SPECIFICATION 403

SUB-SOIL DRAINS

REVISION REGISTER			
Clause Number	**Description of Revision**	**Authorised By**	**Issue Date**
403.34	Clause Heading Changed	GSME	16/11/2021
403.02	Added WA 123.1 Linear Shrinkage	GSME	5/11/2021
403.06	Amended Table 403.1 and Table 403.2 and updated wording on Geotextile	GSME	5/11/2021
403.07	Amended Table 403.3	GSME	5/11/2021
403.08	Updated wording on Backfill Layer	GSME	5/11/2021
403.25	Amended Clause 403.25 to 403.26	GSME	5/11/2021
403.28	Updated wording on Drain Lining	GSME	5/11/2021
403.34	Inclusion of Compaction Requirements for Backfill Layer	GSME	5/11/2021
Guidance Notes	Deleted Clause 403.34	GSME	5/11/2021
403.02 403.08	Reference to AS 1254 changed to AS/NZS 1254 Title changed from Drainage Layer to Backfill Layer	GSME	26/9/2019
Whole document 403.31.3	Reformatted Hold Point Added	SCO GSME	27/04/2017
403.35	Use of powder coating instead of metallic paint recommended	GSME	17/10/2012
Whole document 403.02 403.06 403.34	Complete review of Specification Australian Standards and Publications amended Table 403.1 amended Not used	GSME	23/07/2010
AS 3704 Table 403.1 403.27.5	Geosynthetics Notes (1) Geotextile installation stresses Grade of subsoil drainage	GSME	20/08/2008
Whole document	Complete review of Specification. Clauses 403.09.1 & 2 amended. Guidance Notes added	GSME	14/11/2006
Whole document	Complete revision of Issue 2.0 to new format	MCP	01/08/2006

Contents

SPECIFICATION 403

SUB-SOIL DRAINS

GENERAL

403.01 SCOPE

1. The work under this specification consists of the supply and installation of subsoil drainage.

403.02 REFERENCES

1. Australian Standards, MAIN ROADS Western Australia Standards and MAIN ROADS Western Australia Test Methods are referred to in abbreviated form (e.g. AS 1234, MRS 67-08-43 or WA 123). For convenience, the full titles are given below:

Acts and Regulations

WorkSafe WA Occupational Safety and Health Regulations 1996

Australian Standards

AS 2439.1	Part 1: Perforated drainage pipe and associated fittings
AS 3704	Geosynthetics – Glossary of Terms
AS 3705	Geotextiles – Identification, Marking and General Data
AS 3706.1	Geotextiles – Methods of Test – General requirements, sampling, conditioning, basic physical properties and statistical analysis
AS 3706.4	Geotextiles – Methods of Test – Determination of burst Strength – California bearing ratio (CBR) – Plunger method
AS 3706.5	Geotextiles – Methods of Test – Determination of puncture Resistance – Drop cone method
AS 3706.7	Geotextiles – Methods of Test – Determination of pore-size distribution – Dry-sieving method
AS 3706.9	Geotextiles – Methods of Test – Determination of permittivity, permeability and flow rate
AS 3706.11	Geotextiles – Methods of Test – Determination of Durability – Resistance to degradation by light, heat and moisture

Australian/New Zealand Standards

AS/NZS 1254 PVC-U pipes and fittings for stormwater surface water applications

Other Standards and Publications

AUSTROADS Guide to Pavement Technology, Part 4G: Geotextiles and Geogrids

MAIN ROADS Test Methods

WA 115.1 Particle Size Distribution: Sieving and Decantation Method

WA 123.1 Linear Shrinkage

WA 210.1 Particle Size Distribution of Aggregate

MAIN ROADS Specifications

Specification 302 EARTHWORKS

Specification 901 CONCRETE – GENERAL WORKS

403.03 – 403.05 NOT USED

PRODUCTS AND MATERIALS

403.06 GEOTEXTILE

1. The geotextile lining shall be a non-woven fabric consisting of long chain synthetic polymer fibres, composed of at least 95% by mass of polyester or polyolefins (polypropylene, polyethylene), and bonded by needle punching, heat or chemical bonding processes or combinations thereof. Bonded fibres must be capable of retaining their relative position in the geotextile. The polymer fibres shall be rot proof, chemically stable and have low water absorbency. ***Geotextile Fibres***

2. The geotextile shall have a high ultraviolet resistance such that when tested in accordance with AS 3706.11, the geotextile shall have retained strength of at least 50% after 672 hours of test exposure. The geotextile shall be free of any flaws or defects that may adversely affect the mechanical or physical properties of the fabric. ***UV Resistance***

3. The Contractor shall certify that the geotextile delivered to site meet the specification requirements. Sampling, conditioning and statistical analysis of results for each batch of geotextile shall be carried out in accordance with AS 3706.1. Sampling frequency shall be in accordance with Appendix A of AS 3706.1. The conformance testing shall include determining the mean weight (mass per unit area) of the geotextile, in accordance with AS 3706.1. ***Sampling and Testing***

4. Prior to installation, the geotextile rolls shall be stored on site under a protective cover or wrapped with a waterproof, opaque UV protective sheeting and supported off the ground. The Contractor shall take appropriate measures to protect the geotextile from any damage. This includes adhering to any other recommendations on method of storage set by the supplier/manufacturer. Each protected geotextile roll shall be clearly marked in conformance with AS 3705. ***Supply and Storage***

5. The geotextile shall comply with the mechanical and hydraulic requirements shown in Tables 403.1 and 403.2 below. ***Properties***

TABLE 403.1 MECHANICAL PROPERTIES

Property	Subsoil Drains	Test Method
Minimum Geotextile Strength Rating, G	1350	AS 3706.4 and AS 3706.5

NOTES:

(i) Geotextile Strength Rating, G = $(L.h_{50})^{0.5}$ Geotextile survivability refers to the ability of the Geotextile to withstand the installation stresses during construction. It is related to the construction method, subgrade condition, backfill material including stone size, and other factors.

(ii) L (in Newtons) is the characteristic value of burst strength (CBR Plunger Method) for the batch tested determined in accordance with AS 3706.1 and AS 3706.4. h_{50} (in mm) is the characteristic value of puncture resistance (Drop Cone Method) for the batch tested determined in accordance with AS 3706.1 and AS 3706.5. The characteristic values of L and h_{50} shall be calculated as the mean value less 0.83 x standard deviation.

TABLE 403.2 MECHANICAL PROPERTIES

Property	Subsoil Drains	Test Method
Maximum Equivalent Opening Size, (EOS) (μm)	250	AS 3706.7
Minimum Q_{100} (l/m²/s)	50	AS 3706.9

NOTES:

(i) Maximum Equivalent Opening Size (EOS) and Minimum Q_{100} are mean values

(ii) EOS = Particle diameter for which 95% of particles would be retained

(iii) Q_{100} = Flow rate under 100mm constant head determined using the Perpendicular Flow Test

6. **Prior to the use of the geotextile for drainage lining, the Contractor shall submit to the Superintendent product certificates of compliance from the supplier, showing that the geotextile complies with all the requirements of this specification. Test results shall be reported on NATA endorsed documents. The certificate must not be more than twelve months old.** ***HOLD POINT***

403.07 FILTER AGGREGATE

1. Filter aggregate for use in backfilling trenches shall consist of hard, durable, clean gravel or crushed rock, and shall be free from organic material, clay or other deleterious substances. Unless otherwise shown on the Drawings, the aggregate shall have the Particle Size Distribution (PSD) as shown in Table 403.3 as determined by WA 210.1: ***Aggregate***

TABLE 403.3 CRUSHED AGGREGATE (NOMINAL 20 mm)

AS Sieve Size (mm)	% Passing by Mass
26.50	100
19.00	70 - 100
13.20	0 - 30
9.50	0 - 10
6.70	
4.75	
2.36	0 - 5
0.075	0 - 1

2. **Prior to the use of the aggregate material for filter aggregate, the Contractor shall provide certification to the Superintendent that the aggregate conforms to the specified requirements. Test results shall be reported on NATA endorsed documents.** ***HOLD POINT***

403.08 BACKFILL LAYER

1. Any backfill layer shall comprise free-draining cohesionless material free of clays, organic matter and any other deleterious substances, and shall conform with the requirements shown in Table 403.4 as determined by WA 115.1. ***Backfill Layer***

TABLE 403.4 BACKFILL LAYER

AS Sieve Size (mm)	% Passing by Mass
37.5	90 - 100
2.36	30 - 100
0.075	1 - 10

The portion of the material passing the 0.425mm sieve for imported material shall have a linear shrinkage not exceeding 1.0%. The compaction requirements applicable to the backfill layer are listed in Clause 403.34 below.

403.09 SLOTTED PIPE

PVC Pipe

1. Drainage pipes and associated fittings and jointing procedures shall comply with the following requirements:

   (a) AS 2439.1 Perforated drainage and effluent pipe and fittings – Part 1 – Perforated drainage pipe and associated fittings

   (b) AS/NZS 1254 PVC-U pipes and fittings for stormwater and surface water applications

2. Unless otherwise noted on the Drawings slotted pipe shall be nominal 100mm outside diameter, Class 400 Type 1 PVC pipe, with 45° elbows as required.

403.10 FLUSH-OUT POINTS

Flush-out Points

1. The subsoil drain flush-out point shall have a concrete cover of Class N32 concrete fitted with a removable cap. Concrete shall be supplied in accordance with Specification 901 CONCRETE - GENERAL WORKS.

403.11 – 403.25 NOT USED

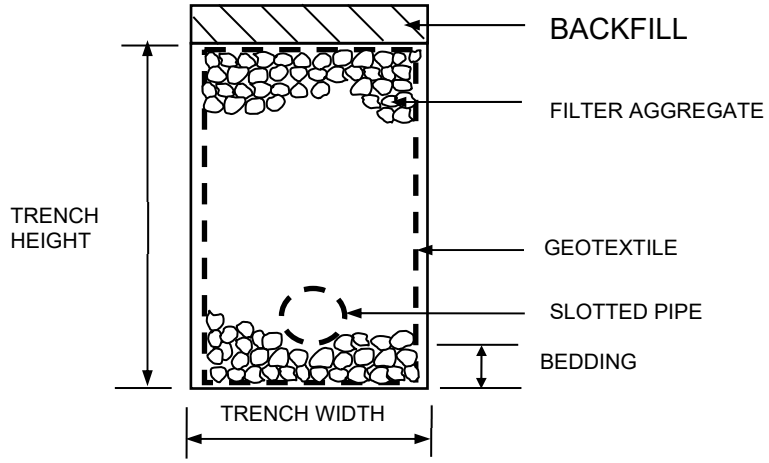
CONSTRUCTION

403.26 GENERAL

Extent

1. Sub-soil drains shall be constructed to the locations, cross-sectional shapes and dimensions as shown on the Drawings. A typical cross section is shown at Figure 403.1 to illustrate various components of the sub-soil drain.

FIGURE 403.1 TYPICAL CROSS SECTION OF SUB-SOIL DRAIN



403.27 TRENCH EXCAVATION

1. The trench for the installation of the sub-soil drain shall be excavated to the width and depth shown on the Drawings. The excavation shall have vertical sides throughout where the excavation is up to 1.5m deep. The bottom of the trench shall be not more than 50mm below the specified level of the invert of the pipe. Excess trench excavation shall be made good by filling back to grade and lightly compacting with material of permeability similar to that of the surrounding material. ***≤ 1.5m Deep***

2. Where the excavation is greater than 1.5m deep, the trench shall be excavated in accordance with the relevant requirements of Occupational Safety and Health Regulations 1996. Any loose or disturbed material shall be removed from the walls of the trench. ***> 1.5m Deep***

3. Unsuitable material from excavations shall be disposed of in accordance with Specification 302 EARTHWORKS. ***Unsuitable Material***

4. Trench excavations in rock shall be carried out in accordance with Specification 302 EARTHWORKS. ***Rock***

5. Trenches should be graded to have reasonably smooth side and bottom faces so that the geotextile lining will not bridge cavities or be damaged by protruding/sharp objects. Cavities should be filled with granular material before placement of geotextile. The minimum grade of subsoil drainage must be 0.5%. ***Shape***

6. **Prior to the placement of Geotextile as detailed in Clause 403.28, the Contractor shall provide certification to the Superintendent that the trench excavation conforms to the trench shape, grade line, filling and light compaction for over excavated section and removal of any protruding/sharp objects.** ***HOLD POINT***

403.28 DRAIN LINING

1. The Contractor shall take every reasonable care to ensure that the geotextile is not damaged during installation and backfilling operations. ***Care***

2. Geotextile shall be placed in the excavated trench to cover the bottom and sides of the trench, with sufficient free fabric to wrap around the completed drain as shown on the Drawings. The geotextile should conform to the shape of the trench with minimal wrinkles, folds or air voids between fabric and trench, but not stretched on the soil. ***Placement***

3. Unless otherwise specified on the Drawings, the minimum overlap in longitudinal direction along the trench shall be 500mm. Successive sheets of geotextile within the trench shall be overlapped with the upstream fabric overlying the downstream fabric. ***Overlap***

4. No construction equipment shall stand or travel directly on the laid geotextile. The initial layer of cover material shall be placed over the geotextile prior to construction equipment travelling over the area concerned. The initial uncompacted layer thickness for fill material placed directly over the geotextile shall be not less than 200mm.

5. Unless otherwise approved in written by the Superintendent, do not use vibratory and heavy compaction plant on the initial layers of fill materials.

6. Where geotextiles are used to line subsoil drainage trenches, the textiles shall fully envelop the drainage material in the trench and be folded over that material with a minimum 300mm overlap at the top of the trench.

7. Damaged areas of geotextile may be repaired by overlaying the damaged section with a patch. The patch shall extend a minimum of 1 m beyond the area of damage. ***Repair***

8. The period between initial laying out and final cover of the geotextile with drainage backfill layer shall not exceed 14 days. Where possible and practical, geotextiles shall be placed just ahead of associated advancing construction work and covered by relevant construction materials or suitable protective sheeting within 48 hours of being placed. ***Exposure***

9. Any fabric allowed to remain exposed to sunlight for a period greater than 14 days shall be removed and replaced at no cost to the Principal. ***Prolonged Exposure***

403.29 BEDDING

1. Filter aggregate bedding in accordance with Clause 403.07 shall be placed on the geotextile to the depth indicated on the Drawings, and tamped level. Unless otherwise shown on the Drawings, the depth of the bedding shall be 50mm.

403.30 INSTALLATION OF SLOTTED PIPE

1. Slotted pipe shall be installed as shown on the Drawings, and shall be placed centrally within the trench on the crushed aggregate bedding. ***Placement***

2. Any required joints in slotted pipe shall be made in accordance with the manufacturer’s instructions. ***Joints***

3. Flush-out points shall be constructed at the locations shown on the Drawings, complete with concrete covers as described in Clause 403.10. ***Flush-out Points***

403.31 FILTER AGGREGATE AND BACKFILL MATERIAL

1. Filter aggregate shall be placed over the slotted pipe to the depth shown on the Drawings, and tamped to a level profile. To avoid post-construction settlement, the filter aggregate material shall be compacted to its full depth to achieve effective mechanical interlock between particles. The geotextile shall be wrapped over the top of the aggregate layer with sufficient overlap (lesser of trench width or 500mm). ***Aggregate Backfill***

2. Where shown on the Drawings, any required drainage backfill layer shall be placed on top of the geotextile wrapped aggregate, and shall be filled to the subgrade surface. This layer shall be compacted as for embankment construction in accordance with Specification 302 EARTHWORKS. ***Backfill***

3. **Prior to backfilling the Contractor shall certify to the Superintendent that compliance has been achieved with all specified requirements.** ***Hold Point***

403.32 FLUSHING

1. After completion of backfilling, subsoils drains shall be flushed in the presence of the Superintendent with sufficient clean water until only clean water discharges at the outlet.

403.33 OUTLETS

1. Where a subsoil drain is provided for the drainage of the pavement layer, outlets are to be provided as shown on the Drawings. Subsoil drains shall discharge into gully pits and other stormwater drainage structures or outlets approved by the Superintendent.

403.34 BACKFILL LAYER

Backfill material shall be selected granular fill compacted to a minimum 96% of Modified Maximum Dry Density Ratio for as shown on the Drawings. ***Compaction***

403.35 MARKER POSTS

1. The Contractor shall supply and erect marker posts at all drain inlets and outlets. They shall be galvanised steel box sections, be capped and have the following dimensions: 80mm in width, 40mm in depth and 1200mm in height. They shall be driven into the ground, leaving 700mm above the ground level. The top 700mm of the posts shall be painted with white powder coating on all faces. The powder coated width facing the road shall be marked "**SUBSOIL DRAIN**". The letters shall be in black paint and of the following dimensions: height 60mm and width 30mm.

403.36 – 403.80 NOT USED

AS BUILT AND HANDOVER REQUIREMENTS

403.81 – 403.90 NOT USED

CONTRACT SPECIFIC REQUIREMENTS

403.91 – 403.99 NOT USED

GUIDANCE NOTES

FOR REFERENCE ONLY – DELETE GUIDANCE NOTES FROM FINAL DOCUMENT

1. All edits to downloaded Specifications shall be made using *Track Changes*, to clearly show added/deleted text.

2. If **all** information relating to a clause is deleted, the clause number should be retained and the words **"NOT USED"** should be inserted.

3. The proposed documents with tracked changes shall be submitted to the Project Manager for review, prior to printing the final batch of documents. When this final printing is carried out, the tracked changes option is to be turned off.

4. Before printing accept all changes in the document, turn off *Track Changes* and refresh the Table of Contents.

5. The Custodian of this specification is Geomechanical and Structural Materials Engineer.

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1. CLAUSE 403.10

The project manager shall ensure that any concrete covers (Clause 403.10) and inspection structures are fully detailed on the Drawings.

CONTRACT SPECIFIC REQUIREMENTS

The following clauses are to be placed under the CONTRACT SPECIFIC REQUIREMENTS, as required. After inserting the clause, change the clause number and heading to style “H2 SP” so it appears in the Table of Contents.

XXX.XX SUB HEADING (H2 SP)

1. Insert text (Main Table SP)

Keyword SP

2. Insert text (Main Table SP)

XXX.XX SUB HEADING (H2 SP)

1. Insert text (Main Table SP)

2. Insert text (Main Table SP)

AMENDMENT CHECKLIST

Specification No. **403** Title: **SUB-SOIL DRAINS** Revision No: _____

Project Manager: _____ Signature: _____ Date: _____

Checked by: _____ Signature: _____ Date: _____

Contract No: _____ Contract Description: _____

ITEM	DESCRIPTION	SIGN OFF
Note: All changes/amendments must be shown in Tracked Changes mode until approved.		
1.	Project Manager has reviewed Specification and identified Additions and Amendments.	
2.	**CONTRACT SPECIFIC REQUIREMENTS** addressed? Contract specific materials, products, clauses added? (Refer Specification Guidance Notes for guidance).	
3.	Any unlisted materials/products proposed and approved by the Project Manager? If "Yes" provide details at 16.	
4.	Standard clauses amended? **MUST SEEK** approval from Manager Commercial.	
5.	Clause deletes shows as **"NOT USED"**.	
6.	Appropriate **INSPECTION AND TESTING** parameters included in Spec 201 (Text Methods, Minimum Testing Frequencies verified).	
7.	**ANNEXURES** completed (refer Specification Guidance Notes).	
8.	**HANDOVER** and **AS BUILT** requirements addressed.	
9.	Main Roads QS has approved changes to **SMM**.	
10.	Project Manager certifies completed Specification reflects intent of the design.	
11.	Completed Specification – independent verification arranged by Project Manager.	
12.	Project Manager's review completed.	
13.	**SPECIFICATION GUIDANCE NOTES** deleted.	
14.	**TABLE OF CONTENTS** updated.	
15.	**FOOTER** updated with Document No., Contract No. and Contract Name.	
16.	Supporting information prepared and submitted to Project Manager.	
Further action necessary:		

Signed: _____ *(Project Manager)* Date: _____