b>	< 15%	USEPA

**1.3.2.2 Permeable Liner Materials**

Requirement: The permeable liner properties shall be a UV stabilised non-woven geotextile provided in accordance with the **Permeable liner properties table** below.

**Table 16A-4 Permeable liner properties table**

Property	Specification to be met	Test Method
<b>Grab Tensile Strength</b>	> 900 N	AS 3706.2
<b>Trapezoidal Tear Strength</b>	> 350 N	AS 3706.3
<b>G Rating</b>	> 2000	Austrroads 90
<b>EOS – Pore Size</b>	≤ 120 µm	AS 3706.7
<b>Flow Rate</b>	> 50 l/m <sup>2</sup> /s	AS 3706.9

### 1.3.3 Underdrainage materials

#### 1.3.3.1 Underdrainage Pipe Materials

General: The underdrainage system shall consist of perforated/slotted pipes.

Pipe Material: The pipe material shall be either slotted uPVC SN8 pipes or flexible perforated SN8 pipes to AS1254

Geotextile Wrapping Prohibited: Under-drainage pipes must not be wrapped in geotextile or any other type of lining material.

Sizing: The minimum pipe diameter shall be 100mm or equivalent hydraulic capacity.

#### 1.3.3.2 Inspection and Maintenance Risers

Risers: Inspection and maintenance risers shall comprise of a 90 degree sweeping bend with a minimum 300mm radius and solid wall uPVC Solvent Weld SN8 pipe brought vertically to the surface of the bioretention system.

Capping: The vertical pipe shall be capped with a threaded end cap fitting.

### 1.3.4 Bioretention materials

#### 1.3.4.1 General

Standards applicable: AS 2758.5, AS 1141 and Austroads AGPT04J.

#### 1.3.4.2 Base / Drainage Layer

Properties: Filtration media properties shall be provided in accordance with the **Drainage media properties table** below.

**Table 16A-5 Drainage Media Properties table**

Property	Specification to be met
<b>Material</b>	Clean, fine aggregate - 2-7 mm washed screenings (not scoria)
<b>Hydraulic conductivity</b>	Must be higher than the hydraulic conductivity of the overlying transition layer. Determined using ASTM F1815-11 method.
<b>Particle size distribution</b>	<p>Bridging criteria:</p> <p>D15 (drainage layer) <math>\leq</math> 5 x D85 (transition media)            where: D15 (drainage layer) - 15th percentile particle size in the drainage layer material (i.e., 15% of the aggregate is smaller than D15 mm), and D85 (transition layer) - 85th percentile particle size in the transition layer material</p> <p>Bridging criteria: only in designs where transition layer is omitted (<i>Water by Design; VicRoads</i>):</p> <p>D15 (drainage layer) <math>\leq</math> 5 x D85 (filter media)            D15 (drainage layer) = 5 to 20 x D15 (filter media)            D50 (drainage layer) &lt; 25 x D50 (filter media)            D60 (drainage layer) &lt; 20 x D10 (drainage layer)</p>
<b>Underdrain Perforations</b>	Confirm D85 (drainage layer) > diameter underdrain pipe perforation

### 1.3.4.3 Transition Layer

Properties: The **Transition media properties table** below describes the minimum requirements for the transition layer media.

Geotextile separation prohibited: Geotextile shall not be used as a separation layer between the filter media and drainage layers in lieu of a transition layer.

**Table 16A-6 Transition media properties table**

Property	Specification to be met
<b>Material</b>	Clean well-graded sand
<b>Hydraulic conductivity</b>	Must be higher than the hydraulic conductivity of the overlying filter media. Determined using <i>ASTM F1815-11</i> method.
<b>Fine particle content</b>	< 2%
<b>Particle size distribution</b>	Bridging criteria – the smallest 15% of sand particles must bridge with the largest 15% of filter media particles ( <i>Water by Design</i> ) ( <i>VicRoads</i> ): D15 (transition layer) ≤ 5 x D85 (filter media) where: D15 (transition layer) is the 15th percentile particle size in the transition layer material (i.e., 15% of the sand is smaller than D15 mm), and D85 (filter media) is the 85th percentile particle size in the filter media The best way to compare this is by plotting the particle size distributions for the two materials on the same soil grading graphs and extracting the relevant diameters ( <i>Water by Design</i> )

### 1.3.4.4 Filtration Layer

Properties: Filtration media properties shall be provided in accordance with the **Filter media properties table** below.

**Table 16A-7 Filter media properties table**

Property	Requirements
<b>Material</b>	A loamy sand, a washed well-graded sand or a sand / fine gravel mix
<b>Hydraulic conductivity</b>	100 – 300 mm/hr. Determined using <i>ASTM F1815-11</i> method.
<b>Clay &amp; silt content</b>	< 3% (w/w)
<b>Grading of particles</b>	Smooth grading – all particle size classes should be represented across sieve sizes from the 0.05mm to the 3.4mm sieve (as per <i>ASTM F1632-03</i> ) Bridging criteria: only in designs where transition layer is omitted ( <i>Water by Design</i> ; <i>VicRoads</i> ): D15 (drainage layer) ≤ 5 x D85 (filter media) D15 (drainage layer) = 5 to 20 x D15 (filter media) D50 (drainage layer) < 25 x D50 (filter media) D60 (drainage layer) < 20 x D10 (drainage layer)
<b>Nutrient content</b>	Total Nitrogen (TN) < 1000 mg/kg Available phosphate (Colwell) < 80 mg/kg

Property	Requirements																								
<b>Organic matter content</b>	≤ 5% to support vegetation																								
<b>pH</b>	5.5 – 7.5																								
<b>Electrical conductivity</b>	< 1.2 dS/m																								
<b>Horticultural suitability</b>	Assessment by horticulturalist – media must be capable of supporting healthy vegetation (see <b>once-off amelioration</b> ). Note that additional nutrients are delivered with incoming stormwater.																								
<b>Particle size distribution</b>	<p>Note that it is most critical for plant survival to ensure that the fine fractions are included</p> <table border="1"> <thead> <tr> <th></th> <th>Retained (% w/w)</th> <th>Sieve Size Fraction</th> </tr> </thead> <tbody> <tr> <td>Clay &amp; silt</td> <td>&lt; 3%</td> <td>(&lt; 0.05 mm)</td> </tr> <tr> <td>Very fine sand</td> <td>5-30%</td> <td>(0.05-0.15mm)</td> </tr> <tr> <td>Fine sand</td> <td>10-30%</td> <td>(0.15-0.25 mm)</td> </tr> <tr> <td>Medium sand</td> <td>40-60%</td> <td>(0.25-0.5 mm)</td> </tr> <tr> <td>Coarse sand</td> <td>&lt; 25%</td> <td>(0.5-1.0 mm)</td> </tr> <tr> <td>Very coarse sand</td> <td>0-10%</td> <td>(1.0-2.0mm)</td> </tr> <tr> <td>Fine gravel</td> <td>&lt; 3%</td> <td>(2.0-3.4 mm)</td> </tr> </tbody> </table> <p><i>Note: Particle size distributions are used to provide guidance to achieve optimum hydraulic conductivity and water holding capacity for the filter media to support vegetation. Providing the hydraulic conductivity criteria are met, the particle size criteria do not need to be met with the exception for the criteria for clay and silt content which are mandatory.</i></p>		Retained (% w/w)	Sieve Size Fraction	Clay & silt	< 3%	(< 0.05 mm)	Very fine sand	5-30%	(0.05-0.15mm)	Fine sand	10-30%	(0.15-0.25 mm)	Medium sand	40-60%	(0.25-0.5 mm)	Coarse sand	< 25%	(0.5-1.0 mm)	Very coarse sand	0-10%	(1.0-2.0mm)	Fine gravel	< 3%	(2.0-3.4 mm)
	Retained (% w/w)	Sieve Size Fraction																							
Clay & silt	< 3%	(< 0.05 mm)																							
Very fine sand	5-30%	(0.05-0.15mm)																							
Fine sand	10-30%	(0.15-0.25 mm)																							
Medium sand	40-60%	(0.25-0.5 mm)																							
Coarse sand	< 25%	(0.5-1.0 mm)																							
Very coarse sand	0-10%	(1.0-2.0mm)																							
Fine gravel	< 3%	(2.0-3.4 mm)																							

**Once-off amelioration** Initial once-off amelioration can be applied to top 100mm of the filter media to aid initial plants establishment of up to four weeks. Further nutrients required will be provided via incoming stormwater and no further fertilisation is generally necessary. Fertiliser required to be added shall be advised by qualified soil scientist / Certified Professional Soil Scientist upon testing the filter media material for nutrient content.

Organic material: The amount of organic material to be added to the filter material shall be that required to achieve the required water holding capacity, up to a maximum of 5% by weight.

Standard: To AS4454.

#### 1.3.4.5 Mulch Layer

Properties: Organic mulching is not permitted.

Mulch type: Non-floatable mulch includes crushed rock, gravel, coarse river sand, scoria or river pebbles.

Mulch Aggregate Sizing: 4-7mm screenings or similar.



## 1.4 Execution

### 1.4.1 General

#### 1.4.1.1 General

General: All works shall be constructed in accordance with the construction drawings.

Survey control: Provide for the following:

- > Mapping and pegging the drainage system.
- > Locating components.

Survey data: Provide data for the set-out of gradients, culverts and drains and construction to tolerances.

Stormwater Pipes and culverts: To *MITS 03B Pipe drainage*

Precast Stormwater Structures: To *MITS 03C Precast box culverts*

Other Drainage Structures: To *MITS 03D Drainage structures*

Recycled Material: To *MITS 03H Road openings and restorations*

#### 1.4.1.2 Earthworks for Construction of Batters/Swales

Earthworks Specification: All earthworks required to construct swales to finish surface levels shall be undertaken in accordance with *MITS 02B Bulk earthworks*.

#### 1.4.1.3 Minimum Thickness of Bioretention Layers

The **Minimum thickness of bioretention layers table** below describes the minimum thickness required and associated construction tolerance for each layer of the bioretention system.

**Table 16A-8 Minimum thickness of bioretention layers table**

Material	Minimum Thickness	Construction Tolerance
Surrounding Topsoil	100mm	+ 50mm, - 0mm
Filter Material (Shrubs)	400mm	+ 50mm, - 0mm
Filter Material (Large Shrubs)	600mm	+ 50mm, - 0mm
Transition Material	100mm	+ 50mm, - 0mm
Drainage Material	200mm	+ 50mm, - 0mm

#### 1.4.1.4 Compaction of Bioretention Layers

Layered Compaction: Compaction of bioretention layers shall be undertaken in maximum 250mm thick layers with two (2) passes only of a compactor plate of approximately 80kg.

Traffic Prohibited: Bioretention layers shall not be trafficked by vehicles or construction equipment.

### 1.4.1.5 Clay Liner Placement

Layered Thickness:

The compacted clay liner must have a minimum thickness of 200 mm and be constructed in two layers of 100 mm each.

Layer Bonding: An effective bond shall be created between successive layers. Prior to placement of each layer the surface of the previous layer shall be scarified to 25mm depth at maximum 300mm spacing and moisture conditioned as necessary to achieve a moisture content % (AS1289.2.1.1 method 2.1.1) between the plastic limit % (AS1289.3.2.1) and the liquid limit % (AS1289.3.1.1), to bond the layers and prevent laminations at the layer interface. The final surface should be smooth and evenly graded.

Tolerance: A constriction tolerance of +50mm and -0mm applies to the clay liner thickness.

Verification: The finished liner thickness must be surveyed to confirm it meets the design specifications and be tested in-situ to ensure that it meets the specified permeability criteria (AS: 1289 6.7.3).

Maintenance: Clay lining should be maintained and watered regularly to avoid desiccation during and following construction. Also if water is encountered while preparing earthworks, the site should be dewatered and dried to an appropriate level before being lined with clay.

Minimum compaction of Clay liners shall be in accordance with Table 2-9 below

**Table 16A-9 Minimum compaction of clay layer table**

Material	Minimum Compaction	Australian Standard
Clay Liner	Minimum dry density ratio of 95% relative to standard or a minimum Hilf density ratio of 95% standard.	AS 1289 5.1.1 or 1289 5.7.1
	0% to +3% of the Standard Optimum Moisture Content (SOMC) or within a Hilf moisture variation of 0% to +3%	AS 1289 5.1.1 or AS 1289 5.7.1
	Coefficient of permeability of less than $1 \times 10^{-9}$ m.s-1	AS1289.6.7.3 Tested in-situ

## 1.4.2 Underdrainage

### 1.4.2.1 Minimum Grade

Grade: The perforated pipes shall have an absolute minimum grade of 0.5% towards the overflow pit and be constructed in accordance with the design grade shown.

### 1.4.2.2 Maximum Spacing

Spacing: The maximum centre to centre spacing of the under-drainage pipes shall be as specified in the **Maximum underdrainage pipe spacing table**

**Table 16A-10 Maximum underdrainage pipe spacing table**

Bioretention Filter Area	Maximum Spacing
≤ 100 m <sup>2</sup>	1.5 m
> 100 m <sup>2</sup>	3.0 m

### 1.4.2.3 Inspection and Maintenance Risers

General: The solid wall uPVC Solvent Weld SN8 pipe shall be constructed vertically to the surface of the bioretention system.

Risers: Capped vertical risers shall protrude 150mm above the finish surface level.

Location: Risers shall be located 0.6m offset from the perimeter of the filter media bed so that they are readily accessible for inspection and maintenance purposes.

## 1.4.3 Bioretention swales

### 1.4.3.1 Batter Slopes

The maximum slope for batters is 1(V) : 6(H). 1(V) : 4(H) batter slopes may be permitted in constrained locations with prior approval in writing by TCCS.

### 1.4.3.2 Longitudinal Grades

Grade Tolerance: The construction tolerances for longitudinal invert grades for bioretention swales are detailed within the **Longitudinal grade tolerances table** below:

**Table 16A-11 Longitudinal grade tolerances table**

Design longitudinal Grade (%)	Tolerance (%)
< 1%	±0.5%
1% to 1.5%	+1%, -0%
1.5% to 3.5%	±0.5%
3.5% to 4%	+0%, -1%
< 4%	±0.5%

## 1.4.4 Raingardens / Bioretention basins

### 1.4.4.1 Cell Grading

The longitudinal and lateral grading of the surface of each cell shall be within 0 – 0.5%.

### 1.4.4.2 Earthworks for Construction to Finish Surface

Finish surface levels of raingardens and bioretention basins shall be constructed to provide an even ponding depth over the submerged area with a maximum depth variation of ± 25mm.

## 1.4.5 Bioretention cell construction

### 1.4.5.1 Cell Dimensions

The maximum plan area of each cell's filtration media bed shall not exceed 500m<sup>2</sup> and the length of each cell shall not exceed 40 m and the width shall not exceed 15m.

### 1.4.5.2 Minimum Cell Separation

Each cell shall be configured such that an access track with a minimum width of 5m is provided between each cell.

### 1.4.5.3 Cell Grading

The longitudinal and lateral grading of the surface of each cell shall be within 0 – 0.5%.

## 2 MAINTENANCE

### 2.1 Commencement

Submission: In order to achieve maintenance period commencement, the following documentation shall be submitted to the Authorised Person:

- > Maintenance Schedule: In tabular format detailing proposed dates for maintenance, description of maintenance to be undertaken in alignment with the Design Operation and Maintenance Plan. The schedule is to include room for signoff by the contractor that the maintenance was undertaken.

### 2.2 Works during maintenance period

General: Maintenance of the bioretention system shall be undertaken in accordance with the following:

- > Inspection: Inspect bioretention systems every fortnight between October to March and once a month between April to September. Items that are to be checked include but are not limited to the following:
  - Litter/dead plant material;
  - Water turbidity;
  - Drainage effectiveness;
  - Scouring and/or cracking/shifting of embankments;
  - Sediment within SQID system;
- > Litter: Remove litter and dead plant material from system.
- > Herbicide: Do not use herbicides in bioretention systems/rainwater gardens.
- > After rainfall of over 10mm, within 2 days:
  - Remove surplus silt build up.
  - Replace washed away soil.
  - Replace gravel or mulch.
  - Remove litter.

A description of works including a photo of each bioretention area before and after each scheduled maintenance must be provided to the Authorised Person within 3 days of the works occurring.

## 2.3 Completion

### 2.3.1.1 Submissions

Work as Executed Records: To *MITS 00B Quality Requirements*.

### 2.3.1.2 Cleaning and Inspection

Flushing: On completion of the system, flush all pipes clean from end to end and leave in working order.

Inspection: The contractor shall arrange a witness point inspection by the Authorised Person to confirm that water induced at flushing points drains to the stormwater connection point with clean water at an adequate flow rate.

### 2.3.1.3 Report

A complete report shall be provided to the Authorised Person upon completion of the maintenance period. The maintenance report shall include the following documentation.

- > All photos of before and after maintenance works undertaken. Including description of location and works undertaken.
- > Signoff against the maintenance schedule by the contractor for each set of works undertaken,

## 3 MEASUREMENT AND PAYMENT

### 3.1 Measurement

#### 3.1.1.1 General

Payments made to the Bill of Quantities: To *MITS 00A General requirements*, this Specification, the drawings and **Pay items**.

#### 3.1.1.2 Methodology

The following methodology will be applied for measurement and payment:

- > Allow for all work, materials, testing and quality assurance requirements in each Pay Item.
- > Earthworks associated with the construction of swales, batters, bulk cutting or filling: To *MITS 02 Earthworks*
- > Inlet/Overflow pits and drainage structures: To *MITS 03C Precast box culverts* and *MITS 03D Drainage structures*.
- > Planting of Macrophytes, shrubs, grassing and mulch: To *MITS 09 Landscape*.
- > Formalised Edge protection such as retaining walls, boulders, fences: To *MITS 08 Incidental Works*.
- > Subsoil drains: To this Specification.
- > Excavation and replacement of Unsuitable Material: *MITS 02B Bulk Earthworks*.
- > Hardstand pavement, driveways, kerbing: To *MITS 06A Concrete kerbs and open drains* and *MITS 06B Concrete paths, driveways medians*.
- > No Additional payment will be made for excavation in rock, overbreak of trench due to ground conditions or over excavation of trenches.

## 3.2 Pay items

**Table 16A-12 Pay items table**

Item No	Pay items	Unit of measurement	Schedule of rates scope
<b>16A.1</b>	Liner Materials for Bioretention Systems	m <sup>2</sup> of liner material installed, not including overlaps required at joints	<p>All activities associated with the construction of a HDPE/Geotextile liner including the supply and installation of the nominated liner material to manufacturer specification except where amended by this specification.</p> <p>A separate pay item shall be included in the Contract for each type of liner material. For example;</p> <p>16A.1.1 Geotextile 16A.1.2 HDPE</p>
<b>16A.2</b>	Clay Liner Material for Bioretention Systems	<p>m<sup>3</sup></p> <p>The volume is determined by the area of work as measured by survey and specified on the drawings or as directed by the Authorised Person multiplied by the relevant design thickness shown on the drawings.</p>	<p>All activities associated with the construction of clay liner including detailed excavation in all types of material encountered including rock, supply, placement and compaction of the clay liner material in accordance with this specification inclusive of dewatering and watering as required.</p>
<b>16A.3</b>	Underdrainage Pipes	Linear metre of pipe installed measured along the centreline	<p>All activities associated with construction of underdrainage pipes including excavation of trenches in all types of material encountered including rock, over excavation for bedding, shoring, supply and laying of pipes, additional excavation at structures, bedding, jointing, markers, fittings, capping of the trench, backfilling, compaction and flushing.</p> <p>This pay item shall also include pipe cutting and connection to existing or new pipes.</p> <p>Separate pay items shall be included in the Contract for each pipe material, class of pipe and pipe diameter.</p>

Item No	Pay items	Unit of measurement	Schedule of rates scope
16A.4	Underdrainage Risers	Number	All activities associated with the construction of the underdrainage riser including excavation in all material types, supply and laying of pipes, concrete formwork, supply, placement, curing and finish of insitu concrete, supply and installation of precast surround and cast iron cover, connection to subsurface drainage and backfill.
16A.5	Base / Drainage Layer	The unit of measurement shall be cubic metre bank volume of material calculated for the base / drainage layer section as detailed on the design plans.	All activities associated with the construction of the base / drainage layer including detailed excavation in all types of material encountered including rock, supply, placement and compaction of the layer materials in accordance with this specification.
16A.6	Transition Layer	m <sup>3</sup> The volume is determined by the area of work as measured by survey and specified on the drawings or as directed by the Authorised Person multiplied by the relevant design thickness shown on the drawings.	All activities associated with the construction of the transition layer including supply, placement and compaction of the layer materials in accordance with this specification.
16A.7	Filtration Layer for Bioretention Systems	m <sup>3</sup> The volume is determined by the area of work as measured by survey and specified on the drawings or as directed by the Authorised Person multiplied by the relevant design thickness shown on the drawings.	All activities associated with the construction of the filtration layer including supply, placement and compaction of the layer materials in accordance with this specification.
16A.8	Maintenance Period	Weeks of maintenance undertaken following maintenance commencement as directed by the Authorised Person.	This pay item shall include all works associated with maintenance of the bioretention system in accordance with the specification.



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