

New Roads and Street Works Act 1991

**SPECIFICATION FOR THE
REINSTATEMENT OF
OPENINGS IN ROADS**

OCTOBER 2003



RAUC(S)



SCOTTISH EXECUTIVE

**SPECIFICATION FOR THE
REINSTATEMENT
OF OPENINGS IN ROADS**

REVISED OCTOBER 2003, FOLLOWING CONSULTATION

© Crown Copyright 2003

ISBN 0 7559 0973 9

Published by
Scottish Executive
St Andrew's House
Edinburgh

Published for the Scottish Executive by Astron B32474 10/03

Further copies are available from
The Stationery Office Bookshop
71 Lothian Road
Edinburgh EH3 9AZ
Tel: 0870 606 55 66

The text pages of this document are produced from 100% elemental chlorine-free, environmentally-preferred material and are 100% recyclable.

Also available

Code of Practice for Inspections
ISBN 0755909771 £8

Buy both documents together for £15

Bulk purchases of 10 or more sets £10 per set

CONTENTS

PREFACE	7
FOREWORD	9
DEFINITIONS	10
SPECIFICATION	13
S1 INTRODUCTION	13
S1.1 General	13
S1.2 Guarantee Period	13
S1.3 Road Categories	14
S1.4 Footway, Footpath and Cycletrack Categories	14
S1.5 Excavation and Trench Categories	15
S1.6 Alternative Options	15
S1.7 Immediate Works	15
S1.8 Apparatus within Road Structures	16
S1.9 Geosynthetic Materials	16
S1.10 Trees	16
S1.11 Conciliation and Arbitration	17
S2 PERFORMANCE REQUIREMENTS	19
S2.1 General	19
S2.2 Surface Profile	20
S2.3 Fixed Features	23
S2.4 Surface Regularity	23
S2.5 Structural Integrity	25
S2.6 Skid Resistance	26
S2.7 Sampling and Testing	30
S3 EXCAVATION	31
S3.1 Breaking the Surface	31
S3.2 Excavation	31
S3.3 Excavated Material	31
S3.4 Side Support	31
S3.5 Drainage	32
S3.6 Shallow and Aborted Excavations	32
S3.7 Trenchless Pipelaying	32
S4 SURROUND TO APPARATUS	34
S4.1 General	34
S5 BACKFILL	35
S5.1 Backfill Material Classification	35
S5.2 Alternative Reinstatement Materials	35
S5.3 Additional Requirements	36
S6 FLEXIBLE AND COMPOSITE ROADS	38
S6.1 Reinstatement Methods	38
S6.2 Sub-base Reinstatement	39
S6.3 Base (Roadbase) Reinstatement	39
S6.4 Surface Reinstatement	41
S6.5 Base and Edge Preparation	45
S6.6 Tolerances	47

S7	RIGID AND MODULAR ROADS	48
S7.1	Reinstatement Methods	49
S7.2	Sub-base Reinstatement	49
S7.3	Concrete Road Slab Reinstatement	49
S7.4	Edge Support and Preparation	50
S7.5	Reinforcement	52
S7.6	Overlays	52
S7.7	Modular Roads	52
S7.8	Tolerances	53
S8	FOOTWAYS, FOOTPATHS AND CYCLETRACKS	54
S8.1	Reinstatement Methods	54
S8.2	Sub-base and Binder Course Reinstatement	55
S8.3	Surface Reinstatement	56
S8.4	Vehicular Trafficking	57
S8.5	Tolerances	58
S9	VERGES AND UNMADE GROUND	59
S9.1	General	59
S9.2	Adjacent Road Structures	59
S9.3	Cultivated Areas	60
S9.4	Grassed Areas	60
S9.5	Verges, Ditches and Drainage Courses	60
S10	COMPACTION REQUIREMENTS	61
S10.1	Introduction	61
S10.2	Reinstatement Materials	61
S10.3	Equipment Operation and Restrictions	63
S11	ANCILLARY ACTIVITIES	66
S11.1	Traffic Signs, Road Markings, Studs and Verge Markers	66
S11.2	Street Furniture and Special Features	67
S11.3	Traffic Sensors, etc.	67
S11.4	Sewers, Drains and Tunnels	67
S11.5	Test Holes	68
S12	REMEDIAL WORKS	70
S12.1	General	70
S12.2	Safety Requirements	70
S12.3	Repair of Cracking	70
S12.4	Repair of Settlement Beyond Reinstatement Limits	71
S12.5	Repair of Other Significant Defects	72
APPENDICES		
A1	BACKFILL MATERIALS	73
A1.1	Class A - Graded Granular Materials	73
A1.2	Class B - Granular Materials	73
A1.3	Class C - Cohesive/Granular Materials	73
A1.4	Class D - Cohesive Materials	73
A1.5	Class E - Unacceptable Materials	74
A1.6	Field Identification Tests	74
A2	KEY TO MATERIALS	77
A2.1	Hot Rolled Asphalt (HRA) Materials	78
A2.2	Stone Mastic Asphalt (SMA) Materials	79
A2.3	Coated Materials	79
A2.4	Cold-lay Surfacing Materials	80

A2.5	Structural Layer Thickness Tolerances	80
A2.6	Compacted Lift Thickness	81
A2.7	Bituminous Laying Temperatures	82
A2.8	Identification of Structural Layers	83
A2.9	Key to Materials	85
A3	REINSTATEMENT – FLEXIBLE ROADS	87
A3.0	Type 0 Flexible Roads	87
A3.1	Type 1 Flexible Roads	88
A3.2	Type 2 Flexible Roads	89
A3.3	Type 3 Flexible Roads	90
A3.4	Type 4 Flexible Roads	91
A3.5	Sub-base Construction - Flexible Roads	92
A4	REINSTATEMENT - COMPOSITE ROADS	93
A4.0	Type 0 Composite Roads	93
A4.1	Type 1 Composite Roads	94
A4.2	Type 2 Composite Roads	95
A4.3	Types 3 & 4 Composite Roads	96
A4.4	Sub-base Construction - Types 0, 1 & 2 Composite Roads	97
A4.5	Sub-base Construction - Types 3 & 4 Composite Roads	98
A5	REINSTATEMENT - RIGID ROADS	99
A5.0	Type 0 Rigid Roads	99
A5.1	Type 1 Rigid Roads	100
A5.2	Types 2, 3 & 4 Rigid Roads	101
A6	REINSTATEMENT - MODULAR ROADS	102
A6.1	Types 3 & 4 Modular Roads - Bituminous Base (Roadbase)	102
A6.2	Types 3 & 4 Modular Roads - Composite Base (Roadbase)	103
A6.3	Types 3 & 4 Modular Roads - Granular Base (Roadbase)	104
A7	REINSTATEMENT - FOOTWAYS, FOOTPATHS AND CYCLYTRACKS	105
A7.1	Flexible Footways, Footpaths and Cycletracks	105
A7.2	Rigid Footways, Footpaths and Cycletracks	106
A7.3	Modular Footways, Footpaths and Cycletracks	107
A8	COMPACTION REQUIREMENTS	108
A8.1	Cohesive and Granular Materials	108
A8.2	Chalk Materials	108
A8.3	Bituminous Materials	109
A9	ALTERNATIVE REINSTATEMENT MATERIALS (ARMS)	111
A9.1	Introduction	111
A9.2	General Requirements for ARMs	112
A9.3	Structural Materials for Reinstatement (SMRs)	113
A9.4	Stabilised Materials for Fill (SMFs)	115
A9.5	Outline Scheme for Approval Trials	117
A10	PERMANENT COLD-LAY SURFACING MATERIALS (PCSMS)	121
A10.1	Introduction	121
A10.2	Permitted Usage of Approved PCSM Materials	121
A10.3	Unsuccessful PCSM Approval Trials	121
A11	BITUMEN BINDER EQUIVALENCE	123
A11.1	Introduction	123
A11.2	Base (Roadbase) and Binder Course Materials	123
A11.3	Surface Course Materials	123

A12 REINSTATEMENT OF MODULAR SURFACE LAYER	125
A12.1 Interim Reinstatement	125
A12.2 Permanent Reinstatement	125
A12.3 Provision of Replacement Modules	125
A12.4 Pre-Existing Surface Damage Outside Limits of Undertaker's Works	125
A12.5 Joint Inspection and Recovery of Costs	126
NOTES FOR GUIDANCE	
NG1 INTRODUCTION	128
NG1.1 General	128
NG1.2 Guarantee Period	128
NG1.3 Road Categories	128
NG1.6 Alternative Options	131
NG1.7 Immediate Works	132
NG1.8 Apparatus within the Road Structure	132
NG2 PERFORMANCE REQUIREMENTS	133
NG2.2 Surface Profile	133
NG2.3 Fixed Features	133
NG2.4 Surface Regularity	134
NG2.5 Structural Integrity	135
NG2.6 Skid Resistance	135
NG3 EXCAVATION	137
NG3.2 Excavation	137
NG3.4 Side Support	137
NG4 SURROUND TO APPARATUS	138
NG4.1 General	138
NG5 BACKFILL	139
NG5.1 Backfill Material Classification	139
NG5.3 Additional Requirements	139
NG6 FLEXIBLE AND COMPOSITE ROADS	141
NG6.2 Sub-base Reinstatement	141
NG6.3 Base (Roadbase) Reinstatement	141
NG6.4 Surface Reinstatement	141
NG6.5 Base and Edge Preparation	142
NG7 RIGID AND MODULAR ROADS	143
NG7.1 Reinstatement Methods	143
NG7.7 Modular Roads	143
NG8 FOOTWAYS, FOOTPATHS AND CYCLETRACKS	144
NG8.2 Sub-base and Binder Course Reinstatement	144
NG8.3 Surface Reinstatement	144
NG9 VERGES AND UNMADE GROUND	145
NG10 COMPACTION REQUIREMENTS	146
NG10.1 Introduction	146
NG10.2 Reinstatement Materials	146
NG10.3 Equipment Operation and Restrictions	146
NG11 ANCILLARY ACTIVITIES	150
NG11.1 Traffic Signs, Road Markings, Stud and Verge Markers	150
NG11.2 Street Furniture and Special Features	150
NG11.3 Traffic Sensors, etc.	150
NG12 REMEDIAL WORKS	151
NGA2 KEY TO MATERIALS	152

Preface

Recognition of Equivalent Standards and Testing

The requirement for goods or materials to comply with certain specifications or to undergo specified tests shall be satisfied if such goods or materials comply with equivalent specifications of, or have undergone equivalent tests in, another member state of the European Economic Area.

The basis on which specifications and tests shall be adjudged to be equivalent is set out in the current version of Clauses 104 and 105 of the Highways Agency "Specification for Highway Works". Relevant extracts are reproduced below.

Clause 104: Standards, Quality Assurance, Agrément Certificates and Other Approvals

Sub-clause 1

"Except where the specified standard implements or is technically equivalent to a Harmonised European Standard or to a European Standard adopted for use after 31 December 1985, any requirement for goods or materials to comply with the specified standard shall be satisfied by compliance with:

- (i) a relevant standard or code of practice of a national standards body or equivalent body of any Member State of the European Economic Area; or
- (ii) a relevant international standard recognised for use in any Member State of the European Economic Area; or
- (iii) a technical regulation of any Member State of the European Economic Area; or
- (iv) traditional procedures of manufacture of any Member State of the European Economic Area where these are the subject of a written technical description sufficiently detailed to permit assessment of the goods or materials for the use specified; or
- (v) a European Technical Approval (ETA) issued in accordance with the Construction Products Directive 89/106/EEC (or, until procedures are available for the issue of ETAs, a specification sufficiently detailed to permit assessment) for goods or materials of an innovative nature or subject to innovative processes of manufacture and which fulfil the purpose provided for by the specified standard

provided that the proposed standard, code of practice, regulation, specification, technical description or European Technical Approval provides, in use, levels of safety, suitability and fitness for purpose equivalent to those required by the specified standard in so far as they are not inconsistent with the "Essential Requirements" of the Construction Products Directive (89/106/EEC). This clause applies also to works only in so far as the means of carrying out such works are indivisibly associated with the goods or materials for which an alternative standard, code of practice, regulation, specification or technical description is proposed."

Clause 105: Goods, Materials, Sampling and Testing Goods and Materials

Sub-Clause 4

"Where testing including sampling is carried out in another Member State of the European Economic Area such tests shall be undertaken by an appropriate organisation offering suitable and satisfactory evidence of technical and professional competence and independence...".

Sub-Clause 5

"Where goods or materials are accepted on the basis of an equivalent standard, code of practice, specification, technical description, quality management scheme, product certification scheme or Agrément certificate as provided for in Clause 104, testing and sampling as specified in or applicable to such equivalent standard, code of practice, specification, technical description, quality management scheme, product certification scheme or Agrément certificate is accepted...".

Foreword to the Second Edition

Under Section 129 of the New Roads and Street Works Act 1991, an undertaker executing road works must when reinstating the road comply with whatever specification may be prescribed for materials to be used and standards of workmanship to be observed. The Undertaker must also ensure that the reinstatement conforms to prescribed performance standards - in the case of an interim reinstatement, until a permanent reinstatement is effected, and, in the case of a permanent reinstatement, for the prescribed period after completion of the reinstatement.

The first edition of the Code of Practice Specification for the Reinstatement of Openings in Highways came into operation in Scotland, England and Wales on 1 January 1993 at the same time as the related Regulations applicable in Scotland (the Road Works (Reinstatement) (Scotland) Regulations 1992 and those applicable in England and Wales (the Street Works (Reinstatement) Regulations 1992).

Road works have been a devolved matter since the promulgation of constitutional changes with effect from 1999. For the purpose of Section 129 of the 1991 Act, this second edition of the Code of Practice has accordingly been approved by the Scottish Ministers for use in Scotland only. The Road Works (Reinstatement) (Scotland) (Amendment) Regulations 2003 made under sections 129 and 163 of the Act set out the revised requirements on materials, workmanship and standard of reinstatement of road works which apply to road works in Scotland.

This edition of the Code of Practice was prepared by a working party of the Road Authorities and Utilities Committee (Scotland) (RAUC(S)) and was the subject of consultation with interested organisations and individuals. The working party consisted members of both utility companies and roads authorities.

The main new features of this edition are:

- new British Standards (in support of EN (European) standards) for asphalt materials covering composition and binder contents; the inclusion of an effective width on either side of a trench excavation line in which modules require to be removed and replaced;
- new procedures for chalk materials; a new section on the use of sustainable alternative reinstatement materials (ARMs);
- changes in road category to include a new Type 0 (heavily trafficked) category;
- a new section on specialist surfacing materials; a new performance specification for materials compaction that includes void content measurement;
- the inclusion of layer thickness tolerances and laying temperatures for asphalt materials; and
- an expanded section covering ancillary services, which includes new features such as road markings.

The Regulations and Code of Practice will come into operation on 1 October 2003. As soon as possible after publication in paper form, the Code will be posted on the Scottish Executive website.

Scottish Executive Enterprise, Transport and Lifelong Learning Department
October 2003

DEFINITIONS

(AAV) Aggregate Abrasion Value	the standard measure of an aggregate's resistance to abrasion
Authority	unless otherwise stated, in this Specification and Glossary, 'the Authority' refers to the Authority as defined in the Act
BBA/HAPAS CBR	a recognized body giving approval for products and processes Californian Bearing Ratio: a measure of the load bearing strength of a granular or unbound material
composite construction	a structure where the base (roadbase) is composed of lean mix concrete or other cement bound granular material, normally with bituminous surfacing layers
cycletrack	a way constituting or comprised in a highway, being a way over which the public have a right of way on pedal cycles only, with or without a right of way on foot
deep openings	all excavations and trenches in which the depth of cover over the buried apparatus is greater than 1.5 metres. Trenches that fall intermittently below 1.5 metres depth of cover for lengths of less than 5 metres are deemed not to be deep openings
emergency works	works whose execution at the time when they are executed is required in order to put an end to, or to prevent the occurrence of, circumstances then existing or imminent for which the person responsible for the works believes on reasonable grounds to be existing or imminent which are likely to cause danger to persons or property
flexible construction	a structure where the base (roadbase) is composed of either bituminous material or granular material, or a combination thereof
footpath	a way over which the public have a right of way on foot only, not being a footway
footway	a way comprised in a highway, which also comprises a carriageway, being a way over which the public have a right of way on foot only
geosynthetic materials	a generic term describing a product at least one of whose components is made from a synthetic or natural polymer, in the form of a sheet or a 3D structure, used in contact with soil and/or other materials in geotechnical and civil engineering applications

immediate works	works comprising the orderly replacement of excavated material, reasonably compacted to finished surface level, usually with a cold-lay surfacing
interim reinstatement	the orderly placement and proper compaction of reinstatement layers to finished surface level, including any temporary materials
intervention	restoration of a reinstatement which does not comply with the performance standards, to a condition complying with those standards
major projects	standard works which have been identified specifically in the Undertaker's annual operating programme or which, if not specifically identified in that programme, are normally planned at least 6 months in advance of works commencing
msa	million standard axles
minor works	works which are not emergency or urgent works, which are of a planned duration of not more than 3 days, do not form part of a rolling programme and are not planned to involve at any one time more than 30 metres of works or leave less than the minimum width of carriageway necessary for one-way traffic
modular construction	a structure where the surface is composed of setts, concrete blocks, brick pavers or paving slabs etc. laid on appropriate sub-construction
narrow trenches	all trenches of 300 mm surface width or less, with a surface area greater than 2 square metres
pen	the penetration grade of a bituminous binder
permanent reinstatement	the orderly placement and proper compaction of reinstatement layers up to and including the finished surface level
PSV	Polished Stone Value
road & footway structure	includes the surface course, binder course, base (roadbase) and sub-base
rigid construction	a structure where the surface slab also performs the function of the base (roadbase); is of pavement quality concrete and may be reinforced. Under certain circumstances, as defined in Section S7, a rigid road that has been overlaid may be deemed to be a composite construction for the purpose of this Specification
SHW	Specification for Highway Works, published as Volume 1 of the Manual of Contract Documents for Highway Works: HMSO

small excavations	all openings with a surface area of 2 square metres or less. For the purposes of this Specification, test holes up to 150 mm diameter are not excavations and shall be reinstated in accordance with the requirements of Section S11
SRV	the skid resistance value of a road surface
standard works	works which are not emergency works, urgent works or minor works. They include resurfacing works in excess of 20 square metres and cases where an Undertaker returns to site after interim reinstatement to complete permanent reinstatement in excess of 20 square metres
street	<p>the whole or any part of any of the following, irrespective of whether it is a thoroughfare:</p> <ul style="list-style-type: none">a) any highway, road, lane, footway, alley or passage;b) any square or court; andc) any land laid out as a way whether it is for the time being formed as a way or not; <p>and for the avoidance of doubt includes land on the verge of a street or between two carriageways. Where a street passes over a bridge or through a tunnel, references to the street include that bridge or tunnel. (NRSWA Section 48 etc.)</p>
STV	the units of viscosity measured in seconds using the Standard Tar Viscometer
the Act	unless otherwise stated in this Specification and Glossary, 'the Act' refers to the New Roads and Street Works Act 1991
traffic sign	has the same meaning as in the Road Traffic Regulation Act: 1984
TRL	Transport Research Laboratory
UKAS	the organisation that has introduced a national scheme for the accreditation of Laboratories used for the testing of materials
Undertaker	unless otherwise stated in this Specification and Glossary, 'the Undertaker' refers to the Undertaker as defined in the Act and is the person in whom a statutory right to execute works is vested or the holder of a street works licence
urgent works	works which fall short of emergency works but are of sufficient urgency to warrant immediate action either to prevent further deterioration of an existing situation or to avoid an Undertaker becoming in breach of a statutory obligation
verge	that part of the highway outside of the carriageway, which may be slightly raised but is exclusive of embankment or cutting slopes, and generally grassed

SPECIFICATION

S1 Introduction

S1.1 GENERAL

This Specification incorporates new terminology which is to be used in future European standards. Readers and practitioners should make themselves familiar with the new terms, as follows:

“surface course”	replaces the previous	“wearing course”
“binder course”	replaces the previous	“basecourse”
“base (roadbase)”	replaces the previous	“roadbase”
“materials to BS 4987”	replaces the previous	“macadam”

- S1.1.1 An Undertaker executing roadworks shall carry out the excavation and reinstatement in accordance with this Specification. Where this Specification allows alternatives, the Undertaker shall select one of the options allowed. Regardless of which alternative is selected, the Undertaker shall guarantee the performance of the reinstatement to the relevant standard, for the relevant guarantee period.
- S1.1.2 The reinstatement shall be carried out using a permitted method incorporating the highest degree of immediate permanent reinstatement appropriate, in the opinion of the Undertaker, to the prevailing circumstances.
- S1.1.3 If, at any time during a guarantee period, the reinstatement fails the relevant performance requirements of this Specification, the Undertaker shall carry out remedial action to restore the reinstatement to the as-laid condition. An interim reinstatement shall normally be made permanent within six months.
- S1.1.4 The requirements and standards in this Specification apply to roads which are maintainable or prospectively maintainable at public expense. In the case of all other roads, only those relevant parts of this Specification relating to “Surround to Apparatus” and “Backfill” shall apply. Surfacing layers, if any, shall be reinstated, as far as is reasonably practicable, to match the existing construction. In all cases, reinstatement must be undertaken to the reasonable satisfaction of the Authority.

S1.2 GUARANTEE PERIOD

- S1.2.1 The Undertaker shall ensure that the interim reinstatement conforms to the prescribed standards until the permanent reinstatement is completed, and that the permanent reinstatement conforms to the prescribed standards throughout the guarantee period.
- S1.2.2 The guarantee period shall begin on completion of the permanent reinstatement and shall run for two years, or three years in the case of deep openings. It should be noted that completion of the permanent reinstatement, rather than the giving of information to the Authority that the reinstatement is completed, is the event that triggers the start of the guarantee period. Failure to give information is an offence under Section 129 (6) of the Act.

S1.3 ROAD CATEGORIES

S1.3.1 Roads are categorised by this Specification into five types, each with a limiting capacity expressed in millions of standard axles (msa) as shown in Table S1.1.

Table S1.1 Road Categories	
Road Category	Traffic Capacity
Type 0	Roads carrying over 30 to 125 msa
Type 1	Roads carrying over 10 to 30 msa
Type 2	Roads carrying over 2.5 to 10 msa
Type 3	Roads carrying over 0.5 to 2.5 msa
Type 4	Roads carrying up to 0.5 msa

S1.3.2 Roads carrying more than 125 msa are not included in this Specification. Reinstatement designs for such roads shall be agreed between the Undertaker and the Authority, on an individual basis.

S1.3.3 Road categories defined in Table S1.1 are based on the expected traffic to be carried by the road over the next 20 years. Each Authority shall categorise its road network on this basis and the Undertaker shall use the most current information available from the Authority. Where an Authority does not classify its roads as required by this Specification, the Undertaker shall determine the classification of all roads, as necessary, and provide a copy of the classification to all parties concerned.

S1.3.4 Valid traffic rates shall be assessed by accurately monitoring commercial vehicles in excess of 1.5 tonnes unladen weight. Traffic growth rates shall be determined from the average of at least three separate assessments carried out over at least three years. Where traffic growth rates are expected to increase significantly, as a result of changing traffic patterns, only predictions generated from a recognised planning process may be used. A zero growth rate shall be assumed until accurate information is available.

S1.3.5 The reinstatement shall be designed using materials specified in Appendices A1, A2, A9, A10 & A11. The overall layer thicknesses shall be as specified in Appendices A3 to A7 for the various categories of road, footway, footpath, cycletrack, verge or unmade ground, and shall be compacted to the requirements of S10 and Appendix A8.

S1.4 FOOTWAY, FOOTPATH AND CYCLETRACK CATEGORIES

Footways, footpaths and cycletracks are categorised by this Specification as follows:

S1.4.1 High duty - routes where the two way traffic flow of pedestrians and/or cyclists exceeds 22 persons per minute, per linear metre width, for at least half of the working day.

S1.4.2 High amenity - routes surfaced with one of the following materials, and which have been constructed and maintained to a high standard:

- 1) Modular surfaces chosen specifically for decorative purposes, with special colours, textures or surface finishes.

- 2) Flexible surfaces with a particular texture or distinctive coloured finish. Such surfaces will usually be situated in conservation, leisure or ornamental areas, pedestrian precincts or where an Authority has maintained high quality paving.

S1.4.3 Other - those that are neither high duty nor high amenity.

S1.5 EXCAVATION AND TRENCH CATEGORIES

Excavations and trenches are categorised by this Specification as follows:

- S1.5.1 Small Excavations - all openings with a surface area of 2 square metres or less. For the purposes of this Specification, test holes up to 150 mm diameter are not excavations and shall be reinstated in accordance with the requirements of Section S11.
- S1.5.2 Narrow Trenches - all trenches of 300 mm surface width or less, with a surface area greater than 2 square metres.
- S1.5.3 Deep Openings - all excavations and trenches in which the depth of cover over the buried apparatus is greater than 1.5 metres. Trenches with a depth of cover which is intermittently more than 1.5m for lengths of less than 5 metres are deemed not to be deep openings.
- S1.5.4 Other Openings - all excavations and trenches with a surface area greater than 2 square metres.

S1.6 ALTERNATIVE OPTIONS

- S1.6.1 An Undertaker may adopt an alternative Specification for materials, layer thicknesses and compaction methods to take advantage of new or local materials and/or alternative compaction equipment, subject to the prior agreement of the Authority, which shall not be unreasonably withheld. There shall be no departure from the performance requirements during the guarantee period.
- S1.6.2 Recycled, secondary or virgin materials, or any combination thereof, are permitted by this Specification, provided they meet the performance requirements and any compositional requirements detailed in this Specification for the relevant material layer.
- S1.6.3 Stabilised materials shall be permitted for use as surround to apparatus, and at backfill and sub-base layers, provided they meet the relevant performance requirements of this Specification.
- S1.6.4 Alternative Reinstatement Materials are described in Appendix A9.

S1.7 IMMEDIATE WORKS

- S1.7.1 There are circumstances when it is necessary to immediately reinstate an excavation, regardless of material availability etc., purely to enable traffic or pedestrian movement to occur on a traffic sensitive route. In such circumstances, reinstatements may be completed using excavated or other materials, properly compacted in 100 mm layers, with a minimum surfacing thickness of 40 mm of bituminous material.

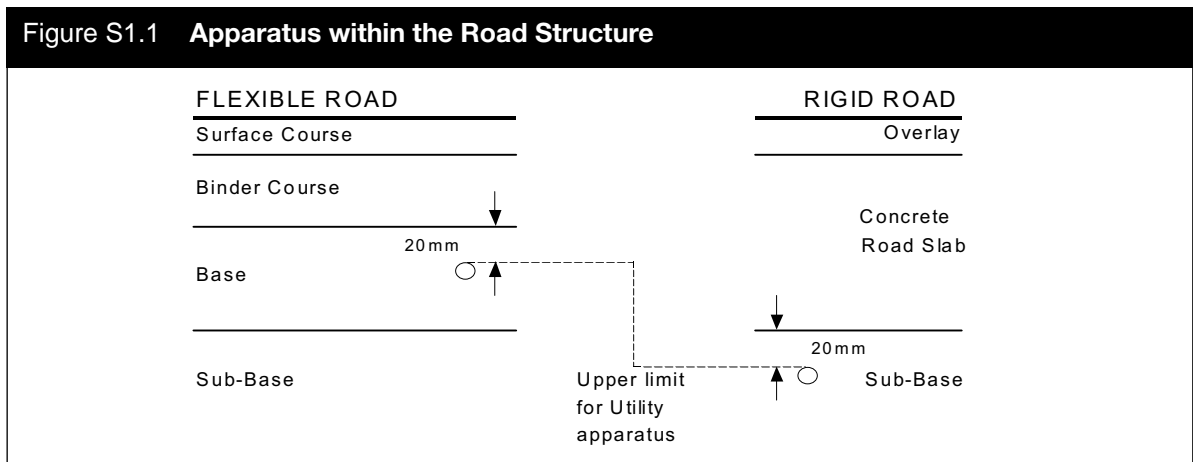
S1.7.2 All materials so placed which do not comply with the requirements of this Specification shall be re-excavated and reinstated, to the appropriate interim or permanent standard as specified, as soon as practicable, but within 10 working days, or as agreed with the Authority following the completion of the immediate works.

S1.8 APPARATUS WITHIN ROAD STRUCTURES

S1.8.1 Undertakers' apparatus greater than 20 mm external diameter will not normally be permitted within road structures.

S1.8.2 Apparatus of 20 mm external diameter or less shall not be permitted above or within 20 mm of the following levels within a road structure, see Figure S1.1:

- 1) The base (roadbase)/binder course interface in a flexible road.
- 2) The underside of the concrete road slab in a rigid road.
- 3) The underside of the modules in a modular road.



S1.8.3 Where other existing apparatus or surrounds occur within the road structure, the method of reinstatement shall be determined by agreement.

S1.9 GEOSYNTHETIC MATERIALS

S1.9.1 Where the Authority knows of the existence of geosynthetic materials it should inform the Undertaker, prior to the commencement of works, so that an appropriate reinstatement method can be agreed.

S1.9.2 If the Undertaker is not informed of the existence of geosynthetic materials prior to the commencement of his works, but notices them during the works, he should inform the Authority immediately so that an appropriate reinstatement method can be mutually agreed. In these circumstances the Undertaker shall not be liable for the repair of any damaged geosynthetic materials caused by him not knowing of their existence.

S1.10 TREES

When working near trees the National Joint Utilities Group publication No 10 "Guidelines for the Planning, Installation and Maintenance of Undertaker Services in

Proximity to Trees” (NJUG 10) should be followed. The publication gives comprehensive advice and should be read in its entirety. However, the following is a brief summary of its recommendations:

S1.10.1 Precautionary Area

The Precautionary Area is determined by measuring the girth of the trunk at chest height, multiplying this by 4 and using the resultant figure as the radius of a circle from the centre of the tree. The area inside the circle is the Precautionary Area in which precautions are essential.

S1.10.2 Precautions during Excavation

- 1) Don't excavate with machinery. Use trenchless techniques where possible, otherwise dig only by hand.
- 2) When hand digging, carefully work around roots, retaining as many as possible.
- 3) Don't cut roots over 25mm in diameter, unless the council's specialist agrees beforehand.
- 4) Prune roots which have to be removed using a sharp tool (e.g.; secateurs or handsaw). Make a clean cut and leave as small a wound as possible.

S1.10.3 Precautions during Reinstatement

- 1) The backfill should, where possible, include the placement of an inert granular material mixed with topsoil or sharp sand (not builders sand) around the retained roots. This should allow the soil to be compacted for resurfacing without damage to the roots and should secure a local aerated zone enabling the root to survive in the longer term.
- 2) Backfilling outside the road limits should be carried out using the excavated soil. This should not be compacted but lightly “tamped” and usually left slightly proud of the surrounding surface to allow natural settlement. Other materials should not be incorporated into the backfill.
- 3) Repeated movement of heavy mechanical plant (excavators etc.) should avoid the Precautionary Area, except on existing hard surfaces, in order to prevent unnecessary compaction of the soil. This is particularly important on soils with a high proportion of clay. Spoil or building material must not be stored in the Precautionary Area.
- 4) Care should be taken to avoid damage to the trunk and branches from machinery. A tree must not be used as an end stop for leaning paving slabs against after lifting, nor for security chaining of machinery.

S1.11 CONCILIATION AND ARBITRATION

- S1.11.1 This Specification is intended to provide sufficiently detailed guidance to enable agreement on its operation and implementation to be reached at local level. Authorities and Undertakers should always use their best endeavours to achieve a solution to disputes without having to refer them to conciliation. This might be achieved by referring the issue to management for settlement.

S1.11.2 If, however, agreement cannot be reached, the provisions set out in the Code of Practice for the Co-ordination of Street Works and Works for Road Purposes and Related Matters should be followed.

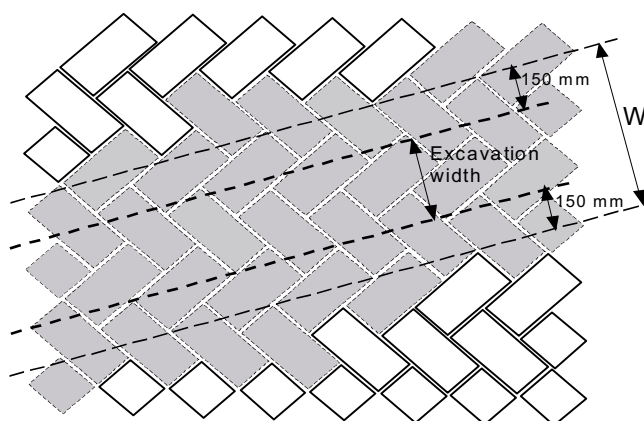
SPECIFICATION

S2 Performance Requirements

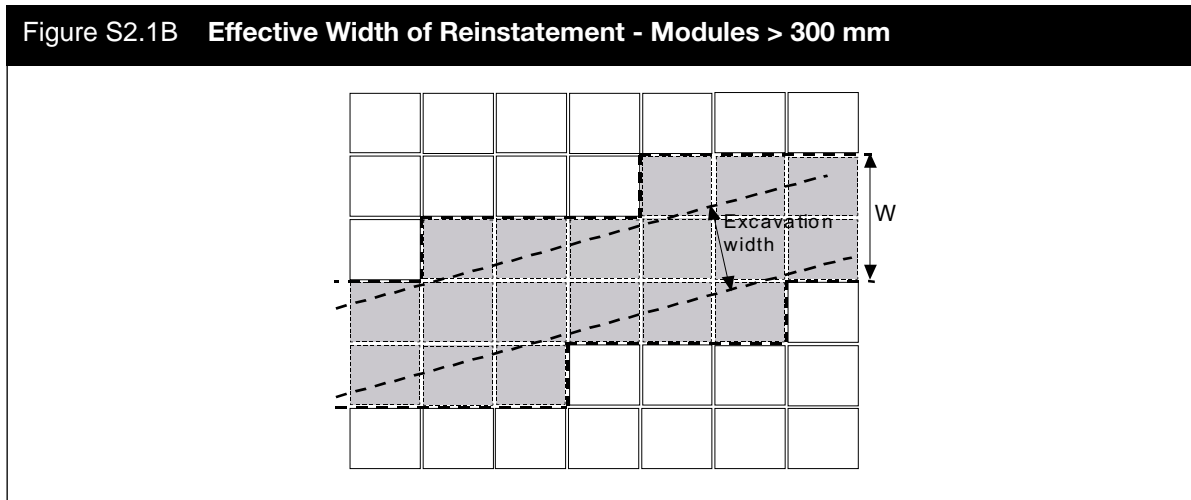
S2.1 GENERAL

- S2.1.1 The performance requirements of this Specification shall apply to roads which are maintainable or prospectively maintainable at public expense. In all other cases, the performance should match that of the existing construction, as far as reasonably practicable.
- S2.1.2 Performance requirements shall apply to the immediate, interim and permanent reinstatements of Undertakers' excavations. If the surface profile of a reinstatement exceeds any intervention limit during any guarantee period, remedial action shall be carried out to return the surface profile of the reinstatement to the as-laid condition defined in Section S2.2.1.
- S2.1.3 No new guarantee period shall be required unless the cumulative settlement intervention limit is exceeded and an engineering investigation has been completed in accordance with Section S2.5. Requirements for the re-excavation and subsequent reinstatement, as determined from the results of the engineering investigation, shall be agreed and completed in accordance with Section S2.5.
- S2.1.4 Reinstatement of Modular Surface Layers is described in Appendix A12. For all modular surfaces the effective width of a reinstatement shall be as follows:
- 1) For modular surfaces consisting of modules up to and including 300mm (or the nearest imperial equivalent), the effective width (W) of a reinstatement shall be the distance between two parallel lines drawn 150mm outside the edges of the excavation (see Fig S2.1A).

Figure S2.1A Effective Width of Reinstatement - Modules \leq 300 mm



- 2) For modular surfaces where one side of the module is greater than 300mm (see Fig S2.1B), the effective width of a reinstatement (W) shall be the distance between the outer extremities of any modules that overlap the edges of the excavation.
- 3) Where there is evidence of further adjoining modules being affected by the excavation, the effective width shall be extended to include such modules.



- S2.1.5 Surface deformation resulting from vehicles over-running reinstatements within paved footways, including footpaths and cycletracks, shall be excluded from all measurements carried out for the purposes of monitoring the reinstatement surface performance, unless such reinstatements have been carried out under the provisions of Section S8.4.

However, properly constructed paved footways and their reinstatements may both be reasonably expected to withstand occasional over-run by non-commercial vehicles (less than 1.5 tonnes unladen). Where it can be shown that occasional over-run by non-commercial vehicles has caused surface deformation to a reinstatement within a paved footway and the adjacent surfaces do not show any associated surface deformation, the Authority may notify the Undertaker accordingly, whereupon the Undertaker shall restore the reinstatement to the as-laid profile.

S2.2 SURFACE PROFILE

S2.2.1 As-laid Profile

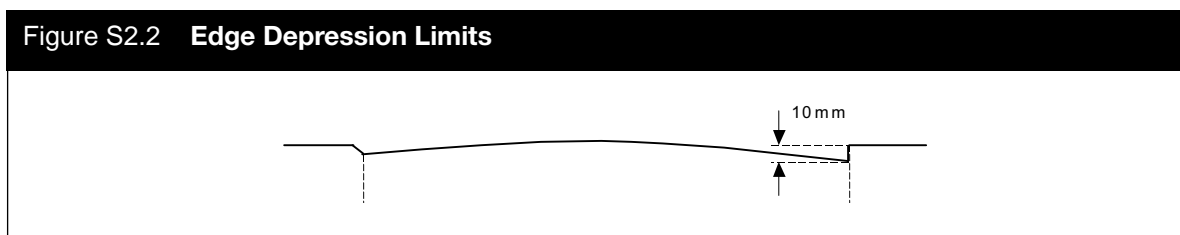
- 1) The reinstatement of any surface shall be completed so that it is as flat and flush as possible with the surrounding adjacent surfaces. There should be no noticeable depression or crowning in the surface. Construction tolerances at the edges shall not exceed ± 6 mm.
- 2) Once the reinstatement is registered as completed and opened to traffic, the Intervention Limits specified in Sections S 2.2.2 to S 2.2.5 shall apply.
- 3) At the end of the guarantee period, where the profile of the existing surfaces adjacent to the reinstatement is uniform and the surface of the reinstatement is outside the intervention limits, the Undertaker shall carry out remedial works to restore the surface profile of the reinstatement to a condition consistent with the adjacent surfaces.

- 4) It should be recognised that the surface profile of reinstatements carried out in restricted areas (for example, around surface boxes and fixed features) using hand tools may be difficult to match with adjacent machine-laid surface profiles. In these cases, localised variations in the hand laid surface profile should be acceptable to the Authority provided that they are within the specified tolerances.

S2.2.2 Edge Depression - Intervention

- 1) An edge depression is a vertical step or trip at the interface of the reinstatement and the existing surface.
- 2) Intervention shall be required where the depth of any edge depression exceeds 10 mm over a continuous length of more than 100 mm in any direction; see Figure S2.2.

Figure S2.2 Edge Depression Limits



S2.2.3 Surface Depression - Intervention

- 1) A surface depression is a depressed area within the reinstatement having generally smooth edges and gently sloping sides, forming a shallow dish; see Figure S2.3.
- 2) Intervention shall be required where the depth of any area of surface depression spanning more than 100 mm in any plan dimension exceeds the intervention limit X shown in Table S2.1

Figure S2.3 Surface Depression Limits

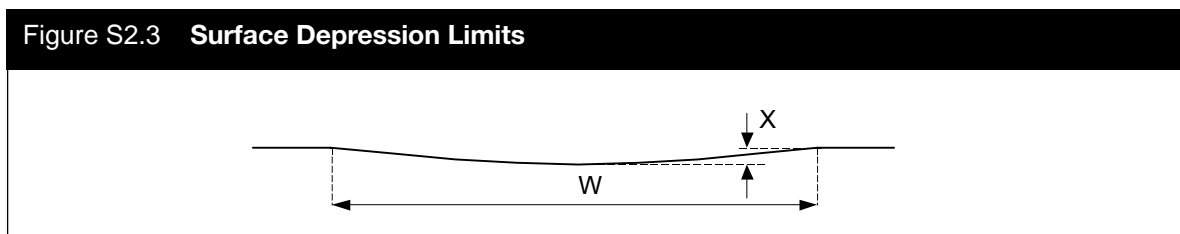


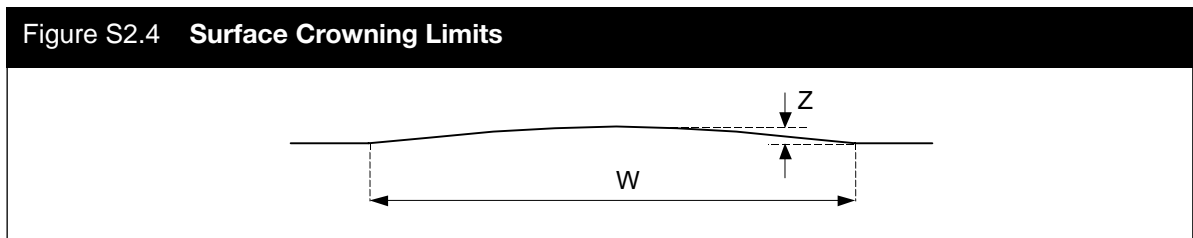
Table S2.1 Intervention Limits – Surface Depression

Reinstatement Width W (mm)	Intervention Limit X (mm)	Combined Defect Intervention Limit (mm)
Up to 400	10	10
Over 400 to 500	12	10
Over 500 to 600	14	12
Over 600 to 700	17	14
Over 700 to 800	19	16
Over 800 to 900	22	18
Over 900	25	20

- 3) Earlier intervention shall be required if the depression alone results in standing water wider than 500 mm or exceeding one square metre in area, at 2 hours after the cessation of rainfall.

S2.2.4 Surface Crowning - Intervention

- 1) Surface crowning is where the reinstatement is above the mean level of the existing adjacent surfaces; see Figure S2.4.
- 2) Intervention shall be required where the height of any area of surface crowning spanning more than 100 mm in any plan dimension exceeds the intervention limit Z shown in Table S2.2.



Reinstatement Width W (mm)	Intervention Limit X (mm)	Combined Defect Intervention Limit (mm)
Up to 400	10	10
Over 400 to 500	12	10
Over 500 to 600	14	12
Over 600 to 700	17	14
Over 700 to 800	19	16
Over 800 to 900	22	18
Over 900	25	20

- 3) Earlier intervention shall be required if crowning alone results in standing water wider than 500 mm or exceeding one square metre in area, at 2 hours after the cessation of rainfall.

S2.2.5 Combined Defect - Intervention

- 1) A combined defect is an area within the reinstatement where any combination of edge depression, surface depression and/or surface crowning, overlap.
- 2) Where combined defects occur, the intervention limits for surface depression and surface crowning, shown in Section S2.2 and Tables S2.1 and Table S2.2 as intervention limits X and Z respectively, shall be reduced by 20% and rounded up to the nearest whole number, subject to a minimum of 10 mm.
- 3) Intervention shall be required where the extent of any individual defect, spanning more than 100 mm in any plan dimension, exceeds the combined defect intervention limit for the relevant defect, as defined in Section S2.2.2 2), Table S2.1 and Table S2.2. The individual defects shall be measured, and the 20% reduction in intervention limits applied, as shown in Section NG2.2.5.

S2.2.6 Condition at End of Guarantee Period

- 1) At the end of the guarantee period the condition of the reinstatement shall not be required to be superior, in any respect, to either the condition existing at the time of excavation or to the condition of the adjacent surfaces.
- 2) Where the profile of the existing surfaces adjacent to the reinstatement is uniform and substantially superior to the surface of the reinstatement, the Undertaker shall carry out remedial work to restore the surface profile of the reinstatement to a condition consistent with the adjacent surfaces.

S2.3 FIXED FEATURES

S2.3.1 As-Laid Profile

All fixed features, such as edgings, channel blocks, drainage fixtures, surface boxes and ironware etc., should be as level and flush as possible with the adjacent surfaces and shall be installed to meet the following level criteria:

- 1) Fixed features shall be laid to coincide with the mean level of immediately adjacent surfaces.
- 2) The construction tolerance between the levels of the fixed feature and immediately adjacent surfaces shall not exceed +/- 6mm.
- 3) Drainage features shall be set flush with the adjacent surface and subject to a construction tolerance of not more than 6mm below the level of the adjacent surface.

S2.3.2 Intervention

- 1) Intervention is required where the mean level of edgings, channel blocks, surface boxes and ironware etc., does not coincide with the mean level of the immediately adjacent surfaces, within a tolerance of ± 10 mm.
- 2) In the case of drainage fixtures, intervention is required where the mean level does not coincide with the mean level of the immediately adjacent surfaces, within a tolerance of +6 mm to -15 mm.

S2.4 SURFACE REGULARITY

S2.4.1 Requirements

At any time during the guarantee period, the longitudinal regularity in the direction of traffic flow at the surface of the permanent reinstatement in the road and the adjacent surfaces shall comply with the following requirements:

- 1) The number of surface irregularities along a permanent reinstatement should not exceed the lower limit shown in Table S2.3.

Table S2.3 Surface Regularity			
Surface Irregularities not less than (mm)	Irregularities per Section		
	Lower Limit	Multiplier	Upper Limit
4	11	1.2	22
7	2	1.2	4
10	1	1.2	2

- 2) Where the number of surface irregularities along a permanent reinstatement exceeds the lower limit shown in Table S2.3, the number of irregularities along the adjacent road shall be recorded, in the direction of traffic flow, for comparison.
- 3) Where, the number of surface irregularities along a permanent reinstatement and the adjacent road both exceed the lower limit shown in Table S2.3, the number of irregularities recorded along the reinstatement should not exceed the product of the number measured along the adjacent road and the multiplier shown in Table S2.3.

S2.4.2 Measurement

- 1) Surface irregularities may be measured using the TRL rolling straightedge. However, the rolling straightedge shall not be used to determine surface regularity where:
 - a) The line of a trench is parallel to the centreline of the road for less than 30 metres length;
 - or b) The line of a trench is parallel to the line of traffic flow for less than 30 metres length;
 - or c) The line of a road and/or the trench follows a bend with a radius of less than 500 metres;
 - or d) The number of surface irregularities recorded along the adjacent road exceeds the upper limit shown in Table S2.3.
- 2) Where the rolling straight edge cannot be used, the surface regularity shall be assessed by an other agreed method.

S2.4.3 Monitoring

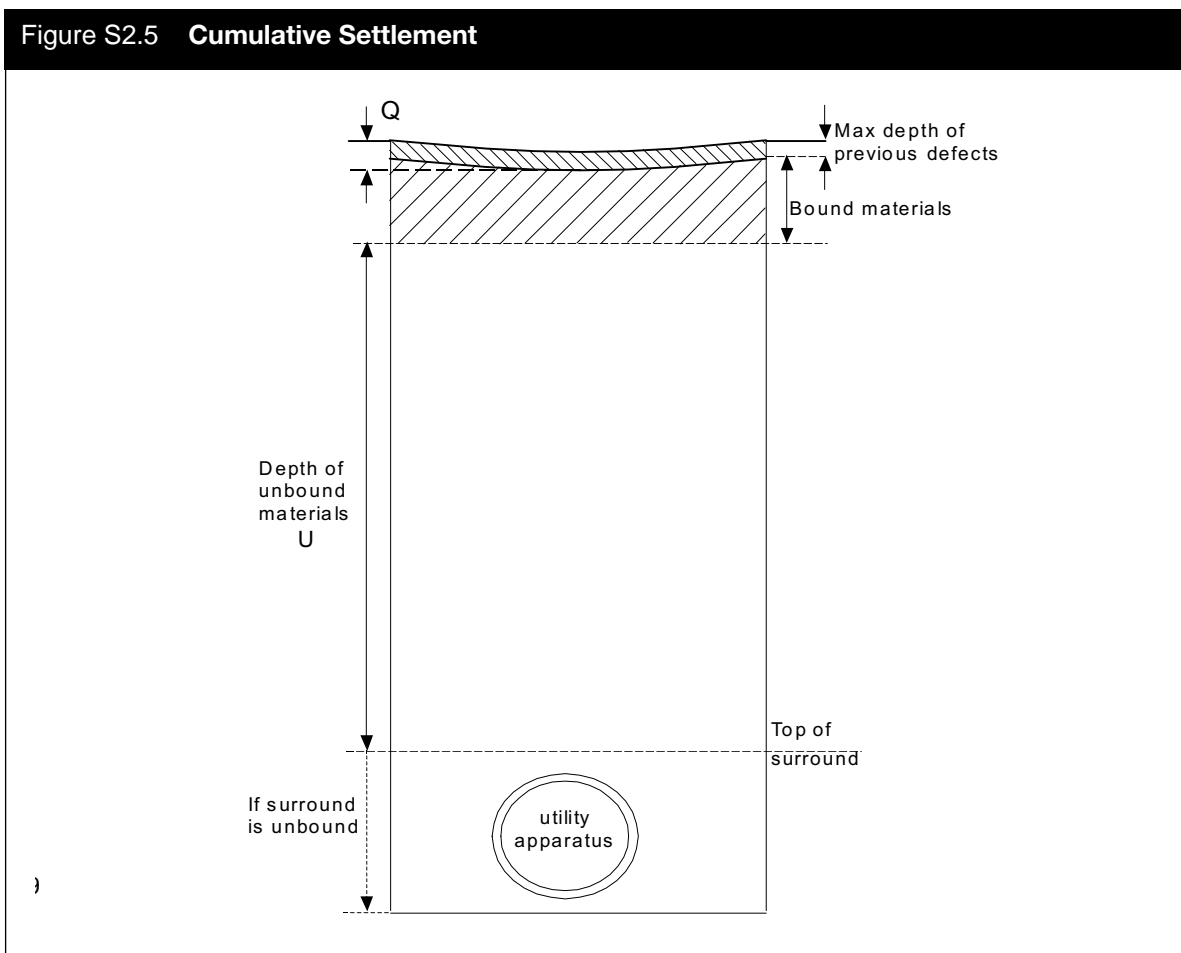
For the purposes of monitoring the surface regularity of road reinstatements, relevant lengths of the trench should be divided into test sections of 30 metres length. The upper and lower limit values for surface irregularities, for each 30 metre section length, are shown in Table S2.3. For the final section length, which may exceed 30 metres but will be less than 60 metres, the limits should be calculated pro rata, and rounded up to the nearest whole number.

S2.5 STRUCTURAL INTEGRITY

The requirements for structural integrity are applicable to both paved and unpaved surfaces.

S2.5.1 Cumulative Settlement

- 1) The cumulative settlement of any reinstatement is the perpendicular distance, from the level of the adjacent surfaces, to the original surface of the reinstatement; see Figure S2.5. This measurement will effectively include the thickness of any additional materials added during any preceding remedial work.



- 2) If the cumulative settlement of a reinstatement exceeds the limits shown in Table S2.4 at any time within the guarantee period, an agreed engineering investigation shall be carried out, jointly with the Authority. The investigation should establish whether settlement is likely to continue and determine the extent of remedial

Table S2.4 Structural Integrity

Reinstatement Width (mm)	Intervention Limit Q			
	Normal Ground Conditions		Bad Ground Conditions	
Up to 1000	1.5% U or 30 mm	whichever is greater	2.5% U or 30 mm	whichever is greater
Over 1000	1.5% U or 35 mm	whichever is greater	2.5% or 35 mm	whichever is greater

- 3) Where it is necessary to re-excavate a reinstatement to carry out an engineering investigation, the subsequent permanent reinstatement shall be deemed to be new and the guarantee period shall begin again.
- 4) Where very deep excavation work is carried out in bad ground, consideration should be given to an agreed extension of the interim reinstatement period. An appropriate extension will allow the reinstatement and surrounding ground to achieve an acceptable degree of stability before permanent reinstatement is required. The performance requirements of Section S2 shall apply throughout the extended interim period.

S2.5.2 Bad Ground

Bad ground is deemed to be natural or made-up ground between the base of the excavation and the binder course level, which contains any of the following:

- a) Class E Unacceptable Materials, as specified in Appendix A1.
- b) Materials that are loose or friable in their natural state and are not self-supporting at an exposed face.
- c) An excessive amount of rocks or boulders, loose random rubble, penning, setts or cobbles etc, at any depth where their removal during excavation could cause loosening of the ground adjacent to the excavation.
- d) Materials that are saturated, regardless of whether free or running water is present.

S2.6 SKID RESISTANCE

S2.6.1 General

The texture depth, Polished Stone Value (PSV) and Aggregate Abrasion Value (AAV) at the running surface of all interim and permanent reinstatements in all roads shall comply with the following requirements:

- 1) There is no requirement to provide a texture depth, PSV or AAV that is superior to that existing at the running surfaces adjacent to the reinstatement.
- 2) For rigid roads, where the surface of the concrete road slab is the running surface of the road and has been randomly grooved, a brushed surface finish to the requirements of Table S2.5 shall be permitted for small excavations, narrow trenches and other openings less than 1 metre wide.

S2.6.2 Texture Depth

- 1) Subject to the requirements of Section S2.6.1, for all bituminous surface course materials permitted in Appendix A2 and for rigid roads where the surface of the concrete road slab is the running surface of the road, the texture depth shall comply with the requirements of Table S2.5.

Table S2.5 Texture Depth (Sand Patch Method)

Reinstatement Location Surface Course Systems	Texture Depth (mm)		
	HRA, SMA, Surface Treatments & Thin Surfaces	All other Bituminous	Concrete Roadslab
Roads where speed limit > 56 mph (90 kph)	1.5 average 1.2 minimum	0.6 minimum	0.6 minimum
All other roads	1.0 minimum	0.6 minimum	0.6 minimum

- 2) Texture depth shall be measured in accordance with BS 598: Part 105: Sand Patch Method. The current BS 598 sand patch test may not be suitable. For narrow reinstatements, a modified version of the BS 598 sand patch test, using 25 ml of sand, may be used.
- 3) Texture depth can be calculated from a sand patch diameter in mm using the following formula:

$$\text{Texture Depth} = \frac{X}{(\text{Patch Diameter})^2} \quad \text{where} \quad \begin{array}{l} \text{for 25ml sand } X=31,830 \\ \text{for 50ml sand } X=63,660 \end{array}$$

The approximate patch diameters for the required texture depths are shown in Table S2.6.

Table S2.6 Sand Patch Method – Equivalent Patch Diameter

Texture Depth (mm)	Equivalent Sand Patch Diameter (mm)	
	25ml Sand	50ml Sand
1.5	145	210
1.2	160	230
1.0	175	250
0.6	225	325

- 4) For the purposes of monitoring texture depth, the entire reinstatement shall be divided into notional units of 18 square metres and a minimum of three texture depth measurements shall be taken on each notional unit. Comparison tests on the existing road should be carried out adjacent to the reinstatement, as close to the reinstatement edge as practicable.
- 5) Where the TRL Mini Texture Meter may be used by agreement, it shall be used in accordance with BS598: Part 105.

S2.6.3 Polished Stone Value (PSV)

- 1) For the purposes of determining PSV requirements, reinstatements in roads are classified into two site categories, according to the apparent degree of risk associated with the site location, as follows:

a) Site A - Potentially High Risk

Traffic signals, pedestrian crossings, railway level crossings - including 50 m approaches

Roundabouts and their exits - including 50 m approaches

Bends < 100 m radius where the speed limit > 40 mph (65 kph) - including 50 m approaches

Downhill gradients > 10% for more than 50 m (single or dual carriageway)

Uphill gradients > 10% for more than 50 m (single carriageway only)

or b) Site B - Average or Low Risk

All other situations on single and dual carriageways, including the following:

Generally straight sections of carriageway

Approaches to and across major/minor road junctions

Bends of 100 m radius or greater, at any speed limit

Downhill/Uphill sections of 10% gradient or less

- 2) Subject to the requirements of S 2.6.1, for all bituminous surface course materials permitted in Appendix A2, the PSV of all precoated chippings and the coarse aggregate in all mixes used without precoated chippings at the running surface shall comply with the requirements of Table S 2.7. The coarse aggregate in all mixes used with precoated chippings at the running surface shall have a minimum PSV of 45.

Table S2.7 Bituminous Roads – Polished Stone Value		
Road Type	Reinstatement Minimum PSV	
	Site A Potentially High Risk	Site B Average or Low Risk
0	68	68
1	68	65
2	65	60
3	65	55
4	65	55

- 3) The PSV shall be tested in accordance with SHW Clause 915.3.
- 4) Where an interim surface course contains an aggregate that may not comply with the requirements of Table S2.7, a surface treatment may become necessary before the reinstatement is made permanent. In this event, the requirements of Table S2.7 are applicable only to the coarse aggregate contained within the surface treatment and not to the underlying aggregate within the interim surface course.
- 5) Where a high friction coating is to be applied to a reinstatement to match an existing coating, an alternative PSV may be specified by agreement, in place of the requirements of Table S2.7, depending upon the nature of the site and the period over which the friction coating will be absent.
- 6) Where the Authority has evidence that a different PSV has proved satisfactory, an alternative PSV may be specified by agreement in place of the requirements of Table S2.7, depending upon the nature of the site.
- 7) Where a permanent surface course contains more than one type of aggregate or aggregates from more than one source, all coarse aggregates within the mixture shall comply with the PSV requirements of Table S2.7.

S2.6.4 Aggregate Abrasion Value (AAV)

- 1) Subject to the requirements of Section S2.6.1, for all bituminous surface course materials permitted in Appendix A2, the AAV of all pre-coated chippings and the coarse aggregate in all mixes used without pre-coated chippings at the running surface shall comply with the requirements of Table S2.7.

Table S2.8 Bituminous Roads – Aggregate Abrasion Value

Road Type	Reinstatement Minimum PSV	
	All Pre-coated Chippings	SMA, un-chipped HRA, Material to BS4987 Surface Courses & Thin Surface Course Systems
0	10	12
1	12	14
2	12	14
3	14	16
4	14	16

- 2) The AAV shall be measured in accordance with BS 812: Part 113.
- 3) Where an interim surface course material contains an aggregate that may not comply with the requirements of Table S2.8, a surface treatment may become necessary before the reinstatement is made permanent. In this event, the requirements of Table S2.8 are applicable only to the coarse aggregate contained within the surface treatment and not to the underlying aggregate within the interim surface course.

S2.7 SAMPLING AND TESTING

- S2.7.1 All sampling and testing shall be carried out by a laboratory holding current UKAS accreditation covering the specified method of testing, unless otherwise agreed.

SPECIFICATION

S3 Excavation

S3.1 BREAKING THE SURFACE

- S3.1.1 Care must be taken when cutting surface layers to avoid undue damage to the running surface or to the bond between the surface course and binder course materials. Cutting by machine, e.g.: road saw or planer, is preferred. All loose materials shall be removed to ensure that the trench edge is in a safe and stable condition.
- S3.1.2 When excavating in modular construction, the existing modules shall be lifted carefully, and stored for re-use.
- S3.1.3 The Authority shall be informed of any material, cobble or setts encountered that may be of historical or archaeological interest and shall be afforded the opportunity to inspect the material prior to it being excavated.

S3.2 EXCAVATION

- S3.2.1 All excavations in the road shall be carried out in a manner that avoids undue damage.
- S3.2.2 The trench width shall be such that adequate access is available for compaction of the surround to apparatus.
- S3.2.3 The trench walls shall be even and vertical with no significant undercutting of the running surface. If undercutting occurs, measures shall be taken to fill any voids as soon as practicable or immediately after trench support has been provided.
- S3.2.4 Excavations shall be protected, as far as is reasonably practical, from the ingress of water, and water running into them shall be drained or pumped to an approved disposal point. Any drainage sumps shall be sited so as to prevent damage to the excavation.

S3.3 EXCAVATED MATERIAL

- S3.3.1 All excavated materials that are to be re-used should be protected from excessive drying or wetting during storage. Additionally, these materials should be excavated, stored, handled and laid so as to avoid contamination and loss of fines.
- S3.3.2 Excavated material which is unsuitable for reuse should be removed from site as soon as practicable. Excavated material which is retained on site shall be stockpiled within the confines of site barriers, at a safe distance from the trench edge and prevented, so far as is practicable, from entering any drainage system or water course.

S3.4 SIDE SUPPORT

- S3.4.1 The sides of all excavations in soft or loose ground shall, ordinarily, be provided with a side support system. The support system shall be properly designed and installed to restrain lateral movement of the sidewalls, and should be installed without delay.

- S3.4.2 Supports shall be progressively withdrawn as backfilling and compaction progresses, and all voids carefully filled.

S3.5 DRAINAGE

- S3.5.1 Any drainage disturbed during excavation shall be immediately notified to the owners, and restored to the requirements of the owner; see Section S11.4.

S3.6 SHALLOW OR ABORTED EXCAVATIONS

- S3.6.1 No shallow or aborted excavation shall be permitted to undermine the integrity of the remaining road structure. Any excavation terminated at an incomplete stage or depth for whatever reason shall, depending on the layer at which the excavation was terminated, be reinstated in accordance with the following requirements:

- 1) Where reinstatement can be achieved by laying a thicker surface course in accordance with the thickness requirements of Appendix A2 and, in the case of small excavations and narrow trenches, in accordance with Section S6.4.10, no further excavation is required.
- 2) In all other cases, the binder course shall be excavated to allow a binder course layer to be reinstated in accordance with Appendix A2. Where the existing depth of excavation is greater than 100 mm and the additional depth is less than the minimum layer thickness of base (roadbase) material a thicker binder course may be laid.
- 3) In deeper excavations, no further excavation shall be required. Reinstatement shall be carried out in accordance with the relevant requirements of Sections S5 to S9 inclusive, as appropriate.

S3.7 TRENCHLESS PIPELAYING

- 3.7.1 Moleploughing uses a ploughing machine to pull a flexible pipe or cable below ground. It is employed in unmade ground and may be used in the verges of roads. The mole plough creates a slit in the surface of the ground, which should not require reinstating provided that the surface profile is restored in accordance with S9.1.7. However, where connections are made to apparatus installed by moleploughing techniques, excavations shall be carried out and reinstated in accordance with this Specification.
- 3.7.2 Soil Displacement Moling and other trenchless methods, as their collective name implies, do not create an excavation and, when carried out in a proper manner, do not require reinstatement. However, reinstatement shall be carried out in accordance with this Specification at the launch and receive pits and at any intermediate excavations where connections are made to apparatus installed by soil displacement moling and other trenchless techniques.
- 3.7.3 Where, as a result of the use of trenchless methods for the installation of apparatus under a road, the Authority has reasonable cause to believe that damage may have been caused to the structure of the road, the Investigatory Works Procedure described in the RAUC Scotland Code of Practice for Inspections should be commenced as if the defect was associated with a reinstatement defect for the purposes of that Code. Any remedial work agreed between the Authority and the Undertaker to be necessary, if carried out by the Undertaker, shall be in accordance with this Specification at the Undertaker's expense.

- 3.7.4 If the agreed remedial work is carried out by the Authority at the Undertaker's expense the provisions of this Specification shall not apply.
- 3.7.5 In the absence of agreement between the Authority and the Undertaker, liability for any damage shall be determined in accordance with Section 141 of the Act.

SPECIFICATION

S4 Surround to Apparatus

S4.1 GENERAL

- S4.1.1 Surround to the apparatus may be laid to a maximum thickness of 250 mm above the crown of the Undertakers' apparatus.
- S4.1.2 Laying and compaction procedures used for all materials laid as surround to the apparatus shall be the responsibility of the Undertakers.
- S4.1.3 The selection of materials for the surround to apparatus shall be the responsibility of the relevant Undertaker. However, all materials used for the surround to apparatus shall comply with the following requirements:
- 1) Class E Unacceptable Materials, as defined in Appendix A1, and materials that contain particles greater than 37.5 mm nominal size shall not be used as surround to the apparatus.
 - 2) An Alternative Reinstatement Material (ARM) may be used for the entire surround to apparatus, or any part thereof, in accordance with Appendix A9.
 - 3) Prefomed modules or other protective measures may be placed within the surround to apparatus, according to the Undertakers' requirements.

SPECIFICATION

S5 Backfill

S5.1 BACKFILL MATERIAL CLASSIFICATION

S5.1.1 General

Backfill materials, whether imported to site or derived on-site from excavated materials, shall be classified as follows:

S5.1.2 Class A - Graded Granular Materials

- 1) Materials with a maximum of 10% by weight passing a 63 micron (μm) BS sieve, and with all material passing a 425 micron (μm) BS sieve showing a plasticity index of 6 or less, determined in accordance with BS1377: Part 2: Method 5.4, are classified as Class A Graded Granular Materials.
- 2) Class A graded granular materials shall include Granular Sub-base Material Type 2 (excluding natural sands and gravels) and Granular Sub-base Material Type 1.

S5.1.3 Class B - Granular Materials

Materials with a maximum of 10% by weight passing a 63 micron (μm) BS sieve are classified as Class B Granular Materials.

S5.1.4 Class C - Cohesive/Granular Materials

Mixtures of granular, silt and clay materials with between 10% and 80% by weight passing a 63 micron (μm) BS sieve are classified as Class C Cohesive/Granular Materials.

S5.1.5 Class D - Cohesive Materials

Clay, silt or mixtures of clay and silt with at least 80% by weight passing a 63 micron (μm) BS sieve are classified as Class D Cohesive Materials.

S5.1.6 Class E - Unacceptable Materials

Materials listed as unacceptable in paragraphs 2 ii) and 3 of SHW Clause 601 shall not be used, at any level, within the permanent structure of any reinstatement. Materials classified as unacceptable are listed in Appendix A1.

S5.1.7 All backfill materials shall be used in accordance with Appendix A1.

S5.1.8 All backfill materials shall be compacted in accordance with Appendix A8.

S5.2 ALTERNATIVE REINSTATEMENT MATERIALS

S5.2.1 Alternative Reinstatement Materials (ARMs) may be used for the entire backfill layer, or any part thereof, in accordance with Appendix A9.

S5.3 ADDITIONAL REQUIREMENTS

S5.3.1 Frost Heave Susceptibility

- 1) Frost susceptible material is deemed to be material with a mean heave greater than 15 mm when tested in accordance with BS 812: Part 124: (as amended by SHW Clause 705).
- 2) Where frost susceptible materials already exist within 450 mm of the surface, such materials may be reinstated to the same levels but, generally, frost susceptible material shall not be used within 450 mm of a road surface. However, 300 mm of wholly bituminous material is considered to provide adequate insulation and may be used as an alternative.
- 3) In the event of prior notification by the Authority, where the existing depth of non-frost susceptible materials is greater than 450 mm below the road surface and the Authority requires such a thickness of non-frost susceptible material to be maintained, then only non-frost susceptible materials shall be used for the relevant depth.
- 4) All frost heave susceptibility testing shall be carried out by a laboratory holding current UKAS accreditation for specified method of testing, unless otherwise agreed.

S5.3.2 Maximum Particle Size

The maximum particle size for all granular backfill materials used as backfill shall comply with the following requirements:

- 1) All granular backfill materials shall pass through a 75 mm BS sieve.
- 2) All granular backfill materials used in the reinstatement of trenches less than 150 mm wide shall pass through a 37.5 mm BS sieve.

S5.3.3 Surround to Apparatus as Backfill

Where the excavation depth does not allow the use of a separate backfill layer, the sub-base layer shall be laid directly onto the surround to apparatus. In such cases, the surround material shall represent backfill material and shall be classified in accordance with Section S5.1, for the purposes of determining the requirements for sub-base reinstatement in accordance with Section S6.2.

S5.3.4 Protective Measures

Preformed modules or other protective measures may be placed within the backfill, according to the Undertaker's requirements.

S5.3.5 Chalk

- 1) Imported chalk materials used as backfill shall comply with the following requirements:
 - a) The saturation moisture content of the chalk shall be determined prior to its use.

- b) The chalk shall be laid and compacted to an approved compaction procedure developed in accordance with Section NG1.6 3). The compaction procedure shall be proven with chalk materials of similar saturation moisture content.
- 2) Excavated chalk to be re-used as backfill shall comply with the following requirements:
- a) Excavated chalk shall be stockpiled for re-use and shall not be subjected to multiple handling.
- b) During wet weather, excavated chalk shall be protected against water ingress at all times.
- 3) Chalk materials shall be assessed by breaking up excavated fragments by hand, or by driving a steel pin into unexcavated deposits, and classified in accordance with Table S5.1. If the classification falls between two densities, then the chalk shall be assumed to be at the lower of the two densities.

Table S5.1 Suitability of Chalk Materials for Use as Backfill

Chalk Density	Physical Assessment	Backfill Suitability
High	Very difficult/impossible to break up by hand Difficult to manner steel pin	Carrigeways, footways and verges
Medium	Some difficulty in breaking up by hand Some effort needed to hammer in steel pin	Footways and verges only
Low	Easy to break up or crush by hand Steel pin can be pushed in by hand	Unsuitable for those in any reinstatement

Notes to Table S5.1:

1 Chalk often contains flint inclusions and care should be taken to ensure that:

a) the steel pin does not strike a flint

b) the hand crushing sample does not contain any flints.

- 4) Chalk materials shall be compacted in accordance with Appendix A8.2.

SPECIFICATION

S6 Flexible and Composite Roads

S6.1 REINSTATEMENT METHODS

S6.1.1 General

- 1) The Undertaker shall carry out the reinstatement in accordance with one of the following methods and should endeavour to achieve the greatest degree of immediate permanent reinstatement.
- 2) Permitted materials and layer thicknesses are specified in Appendices A1 to A4, A9, A10 and A11.
- 3) Where the Authority knows of any site with high sulphate levels it should advise Undertakers in advance of the works so that appropriate measures may be taken.

S6.1.2 Method A- All Permanent Reinstatement

The excavation shall be reinstated to a permanent standard at the first visit.

S6.1.3 Method B - Permanent Binder Course Reinstatement

- 1) The backfill, sub-base, base (roadbase) and binder course shall be reinstated to a permanent standard at the first visit.
- 2) The permanent binder course material, or an alternative interim material, shall be extended to the surface as the interim surface course, with or without a thin separating material layer of sand at the position of the binder course/surface course interface. An alternative interim material may be deferred set material.
- 3) On the second visit, all interim surfacing materials shall be removed, to the top of the binder course, typically by cold planing, and a permanent surface course shall be laid.
- 4) Where a sand separation layer is present, prior to the reinstatement of the permanent surface course the sand shall be removed, the surface brushed clean and a tack coat applied.

S6.1.4 Method C - Permanent Base (Roadbase) Reinstatement

- 1) The backfill, sub-base and base (roadbase) shall be reinstated to a permanent standard at the first visit.
- 2) The interim surface course and part, or all, of the interim binder course, may be deferred set material. Part or all of the interim binder course may be an unbound granular material.

- 3) On the second visit, all interim surfacing materials shall be removed, to the top of the base (roadbase), and a permanent binder course and surface course shall be laid.

S6.1.5 Method D - Permanent Sub-base Reinstatement

- 1) The backfill and sub-base shall be reinstated to a permanent standard at the first visit
- 2) The interim base (roadbase) shall be granular and the interim surfacing shall be in accordance with the relevant requirements of Section S6.1.4.
- 3) On the second visit, all interim materials shall be removed, to the top of the sub-base, and a permanent base (roadbase), binder course and surface course laid.

S6.2 SUB-BASE REINSTATEMENT

S6.2.1 General

Where the Authority knows of areas with drainage problems it should advise Undertakers in advance. Care must be taken to ensure that natural drainage is not adversely affected. If site conditions indicate to the Undertaker that the use of some sub-base materials may be detrimental to drainage, advice on the selection of suitable materials should be sought from the Authority.

Permitted options are shown in Appendix A1, subject to the following exceptions:

- a) **Sub-base Equivalence:** The thickness of granular sub-bases may be reduced, provided that the thickness of the bituminous binder course is increased proportionately, in accordance with S6.3 4.
- b) **Small Reinstatements:** A CBM3 sub-base of 150 mm thickness may be used in small excavations and narrow trenches regardless of whether the existing sub-base is cement bound. Where this option is utilised, the base (roadbase) material shall also be a bound material.
- c) **Alternative Reinstatement Materials:** Alternative Reinstatement Materials (ARMs) may be laid at sub-base level, in accordance with Appendix A9, regardless of whether the existing sub-base is a bound material.

S6.3 BASE (ROADBASE) REINSTATEMENT

S6.3.1 General

Permitted options are shown in Appendix A4, subject to the following exceptions:

S6.3.2 CBM3 in Flexible and Composite Roads

- 1) In Types 0 & 1 roads, where a CBM3 base (roadbase) is used, the reinstatement may either be surfaced on the same day or the CBM3 shall be allowed 7 days to cure before surfacing is undertaken. In either case, the CBM3 shall be allowed 7 days to cure before the road is opened to traffic.

- 2) In Types 2, 3 & 4 roads, where the reinstatement is surfaced on the same day that the CBM3 base (roadbase) is placed, the road may be opened to traffic on the following day. Where the CBM3 base (roadbase) is not surfaced on the same day, the reinstatement shall be allowed 3 days to cure before surfacing is undertaken.
- 3) All composite roads constructed with a base (roadbase) of CBM3 lean-mix concrete or equivalent shall be reinstated with a CBM3 base (roadbase).
- 4) In composite roads, the reinstated CBM3 base (roadbase) shall be laid flush with the existing cement-bound base (roadbase).
- 5) Continuously reinforced concrete bases (roadbases) are not covered by this clause. Special conditions will apply to such reinstatement work and must be agreed with the Authority.

S6.3.3 Base (Roadbase) Equivalence

In Type 3 and 4 flexible roads, the thickness of granular bases (roadbases) may be reduced provided that the thickness of the bituminous binder course is increased proportionately, in accordance with the following requirements:

- 1) Each 10 mm increase in bituminous binder course thickness is equivalent to a 35 mm decrease in thickness of Type 1 Granular Sub-Base at base (roadbase) and/or sub-base levels.
- 2) This equivalence rule may be applied to include the total replacement of all granular materials at both sub-base and base (roadbase) levels, subject to the following restrictions:
 - a) Binder course and surface course thicknesses in Type 3 and 4 roads are minimum values and shall not be reduced by application of the 10:35 equivalence of bituminous/granular materials;
 - and b) Where part of a granular base (roadbase) and/or sub-base is to be replaced by additional binder course material, the remaining total thickness of granular material at base (roadbase) and/or sub-base level shall not be less than 150 mm.

S6.3.4 Modular Materials Within The Excavation

- 1) Where cobbles or setts are encountered during excavation, they may be recovered and reused for reinstatement of the relevant layer. Alternatively, at the discretion of the Undertaker, the layer may be reinstated using CBM3 laid to a thickness of 100 mm, or to match the original thickness, whichever is greater.
- 2) Layers of modules, cobbles/setts, stones, rocks, or other large aggregate particles laid upright, in an interlocking fashion, often termed 'penning', will exhibit a greater stiffness than an equivalent layer of cobbles/setts laid horizontally. Where such upright interlocking modules are encountered, the layer shall be reinstated using CBM3 laid to a thickness of 100 mm, or to match the original thickness, whichever is greater.
- 3) Where surplus modules, cobbles or setts are removed from site, they shall remain the property of the Authority. The Undertaker shall notify the Authority and

retain them for 10 days following such notification. Thereafter, the Undertaker shall be free to dispose of all remaining modules, cobbles and setts.

- 4) The Authority shall be informed of any material, cobbles or setts encountered which may be of historical or archaeological interest and shall be afforded the opportunity to inspect the material prior to it being covered.
- 5) Where CBM3 is used at base (roadbase) level, it shall be used in accordance with S6.3.2.

S6.3.5 Alternative Reinstatement Materials

Alternative Reinstatement Materials (ARMs) may be laid at base (roadbase) level, in accordance with Appendix A9, regardless of whether the existing base (roadbase) is a bound material.

S6.4 SURFACE REINSTATEMENT

Permitted options are shown in Appendices A2 to A4 inclusive, subject to the following exceptions:

S6.4.1 Hot Rolled Asphalt (HRA) Surface

- 1) Type 0, 1 & 2 roads, where the existing surface course is HRA, shall be reinstated with HRA surface course, regardless of whether the running surface has a surface dressing or other surface treatment.
- 2) Type 3 & 4 roads, where the existing surface course is HRA which does not have a surface dressing or other surface treatment, shall be reinstated with HRA surface course.

S6.4.2 Stone Mastic Asphalt (SMA) and Thin Surface Course Systems

- 1) Where the existing surface course material is SMA or a thin surface course system the road shall be reinstated with SMA surface course, subject to the following requirements:
 - a) Existing SMA surface courses of nominal aggregate size greater than 10 mm shall be reinstated using 14 mm SMA, laid to a standard thickness of 40 mm.
 - b) Existing SMA surface courses of 10 mm nominal aggregate size or less shall be reinstated using 10 mm SMA, laid to a standard thickness of 30 mm.
 - c) The standard combined thickness of binder course and SMA surface course shall be 100 mm.
- 2) Edge and base preparation for permanent SMA reinstatements shall be as follows:
 - a) All edges shall be saw cut or trimmed by saw, to a depth of 40 mm or the thickness of the surface course, prior to permanent reinstatement.
 - b) A K1-40 tack coat shall be applied in accordance with S6.5.1.

- c) An edge sealant shall be applied in accordance with S6.5.2.2.
- 3) Where the existing surface is a thin surface course material and the Authority does not want the reinstatement to be completed using SMA, the Authority shall contact the Undertaker in accordance with Section S6.4.5.5.

S6.4.3 Surface Course Material to BS 4987

Surface course material to BS 4987 shall be 10 mm CGSC, laid 40 mm thick subject to the following exceptions:

- a) Types 0, 1 & 2 HRA surfaces (Section S6.4.1 1))
- b) Non-overlaid Types 3 & 4 roads (Section S6.4.1 2))
- c) SMA and thin surface courses surfaces (Section S6.4.2)
- d) Other bituminous materials (Section S6.4.5)

S6.4.4 Binder Course Material to BS 4987

Where a dense binder course material to BS 4987 is to be used as the running surface for a period in excess of 6 months, the target binder content shall be increased by 0.5% above the BS 4987 target value.

S6.4.5 Other Bituminous Materials

Where it is necessary to use bituminous materials not included in Appendix A2, they shall be used in accordance with the following:

S6.4.5.1 General Requirements

- 1) Where existing road surfaces have been treated or constructed with high friction surfacings, porous asphalt or coloured surfacings and local custom and practice has been to complete all previous resurfacing with like materials, their permanent reinstatement shall be carried out in accordance with the following requirements:
 - a) High friction surfacings shall be permanently reinstated with like materials, or an agreed alternative material, in accordance with Section S6.4.5.2.
 - b) Porous asphalt surface courses shall be permanently reinstated with porous asphalt, or an agreed alternative material, in accordance with Section S6.4.5.3.
 - c) Coloured surfacings shall be permanently reinstated with like materials, or an agreed alternative material, in accordance with Section S6.4.5.4.
- 2) When requested by the Undertaker, the Authority shall identify an appropriate source of suitable like or alternative materials, wherever possible. Where the Authority is unable to identify an appropriate source of suitable material, the Undertaker shall provide a suitable material on the basis of best reasonable endeavours.

- 3) Where existing road surfaces have been treated or constructed with high friction surfacings, porous asphalt or coloured surfacings and local custom and practice has not been to complete all previous resurfacing with like materials, the Undertaker shall consult with the Authority to determine appropriate reinstatement requirements.
- 4) Where other specialist surfacing materials not included in Appendix A2 or Section S6.4.5.1 1) above have been used, they may generally be permanently reinstated in accordance with Section S6.4.5.5.

S6.4.5.2 High Friction Surfacings

- 1) High friction surfacings shall be permanently reinstated with a like material, applied at the earliest opportunity. The surface shall be permanently reinstated within 15 working days following the date of completion of the reinstatement, unless the prevailing weather conditions or other site circumstances mitigate against the successful application of the high friction surfacing. Where this occurs, the permanent reinstatement shall be deferred, until such time as the unfavourable weather conditions or other site circumstances abate.
- 2) Prior to the application of the permanent, or any interim, friction surfacing, warning signs shall be displayed indicating a potential slippery road surface.

S6.4.5.3 Porous Asphalt

- 1) Existing porous asphalt surface courses shall be permanently reinstated with a like material, with no permitted alternative materials, subject to the following exceptions:
 - a) Small reinstatements of less than 2.5 m overall length, which do not adversely affect the overall drainage characteristics of the site, may be reinstated using SMA.
 - b) Multiple small reinstatements using SMA shall not be closer than 3 m of each other in the principal direction of fall or surface drainage flow.
- 2) Porous asphalt surface courses shall be reinstated to nominally match the thickness of the existing layer.
- 3) The binder course of porous asphalt reinstatements shall be an asphalt material
- 4) Edge and base preparation for all permanent reinstatements in porous asphalt surfaces shall be as follows:
 - a) All edges shall be saw cut, or trimmed by saw, to a minimum depth of 50 mm (or the thickness of the surface course, if greater), prior to permanent reinstatement.
 - b) For permanent reinstatements using porous asphalt, all edges shall be cleared of all contamination and treated with a light application of tack coat, not edge sealant. A K1-40 tack coat shall be applied at a minimum rate of 0.5 to 0.7 l/m, in accordance with S6.5.1.

- c) For permanent reinstatements using SMA, all edges shall be treated with edge sealant, preferably a non-rubberised sealant applied by spray. A K1-40 tack coat shall be applied to the base of the reinstatement in accordance with S6.5.1.

S6.4.5.4 Coloured Surfacing

Coloured surfacings used to highlight road features such as speed warnings, bus or cycle lanes, 'gateways' etc. shall be permanently reinstated using like materials of equivalent type and similar colour, subject to the following requirements:

- a) Where the coloured surfacing is overlaid onto a road surface, a coloured overlay shall be applied to the same thickness.
- b) Where the coloured surfacing is laid full depth, a coloured material shall be laid to the same thickness, wherever possible and practical. Where it is not possible or practical, the coloured surfacing material shall be reinstated by agreement.

S6.4.5.5 Other Specialist Surfacing Materials

- 1) Specialist surfacings not included in Appendix A2 or Section S6.4.5.1 1) shall generally be reinstated with SMA.
- 2) Where the overall area is sufficiently large to facilitate machine laying and the local custom and practice has been to complete all previous resurfacing with like materials and the Authority wishes to request the use of like materials, the Authority shall:
 - a) Notify the Undertaker accordingly at the planning or notice stage, or in the case of immediate works, before the permanent reinstatement.
 - b) Identify an appropriate source of suitable like or equivalent materials.
- 3) All other surfacing materials not covered above, including grouted bituminous materials, traffic calming materials, surface treatments etc., shall be permanently reinstated by agreement.

S6.4.6 Surface Treatments

- 1) In Types 0, 1 & 2 roads, where an existing surface dressing or other surface treatment is readily apparent, the Undertaker shall apply an equivalent surface treatment.
- 2) In Types 3 & 4 roads either:
 - a) Surface dressing or other surface treatment is not required when any binder course and surface course option permitted by section S6.4 is laid.
 - or b) The surfacing layers and equivalent surface dressing or other surface treatment shall be reinstated by agreement.

S6.4.7 Coated Chippings

- 1) All chippings shall be 14 mm or 20 mm nominal size, pre-coated in accordance with BS594: 1992
- 2) Where pre-coated chippings are to be embedded into a road surface, they shall be spread to give a chipping density reasonably matching that of the existing surface.

S6.4.8 Composite Roads

The total combined thickness of the reinstated binder course and surface course shall match the existing. Wherever practicable, the required surface course thickness should be maintained by adjustment of the binder course thickness.

S6.4.9 Single Course Construction

Where the existing road is of single course construction, permanent binder course material may be laid in place of a separate surface course, provided that the target binder content is increased by 0.5% above the BS4987 target value.

S6.4.10 Small Excavations and Narrow Trenches

- 1) A permanent surface course material in accordance with Appendix 2 may be laid in place of a permanent binder course material at base (roadbase) and/or binder course level.
- 2) Where this option is used there shall be no substitution of bitumen binder equivalence, as permitted under Appendix A11.

S6.5 BASE AND EDGE PREPARATION**S6.5.1 Base Preparation**

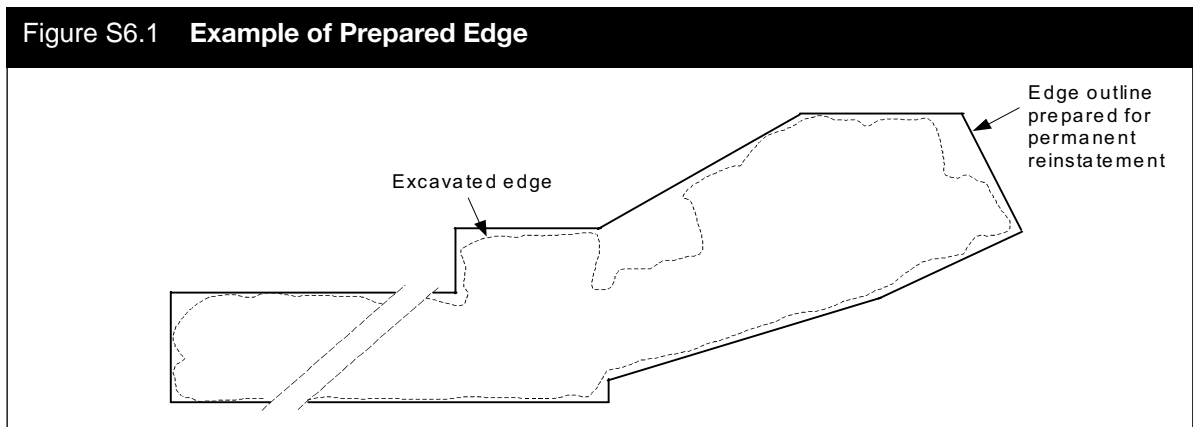
- 1) A tack coat shall be applied to the surface in the following circumstances:
 - a) Where bituminous material is to be laid onto an existing bituminous surface that has been trafficked or otherwise disturbed.
 - b) Where bituminous material is to be laid onto an existing bituminous surface laid more than 72 hours earlier.
- 2) The tack coat shall be applied at a rate of 0.3 to 0.5 litres per m², unless otherwise recommended by the manufacturer. The tack coat shall be applied evenly, with no pooling or dry areas.
- 3) A bitumen emulsion edge sealant may be used as a tack coat in small excavations and narrow trenches.

S6.5.2 Edge Preparation**S6.5.2.1 Edge Regularity**

The edges of excavations may need to be trimmed, at binder course and/or surface course level, to meet the following requirements:

- 1) All bound edges shall be essentially straight, smooth and vertical.

- 2) All openings shall be "squared off", as necessary, to give a reasonably regular, plain shape when viewed from above, as shown in Figure S6.1



S6.5.2.2 Edge Sealing

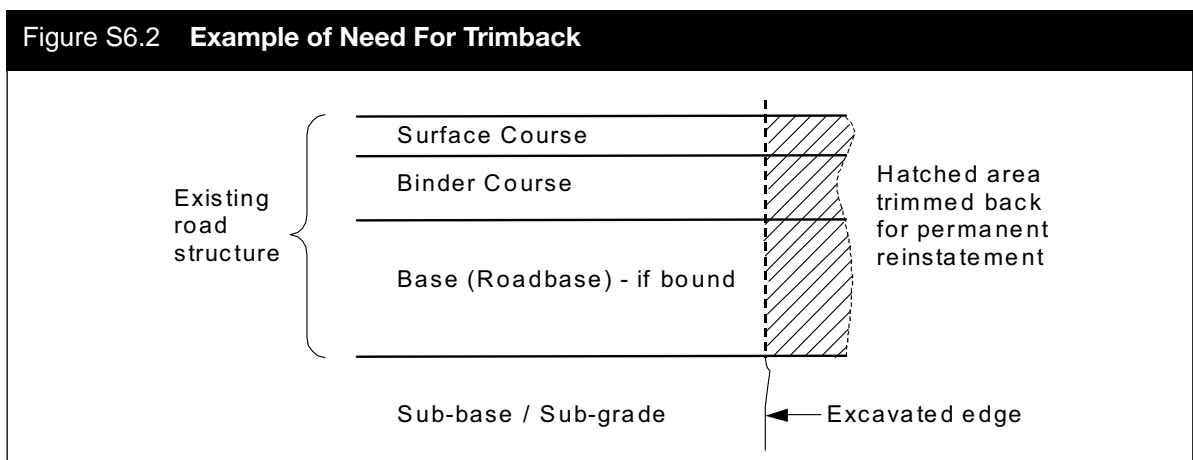
- 1) At any interim stage and at the time of permanent reinstatement, the top 100 mm, at least, of all bound vertical edges at surface course and binder course levels, and the equivalent area on kerbs and exposed fixed features, shall be painted with a bitumen based edge sealant or otherwise prepared with an edge sealing system or equivalent material.
- 2) There shall be no significant splashing, spillage or any deliberate overpainting of the adjacent road surface, subject to the requirements of Section S6.5.2.5.
- 3) Tack coat material shall not be used as an edge sealant unless otherwise specified in S6.4.5.3.

S6.5.2.3 Proximity to Road Edges, Ironwork, etc.

- 1) Where the "trimmed" edge of any excavation is within 250 mm of the road edge, kerbing, other fixed features or another reinstatement, the trim-line shall be extended to the interface with the road edge, kerbing etc.
- 2) The additional reinstatement area required by extending the trim-line may be confined to the surface course, provided the lower layers have not been damaged.

S6.5.2.4 Undercutting

All bound edges shall be essentially smooth and vertical with no significant undercutting, as shown in Figure S6.2.



S6.5.2.5 Overbanding

Overbanding or coating of the road surface at the interface between the existing road and the reinstatement edge is not mandatory, but may be beneficial when carried out in accordance with the following requirements:

- 1) The minimum skid resistance value (SRV) for all overbanding materials shall be 55 SRV.
- 2) Overbanding shall not exceed 3 mm thickness nor 40 mm width. Properly applied overbanding may be subject to spreading and may eventually wear away when subjected to trafficking. Overbanding which displays these characteristics shall not require intervention.
- 3) Overbanding shall not be used as a substitute for any edge sealing required in accordance with Section S6.5.2.2.
- 4) The SRV shall be measured in accordance with TRL Road Note 27, second edition 1969.
- 5) All materials used for overbanding shall have a current HAPAS Approval Certificate.

S6.6 TOLERANCES

- 1) All tolerances for all bituminous materials permitted in Appendix A2 in the reinstatement of flexible and composite roads, shall be in accordance with the requirements of Appendix A2.
- 2) Tolerances permitted for all other bituminous materials shall be by agreement.

SPECIFICATION

S7 Rigid and Modular Roads

S7.1 REINSTATEMENT METHODS

S7.1.1 General

- 1) Rigid roads shall be considered to be composite when the total thickness of any existing bituminous overlay exceeds 100 mm, and shall be reinstated in accordance with Section S6. Where steel reinforcement has been used, it should be replaced in accordance with Section S7.5, unless otherwise agreed with the Authority.
- 2) Some modern road constructions incorporating special design philosophies are outside the scope of this Specification and reference should be made to Section NG 7.1.
- 3) The Undertaker shall carry out the reinstatement in accordance with one of the following methods and should endeavour to achieve the greatest degree of immediate permanent reinstatement.
- 4) Permitted materials and layer thicknesses are specified in Appendices A1, A2, A5, A9, A10 and A11.
- 5) Where the Authority knows of any site with high sulphate levels, it should advise Undertakers in advance of the works so that appropriate measures may be taken.

S7.1.2 Method A - All Permanent Reinstatement

- 1) The excavation and concrete road slab shall be reinstated to a permanent standard at the first visit.

S7.1.3 Method B - Permanent Reinstatement incorporating Interim Surface Overlay

- 1) Any bituminous surface overlay may be reinstated, to an interim standard, in accordance with the relevant requirements of Section S6.1.4.
- 2) Any interim overlay shall be removed at a later date, to the top of the concrete road slab, and a permanent overlay reinstated.

S7.1.4 Method C - Permanent Sub-base Reinstatement

- 1) The backfill and sub-base shall be reinstated to a permanent standard at the first visit.
- 2) The concrete road slab and overlay (if existing) shall be reinstated, for the interim period only, with an unbound granular material. The interim surfacing may be a deferred set material as shown in Appendix A5.

- 3) On the second visit, all interim materials shall be removed, to the top of the sub-base and a permanent concrete road slab reinstated. The road slab shall be in accordance with S7.3.2 & S7.3.5. Any overlay may be reinstated, to an interim standard, in accordance with the relevant requirements of Section S6.1.4.
- 4) Any interim overlay shall be removed at a later date, to the top of the concrete road slab, and a permanent overlay reinstated.

S7.2 SUB-BASE REINSTATEMENT

S7.2.1 General

- 1) In a rigid road, the sub-base is deemed to be any layer of imported granular or cement bound material existing immediately below the base of the concrete road slab. Where such a sub-base layer exists, a similar or equivalent material shall be laid to match the existing thickness subject to a minimum thickness of 150mm.
- 2) Permitted options are shown in Appendix A5, subject to the following exceptions:

S7.2.2 Small Reinstatements

A CBM3 sub-base of 150 mm thickness may be used in small excavations and narrow trenches regardless of whether the existing sub-base is cement bound.

S7.2.3 Alternative Reinstatement Materials

Alternative Reinstatement Materials may be laid at sub-base level, in accordance with Appendix A9.

S7.3 CONCRETE ROAD SLAB REINSTATEMENT

S7.3.1 General

Permitted options are shown in Appendix A5, subject to the following exceptions:

S7.3.2 Concrete Specification

- 1) The concrete road slab shall be reinstated using C40 concrete mixed in accordance with SHW Clause 1001, with an air entrainment admixture used in at least the top 50 mm of the road slab.

Exceptionally, where agreed, the concrete road slab may be reinstated using an alternative material, to suit site conditions, e.g. a high early strength mix may be agreed to allow an earlier re-opening of a heavily trafficked road.

- 2) Where concrete is mixed off site, Quality Assurance Certificates detailing the Specifications against which the concrete has been ordered and supplied should be obtained by the Undertaker for confirmation of material quality. Where possible, the concrete should be obtained from a plant which holds a valid Quality Assurance Certificate.

- 3) In the case of small excavations, a site-batched equivalent to C40 concrete may be used.

S7.3.3 Joints

All expansion, contraction and warping joints removed or otherwise damaged during the excavation must be replaced or reconstructed to a similar design, using equivalent materials, at the time of permanent reinstatement.

S7.3.4 Membranes

- 1) A slip membrane shall be used beneath the road slab and a curing membrane shall be used above the road slab.
- 2) Impermeable polythene or similar sheeting may be used for both the slip and curing membranes.
- 3) Sprayed plastic film may be used as a curing membrane by agreement.

S7.3.5 Opening to Traffic

The cured road slab may be opened to traffic as soon as a crushing strength of 25 N/mm² has been achieved.

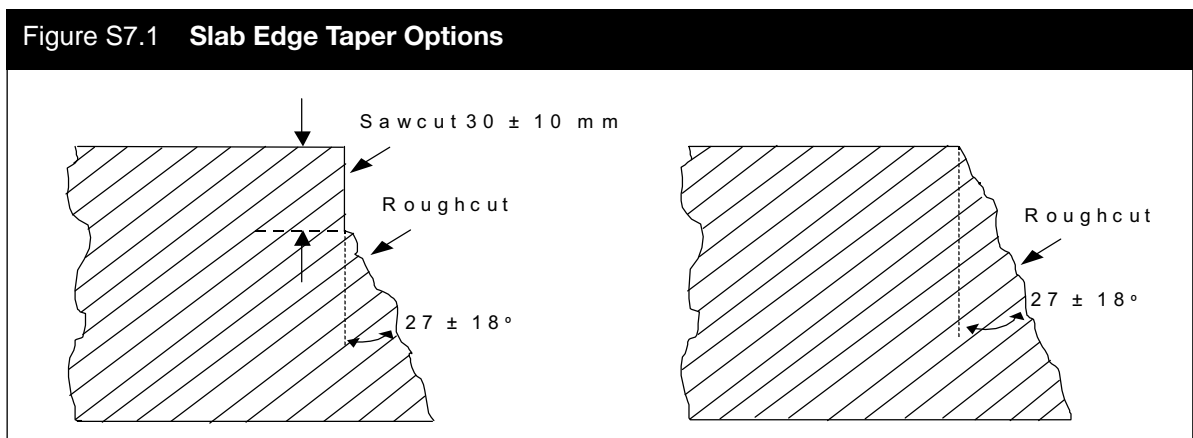
S7.4 EDGE SUPPORT AND PREPARATION

The edges of all excavations in rigid roads shall comply with the following requirements:

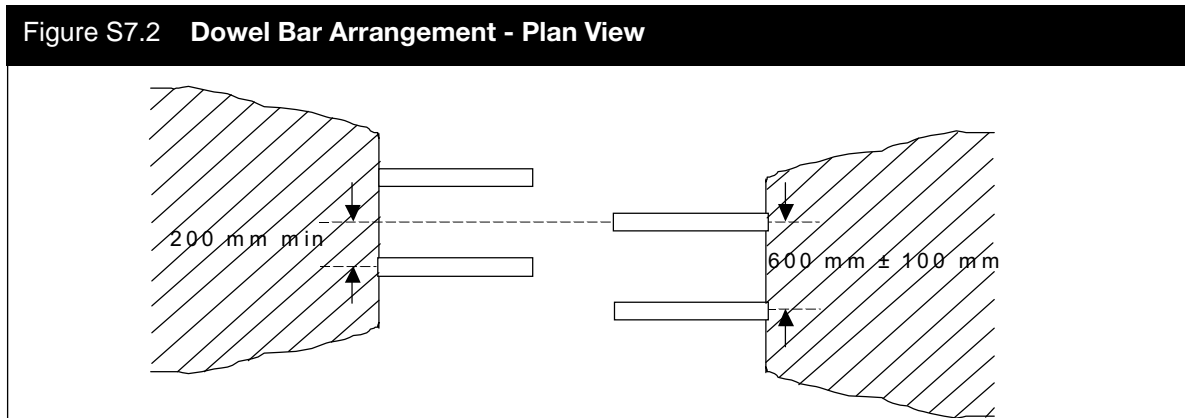
S7.4.1 Edge Support

Support for the edges of the reinstatement shall comply with one of the following options:

- 1) Edge Taper Support
 - a) Where the surface of the road slab is the running surface of the road, the excavation shall be delineated by pavement saw, to a depth of 30 mm ± 10 mm. The remainder of the exposed faces should be roughcut, at an angle of 27° ± 18° to the vertical; see Figure S7.1.
 - b) In all other cases, the exposed faces should be roughcut, at an angle of 27° ± 18° to the vertical. Delineation by pavement saw, to a depth of 30 mm ± 10 mm, may also be applied.



- 2) Dowel Bar Support
 - a) Where the surface of the road slab is the running surface of the road, the excavation shall be delineated by pavement saw, to a minimum depth of 20 mm. Any unsawn section of the slab shall be left roughcut to give an essentially vertical surface; see Figure S7.2.
 - b) In all other cases, the exposed faces should be roughcut to give an essentially vertical surface. Delineation by pavement saw, to a minimum depth of 20 mm, may also be applied.
 - c) In all excavations, a row of horizontal holes shall be drilled along the centreline of the exposed faces, to provide a sliding fit for 20 mm or 25 mm nominal diameter steel dowel bars.
 - d) All holes shall be drilled at $600 \text{ mm} \pm 100 \text{ mm}$ centres, with the holes along one face offset or staggered, relative to the opposite face, by at least 200 mm when viewed from above; see Figure S7.2. The nominal hole depth shall be equal to 50% of the dowel bar length $\pm 50 \text{ mm}$.
 - e) The maximum dowel bar length shall be 400 mm; minimum dowel bar length shall be equal to the width of the reinstatement less 50 mm.



S7.4.2 Edge Preparation

The edges of the reinstatement shall be trimmed, where necessary over part or all of the thickness of the concrete road slab, to comply with the following requirements:

- 1) The edge regularity shall comply with the requirements of Section S6.5.2.
- 2) Any undercutting shall comply with the requirements of Section S6.5.2.4.
- 3) Cracking within the adjacent road slab, resulting from the excavation operation, shall require the relevant area of the slab to be removed and included within the area to be reinstated.
- 4) Where, following trimming, the excavation extends to within 300 mm of the road slab edge, joint, other reinstatement or ironwork, the relevant area of the slab shall be removed and included within the area to be reinstated.

- 5) All edges shall be cleaned and wetted prior to the placement of the concrete.

S7.5 REINFORCEMENT

Where steel reinforcement within the concrete road slab has been cut out, new steel reinforcing mesh of equivalent weight shall be provided, in accordance with the following requirements:

- 1) The new reinforcement mesh shall be welded or lapped and wired to the existing reinforcement.
- 2) A minimum of 150 mm of the existing reinforcement shall be exposed to allow adequate attachment of the new reinforcement.
- 3) Where 150 mm of the exposed reinforcement cannot be preserved during the excavation, the concrete road slab shall be trimmed, as necessary, to expose additional reinforcement. This additional trimming shall not supersede the requirement to provide a slab edge taper or dowel bars.

S7.6 OVERLAYS

S7.6.1 General

- 1) Where the surface of the concrete road slab or the modular surface layer is overlaid with a bituminous material, a matching thickness of a similar or equivalent material shall be laid.
- 2) Wherever practicable, the required surface course thickness should be maintained, by adjustment of the binder course thickness. The surface course and binder course materials shall not be laid to a thickness less than that required by Appendix A2 and A3 for the nominal size of each material laid.

S7.6.2 Surface Reinstatement

Permitted options are shown in Appendices A4 and A5, subject to the following exceptions:

- 1) Edge preparation shall be carried out in accordance with Section S6.5, except that the existing edge of the overlay shall be trimmed by a distance equal to the nominal thickness of the surface course, or 40 mm, whichever is the greater.
- 2) Surface reinstatement shall be carried out in accordance with the requirements of Section S6.4.

S7.7 MODULAR ROADS

S7.7.1 General

- 1) Types 0, 1 and 2 modular roads are not included in this Specification and reinstatement designs shall be in accordance with BS 7533 part 3, BS 6717 part 1 & BS 6667 part 1.

- 2) The Undertaker shall carry out the reinstatement of Types 3 and 4 modular roads in accordance with one of the following methods and should endeavour to achieve greatest degree of immediate permanent reinstatement.
- 3) Permitted materials and layer thicknesses are specified in Appendices A1, A2, A6 and A9 to A12, subject to the following requirements.

S7.7.2 Method A - All Permanent Reinstatement

The backfill, sub-base (if existing), bedding and modular surface layer shall all be reinstated to a permanent standard at the first visit.

S7.7.3 Method B - Permanent Sub-base Reinstatement

- 1) The backfill and sub-base shall all be reinstated to a permanent standard at the first visit, together with an interim granular base (roadbase) and interim bituminous surface course, as per Section S6.1.5.
- 2) On the second visit, the interim reinstatement shall be removed to the top of the sub-base and a permanent base (roadbase) and modular surface layer reinstated.

S7.7.4 Sub-base Reinstatement

- 1) Permitted options are shown in Appendix A6, subject to the requirements of section S6.2.
- 2) The sub-base shall be reinstated to match the existing, or its structural equivalent.

S7.7.5 Base (Roadbase) Reinstatement

- 1) Permitted options are shown in Appendix A6, subject to the requirements of section S6.3.
- 2) The base (roadbase) shall be reinstated to match the existing, or its structural equivalent.

S7.7.6 Surface Reinstatement

The modular surface layer shall be reinstated in accordance with Appendices A6 and A12. The requirements and recommendations for the provision of replacement modules are shown in Appendix A12.

S7.8 TOLERANCES

- S7.8.1** All performance requirements and tolerances permitted in the reinstatement of rigid and modular roads shall be in accordance with the requirements of Section S2 and Appendix A2.

SPECIFICATION

S8 Footways, Footpaths and Cycle Tracks

S8.1 REINSTATEMENT METHODS

S8.1.1 General

- 1) Cycletracks that are part of the carriageway shall be reinstated to carriageway standards. The Undertaker shall carry out the reinstatement in accordance with one of the following methods and should endeavour to achieve the greatest degree of immediate permanent reinstatement.
- 2) In the event of prior notification by the Authority, where local custom and practice has been to surface footways, footpaths and cycletracks with aggregates of a certain minimum PSV, then the Undertaker shall provide a similar PSV, at the time of permanent reinstatement, subject to the requirements of Section S2.6.1.
- 3) Permitted materials and layer thicknesses are specified in Appendices A1, A2, A7 and A9 to A12.

S8.1.2 Method A - All Permanent Reinstatement

The excavation shall be reinstated to a permanent standard at the first visit.

S8.1.3 Method B - Permanent Binder Course Reinstatement

- 1) In flexible structures, the backfill, sub-base and binder course shall be reinstated to a permanent standard at the first visit.
- 2) The permanent binder course material, or an alternative interim material, shall be extended to the running surface, with or without a thin separating medium at the binder course/surface course interface. The alternative interim material may be deferred set material.
- 3) On the second visit, all interim surfacing materials shall be removed, to the top of the binder course, and an appropriate permanent surface course laid.
- 4) Where a sand separation layer is present, prior to the reinstatement of the permanent surface course, the sand shall be removed, to the top of the binder course, the surface brushed clean and a tack coat applied.

S8.1.4 Method C - Permanent Sub-Base Reinstatement

- 1) The backfill and sub-base shall be reinstated to a permanent standard at the first visit, with an interim surfacing.

- 2) For flexible or rigid structures, the interim surface course and some or all of the interim binder course may be deferred set material. The lower portion of the interim binder course may be an unbound granular material.
- 3) For modular structures, the interim surfacing may be deferred set material, paving modules or any combination thereof.
- 4) On the second visit, all interim surfacing materials shall be removed, to the top of the sub-base, and an appropriate permanent surfacing shall be laid.

S8.2 SUB-BASE AND BINDER COURSE REINSTATEMENT

S8.2.1 General

- 1) In a footway, footpath or cycletrack, the sub-base is any layer of imported granular or cement bound material existing immediately below the surfacing materials. Where such a sub-base layer exists, a similar or equivalent material shall be laid to a thickness of 150 mm, or to match the existing, whichever is less, subject to a minimum of 100 mm of Class A Graded Granular Material.
- 2) Permitted options are shown in Appendix A7, subject to the following exceptions:

S8.2.2 Small Reinstatements

- 1) In small excavations and narrow trenches, the following options shall be permitted, regardless of whether the existing sub-base is a bound material:
 - a) A CBM3 sub-base of 100 mm thickness.
 - b) A 50/20 HRABC or 20 mm DBC sub-base of 40 mm thickness.
 - c) Three equal layers of 15/10 HRAWC or 6 mm DBWC material may be laid to a total thickness of 100 mm, as a combined sub-base, binder course and surface course.

S8.2.3 Alternative Reinstatement Materials

Alternative Reinstatement Materials may be laid at sub-base level, in accordance with Appendix A9.

S8.2.4 Reinstatements Adjacent to Roads

Where road construction layers, foundation platforms, structural courses, kerb beams and/or backing providing the edge support to the road structure are found to extend below an adjacent footway, footpath, cycletrack or verge, any reinstatement therein shall take account of such provisions.

In such cases, the sub-structure of the footway, footpath, cycletrack or verge shall be reinstated to match the existing layer thicknesses with similar or equivalent materials.

S8.3 SURFACE REINSTATEMENT

S8.3.1 General

Surface reinstatement options are shown in Appendix A7, subject to the following exceptions:

S8.3.2 High Duty and High Amenity

- 1) The Authority shall register all high duty and/or high amenity footways, footpaths or cycletracks and shall identify a suitable source or supplier of reinstatement materials.
- 2) The Undertaker shall reinstate all registered High Duty/High Amenity footways, footpaths or cycletracks with matching materials from the identified source or supplier.
- 3) Where aggregates of an especially distinctive colour are encountered and the local custom and practice has been to complete all previous surfacing in a similarly matching material, the reinstatement shall be in accordance with S6.4.5.4.

S8.3.3 Other Material to BS 4987

Other coated material to BS 4987 footways, footpaths or cycletracks shall be reinstated with a 6mm dense surface course material to BS 4987, unless the existing surface is a material to BS 4987 of aggregate size significantly finer than 6mm, in which case it may be regarded by the Undertaker as either coated material to BS 4987 or asphalt and reinstated accordingly.

S8.3.4 Other Asphalt

Other asphalt footways, footpaths or cycletracks shall be reinstated with a 15/10 hot rolled asphalt, chipped as necessary to match the existing. A 15/10 hot rolled asphalt may also be used where the existing material is mastic asphalt, asphalt sand carpet or other derivatives, unless otherwise designated.

S8.3.5 Concrete Materials

- 1) Concrete footways, footpaths or cycletracks shall be reinstated with C30 minimum strength concrete, to match the existing thickness. For small excavations, a site-batched concrete of equivalent strength may be used.
- 2) Where the existing concrete has been air entrained, then air-entrained concrete, to SHW Clause 1001, shall be used. Air entrained concrete may be used elsewhere, at the discretion of the Undertaker.

S8.3.6 Modular Footways, Footpaths and Cycletracks

- 1) Modular footways, footpaths and cycletracks shall be reinstated in accordance with the permitted materials and layer thicknesses specified in Appendix A7.3.
- 2) The modular surface layer shall be reinstated in accordance with Appendix A12. The requirements and recommendations for the provision of replacement modules are shown in Appendix A12.

S8.3.7 Edge Requirements

- 1) For all footways, footpaths and cycletracks, the edge regularity and any undercutting shall comply with the requirements specified in Sections S6.5.2.1 and S6.5.2.4, respectively.
- 2) For all flexible footways, footpaths and cycletracks, the edge sealing and any overbanding shall comply with the requirements specified in Sections S6.5.2.2 and S6.5.2.5, respectively.
- 3) For all concrete footways, footpaths and cycletracks, the treatment of any cracking shall comply with the requirements specified in Section S7.4.2 3).
- 4) For all footways, footpaths and cycletracks, where trim-lines for the reinstatement edges are within 150 mm of an edge, kerb, ironwork or other reinstatements, the trim-lines shall be extended to the interface of the edge, kerb etc. This additional reinstatement may be confined to the surface course provided lower courses have not been damaged.

S8.3.8 Special Materials

- 1) Other specialist surfacing materials shall be reinstated in accordance with Section S6.4.5.5.
- 2) In high duty footways, footpaths and cycletracks where local custom and practice has been to complete previous surface restoration of excavations with overbanding or other coating of a certain minimum skid resistance value, the Undertaker shall provide a similar minimum skid resistance value for the material used to overband reinstatement edges.

S8.4 VEHICULAR TRAFFICKING**S8.4.1 Commercial Access**

- 1) Where a recognised route for commercial vehicles crosses a footway, footpath or cycletrack, including specified pedestrian areas and precincts, it shall be assumed that provisions for commercial vehicle loading were incorporated in the original design. The relevant area of footway, footpath or cycletrack shall be deemed to be a Type 4 road, of flexible, composite, rigid or modular construction, depending on the existing structure.
- 2) The reinstatement of such areas shall comply with the relevant requirements of Sections S6 or S7, as appropriate.
- 3) Where a special construction has been incorporated within the original design to cater for expected traffic greater than the Type 4 limiting capacity, the Undertaker should consult the Authority.

S8.4.2 Domestic Access

- 1) Where a recognised domestic vehicle crossing or occasional emergency service vehicle access route crosses a footway, footpath or cycletrack, including specified pedestrian areas or precincts, the existing structure may include thicker layers, higher quality materials or other strengthening measures.

- 2) The reinstatement of such areas shall match the existing layer thicknesses, with similar or equivalent materials.

S8.4.3 Other Trafficking

- 1) Where a footway, footpath or cycletrack, including specified pedestrian areas or precincts, is subjected to regular vehicle overrunning or parking, the existing structure may include thicker layers, higher quality materials or other strengthening measures.
- 2) The reinstatement of such areas shall match the existing layer thicknesses, with similar or equivalent materials.

S8.5 TOLERANCES

- S8.5.1** Performance requirements and tolerances permitted in the reinstatement of footways, footpaths and cycletracks shall be in accordance with the requirements of Section S2 and Appendix A.2.

SPECIFICATION

S9 Verges and Unmade Ground

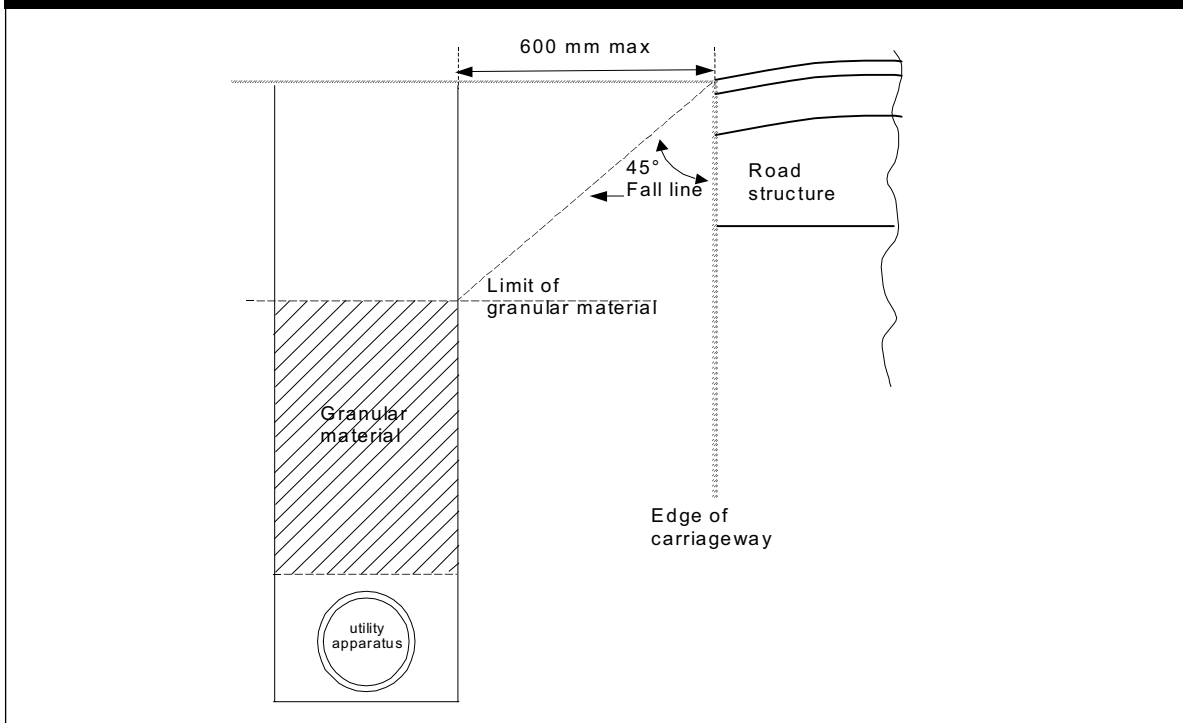
S9.1 GENERAL

- 1) All backfill materials shall comply with the requirements of Section S5.
- 2) Existing top soil within 200mm of the surface shall be kept separate for subsequent re-use. Alternatively, an imported top soil may be used to a depth of 100mm or to match the existing depth of top soil, whichever is less.
- 3) The re-use of excavated materials as backfill material in verges and unmade ground is to be encouraged as part of a policy of environmentally sustainable construction.

S9.2 ADJACENT ROAD STRUCTURES

- 1) Where road construction layers, structural courses, foundations, kerbs and/or backing providing edge support to road structures extend below adjacent verges or unmade ground, any reinstatement therein shall take account of such provisions. The reinstatement of such areas shall match the existing layer thicknesses, with similar or equivalent materials.
- 2) Where there is no such edge support within adjacent verges or unmade ground, any reinstatement within 600 mm of the edge of a road shall include sub-base materials at backfill level up to a 45° fall line extending downwards from the road surface at the nearest point to the reinstatement, as shown in Figure S9.1.

Figure S9.1 Verge Reinstatement Adjacent to Edge of Road



S9.3 CULTIVATED AREAS

Unless otherwise agreed, cultivated areas containing shrubs, plants or bulbs shall be reinstated using the same or similar species. Thereafter, a reasonable growth shall be established within the following 12 months. Where the Authority knows of special features in verges (e.g.: orchid sites etc.) it should inform the Undertaker in order to agree the best means of conserving the special features.

S9.4 GRASSED AREAS

- 1) Grassed areas shall be reinstated using the original turf, replacement turf or an equivalent seed, depending on weather and growing season. In all cases, a reasonable growth shall be established within the following 12 months.
- 2) Where grassed areas have previously been mown, the reinstated surface shall be demonstrably free from stones greater than 20mm nominal size. All other debris arising from the works shall be removed from the site. It should be recognised that stones in grassed areas tend to migrate over a period of time and this should not lead to repeated intervention.

S9.5 VERGES, DITCHES AND DRAINAGE COURSES

Verges, ditches and drainage courses shall be restored to their original profile, unless otherwise agreed.

SPECIFICATION

S10 Compaction Requirements

S10.1 GENERAL

- 1) All compaction equipment covered by this Specification shall be checked, adjusted, maintained and operated in accordance with working practices, maintenance schedules, operating procedures and vibrating frequencies recommended by the equipment manufacturer.
- 2) All equipment and operating procedures used for the compaction of all reinstatement materials laid above the surround to apparatus shall comply with the following relevant requirements:

S10.2 REINSTATEMENT MATERIALS

For all materials, compaction shall be carried out in accordance with the requirements of Appendix A2 and or A8, immediately after the material has been placed and spread.

S10.2.1 Unbound Granular and Cohesive Materials

- 1) All Class A Graded Granular Materials, Class B Granular Materials and Class C Cohesive/Granular Materials shall be compacted in accordance with the relevant requirements of Appendix A8, Table A8.1.
- 2) All Class D Cohesive Materials shall be compacted in accordance with the relevant requirements and restrictions of Appendix A8, Table A8.1.
- 3) Where access is restricted, including small excavations and trenches less than 200 mm wide, compaction shall be in accordance with the restricted access provisions of Appendix A8, Table A8.1.

S10.2.2 Alternative Reinstatement Materials

- 1) Certain Structural Materials for Reinstatements (SMRs) and Stabilised Materials for Fill (SMFs) may not require the full compaction specified in Appendix A8, Table A8.1 and may be damaged if compaction is continued. Appendix A9 deals with these materials. Such materials should be placed and compacted in accordance with the manufacturer's recommendations and with due regard to the requirements of Appendix A9.
- 2) Foamed concretes (FCRs) shall not be compacted or tamped unless specifically required by the manufacturer. Thereafter, such FCR materials shall be placed and compacted in accordance with the manufacturer's recommendations and with due regard to the requirements of Appendix A9.

S10.2.3 Bituminous Materials

- 1) All bituminous materials permitted by Appendix A2 shall be laid and compacted in accordance with the relevant requirements of Appendix A2, Tables A2.1 to A2.3 inclusive, and Appendix A8, section A8.3. Where access is restricted, including small excavations and trenches less than 200 mm wide, compaction shall be in accordance with the restricted access provisions of Appendix A8, Table A8.3.
- 2) The in-situ air void content for all bituminous materials as permitted in Appendix A2 shall comply with the requirements shown in Table S10.1. The in-situ air void content shall be calculated as the average from all results obtained and shall be determined in accordance with SHW Clause 937: sub-clauses 32 & 33. The overall accuracy of this test measurement is deemed to be $\pm 0.5\%$.

Table S10.1 In-Situ Air Void Content Requirements				
Bituminous Materials	Permitted Air Voids			
	Carriageways		Footways	
	Max %	Min %	Max %	Min %
6 mm Dense Bitumen Surface Course	NP	NP	13	2
10 mm Close Graded Surface Course	10	2	NP	NP
HRA Surface Course	8	2	10	2
SMA Surface Course	8	2	10	2
HRA / Material to BS 4987 Base (Roadbase)	10	2	12	2
HRA / Material to BS 4987 Binder Course	10	2	12	2
PCSM Materials	10	2	13	2
Note to Table S10.1 - NP = not permitted				

- 3) All surface course materials used at binder course level shall comply with the in-situ air void content requirement for the relevant surface course material.
- 4) To determine the in-situ air void content, the entire reinstatement shall be divided into notional units of 18 m² area and a minimum of three core samples shall be extracted from each notional unit. For reinstatements up to 2 m² area, a single core sample shall be extracted. All core samples shall be 100 mm minimum diameter, with no part of any core being within 75 mm of either the edge of the reinstatement or of any fixed feature within the reinstatement. The average void content shall be calculated for each notional unit, from all results obtained.
- 5) Unless agreed otherwise, all air void testing shall be carried out by a laboratory holding current UKAS accreditation for the specified test methods.
- 6) Where the prevailing weather conditions or other site circumstances are considered likely to mitigate against the successful laying and compaction of any surfacing materials and the achievement of the required in-situ air void content, consideration should be given to deferring the permanent surface reinstatement and, if necessary, to an agreed extension of the interim reinstatement period.

S10.2.4 Cementitious Materials

- 1) Pavement quality concrete, laid as the surface slab of road, footway, footpath or cycletrack reinstatements, shall be compacted using a proprietary vibrator, selected and operated in accordance with the manufacturer's recommendations. However, proprietary vibrators may be unsuitable for concrete sections less than 100 mm wide or less than 0.5 square metres in area. In such cases, as a minimum requirement, all concrete shall be thoroughly tamped, by hand.
- 2) Cement-bound granular materials, including CBM3 shall be compacted in accordance with the relevant requirements of Appendix A8, Table A8.1.

S10.2.5 Modular Surfacing Materials

Compaction equipment shall be operated in accordance with the manufacturer's instructions.

S10.3 EQUIPMENT OPERATION AND RESTRICTIONS

- 1) All compaction equipment shall be used in accordance with the requirements of Appendix A8.
- 2) Additional guidance on compaction procedures and the maintenance of compaction equipment is included in Section NG10.6.

S10.3.1 Hand Rammers

Except as permitted in Sections S2.2.6, S10.2.2 and S10.2.4 (1), hand rammers shall be permitted to assist the initial placement of material only. For all materials, full compaction shall be applied, in accordance with the relevant requirements of Appendix A8.

S10.3.2 Percussive Rammers

Percussive rammers shall be permitted for the compaction of reinstatement materials, in accordance with the following requirements:

- a) The nominal mass shall not be less than 10 kg.
- b) The width of the foot shall not exceed 200 mm.
- c) The contact length of the foot shall not exceed 200 mm.

S10.3.3 Vibrotampers

Vibrotampers shall be permitted for the compaction of reinstatement materials, in accordance with the following requirements:

- 1) 50 kg Minimum Nominal Mass
 - a) The width of the foot shall not exceed 5 mm per kg of the nominal mass.
 - b) The contact length of the foot shall not exceed 350 mm nor be less than 175 mm.

- c) The foot contact area shall not exceed 1000 sq. mm per kg of the nominal mass.
 - d) The mass of any extension leg shall not exceed 10% of the nominal mass.
- 2) 25 to 50 kg Nominal Mass - permitted in areas of restricted access only
- a) The width of the foot shall not exceed 150 mm.
 - b) The contact length of the foot shall not exceed 200 mm.

S10.3.4 Vibrating Rollers

Vibrating rollers shall be permitted for the compaction of reinstatement materials, in accordance with the following requirements:

- 1) Single-Drum Vibrating Rollers
 - a) Single drum vibrating rollers shall include a mechanical means of applying vibration to the roll. Single-drum rollers without a specific vibration unit shall be considered to be single-drum deadweight rollers and shall not be permitted for reinstatement purposes.
 - b) The minimum mass of a single-drum vibrating roller shall be 1000 kg per metre width.
- 2) Twin-Drum Vibrating Rollers
 - a) Twin-drum vibrating rollers shall include two vibrating rolls. Twin-drum rollers in which only one roll vibrates shall be considered to be single-drum vibrating rollers.
 - b) The minimum mass of a twin-drum vibrating roller shall be 600 kg per metre width.
- 3) All Vibrating Rollers
 - a) The mass per metre width of a vibrating roller shall be calculated by dividing the total mass supported by the roll(s) by the total width of the roll(s).
 - b) Where existing roads, footways, footpaths or cycletracks may be marked or otherwise damaged by the use of heavy vibrating equipment, the Authority shall notify the Undertaker accordingly, whereupon the use of lower weight vibrating compaction equipment shall be agreed.

S10.3.5 Vibrating Plate Compactors

Vibrating plate compactors of 1400 kg per square metre minimum mass shall be permitted for the compaction of reinstatement materials.

S10.3.6 Other Compaction Equipment

Other compaction equipment, including machine-mounted compactors and all other compaction devices not specifically referenced within Appendix A8, may be permitted for the compaction of reinstatement materials, subject to the requirements of Section NG10 and agreement with the Authority.

SPECIFICATION

S11 Ancillary Activities

S7.11.1 TRAFFIC SIGNS, ROAD MARKINGS, STUDS AND VERGE MAKERS

- 1) Prior to the opening of any works to traffic, all traffic signs, road markings, studs and verge markers removed during the works shall be reinstated to a permanent or temporary standard. Temporary traffic signs, road markings, studs and verge markers shall be permitted for up to 10 working days following completion of the permanent reinstatement.
- 2) All traffic signs, road markings, studs and verge markers removed during works shall be reinstated at their original location, wherever possible. Where any traffic signs, road markings, studs or verge markers cannot be reinstated at their original locations, they shall be permanently reinstated to a new layout in accordance with the Traffic Signs Manual: Chapter 5 and the Traffic Signs Regulations & General Directions.
- 3) Where the layout of existing traffic signs, road markings, studs or verge markers is not in accordance with the Traffic Signs Manual: Chapter 5 and the Traffic Signs Regulations & General Directions, and the Authority notifies the Undertaker prior to the commencement of works, the layout of all traffic signs, road markings, studs or verge markers to be reinstated following the works shall be determined by agreement. In this event, if the Authority provides any new traffic signs, studs or verge markers, to replace obsolete or previously damaged items removed during the works, then the Undertaker shall install such items as part of the permanent reinstatement of the works.

S11.1.1 Traffic Signs, Studs and Verge Markers

- 1) Wherever possible, all traffic signs, studs and verge markers removed during the works shall be re-erected on completion. Where the original items cannot be re-erected, they shall be replaced using items of equivalent type, colour and dimensions.

S11.1.2 Road Markings

- 1) Prior to their permanent reinstatement, temporary road markings may be made using quick drying, durable paint, adhesive strip or like materials of similar colour and dimensions to the original markings.
- 2) Road markings removed during the works shall be permanently reinstated using materials of equivalent colour and dimensions, subject to the following requirements:
 - a) For small reinstatements affecting up to 2.5 m overall length of road markings, alternative materials may be substituted for the existing, subject to the following:
 - i) Road marking tape may be used in place of thermoplastic markings or pavement marking paint.

- ii) Pre-formed thermoplastic markings may be used in place of hot applied thermoplastic materials.
- iii) No alternatives may be used in place of specialist materials such as rib markings.
- b) Except where otherwise specified by the Authority, the retro-reflectivity and skid resistance of all yellow and white lines shall comply with BS EN 1436, as follows:
 - i) Dry retro-reflectivity to Table 2 Yellow - Class R0 White - Class R2
 - ii) Wet skid resistance to Table 7 Yellow - Class S1 White - Class S3
- 3) Unless otherwise agreed by the Authority, all white thermoplastic road markings shall be treated with surface-applied glass beads.
- 4) Thermoplastic road marking materials with synthetic resin binder shall be laid to the following thickness:
 - a) Screed lines - 3.5 mm \pm 1.5 mm
 - b) Sprayed yellow edge lines (No Waiting, etc.) - 0.8 mm minimum
 - c) Sprayed lines, other than yellow - 1.5 mm minimum
 - d) Extruded lines - 3.0 mm \pm 0.5 mm

S11.2 Street Furniture and Special Features

Street furniture and other special features, such as tactile paving removed to facilitate road works, shall be replaced in the same position and layout before opening the road to traffic and pedestrians. Items removed to facilitate road works must be carefully stored and maintained during the works. Advice on replacement may be provided by the Authority.

S11.3 Traffic Sensors, etc.

Where excavation is planned at or near to traffic sensors, advice regarding precautions to avoid damage shall be sought from the relevant Authority before work commences.

S11.4 Sewers, Drains and Tunnels

- 1) An Undertaker executing road works that involve breaking up or opening a sewer, drain or tunnel shall complete the reinstatement works to the reasonable requirements and satisfaction of the responsible Authority.
- 2) In the case of a public sewer, the "responsible Authority" shall mean Scottish Water (i.e. the water service company for Scotland).
- 3) In the case of any other sewer, drain or tunnel, the "responsible Authority" shall mean the owner (or the Authority, body or person) responsible for the management or control of the sewer, drain or tunnel.

S11.5 Test Holes

Test holes of 150 mm diameter or less are not excavations for the purposes of this Specification and shall be reinstated to a permanent standard within 10 working days of completion of all associated work on the site.

- 1) General
 - a) Prior to reinstatement, all test holes should be made safe and maintained in a safe condition.
 - b) Test holes up to 25 mm diameter shall be reinstated to an immediate permanent standard.
 - c) Test holes larger than 25 mm diameter may be reinstated to an interim standard, if required
 - d) In modular surfaces, preference should be given to the lifting of individual modules prior to the drilling of test holes, whenever reasonably practical.
 - e) In unmade ground, test holes shall be tamped closed or filled with appropriate materials.
- 2) 50 mm Diameter or Less
 - a) In paved surfaces, test holes shall be reinstated using a fine aggregate, bound with cement or bitumen for the upper layers, as appropriate, and compacted in layers of 100 mm thickness, or less, to finish flush with the surface. Alternatively, a flexible sealing plug may be installed flush with the surface.
 - b) In bituminous surfaces, all sealing plugs shall be coloured black (or dark grey).
 - c) In modular or concrete surfaces, sealing plugs up to 25 mm nominal diameter may be coloured black (or dark grey) or white (or light grey).
 - d) In modular or concrete surfaces, sealing plugs greater than 25 mm nominal diameter shall be coloured white (or light grey) and may be installed with black (or dark grey) or white (or light grey) coloured sealant.
- 3) 50 to 150 mm Diameter
 - a) In paved surfaces, test holes shall be reinstated using a fine aggregate, compacted in layers of 100 thicknesses, or less, and surfaced with appropriate cementitious, cold or hot-lay bituminous materials.
 - b) The surfacing materials and compaction shall comply with the relevant requirements of Appendix A3, A4, A5, A6, A7, A9 or A10, as appropriate, to finish flush with the surface.

- 4) Greater than 150 mm Diameter
 - a) In paved surfaces, test holes shall be reinstated using Class A Graded Granular Material, placed in layers of 100 mm thickness, or less, compacted using mechanical plant and surfaced with appropriate cementitious, cold or hot-lay bituminous materials. The surfacing materials and compaction shall comply with the relevant requirements of Appendix A3, A4, A5, A6, A7, A9 or A10, as appropriate, to finish flush with the surface.
 - b) In flexible surfaces, the edge sealing requirements of Section S6.5 3) shall apply.

SPECIFICATION

S12 Remedial Works

S12.1 GENERAL

S12.1.1 The Undertaker shall be responsible for ensuring that reinstatements comply with the required performance criteria throughout the interim reinstatement and guarantee periods.

S12.1.2 When determining whether a reinstatement requires any remedial action, the quality of the reinstatement shall be assessed relative to the condition of the adjacent surfaces.

S12.2 SAFETY REQUIREMENTS

Should a reinstatement fail any safety requirements of this Specification, the surface shall be restored to comply with such requirements, in accordance with Section 130 of the New Roads and Street Works Act: 1991.

S12.3 REPAIR OF CRACKING

S12.3.1 Interface Cracking

Cracking along the reinstatement interface, greater than 2.5 mm open width at the surface for more than the maximum permitted length shown in Table S12.1, shall require remedial action in accordance with the requirements of Section S12.3.3.

Table S12.1 Interface Cracking		
Reinstatement	Maximum Crack Length	
Small Excavations	500 mm total cumulative length	
Other Openings	1000 mm continuous length or 10 % of reinstatement perimeter	} Whichever is greater

S12.3.2 Cracking Beyond Reinstatement Limits

Cracks remote from the reinstatement interface, greater than 2.5 mm open width at the surface for more than 2 metres of continuous length, shall also require remedial action in accordance with the requirements of Section S12.3.3, provided it can reasonably be shown that such cracks occurred directly as a result of the Undertakers' works (see also S10.3.4 3) b)).

S12.3.3 Repair of Interface Cracking

- 1) When required, cracking along the interface of the reinstatement shall be repaired in accordance with the following methods:

- a) Cracks of between 2.5 mm and 10 mm open width at the surface shall be repaired by filling with a flexible bituminous sealant, subject to the requirements of Section S6.5.2.5.
 - b) Cracks between 10 mm and 15 mm open width at the surface shall be repaired by filling with a flexible bituminous sealant incorporating suitable fine aggregate filler, subject to the requirements of Section S6.5.2.5.
 - c) Cracks of greater than 15mm open width shall be repaired using the procedure described in Section 2) a) & b) below.
- 2) Two re-sealing operations, excluding the original sealing, shall be permitted during the guarantee period. Further significant cracking of the third seal shall require a surface repair, as follows:
- a) The surfacing materials shall be removed to the full depth of the surface course or to 40 mm depth, whichever is less; for the full length of the crack or for 1 metre length, whichever is greater. If the crack extends into the binder course layer, the affected materials shall be removed and replaced in accordance with Section S6.4.
 - b) Surfacing materials shall be removed over sufficient width to ensure that the repair patch extends beyond the edges of the crack, by a minimum distance equal to the nominal thickness of the replacement surface course. The minimum width of the repair patch shall be 100 mm.
 - c) The replacement surface course patch shall be laid in accordance with Section S6.4.
- 3) Where, as a result of Undertaker's works, a crack requiring repair in accordance with Section S12.3.3 exists within 300 mm of another similar crack repair, the intermediate area shall be included in the new repair.

S12.4 Repair of Settlement Beyond Reinstatement Limits

- 1) Where significant settlement of the surface beyond the edges of the reinstatement can reasonably be shown to have occurred as a direct result of the Undertaker's works, the effective width of the reinstatement shall be revised to include the actual width of the settled area. The relevant requirements of this Specification shall apply over the revised width of the reinstatement.
- 2) The extent of any significant settlement beyond the reinstatement limits shall be assessed, by agreement, from consideration of the following:
 - a) The apparent extent of any excessive areas of standing water following heavy rainfall;
 - or b) The apparent extent of any significant deterioration of road shape compared with the existing profile remote from the excavation;
 - or c) The true extent of any significant deterioration of road shape determined by profile measurements taken before and after the Undertaker's works.

S12.5 REPAIR OF OTHER SIGNIFICANT DEFECTS

- 1) The requirement for, and extent of, any repair shall be determined, by agreement, from a consideration of the existing and adjacent surfaces.
- 2) Where it can reasonably be shown that a repair operation is required, as a direct result of the Undertaker's works, the Undertaker shall carry out remedial actions, as necessary.

APPENDIX A1

Backfill Materials

A1.1 Class A - Graded Granular Materials

1) Materials should be well graded granular material with a uniformity coefficient greater than 10. Material shall, at the time of compaction, be at an appropriate moisture content between +1% and -2% of the optimum moisture content as determined by BS1377: Part 4; Vibrating Hammer Method, Method 3.7, or shall be acceptable when subjected to Field Identification Test No.3.

2) Materials shall show a 10% fines value of 40 kN or more, as determined in accordance with BS812: Part 111, tested in the soaked condition. The principal materials that will be excluded are sandstones, weakly cemented gritstones, the softer magnesium limestones, oolitic limestones and the majority of chalks.

3) Manmade aggregates, e.g. slag, PFA's, clinkers and bottom furnace ash will need individual assessment; it is possible to demonstrate satisfactory performance with some of these materials, even when they fail to meet the 10% fines value requirement.

A1.2 Class B - Granular Materials

Material at the time of compaction shall be at an appropriate moisture content between +1% and -2% of the optimum moisture content as determined by BS1377: Part 4; Vibrating Hammer, Method 3.7, or shall be acceptable when subjected to Field Identification Test No.3.

A1.3 Class C - Cohesive/Granular Materials

1) Materials with less than 50% granular content by weight at the time of compaction shall be at an appropriate moisture content between 0.8 and 1.2 times the plastic limit, or be acceptable when subjected to Field Identification Test No.2.

2) Materials with a minimum of 50% granular content by weight at the time of compaction shall be at an appropriate moisture content between +1% and -2% of the optimum moisture content as determined by BS1377: Part 4; Vibrating Hammer, Method 3.7, or shall be acceptable when subjected to Field Identification Test No.3.

A1.4 Class D - Cohesive Materials

1) Cohesive materials at the time of compaction shall be at an appropriate moisture content between 0.8 and 1.2 times the plastic limit, or be acceptable when subjected to Field Identification Test No. 2.

2) Clays that contain insufficient moisture when excavated, or have dried excessively during site storage, as defined by Field Identification Test No. 2, may only be re-used provided that they are wetted to comply with Section A1.4 1) and compacted in accordance with Appendix A8 for Class D Cohesive Materials.

3) It may be difficult to compact cohesive materials to uniformly achieve an adequate bearing capacity. Undertakers must select a lump size for clays within the limits specified in Appendix A2 and must ensure that all compaction equipment is operated within the overriding requirements of Appendix A8. Failure to comply with Appendix A2 and/or Appendix A8 will result in unacceptable settlement and variable bearing capacity.

4) High silt content materials, as defined by field identification test No. 1, shall be compacted in accordance with Appendix A8 requirements for Class D Cohesive Materials.

A1.5 Class E - Unacceptable Materials

The following materials, listed as unacceptable in SHW Clause 601 paragraphs 2(ii) and 3, shall not be used at any level within the permanent structure of any reinstatement:

- 1) Peat and materials from swamps, marshes or bogs.
- 2) Logs, stumps and perishable materials.
- 3) Materials in a frozen condition. (Such materials, if otherwise suitable, shall be classified as suitable when unfrozen.)
- 4) Clays having a liquid limit exceeding 90, determined in accordance with BS1377: Part 2 Method 4, or a Plasticity Index exceeding 65, determined in accordance BS1377: Part 2, Method 5.4.
- 5) Materials susceptible to spontaneous combustion.
- 6) Materials having hazardous chemical or physical properties requiring special measures for its excavation, handling, storage, transportation, deposition and disposal.

A1.6 Field Identification Tests

The following identification tests must be carried out immediately prior to the placement and compaction of the backfill material.

Field Identification Test No 1 - Silt Identification

High silt content materials can usually be identified by a simple hand test:

Preparation

Select a moist sample of the fine material only.

Test - Silt Identification

With clean dry hands, rub the sample between the palms, remove the excess material by striking the palms together and wait a few minutes for body heat to dry out any material adhering to the hands. Finally, rub hands together briskly.

Result

If no significant quantity of material remains adhering to the palms, i.e. the palms are relatively clean, then the sample tested is essentially a silt.

Note: The proportion of granular material discarded to produce the fine sample must to be taken into account when estimating the approximate silt content of the bulk material.

Field Identification Test No 2 - Clay Condition

Clays suitable for compaction with pedestrian controlled compaction plant can usually be identified by a simple roll test:

Preparation

Select a sample of small lumps of the fine material only, at a moisture content representative of the bulk material.

Test - Clay Condition

With clean dry hands, take the sample and squeeze together in one hand and release. If the sample crumbles away and mostly fails to hold together into a 'ball' then the sample is too dry for compaction. If not, break off part of the ball and

roll between the palms or between one palm and any convenient clean dry flat surface, for example the back of a spade. Roll out the sample into a long thin cylinder until it fractures or begins to show significant transverse cracks.

Result

If the strand can be rolled into intact or uncracked lengths that are thinner or longer than a standard pencil, i.e. less than 7 mm diameter or more than 175 mm length then the sample is too wet or too plastic for compaction. Any result between the ball and the pencil is acceptable for use provided the bulk of the material consists of lumps less than 75 mm in size.

Field Identification Test No 3 - Granular Condition

All granular materials must be compacted near to their optimum moisture content. The optimum moisture content can vary considerably depending on the average particle size and to a much smaller extent, on the type of mineral or rock involved. However, a laboratory compaction test is invariably carried out on a sample of material from which the larger particles have been removed, the sample is always compacted in a small smooth sided steel cylinder and the standard methods of compaction bear little similarity with current compaction plant. Experience has shown that the most commonly specified laboratory compaction test i.e. BS1377: Part 4; Vibrating Hammer, Method 3.7 will produce an optimum moisture content result that is, typically, significantly wetter than the field optimum for a granular material that is to be compacted within a trench using a vibrotamper.

Granular materials suitable for compaction by pedestrian controlled plant can usually be identified by a simple visual examination. Typically, the test will identify materials within 1% to 1.5% of the field optimum moisture content depending on the mineral type. Experience has shown that compaction within this visual moisture range will not normally show any significant reduction in compaction performance. The test cannot indicate the actual moisture content of any material but this is rarely of any relevance as far as an operator is concerned.

Preparation

Depending on the size of the stockpile, dig out representative samples from beneath the outer surface, at several positions around the outside.

Test - Coarse Aggregate

Examine several of the medium and larger sized particles from each sample extracted.

Result

Material within the target moisture content range will show a dull sheen when viewed obliquely against the light, with all fines adhering to the larger particles, and no free water will be visible. Material at the dry limit will not show the characteristic sheen, fines will not be strongly adherent and many of the fines will be free. Material at the wet limit will begin to show free moisture collecting in surface grooves or amongst the fines, fines will not be strongly adherent and many of the fines will amalgamate as soggy clusters. Any result between the wet and dry limits is acceptable provided the bulk of the sample is reasonably well graded.

Sands used as finefill or as a regulating layer also need to be used near to the optimum moisture content and can be identified by a simple squeeze test.

Test - Fine Aggregate

Take a small sample of representative sand, squeeze in one hand and release.

Result

If the sample crumbles away and mostly fails to adhere together into a 'ball' then the sample is too dry. Any reasonable degree of adherence is acceptable provided no free water is squeezed out.

Field Identification Test No 4 - Granular Grading

All unbound granular materials must be reasonably well graded; i.e. must contain a range of particle sizes, from fine to coarse, with an adequate proportion of particles of intermediate sizes. A well-graded material can be compacted to give a dense and stable structure of interlocking particles with a low proportion of air voids within the structure.

Preparation

Depending on the size of the stockpile, dig out representative samples from beneath the outer surface at several positions around the outside.

Test - Granular Grading

Spread out each sample and examine under good light.

Result

Class A Graded Granular Materials - should not contain any particles greater than 75 mm nominal size and, in general, should be 50 mm or smaller. Smaller particles down to less than 5 mm nominal size should be present in gradually increasing numbers as the size decreases. Finer particles, from sand size down to dust, should be present and will usually be adhering to the larger particles. Fine particles should be visible adhering to around 30 per cent or more of the surface of the majority of the larger particles.

Class B Granular Materials - should show the same general features as described above but will usually be less well graded overall compared with Class A Graded Granular Materials.

Class C Cohesive/Granular Materials - will usually contain a much larger proportion of fine material. The granular content should still be less than 75 mm nominal size, down to less than 5 mm nominal size and should not be single sized.

APPENDIX A2

Key to Materials

A2.1 Hot Rolled Asphalt (HRA) Materials

- 1) HRA materials referred to below are permitted.
- 2) All HRA material references are to BS594:Part 1 1992, except that natural gravels are not permitted as coarse aggregate for use in Types 0, 1 and 2 roads.
- 3) Design Type C and Type R mixtures listed in this section may only be used by agreement where satisfactory local experience has been gained in their use.

A2.1.1 Surface Course Materials

The following HRA surface course material options are permitted:

1) Roads Type 0 and 1

The preferred HRA surface course material shall be:

30/14 HRA Design Type F, 50 pen, 6kN to 10kN stability, to Table B1 Annex B and to Table 3, Column 3/2.

Alternative permitted mixtures are:

- a) 35/14 HRA Surface Course Design Type F, 50 pen, 6kN to 10kN stability, to Table B1 Annex B and to Table 3, Column 3/3
- b) 30/14 HRA Design Type C, 50 pen, 6kN to 10kN stability, to Table B1 Annex B and to Table 4, Column 4/2

2) Roads Type 2, 3 and 4

The preferred HRA surface course mixtures shall be:

- a) 30/14 HRA Design Type F, 50 pen, 3kN to 8kN stability, to Table B1 Annex B and Table 3, Column 3/2,
- b) 30/14 HRA Recipe Type F, 50 pen, to Table 6, Column 6/4.

Alternative permitted mixtures are:

- c) 35/14 HRA Design Type F. 50pen, to 3kN to 8kN stability, to Table B1 Annex B and to Table 3, Column 3/3.
- d) R30/14F HRA Design Type R, 50 pen, 3kN to 8kN stability, to Table 5, Column 5/1.
- e) R30/14C HRA Design Type R, 50 pen, 3kN to 8kN stability to Table 5, Column 5/3.
- f) 30/14 HRA Design Type C, 50 pen, 6kN to 10kN stability, to Table B1 Annex B and to Table 4, Column 4/2.

The preferred material may be replaced by other materials, where the existing road is either of single course construction (see Section S6.4.9), or has a surface dressing or other surface treatment, (see Section S6.4.6).

3) Footways, Footpaths and Cycletracks

HRA surface course material shall be 15/10 HRA Recipe Type F, 125 or 50 pen, to Table 6, Column 6/2.

A2.1.2 Binder Course Materials

1) Road Type 0

The HRA binder course mixture shall be 50/20 HRA Type F, 50 pen, to Table 2, Column 2/3. No alternative HRA binder course materials are available.

2) Road Types 1, 2, 3 and 4

The preferred HRA binder course mixture shall be 50/20 HRA Type F, 50 pen, to Table 2, Column 2/3.

Alternative permitted mixtures (a) and (b) below may be used by agreement where satisfactory local experience has been gained in their use.

- a) Openings up to 500 mm width - 50/14 HRA, 50 pen, to Table 2, Column 2/2.
- b) Openings over 500 mm width - 60/20 HRA, 50 pen, to Table 2, Column 2/4.

In small excavations and narrow trenches, the preferred binder course mixture may also be replaced by any surface course material that complies with the Specification for the respective road type, provided that the same material is used as the surface course, see Section S6.4.10.

3) Footways, Footpaths and Cycletracks

The preferred HRA binder course material shall be 50/20 HRA, 125 pen or 50 pen, to Table 2, Column 2/3.

Alternative permitted mixtures (b) and (c) below may be used by agreement where satisfactory local experience has been gained in the use of these mixtures.

- a) Openings up to 500 mm width - 50/14 HRA, 125 pen or 50 pen, to Table 2, Column 2/2.
- b) Openings over 500 mm width - 60/20 HRA, 125 pen or 50 pen, to Table 2, Column 2/4.

In small excavations and narrow trenches, the preferred material may also be replaced by any material that complies with the Specification for footways, footpaths and cycletracks surface course use, provided that the same material is used as the surface course, see Section S8.2.2.

A2.2 Stone Mastic Asphalt (SMA) Materials

The following SMA materials are permitted by this Specification, depending upon the detail requirements of the relevant section. For the purposes of this Specification the Overseeing Organisation referred to in Clause 937 of the SHW, shall be the Undertaker.

A2.2.1 Surface Course Materials

- 1) For all road types SMA surface course mixtures shall be 14mm SMA or 10mm SMA, see Section S6.4.2.
- 2) The requirements of Clause 937 (Stone Mastic Asphalt Binder Course and Regulating Course) shall additionally apply to SMA surface course mixtures used for reinstatements under this Specification - except as amended by this Specification.
- 3) Sub-Clauses 937.8 and 937.9 shall not apply.
- 4) Sub-Clause 937.14 shall be replaced by the requirement that samples of surface course mixtures delivered to site and sampled at the time of laying, shall have a binder content complying with Table A2.1 when sampled in accordance with BS598: Part 100 and tested in accordance with BS 598:Parts 101 and 102, corrected by any correction factor mutually agreed by the supplier, Undertaker and Authority.

Table A2 'As-Found' Binder Content of Surface Course Mixtures

Nominal Size	* Binder Content (% by mass)
14mm	5.5 to 6.5
10mm	5.7 to 6.7

- 5) Sub-Clauses 937.15 to 937.18 shall not apply
- 6) Sub-Clauses 937.21 to 937.44 shall not apply as these requirements are covered elsewhere within this Specification.

A2.2.2 Binder Course Materials

- 1) For all Road Types the preferred SMA binder course mixture shall be 20mm SMA binder course 50 pen.

Alternative permitted mixtures shall be 14mm SMA binder course 50 pen.

- 2) The requirements of Clause 937 (Stone Mastic Asphalt Binder Course and Regulating Course) shall apply to SMA binder course mixtures used for reinstatements under this Specification except as amended by this Specification.
- 3) Sub-Clauses 937.8 and 937.9 shall not apply.
- 4) Sub-Clause 937.14 shall apply except that any correction to the determined binder content shall be mutually agreed by the supplier, Undertaker and Authority.
- 5) Sub-Clauses 937.15 to 937.18 shall not apply
- 6) Sub-Clauses 937.21 to 937.44 shall not apply as these requirements are covered elsewhere within this Specification.

A2.3 Coated Materials

- 1) The following coated material mixtures to BS 4987 are permitted by this Specification, depending upon the detailed requirements of the relevant section.
- 2) All coated material mixtures to BS 4987 Specification references are to BS4987:Part 1:2001.
- 3) All HRA mixture Specification references are to BS594:Part 1:1992.
- 4) Where the existing material is HDM (Heavy Duty Material to BS 4987) or HMB (High Modulus Base) and the Authority requires the reinstatement to be completed using similar material, the Authority shall notify the Undertaker accordingly.

A2.3.1 Surface Course Materials

- 1) **Roads Types 0, 1 & 2**

No coated material to BS 4987 surface course mixtures are permitted

- 2) **Roads Types 3 & 4**

The coated material to BS 4987 surface course material shall be 10 mm Close Graded Surface Course, 125 pen to Clause 7.4.

- 3) **Footways, Footpaths and Cycletracks**

- 1) The preferred coated material to BS 4987 surface course material shall be 6 mm Dense Surface Course 125 pen or 190 pen, to Clause 7.5.

- 2) The preferred material may be replaced by other agreed, alternative materials where the existing surface is a coated material to BS 4987 of aggregate size significantly finer than 6 mm nominal size, see Section S8.3 3.

A2.3.2 Binder Course Materials

1) Roads Type 0

The preferred coated binder course mixture to BS 4987 shall be:

20 mm DBC, 50 pen, to Clause 6.5.

2) Roads Types 1, 2,3 & 4

The preferred binder course mixture to BS 4987 shall be:

20 mm DBC, 125 pen, to Clause 6.5.

In small excavations and narrow trenches, the preferred material may also be replaced by any surface course material that complies with the Specification for the respective road type, provided that the same material is used as the surface course, see Section S6.4.10.

3) Footways, Footpaths and Cycletracks

The preferred coated binder course mixture to BS 4987 binder course shall be 20 mm DBC, 125 pen or 190 pen to Clause 6.5.

In small excavations and narrow trenches, the preferred material may also be replaced by any surface course material that complies with the Specification for Footways, Footpaths and Cycletracks provided that the same material is used for the surface course, see Section S8.2.2.

A2.4 Cold-lay Surfacing Materials

A2.4.1 Permanent Cold-lay Surfacing Materials (PCSMs)

PCSMs shall be in accordance with the requirements of Appendix A10.

A2.4.2 Deferred Set Materials (DSM)

1) Deferred set coated material to BS 4987 shall be 6 mm Surface Course or 10 mm Surface Course or 20 mm dense Binder Course, in general accordance with BS 4987: Part 1:2001:Annex A, where relevant, and amended as necessary to meet the performance requirements for surfacing materials for the duration of the interim reinstatement period. The minimum binder viscosity should be 30 secs STV, approximately equivalent to 10 days deferred set.

2) Deferred set coated materials to BS 4987 are not permitted within permanent reinstatements.

A2.5 Structural Layer Thickness Tolerances

1) Several individual layers of material, commonly termed “lifts”, may be required to reinstate a structural layer.

2) The thickness of each complete structural layer is specified as a nominal value.

3) The lower tolerance for the thickness of a structural layer shall be as follows:

- a) - 5 mm for the surface course
- b) - 10 mm for any other structural layer comprising bound material
- c) - 20 mm for any other structural layer comprising unbound material

- 4) The upper tolerance for a structural layer thickness is not subject to any restriction.
- 5) The combination of permitted tolerances for the thickness of each structural layer of bituminous and / or cement bound materials shall not result in any of the following:
- An overall reduction in thickness of the bound pavement, excluding the sub-base, of more than 15 mm from the specified nominal thickness in a road, subject to an absolute minimum of 100 mm of bound materials.
 - An overall reduction in the thickness of the bound pavement, excluding the sub-base, of more than 10 mm from the specified nominal thickness in a footway, subject to an absolute minimum of 60 mm of bound materials.
 - A non-compliance with the Specification if the combined thickness of the relevant layers equals or exceeds that of the Specification requirements, provided that each individual lift meets the thickness requirements of Tables A2.1 or A2.2 and the bituminous materials meet the void requirements of S10.2.3.

A2.6 Compacted Lift Thickness

The compacted thickness of all individual lifts of reinstatement materials, within all reinstatement structural layers, shall be in accordance with the following requirements:

A2.6.1 Bituminous Materials

The compacted thickness of all individual 'lifts' of bituminous materials shall be in accordance with Table A2.1.

Table A2.1 Compacted Lift Thickness - Bituminous Materials			
Material	Compacted Lift Thickness (mm)		
	Minimum at any point	Nominal Lift Thickness	Maximum at any point
6 mm DSC	15	20 to 30	40
10 mm CGSC	25	30 to 40	50
15/10 HRA SC	25	30 to 40	50
30/14 HRA SC	25	30 to 40	50
10mm SMA SC	20	25 to 35	40
14mm SMA SC	30	35 to 45	50
10mm Porous Asphalt	25	30 to 35	40
20mm Porous Asphalt	40	45 to 60	65
50/20 HRA BC	40	45 to 80	100
14mm SMA BC	30	35 to 45	50
20mm SMA BC	40	45 to 55	60
20 mm DBC	40	50 to 100	110

A2.6.2 Non-Bituminous Materials

The compacted thickness of all individual 'lifts' of non-bituminous materials shall be in accordance with Table A2.2.

Table A2.2 Compacted Lift Thickness (mm) – Bituminous Mixtures

Material	Compacted Lift Thickness (mm)		
	Minimum at any point	Nominal Lift Thickness	Maximum at any point
CBM 3	75	100 to 150	200
C30 Concrete	100	As Required	As Existing
C40 Concrete	100	As Required	As Existing
Granular	75	100 to 150	200
Cohesive	75	100 to 150	200
Clay Lumps	25	40 to 60	75

A2.7 Bituminous laying temperatures.

The laying temperatures for bituminous materials shall be in accordance with Table A2.3.

Table A2.3 Laying Temperatures – Bituminous Materials

Material	Binder Grade	Maximum Temperature at any stage (°C)	Minimum Temperatures (°C)	
			Arrival	Minimal Rolling
CGSC	125	160	120	95
DSC	190	150	110	85
DBC	50	185	130	100
	125	170	120	90
	190	150	110	80
HRA SC	50	190	130	100
	100	175	120	85
HRA BC	50	170	130	100
	100	165	120	90
SMA SC	50	200	N/A	150
SMA BC	100	190		140
Porous Asphalt	125	135	110	85
	190	145		

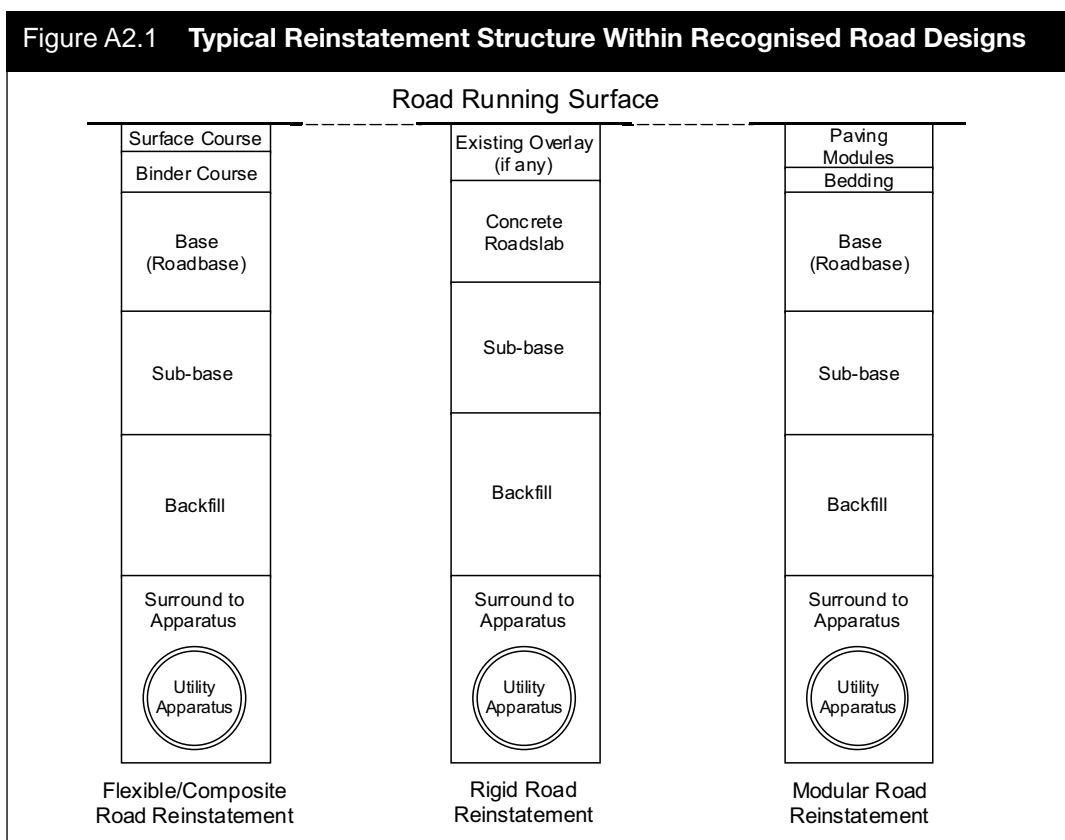
Notes to Table A2.3:

- * = In the lorry within 30 minutes after arrival on site
- For coated slag material to BS 4987 mixtures 10 °C lower may be used
- Greater compactive effort may be required to achieve an acceptable air voids ratio as the temperature approaches the lower limit.

A2.8 Identification of Structural Layers

A2.8.1 Road Structures

1) For the purposes of defining permissible material options, layer thicknesses etc, this Specification classifies road structures as being of flexible, composite, rigid or modular design. The road structures assumed to be representative of each of these designs are shown in Figure A2.1. For each design, a typical reinstatement structure, identifying the principal structural layers, is also shown.



- 2) Permitted materials and layer thicknesses for road structures are Specified as follows:
- Flexible Design see Appendix A3.0 to A3.4
 - Flexible Sub-structure see Appendix A3.5
 - Composite Design see Appendix A4.0 to A4.3
 - Composite Sub-structure see Appendix A4.4 to A4.5
 - Rigid Design see Appendix A5.0 to A5.2
 - Modular Design see Appendix A6.1 to A6.3

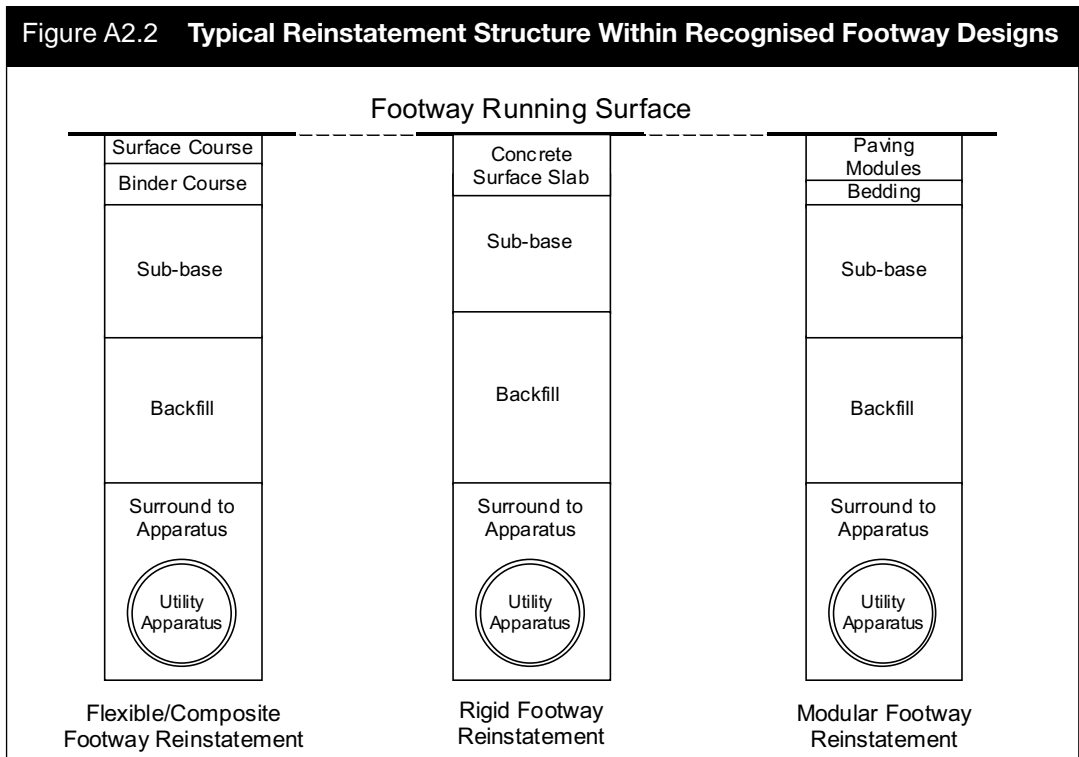
- 3) All layer thicknesses are in millimetres.

A2.8.2 Footway, Footpath and Cycletrack Structures

1) For the purposes of defining permissible material options, layer thicknesses, etc. this Specification classifies footway, footpath and cycletrack structures as being of flexible, rigid or modular design. The structures assumed to be representative of each of these designs are shown in Figure A2.2. For each design, a typical reinstatement structure, identifying the principal structural layers, is also shown.

2) Permitted materials and layer thicknesses for footway, footpath and cycletrack structures are specified as follows:

- a) Flexible Design see Appendix A7.1
 - b) Rigid Design see Appendix A7.2
 - c) Modular Design see Appendix A7.
- 3) All layer thicknesses are in millimetres.



A2.9 Key to Materials

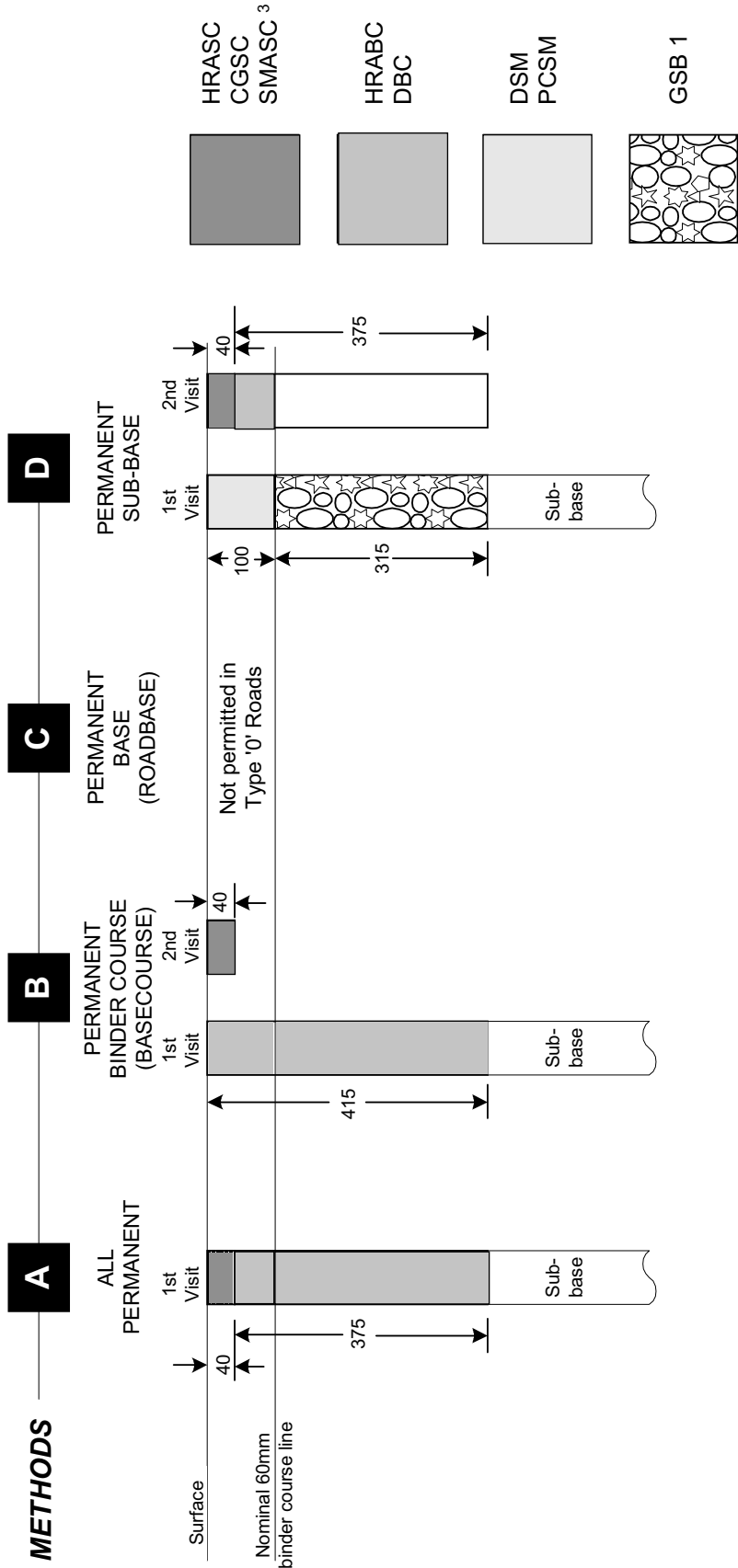
For the purposes of defining the main material options, layer thicknesses, etc. required by this Specification, Appendices A3 to A7, inclusive, show the principal structural layers within cross-sections of typical reinstatement designs in each of the main surface categories. Materials are denoted by the following symbols:

	HRASC CGSC SMASC	HRASC - Hot Rolled Asphalt Surface Course See Appendix A2.1.1
	HRASC CGSC DSC SMASC PCSC	SMASC - Stone Mastic Asphalt Surface Course See Appendix A2.2.1 CGSC - Close Graded Surface Course See Appendix A2.3.1 DSC - Dense Surface Course See Appendix A2.3.1 PCSC - Permanent Cold-lay Surface Course See Appendix A10
	HRABC DBC	HRABC - Hot Rolled Asphalt Binder Course See Appendix A2.1.2
	HRABC DBC PCBC	SMABC - Stone Mastic Asphalt Binder Course See Appendix A2.2.2 DBC - Dense Binder Course See Appendix A2.3.2 PCBC - Permanent Cold-lay Binder Course See Appendix A10
	DSM PCSM	DSM - Deferred Set Material to BS 4987 See Appendix A2.4 PCSM - Permanent Cold-lay Surfacing Material See Appendix A10
	Concrete	Concrete - Pavement Quality Concrete To SHW Clause 1001 See Appendix A5.0 & A7.2
	CBM 3	CBM 3 - Cement Bound Material Category 3 To SHW Clause 1038
	GSB 1	GSB 1 - Type 1 Granular Sub-base Material To SHW Clause 803

<div style="border: 1px solid black; padding: 2px; text-align: center;">AAA AAA</div>	CLASS A	Class A - Graded Granular Backfill Material See Appendix A1.1
<div style="border: 1px solid black; padding: 2px; text-align: center;">BBB BBB</div>	CLASS B	Class B - Granular Backfill Material See Appendix A1.2
<div style="border: 1px solid black; padding: 2px; text-align: center;">CCC CCC</div>	CLASS C	Class C - Cohesive Granular Backfill Material See Appendix A1.3
<div style="border: 1px solid black; padding: 2px; text-align: center;">DDD DDD</div>	CLASS D	Class D - Cohesive Backfill Material See Appendix A1.4

Appendix A3.0 Type 0 Flexible Roads

Scale 1:10



NOTES:

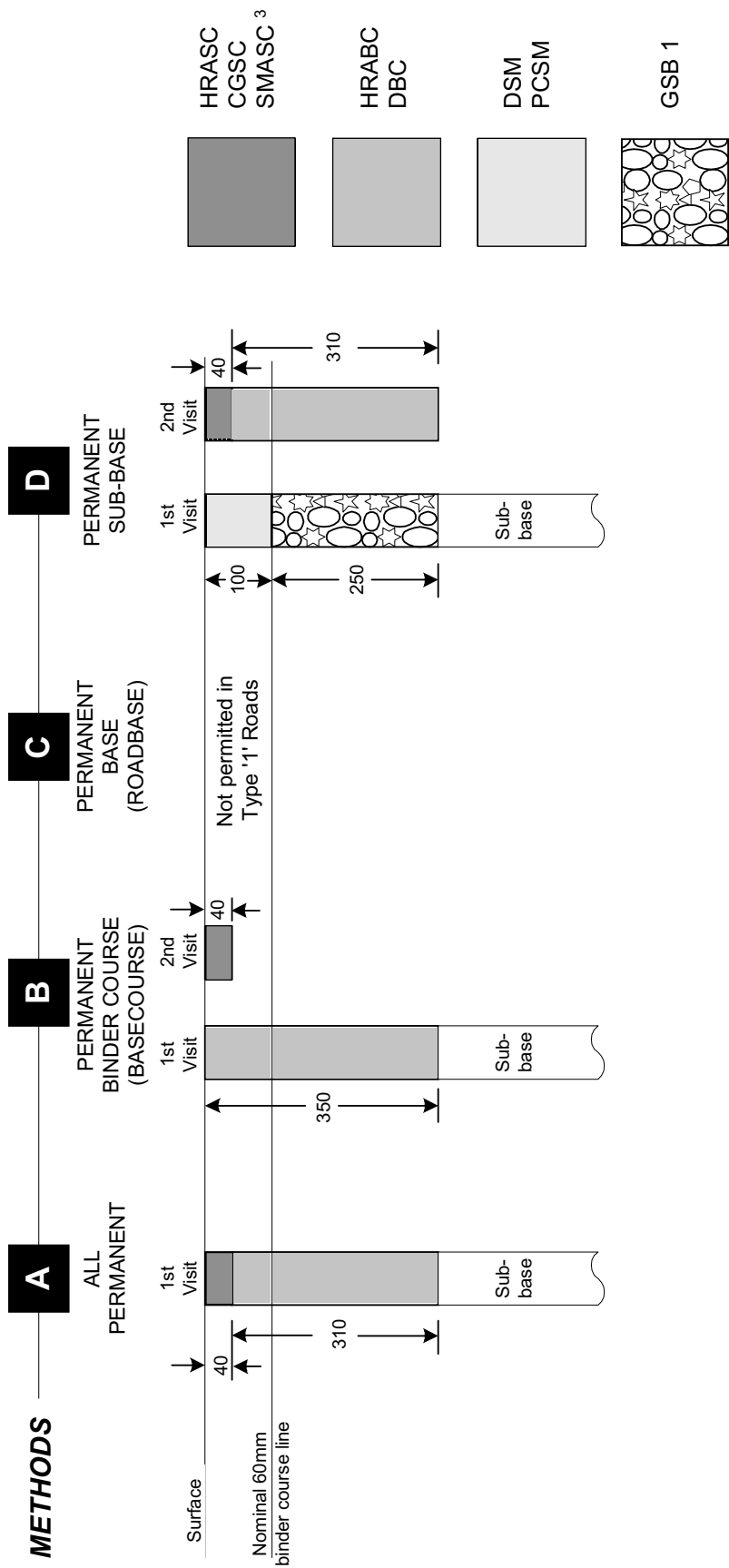
- 1). Sub-base in accordance with Appendix A3.5
- 2). For alternative reinstatement materials refer to Appendix A9
- 3). Where 10mm SMASC is used the thickness is reduced to 30mm and the binder course adjusted accordingly

Appendix A3.0

Flexible Roads Type - '0'

Appendix A3.1 Type 1 Flexible Roads

Scale 1:10



NOTES:

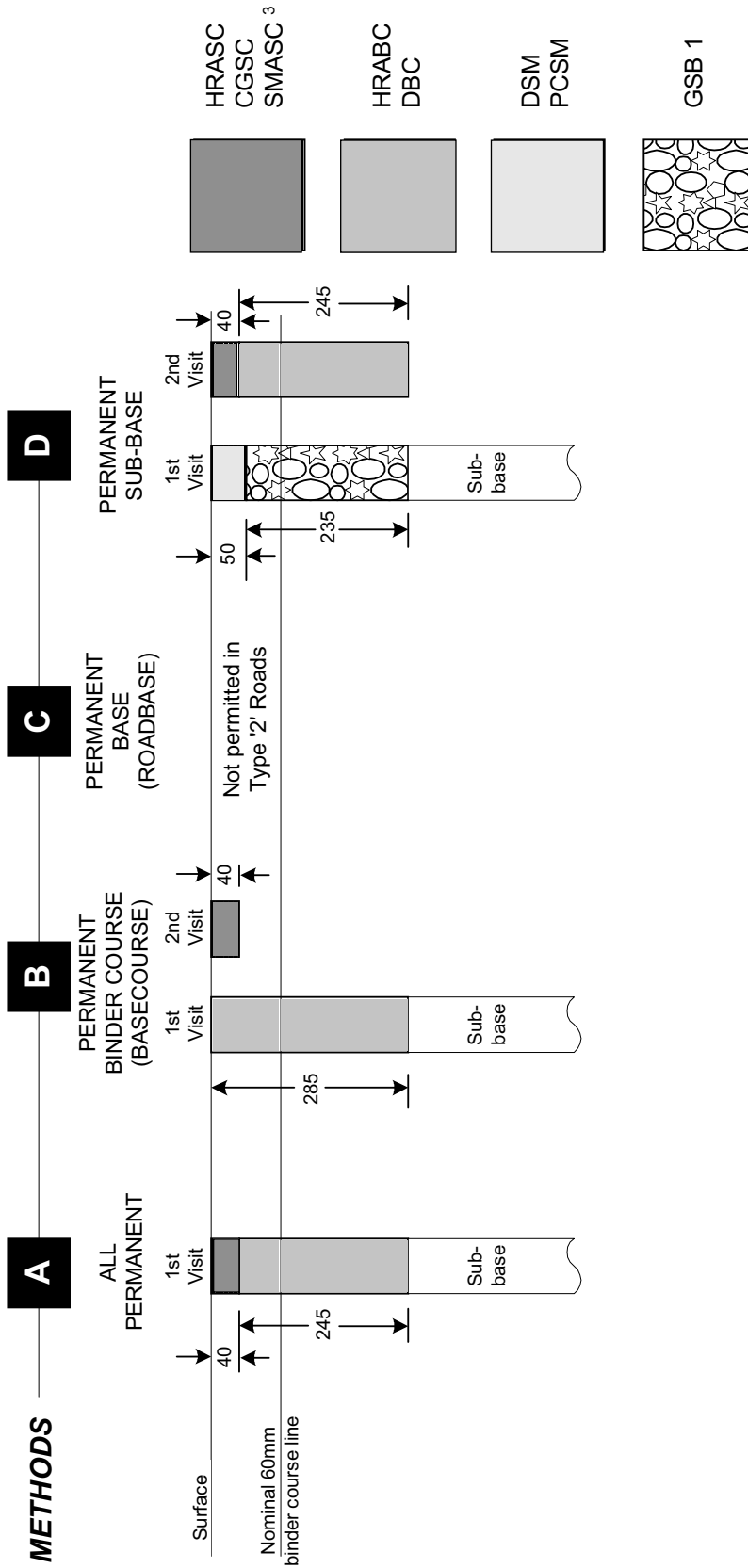
- 1) Sub-base in accordance with Appendix A3.5
- 2) For alternative reinstatement materials refer to Appendix A9
- 3) Where 10mm SMASC is used the thickness is reduced to 30mm and the binder course adjusted accordingly

Appendix A3.1

Flexible Roads Type - '1'

Appendix A3.2 Type 2 Flexible Roads

Scale 1:10



NOTES:

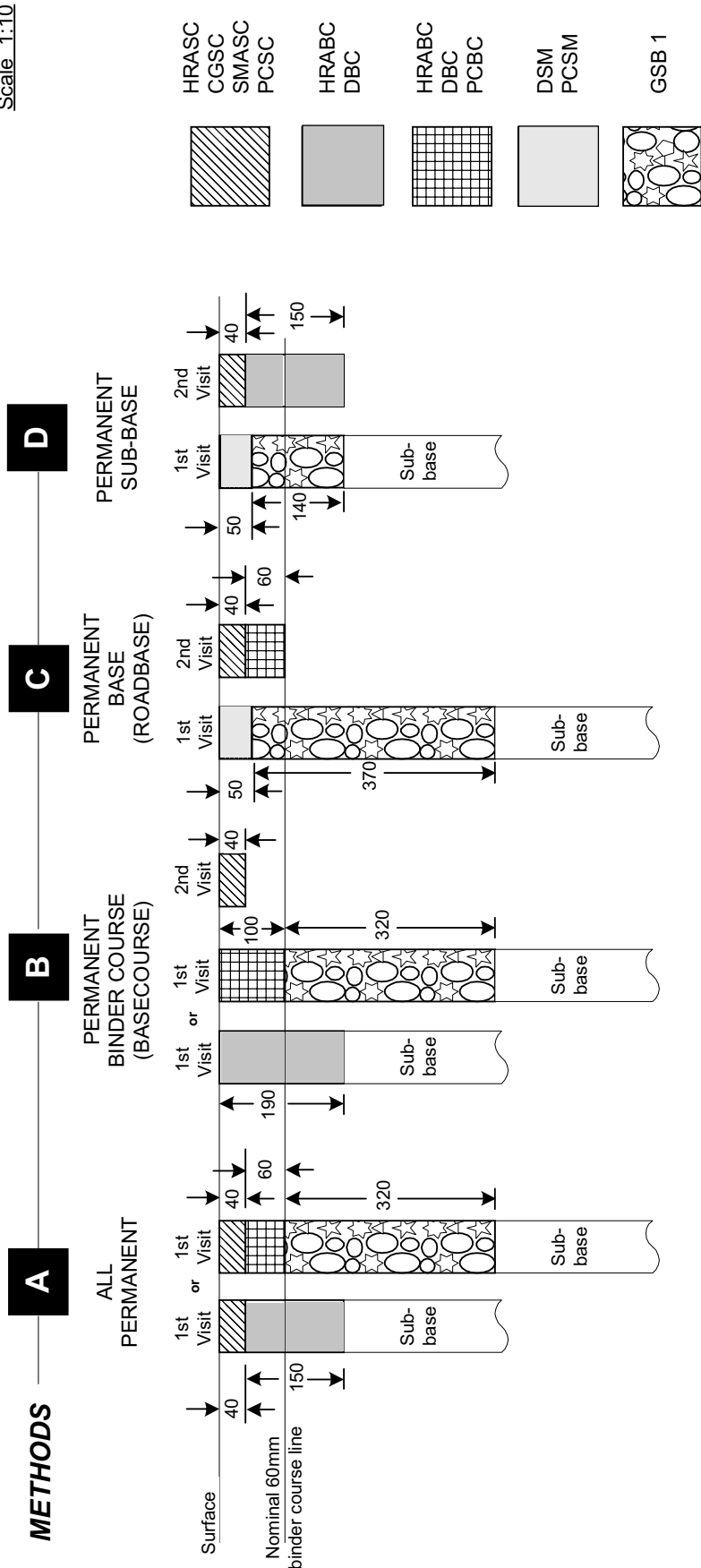
- 1). Sub-base in accordance with Appendix A3.5
- 2). For alternative reinstatement materials refer to Appendix A9
- 3). Where 10mm SMASC is used the thickness is reduced to 30mm and the binder course adjusted accordingly

Appendix A3.2

Flexible Roads Type - '2'

Appendix A3.3 Type 3 Flexible Roads

Scale 1:10



NOTES:

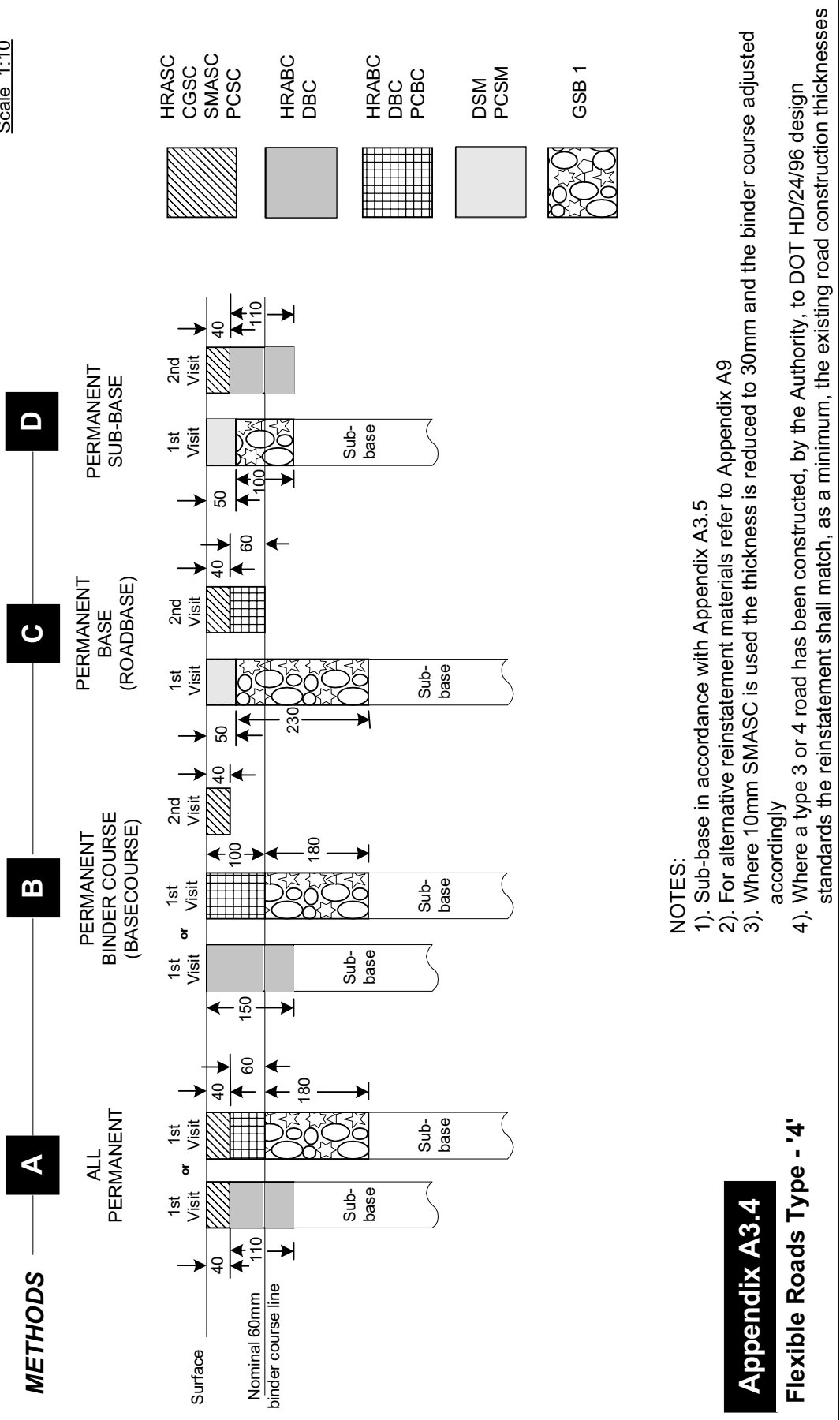
- 1). Sub-base in accordance with Appendix A3.5
- 2). For alternative reinstatement materials refer to Appendix A9
- 3). Where 10mm SMASC is used the thickness is reduced to 30mm and the binder course adjusted accordingly
- 4). Where a type 3 or 4 road has been constructed, by the Authority, to DOT HD/24/96 design standards the reinstatement shall match, as a minimum, the existing road construction thicknesses

Appendix A3.3

Flexible Roads Type - '3'

Appendix A3.4 Type 4 Flexible Roads

Scale 1:10

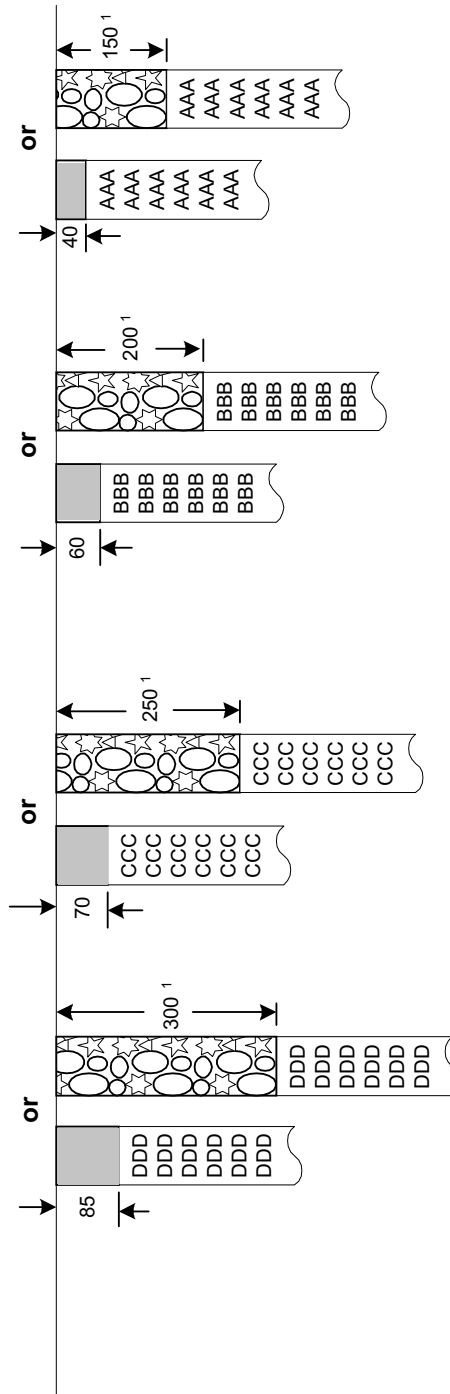
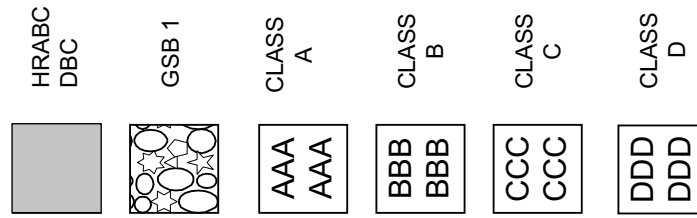


- NOTES:**
- 1). Sub-base in accordance with Appendix A3.5
 - 2). For alternative reinstatement materials refer to Appendix A9
 - 3). Where 10mm SMASC is used the thickness is reduced to 30mm and the binder course adjusted accordingly
 - 4). Where a type 3 or 4 road has been constructed, by the Authority, to DOT HD/24/96 design standards the reinstatement shall match, as a minimum, the existing road construction thicknesses

Appendix A3.4 Flexible Roads Type - '4'

Appendix A3.5 Sub-base Construction – Flexible Roads

Scale 1:10



Class A
Graded-granular

Class B
Granular

Class C
Cohesive-granular

Class D
Cohesive

BACKFILL

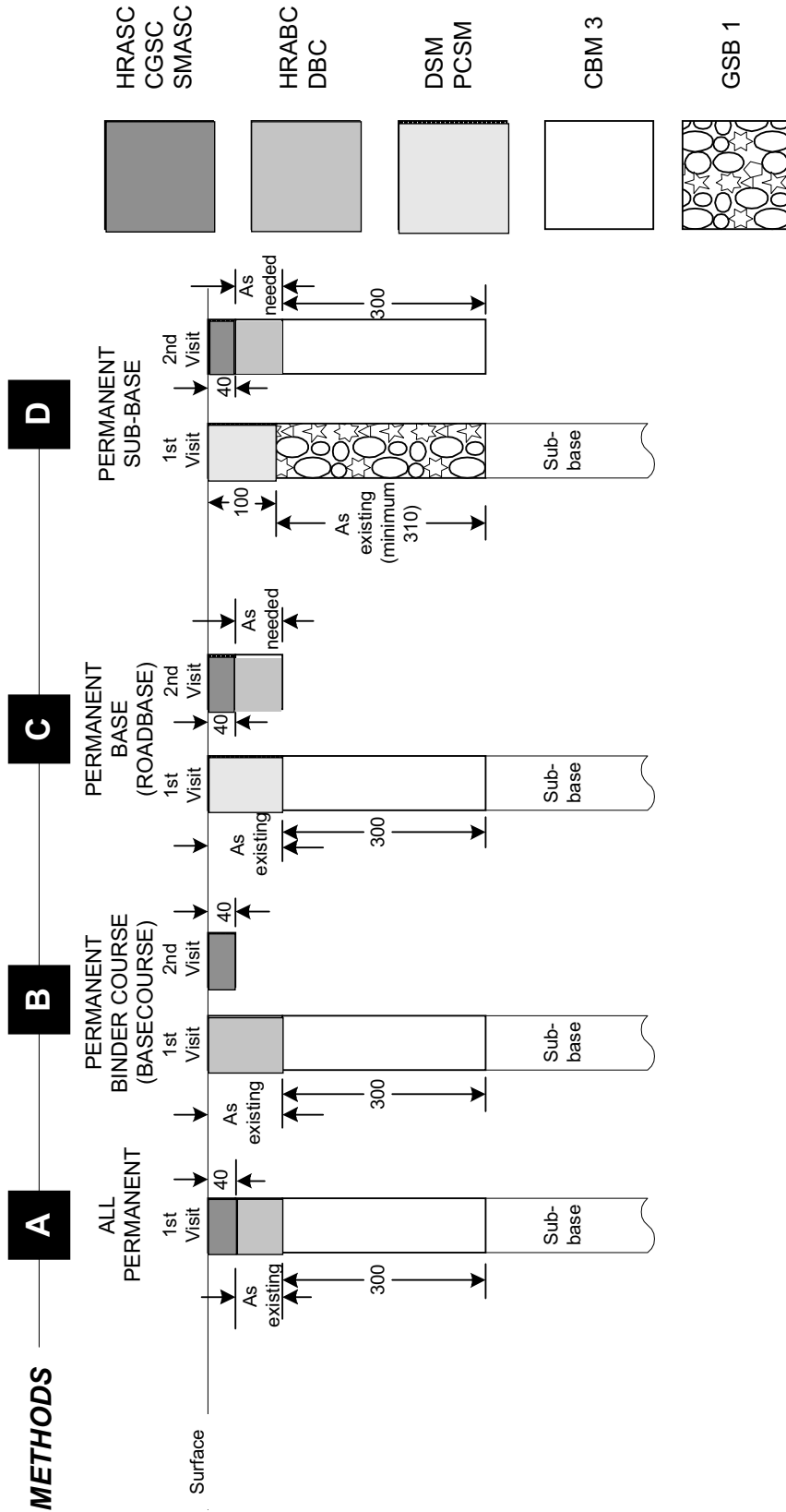
- NOTES:**
- 1). Class A Graded-granular material is permitted alternative
 - 2). For alternative reinstatement materials refer to Appendix A9

Appendix A3.5

Sub-base Construction - Flexible Roads

Appendix A4.0 Type 0 Composite Roads

Scale 1:10



NOTES:

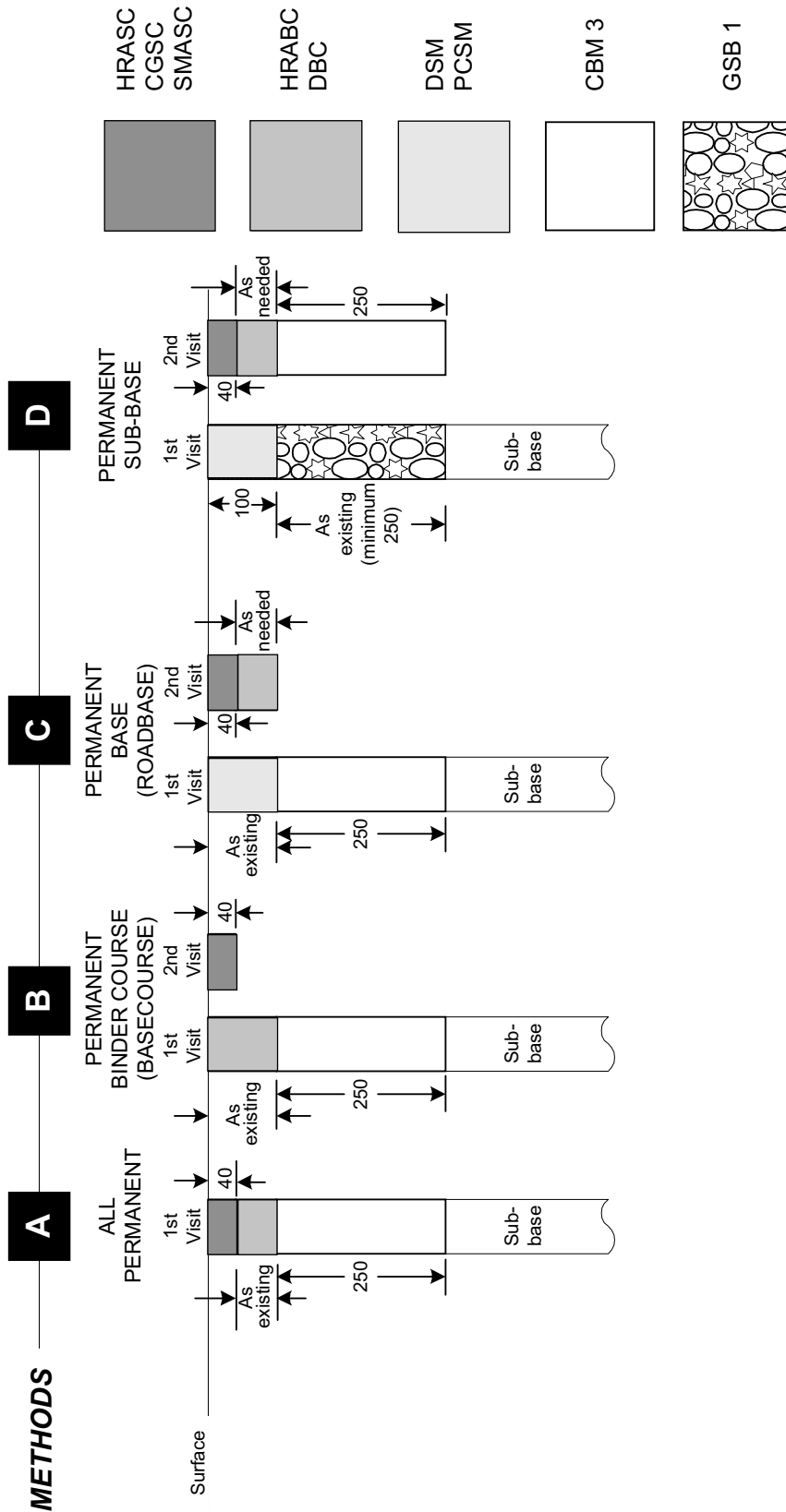
- 1). Sub-base in accordance with Appendix A3.5
- 2). For alternative reinstatement materials refer to Appendix A9
- 3). Where 10mm SMAASC is used the thickness is reduced to 30mm and the binder course adjusted accordingly

Appendix A4.0

Composite Roads Type - '0'

Appendix A4.1 Type 1 Composite Roads

Scale 1:10



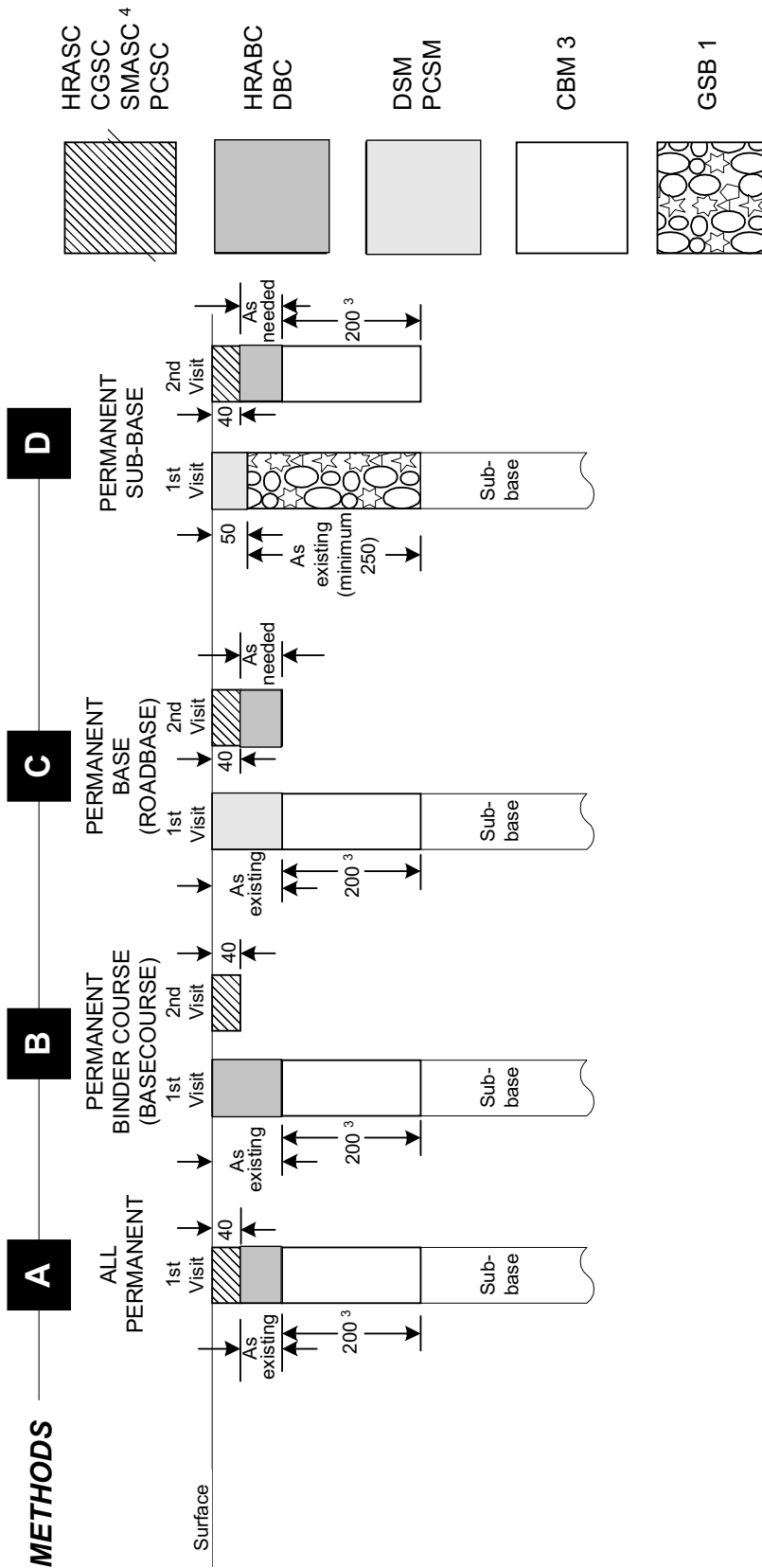
NOTES:

- 1). Sub-base in accordance with Appendix A3.5
- 2). For alternative reinstatement materials refer to Appendix A9
- 3). Where 10mm SMASC is used the thickness is reduced to 30mm and the binder course adjusted accordingly

Appendix A4.1
Composite Roads Type - '1'

Appendix A4.2 Type 2 Composite Roads

Scale 1:10



NOTES:

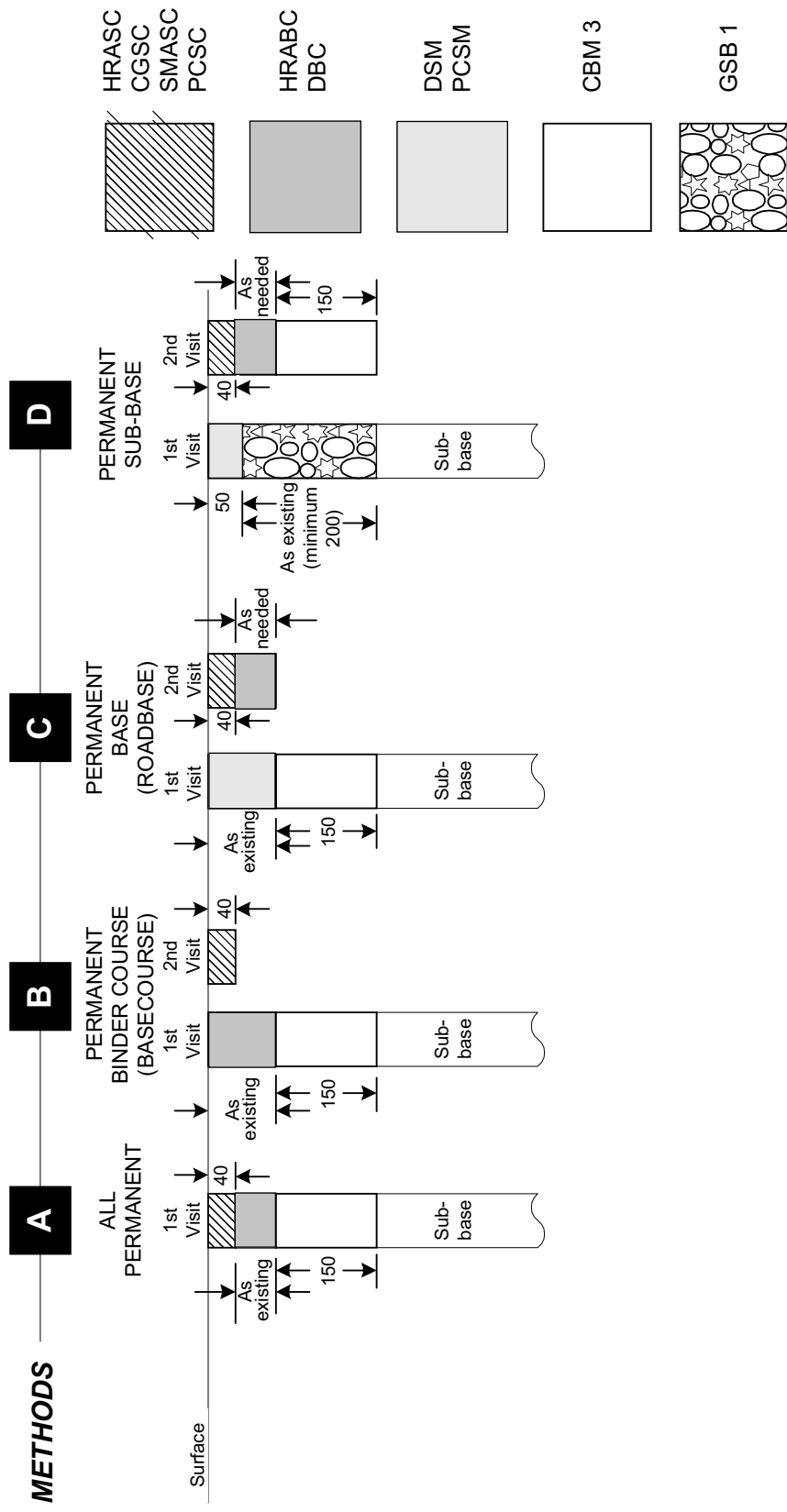
- 1). Sub-base in accordance with Appendix A4.4
- 2). For alternative reinstatement materials refer to Appendix A9
- 3). Roadbase to be 250mm thick if existing exceeds 200mm
- 4). Where 10mm SMASC is used the thickness is reduced to 30mm and the binder course adjusted accordingly

Appendix A4.2

Composite Roads Type - '2'

Appendix A4.3 Types 3 & 4 Composite Roads

Scale 1:10

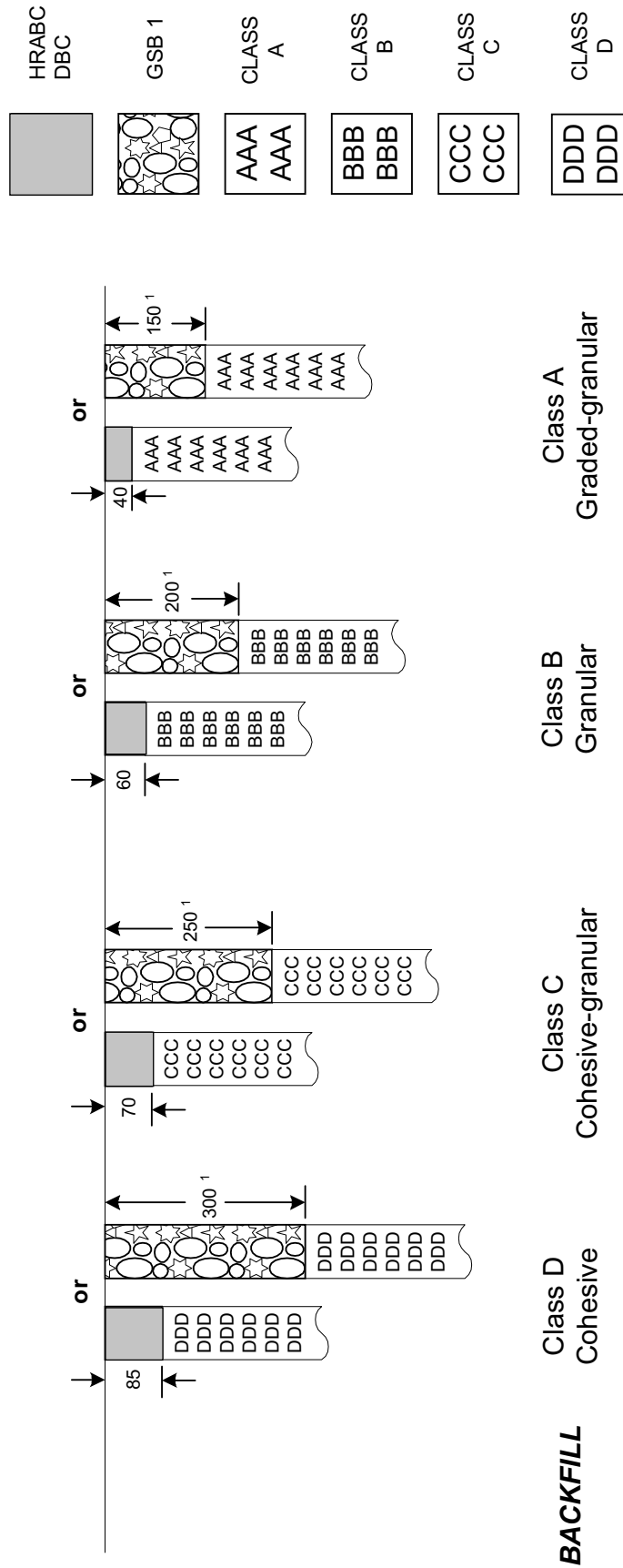


- NOTES:**
- 1). Sub-base in accordance with Appendix A3.5
 - 2). For alternative reinstatement materials refer to Appendix A9
 - 3). Where 10mm SMASC is used the thickness is reduced to 30mm and the binder course adjusted accordingly

Appendix A4.3
Composite Roads Type - '3' & '4'

Appendix A4.4 Sub-base Construction – Types 0, 1 & 2 Composite Roads

Scale 1:10



NOTES:

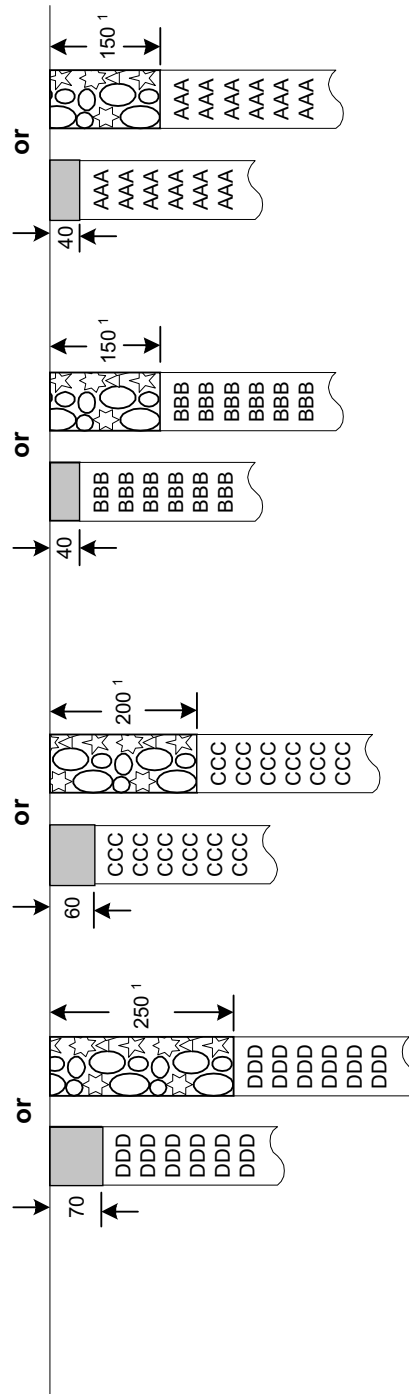
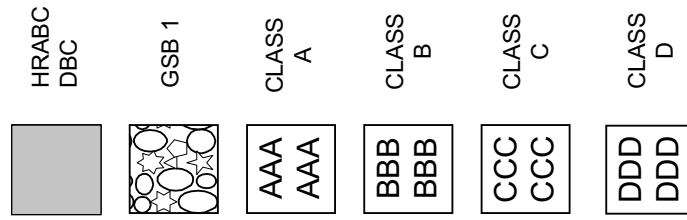
- 1). Class A Graded-granular material is permitted alternative
- 2). For alternative reinstatement materials refer to Appendix A9

Appendix A4.4

Sub-base Construction - Composite Roads - Types '0', '1' & '2'

Appendix A4.5 Sub-base Construction – Types 3 & 4 Composite Roads

Scale 1:10



BACKFILL Class D Cohesive Class C Cohesive-granular Class B Granular Class A Graded-granular

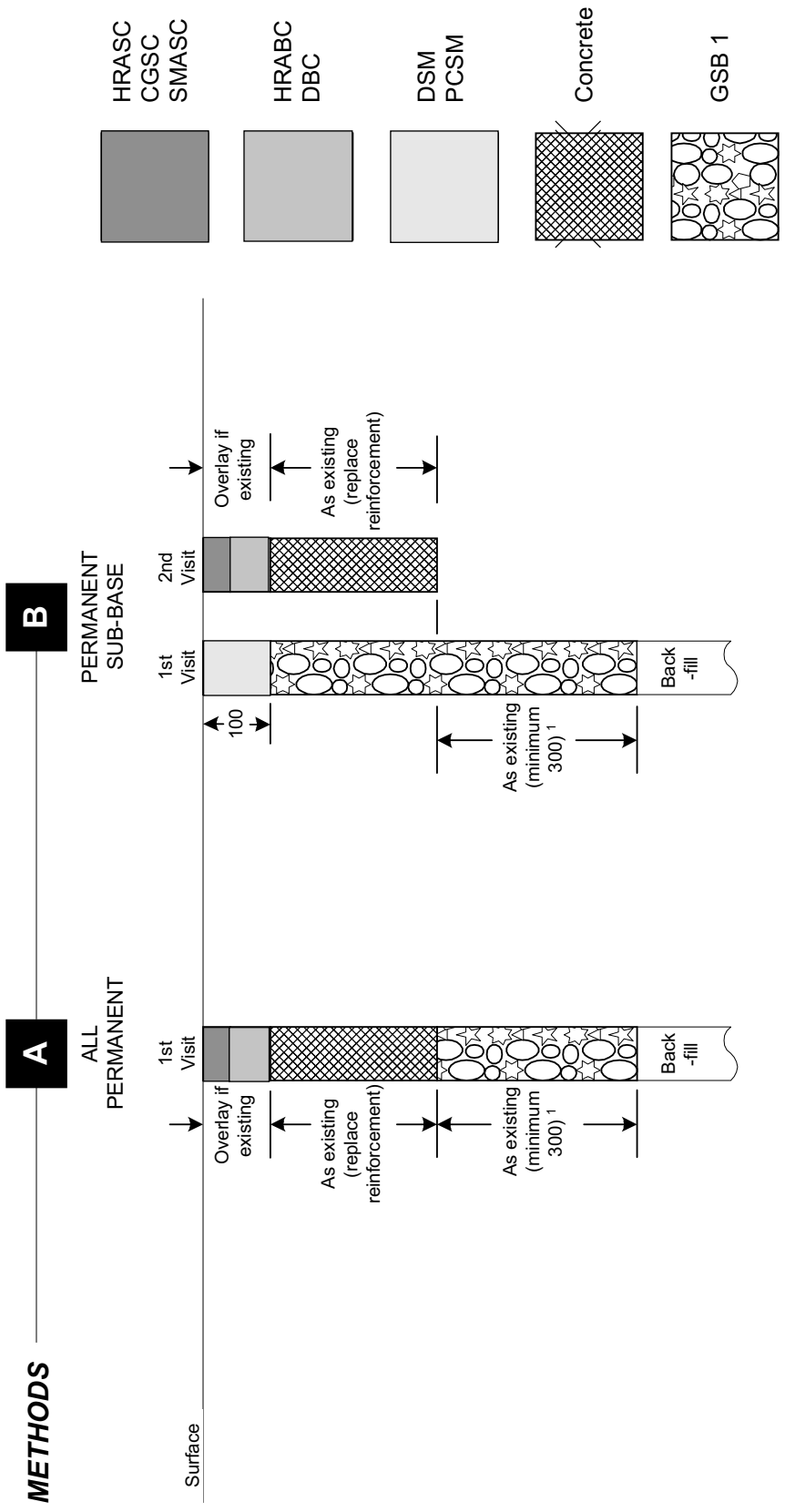
Appendix A4.5

Sub-base Construction - Composite Roads - Types '3' & '4'

- NOTES:
- 1). Class A Graded-granular material is permitted alternative
 - 2). For alternative reinstatement materials refer to Appendix A9

Appendix A5.0 Type 0 Rigid Roads

Scale 1:10



Appendix A5.0

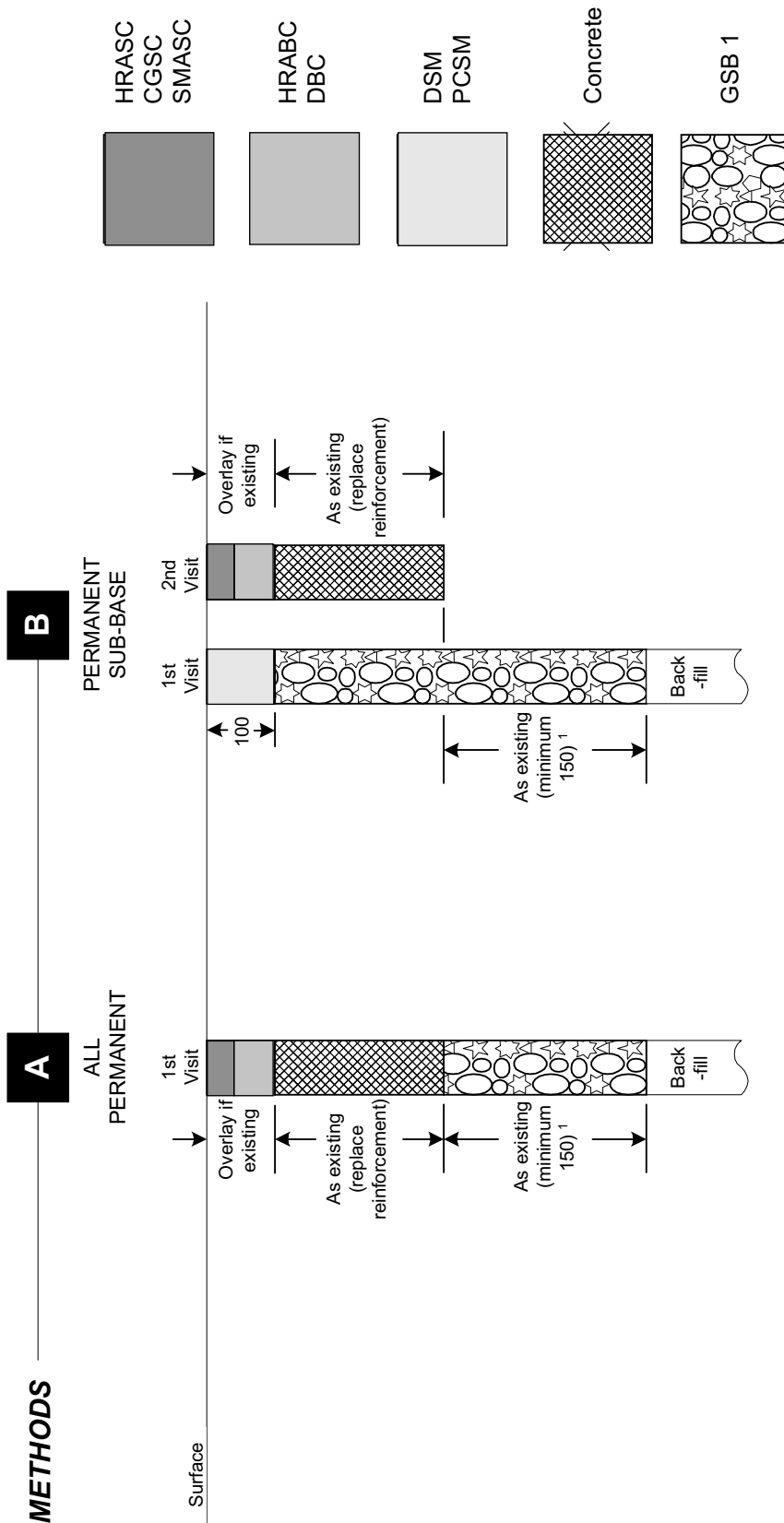
Rigid Roads Type - '0'

NOTES:

- 1). CBM 3 if existing
- 2). For alternative reinstatement materials refer to Appendix A9

Appendix A5.1 Type 1 Rigid Roads

Scale 1:10



Appendix A5.1

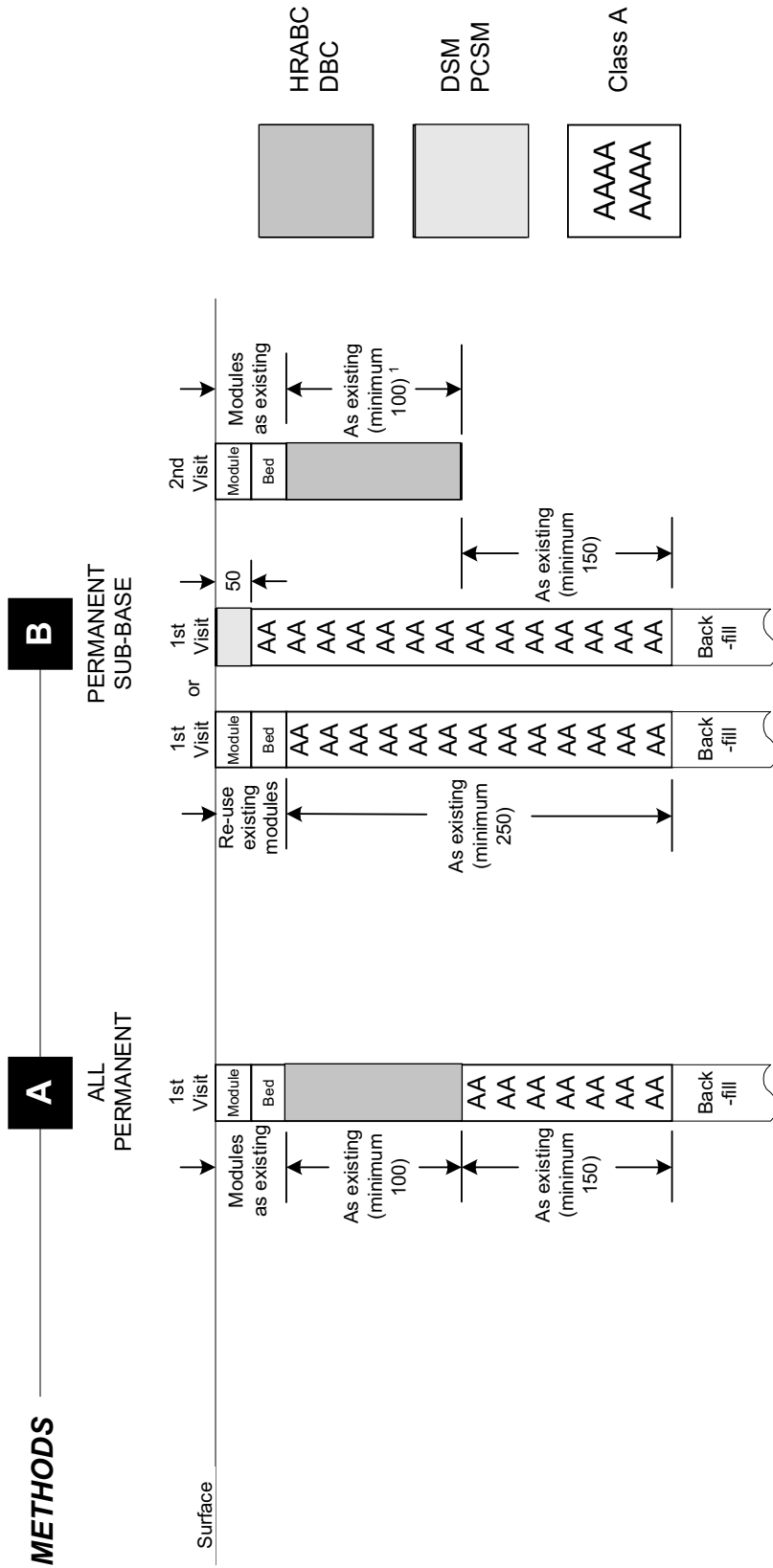
Rigid Roads Type - '1'

NOTES:

- 1). CBM 3 if existing
- 2). For alternative reinstatement materials refer to Appendix A9

Appendix A6.1 Types 3 & 4 Modular Roads – Bituminous Base (Roadbase)

Scale 1:10



Appendix A6.1

Modular Roads (Bituminous Base (Roadbase)) Types - '3' & '4'

NOTES:

- 1). May be permanently reinstated on the first visit
- 2). For alternative reinstatement materials refer to Appendix A9

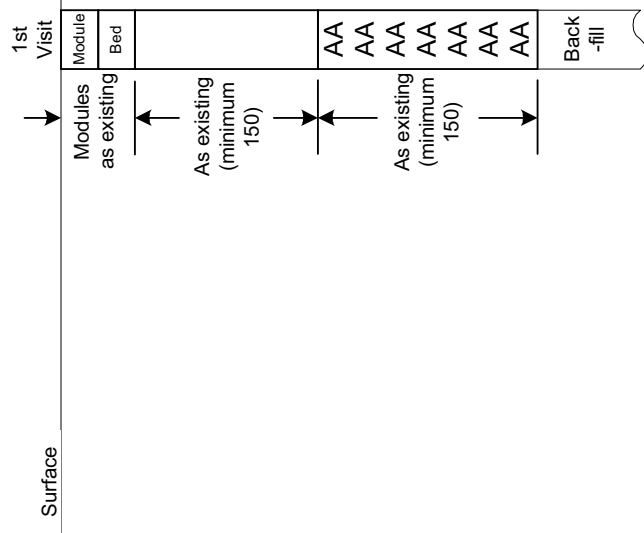
Appendix A6.2 Types 3 & 4 Modular Roads – Composite Base (Roadbase)

Scale 1:10

METHODS

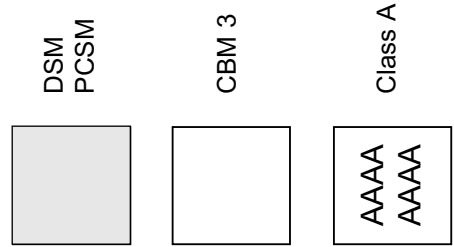
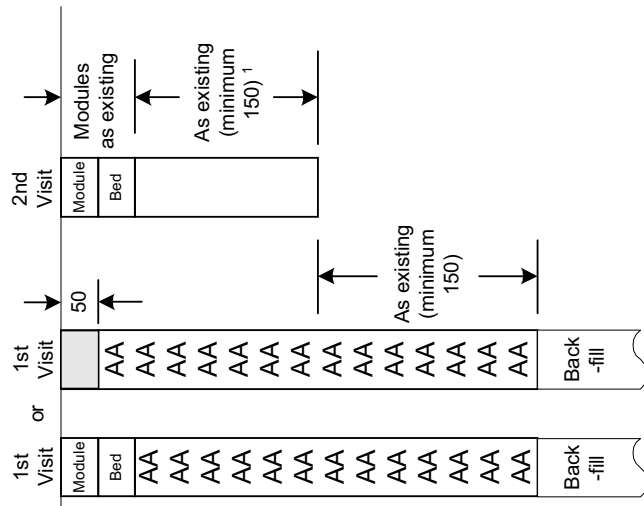
A

ALL PERMANENT



B

PERMANENT SUB-BASE



Appendix A6.2

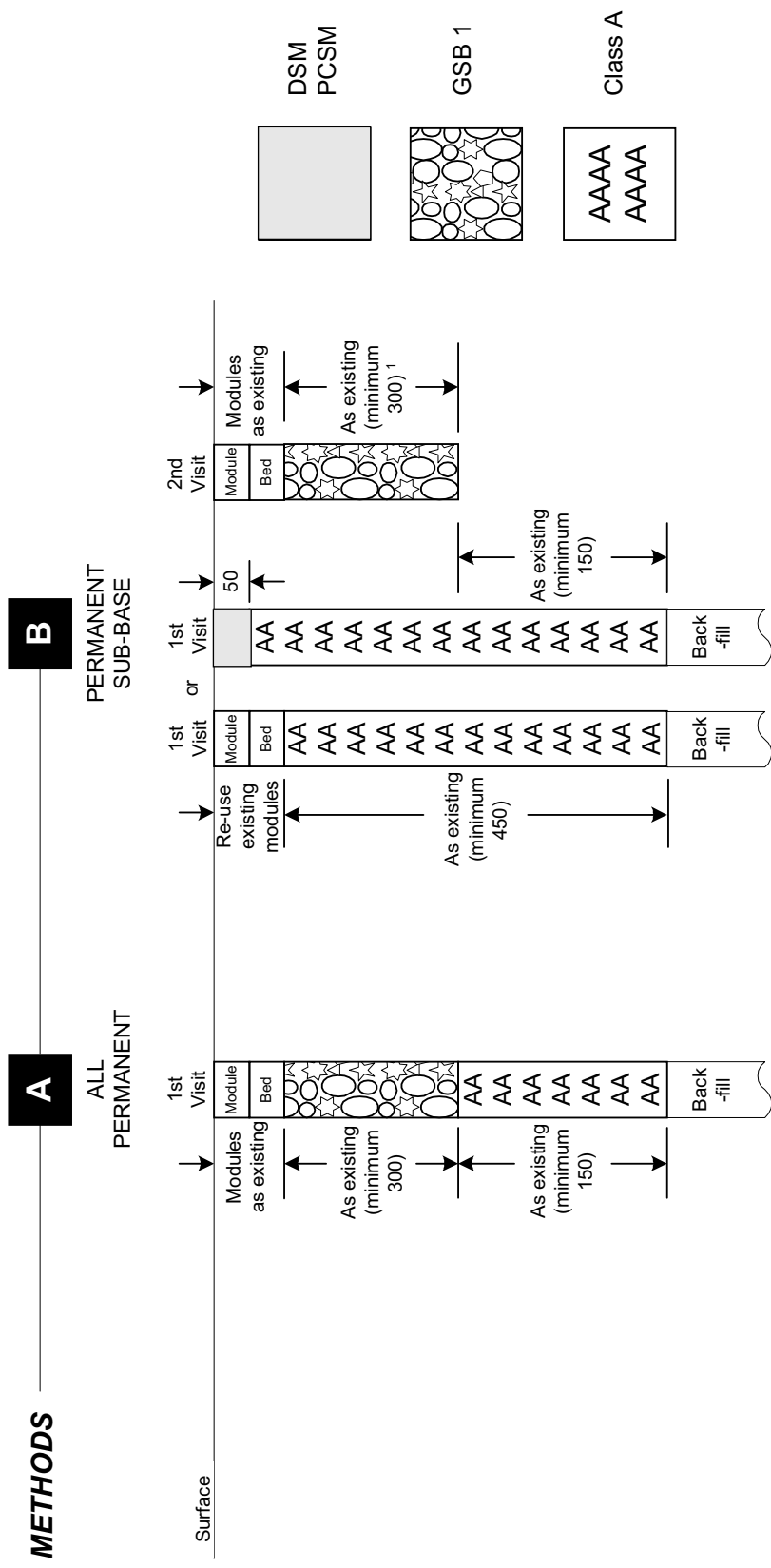
Modular Roads (Composite Base (Roadbase)) Types - '3' & '4'

NOTES:

- 1). May be permanently reinstated on the first visit
- 2). For alternative reinstatement materials refer to Appendix A9

Appendix A6.3 Types 3 & 4 Modular Roads – Granular Base (Roadbase)

Scale 1:10



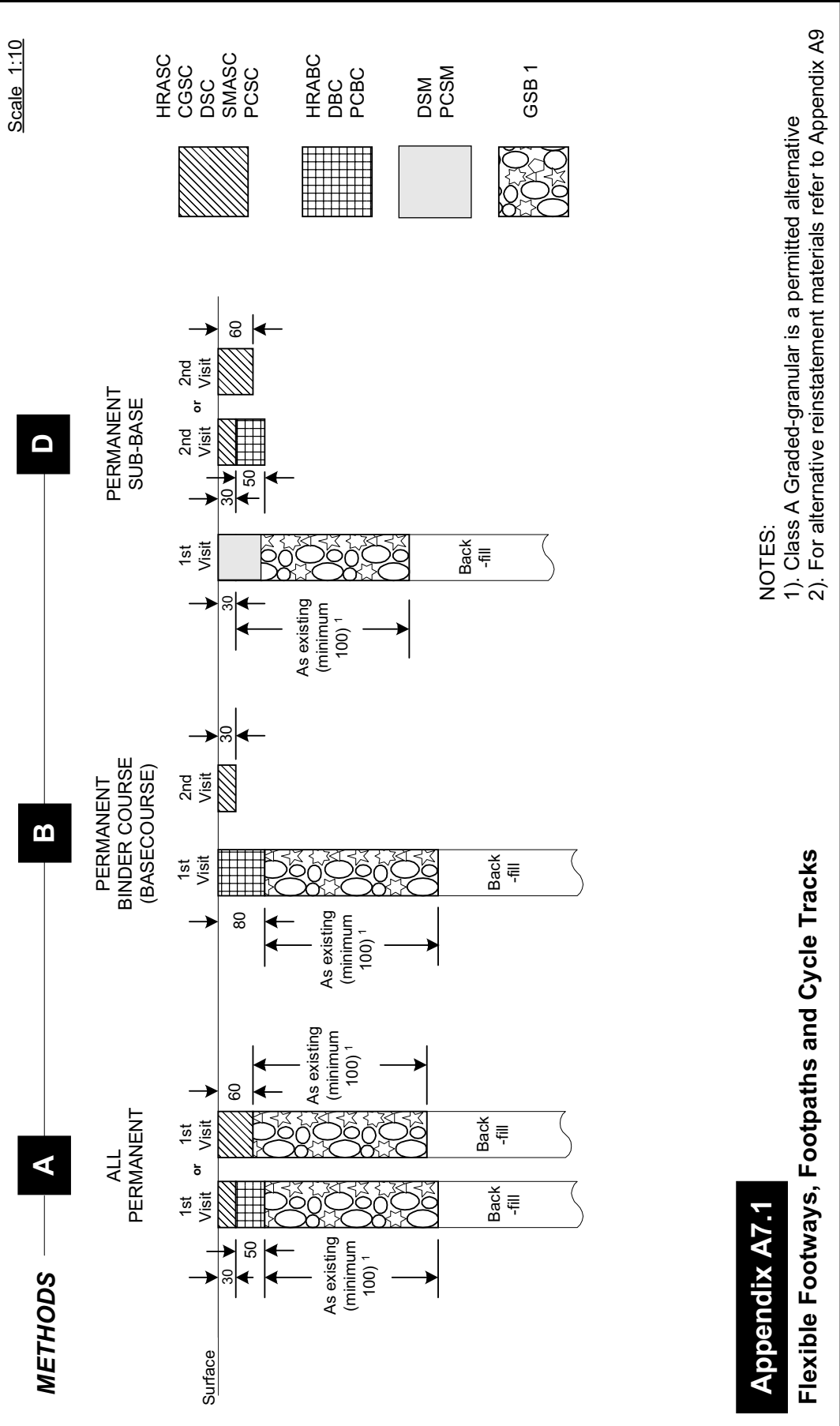
Appendix A6.3

Modular Roads (Granular Base (Roadbase)) Types - '3' & '4'

NOTES:

- 1). May be permanently reinstated on the first visit
- 2). For alternative reinstatement materials refer to Appendix A9

Appendix A7.1 Flexible Footways, Footpaths & Cycle Tracks



Appendix A7.1

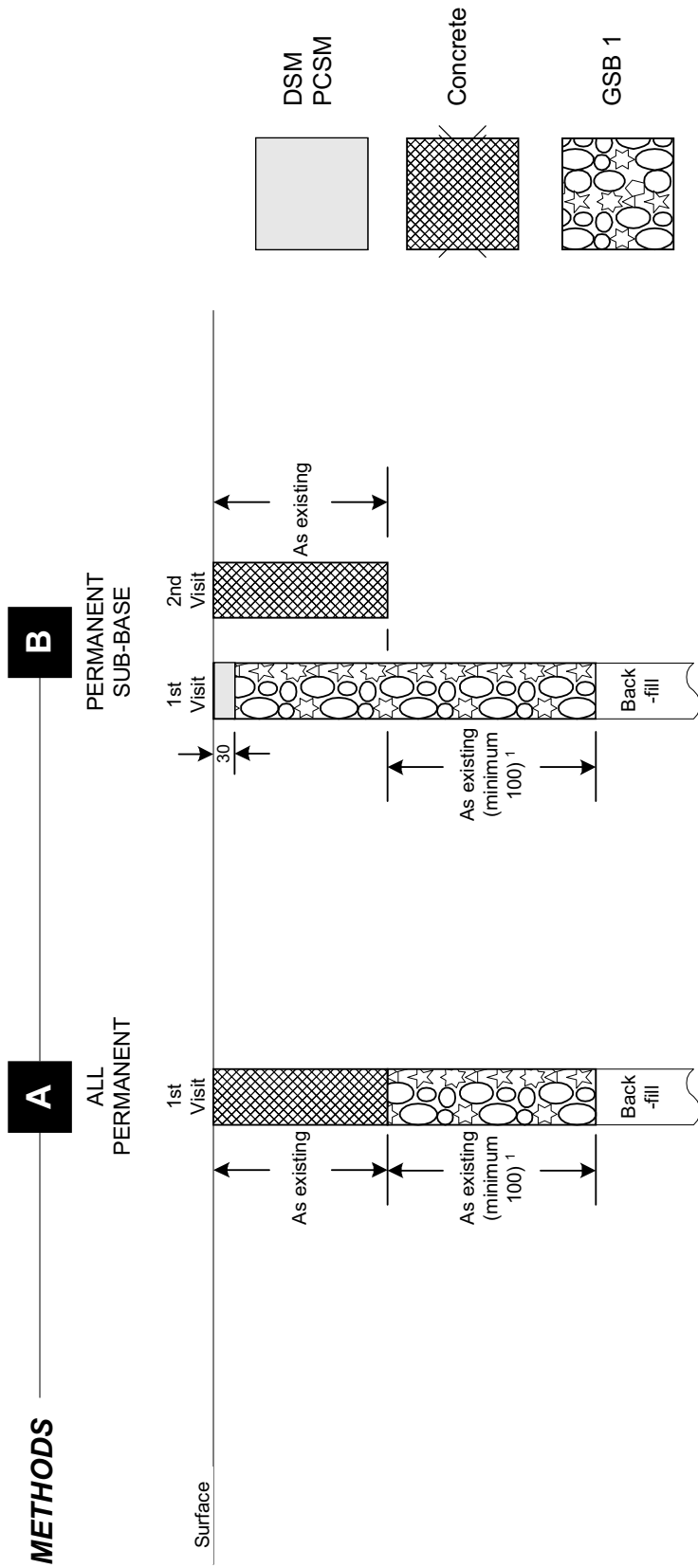
Flexible Footways, Footpaths and Cycle Tracks

NOTES:

- 1). Class A Graded-granular is a permitted alternative
- 2). For alternative reinstatement materials refer to Appendix A9

Appendix A7.2 Rigid Footways, Footpaths & Cycle Tracks

Scale 1:10



Appendix A7.2

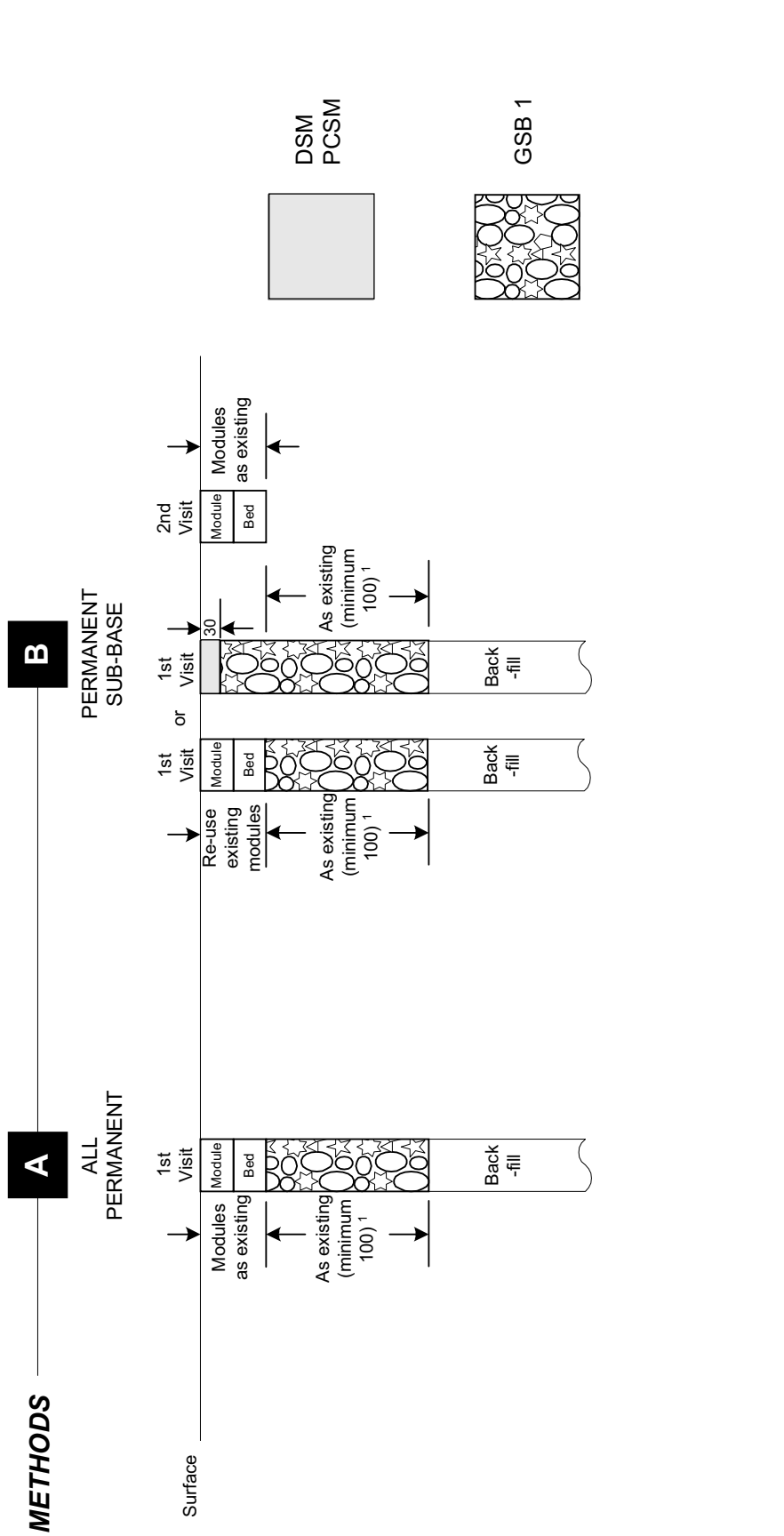
Rigid Footways, Footpaths and Cycle Tracks

NOTES:

- 1). Class A Graded-granular is a permitted alternative
- 2). For alternative reinstatement materials refer to Appendix A9

Appendix A7.3 Modular Footways, Footpaths & Cycle Tracks

Scale 1:10



Appendix A7.3

Modular Footways, Footpaths and Cycle Tracks

NOTES:

- 1). Class A Graded-granular is a permitted alternative
- 2). For alternative reinstatement materials refer to Appendix A9

APPENDIX A8

Compaction Requirements

A8.1 Cohesive and Granular Materials

All cohesive, granular, graded granular and cement bound granular materials laid before the surround to apparatus shall be compacted in accordance with Table A8.1.

Table A8.1 Compaction Requirements for Granular and Cohesive Materials						
Compaction Plant and Weight Category	Cohesive Material (less than 20% granular cement)			Granular Material (20% or more granular content including cement bound material)		
	Minimum Passes/Lift for compacted lift thickness up to			Minimum Passes/Lift for compacted lift thickness up to		
	100 mm	150 mm	200 mm	100 mm	150 mm	200 mm
Vibrotamper 50 kg minimum	4	8 #	NP	4	8	NP
Vibrating Roller Single Drum 1000-2000 kg/m	8	NP	NP	6	NP	NP
2000-3500 kg/m	3	6	NP	3	5	7
Over 3500 kg/m	3	4	6 #	3	4	6
Twin Drum 1000-2000 kg/m	4	8	NP	3	6	NP
Over 1800 kg/sq.m	2	3	5 #	2	3	4
Vibrating Plate 1400-1800 kg/sq.m	NP	NP	NP	5	NP	NP
Over 1800 kg/sq.m	3	6	NP	3	5	7
All Above Plant	For Maximum and Minimum compacted layer thickness See Appendix A2.6, Table A2.2					
Alternative Compaction Plant for Areas of Restricted Access (including small excavations and trenches less than 200 mm width)						
Vibrotamper 25 kg minimum	Minimum of 6 compaction passes Maximum of 100 mm compacted lit thickness					
Percussive Rammer 10 kg minimum						
Notes:						
1 NP = Not Permitted						
2 # = Not permitted on wholly cohesive material i.e. clay and/or silt with no particles > 75 micron (um)						
3 Single drum vibrating rollers are vibrating rollers providing vibration on only one drum						
4 Twin drum vibrating rollers are vibrating rollers providing vibration on two separate drums						

A8.2 Chalk Materials

All chalk materials, including medium and high density chalks shall be compacted in accordance with Table A8.2. However, if the chalk is unstable after compaction, the unstable material shall be removed and replaced with fresh material. The fresh chalk shall be compacted in accordance with Table A8.2, except that the specified number of compaction passes shall be reduced by one pass. If the chalk is still unstable after compaction, it shall be deemed to be unsuitable for use as backfill and replaced with alternative materials.

Table A8.2 Bituminous Materials			
Compaction Plant And Weight Category	Chalk Material Minimum Passes/Layer for compacted layer thickness up to		
	100 mm	150 mm	200 mm
Vibrotamper 50 kg minimum	3	6	NP
Vibrating Roller Single Drum 1000-2000 kg/m 2000-3500 kg/m Over 3500 kg/m	6 NP NP	8 4 NP	NP 6 4
Twin Drum 600-1000 kg/m 1000-2000 kg/m Over 2000 kg/m	6 2 NP	8 4 3	NP 6 4
Vibrating Plate 1400-1800 kg/sq.m Over 1800 kg/sq.m	6 NP	8 6	NP 8
All Above Plant	For Maximum and Minimum compacted layer thickness See Appendix A2.6, Table A2.2		
Alternative Compaction Plant for Areas of Restricted Access (including small excavations and trenches less than 200 mm width)			
Vibrotamper 25 kg minimum	Minimum of 6 compaction passes Maximum of 100 mm compacted lit thickness		
Percussive Rammer 10 kg minimum			
Notes for Table A8.2: 1 NP = Not Permitted 2 Single drum vibrating rollers are vibrating rollers providing vibration on only one drum 3 Twin drum vibrating rollers are vibrating rollers providing vibration on two separate drums			

A8.3 Bituminous Materials

All bituminous materials permitted in Appendix A2 shall be compacted to the following requirements:

- 1) Materials laid within any reinstatement as follows:
 - a) Reinstatement of 250 mm width or less;
 - b) Reinstatement within 250 mm of the edge of any other reinstatement; or
 - c) Reinstatement within 250 mm of a fixed feature within any reinstatement

Shall be compacted in accordance with Table A8.3.

- 2) Compaction should be discontinued if the material shows any signs of distress, regardless of whether the minimum number of passes required by Table A8.3 have been applied; see Section NG10.2.3.

3) Materials laid in all other locations shall be compacted to the in-situ air void requirements of Section S10.2.3. However, material requirements and laying conditions are unchanged and it will be necessary for compaction to be carried out to a procedure that is capable of achieving the in-situ air void content requirements.

Table A8.3 Compaction Requirements for Bituminous Mixtures				
Compaction Plant And Weight Category	Bituminous Material (all bituminous materials and asphalts) Minimum Passes/Layer for compacted layer thickness up to			
	40 mm	60 mm	80 mm	100 mm
Vibrotamper 50 kg minimum	5 #	7 #	NP	NP
Vibrating Roller Single Drum 1000-2000 kg/m 2000-3500 kg/m Over 3500 kg/m	6 5 4	NP 7 6	NP 8 7	NP NP NP
Twin Drum 600-1000 kg/m 1000-2000 kg/m Over 2000 kg/m	5 4 3	7 5 4	NP 6 4	NP 8 6
Vibrating Plate 1400-1800 kg/sq.m Over 1800 kg.sq.m	6 3	NP 5	NP 6	NP 8
All Above Plant	For Maximum and Minimum compacted layer thickness See Appendix A2.6, Table A2.1			
Alternative Compaction Plant for Areas of Restricted Access (including small excavations and trenches less than 200 mm width)				
Vibrotamper 25 kg minimum	Minimum of 6 compaction passes Maximum of 100 mm compacted lit thickness			
Percussive Rammer 10 kg minimum				
Notes for Table A8.3: 1 NP = Not Permitted 2 # =Vibrotamper not permitted on permanent surface course of trenches > 500 mm width 3 Twin drum vibrating rollers are preferred for compaction of bituminous materials 4 Single drum vibrating rollers are vibrating rollers providing vibration on only one drum 5 Twin drum vibrating rollers are vibrating rollers providing vibration on two seperate drums				

APPENDIX A9

Alternative Reinstatement Materials (ARMs)

A9.1 Introduction

1) New or alternative materials have been, or may be, developed for use in road construction and reconstruction. These materials may allow more rapid, reliable and cost-effective reinstatements, with less dependence on the skill and physical effort of the operators. These materials may also offer significant environmental or practical advantages, and/or cost benefits, compared with conventional materials, including various combinations of the following:

- a) Reduced usage of virgin materials, by including recycled, secondary or waste materials
- b) Lower energy requirements during manufacture
- c) Reduced landfill requirements during construction or reconstruction
- d) Self-cementing properties to improve reliability of laying and compaction
- e) Self-levelling or flowable, to avoid need for compaction
- f) May be placed in fewer layers

2) These materials are termed Alternative Reinstatement Materials (ARMs), and are categorised by this Specification into two generic groups:

a) **Structural Materials for Reinstatements (SMRs)**

This generic group is intended to include proprietary or alternative bound reinstatement materials that include a cementitious, chemical or hydraulic binder or are inherently self-cementing. SMRs are categorised as follows:

i) **Foamed Concretes for Reinstatements (FCRs)**

These are cement-bound materials that have been prepared off-site, generally as “prescribed” mixes, at an approved mixing plant and under appropriate quality control procedures. They are flowable in nature and should not require compaction when placed. Such materials manufactured under these conditions, and any foamed concretes conforming to Clause 1043 of the Specification for Highway Works are deemed to be approved for use as ARMs. FCRs may not necessarily incorporate an aggregate.

ii) **Flowable SMRs (FSMRs)**

These materials comprise of any type and combination of aggregates and binders. They are flowable mixes that should not normally require compaction, and will be capable of achieving strengths equivalent to FCRs. These materials may only be used on a trial basis by prior agreement.

iii) **Non-flowable SMRs (NFSMRs)**

These materials comprise of any type and combination of aggregates and binders. They are non-flowable mixes that will normally require compaction on site, and will be capable of achieving strengths equivalent to FCRs in their compacted state. These materials may only be used on a trial basis by prior agreement

b) **Stabilised Materials for Fills (SMFs)**

This generic group is intended to include materials derived from excavated spoil, virgin, secondary recycled or waste materials, or any combination thereof, that have been improved by re-processing, re-grading and/or by the inclusion of a cementitious, chemical or hydraulic binder. SMFs shall generally be non-flowable and shall therefore normally require compaction.

These materials may only be used on a trial basis by agreement.

A9.2 General Requirements for ARMs

- 1) With the exception of FCRs as described in A9.1.2 (a) (i) above, (which are deemed to be approved for use), ARMs shall only be used with the prior agreement of the Undertaker and the Authority on an approved trial basis. A trial procedure scheme is described in A9.5.
- 2) ARMs shall be prepared and installed in accordance with the approved mix formulations and procedures proven by prior development and testing.
- 3) Alterations to the proven mix formulations, mix proportions, aggregate type, admixtures, etc. shall not be undertaken without confirmation of their suitability, obtained by further development and testing. The approval of the Authority is required prior to the use of any ARM whose formulation has been altered.
- 4) ARMs used within 450mm of the road surface shall be non-frost susceptible subject to the exceptions referred to in S5.3.1.
- 5) Where the Authority is aware of areas with drainage or groundwater problems it should notify the Undertaker. Following such notification, the Undertaker shall provide at backfill and sub-base levels within trench reinstatements, ARMs that are permeable to a degree not less than the surrounding ground. A backfill layer of pea gravel, of 100 mm minimum thickness and surrounded by a geotextile filter fabric where appropriate, may be considered to offer an equivalent drainage potential.
- 6) Where the Authority is aware of any site where high sulphate levels are known to occur, it should notify the Undertaker. Following such notification, any Ordinary Portland Cement based binders in the ARMs shall be replaced with sulphate resistant Portland cement based binders.
- 7) Surfacing materials shall not be reinstated until the ARM has attained sufficient strength to allow adequate compaction of bituminous materials and to sustain adequate traffic loading. A simple penetration or indentation test is recommended to allow confirmation of adequate strength prior to surfacing. Any standardised test procedure may be used and, with prior experience, can indicate the earliest time at which surfacing may be carried out.
- 8) Fluid ARMs may flow into damaged drainage or ducting within, or adjacent to, the excavation. Where required, plastic sheeting etc. may provide adequate protection during pouring and curing

A9.3 Structural Materials for Reinstatements (SMRs)

A9.3.1 Permitted Usage of SMRs

- 1) SMRs may be used on a trial basis, by prior agreement, in any combination of the following, regardless of the nature of reinstatement materials used above and below:
 - a) At any position within the surround to apparatus and/or backfill, as the entire layer or combined with any other permitted backfill materials, in any proportion, within any reinstatement.
 - b) As a sub-base, within any reinstatement.
 - c) As combined sub-base and base (roadbase) within any reinstatement in Road Types 1, 2, 3 & 4.
 - d) As combined sub-base and binder course, within any reinstatement in footways, footpaths and cycletracks.
- 2) SMRs shall not be used in place of surface course materials.

A9.3.2 General Requirements for SMRs

- 1) SMRs shall comply with the minimum layer thicknesses and compressive strength requirements shown in Table A9.1

Table A9.1 SMR Minimum Layer Thickness and Compressive Strength Requirements						
Layer	Road Type					Footway Footpath or Cycle Track
	0	1	2	3	4	
Combined binder Course & Sub-base	NP	NP	NP	NP	NP	150 mm C2
Base (Roadbase) Alone	NP	NP	NP (see A9.2.1.1)	300 mm C2	200 mm C2	–
Base (Roadbase) & Sub-base	NP (see A9.2.1.1)	450 mm C4	450 mm C4	450 mm C2	350 mm C2	–
Sub-base &/or below	150 mm C2	150 mm C2	150 mm C2	150 mm C2	150 mm C2	100 mm C2
Crushing Strength at 90 days	C4 – 4 N/mm ² Minimum to 10 N/mm ² Maximum C2 – 2 N/mm ² Minimum to 10 N/mm ² Maximum					
Note to Table A9.1:	NP = Not Permitted ref A9.3.1					

- 2) Where the total thickness of SMR laid exceeds 1000 mm, any minimum crushing strength requirement of 4N/mm^2 shall apply to the top 1000 mm only.

A9.3.3 Particular Requirements for FCRs and FSMRs

- 1) The compressive strength shall be determined in accordance with the principles of BS1881: Part 116 or Part 120, with the following exceptions or options:
 - a) Test specimens may be prepared at the time of placement by casting within a test mould, or recovered from site after placement by the extraction of cores from the reinstatement.
 - b) Cast specimens may be conventional test cubes with a nominal side length of 150 mm, or they may be cylindrical with a diameter in the range 150 - 300 mm and an aspect ratio of 1.0. Moulds may be manufactured from cellular foam (preferably polystyrene) and include a cellular foam lid. The samples shall not be compacted, except for minimal tamping to allow the mould to be filled without leaving excessive regions of voidage.
 - c) Core test specimens shall be cylindrical, with a diameter in the range 150 - 300 mm and an aspect ratio of 1.0. The top and bottom surfaces of the test specimen may be grouted to ensure flat, parallel loading surfaces.
 - d) Following preparation or recovery, the test samples shall be stored upright, at ambient temperature until 90 days have elapsed from the placement of the material on site. Accelerated curing at temperatures exceeding 25°C is not permitted.
- 2) Experience suggests that results obtained from 150 mm test cubes, in lidded cellular foam moulds, stored at ambient temperature, within the mould, are most representative of in-ground conditions.
- 3) FCRs and FSMRs shall not normally be tamped or otherwise compacted.
- 4) FCRs and FSMRs of density less than 1000 kg/m^3 may not displace standing water. In excavations containing water, the minimum recommended density for foam concretes is 1050 kg/m^3 . FCRs may flow into, and block, damaged drainage or ducting within, or adjacent to, the excavation. Where required, plastic sheeting etc. may provide adequate protection during pouring and curing.
- 5) FCRs and FSMRs are unlikely to provide significant load bearing capacity for several hours after mixing, depending on the ambient temperature. During this time, unguarded reinstatements may be a hazard to children and animals etc and shall be protected.

A9.3.4 Particular Requirements for NFSMRs

- 1) The compressive strength of NFSMRs shall be determined in accordance with the principles of BS1881: Part 116 or Part 120, with the following exceptions or options:
 - a) Test specimens may be prepared at the time of placement by compaction of a sample of material within a test mould, or, preferably, recovered from site after placement, by the extraction of cores from the reinstatement.
 - b) Specimens prepared on site may be placed in conventional steel test cubes with a nominal side length of 150 mm, or in cylindrical steel moulds with a diameter in the range 150 - 300 mm and an aspect ratio of 1.0. Compaction shall be applied in order to achieve a specimen density between 95% and 105% of that achieved on site.

- c) Core test specimens shall be cylindrical, with a diameter in the range 150 - 300 mm and an aspect ratio of 1.0. The top and bottom surfaces of the test specimen may be grouted to ensure flat, parallel loading surfaces.
 - d) Following preparation or recovery, the test samples shall be stored upright, at ambient temperature until 90 days have elapsed from the placement of the material on site. Accelerated curing at temperatures exceeding 25°C is not permitted.
- 2) NFSMRs shall normally require compaction to ensure adequate strength. The compaction regime (i.e. details of plant type, weight category, layer thicknesses and number of passes) shall be specified before the NFSMR is used, and should be obtained by prior development and testing.

A9.3.5 SMR Material Production

A9.3.5.1 FCR Material Production

- 1) FCRs shall be produced from virgin aggregates to prescribed mix formulations at an approved mixing plant, in accordance with approved preparation procedures and under approved quality control procedures. FCRs conforming to SHW Clause 1043 are deemed to be approved for use.
- 2) The wet density of the FCRs should be checked when required, prior to placement. Depending on the method of manufacture, the quality of any foam added at site should be checked prior to addition to the mix. Any on-site addition of foaming agents must be in accordance with the prescriptions of the approved mix design.

A9.3.5.2 FSMR and NFSMR Material Production

- 1) FSMRs and NFSMRs shall be prepared in accordance with the procedures set out in the Approval Trial Agreement (see A9.5), to the approved mix formulation(s) (obtained by prior development and testing), to achieve the required compressive strength. Binders, additives and admixtures may be included as agreed and based on prior development and testing.
- 2) FSMRs and NFSMRs may be delivered to site as ready-made materials or be prepared partly or wholly on site.
- 3) Mixing may be carried out using any equipment, adapted as necessary for the manufacture of FSMRs and NFSMRs in quantities appropriate to the intended usage, provided the approved mixing procedure is used throughout. Mixing equipment should be maintained in accordance with the manufacturer's recommendations and checked regularly. All metering or weighing apparatus should be calibrated regularly.
- 4) All binders, additives and admixtures, including diluted solutions thereof, should be stored according to the manufacturer's recommendations and used within the recommended shelf life.
- 5) NFSMRs shall be compacted in accordance with the manufacturer's recommendations or an agreed compaction regime obtained by prior development and testing.

A9.4 Stabilised Materials for Fill (SMFs)

A9.4.1 Permitted Usage of SMF Materials

- 1) SMFs may be used in place of other materials on a trial basis by prior agreement, in the layers appropriate to their strength classification as defined by Table A9.2, and

regardless of the nature of reinstatement materials used above and below, in any combination of the following:

- a) At any position within the surround to apparatus and/or backfill, as the entire layer or combined with any other permitted backfill materials, in any proportion, within any reinstatement.
 - b) As a sub-base, within any reinstatement.
 - c) As a combined surround to apparatus and/or backfill and/or sub-base, within any reinstatement.
- 2) SMFs shall not be used in place of the permanent binder course or surface course.

A9.4.2 Overall Requirements for SMFs

1) Each stabilisation method and formulation shall be classified as yielding SMF materials equivalent to one of the four defined classes of backfill material permitted in Appendix A1, as follows:

- a) Class A SMF Material - equivalent to Class A Graded Granular Backfill Material;
- or b) Class B SMF Material - equivalent to Class B Granular Backfill Material;
- or c) Class C SMF Material - equivalent to Class C Cohesive/Granular Backfill Material;
- or d) Class D SMF Material - equivalent to Class D Cohesive Backfill Material.

2) In addition stabilised materials that achieve CBR values in excess of 30% are designated class ‘S’ SMF materials and may be used as a combined backfill and sub-base.

3) The SMF material classification shall based on the “soaked” %CBR or equivalent value proven during the development and laboratory testing, in accordance with Table A9.2.

Table A9.2 SMF Strength Requirements	
SMF Class	% CBR
S	Over 30
A	15 to 30
B	7 to 15
C	4 to 7
D	2 to 4

4) The %CBR value shall be determined by laboratory testing in accordance with the principles of BS1377, with the following exceptions or options:

- i) Conventional test moulds may be unsuitable for some SMF materials, for which in-situ testing may need to be considered. The preparation of SMF test samples is not restricted and may include test cores extracted from site.
- ii) Following preparation, the test samples shall be stored at ambient temperature until a period of 90 days has elapsed from the placement of the material on site.
- iii) The laboratory CBR test shall be performed on samples in a soaked condition.
- iv) The test results shall be verified by a UKAS accredited laboratory.

- v) On site, using a recognised appropriate direct or indirect test method.

A9.4.3 SMF Material Production

- 1) SMFs shall be prepared in accordance with the procedures set out in the Approval Trial Agreement (see A9.5), to the approved mix formulation(s) (obtained by development and testing), to achieve the required strength classification. Binders, additives and admixtures may be included as agreed and based on prior development and testing.
- 2) SMFs shall normally be prepared on site from basic constituents or delivered to site as a ready-made fill material. However subject to experience gained by prior development testing, the mix may, by prior agreement, be prepared, wholly or partially, away from the site.
- 3) Mixing may be carried out using any equipment, adapted as necessary for the manufacture of SMFs in quantities appropriate to the intended usage, providing the approved mixing procedure is used throughout. Mixing equipment should be maintained in accordance with the manufacturer's recommendations and checked regularly. All metering or weighing apparatus should be calibrated regularly.
- 4) All binders, additives and admixtures, including diluted solutions should be stored according to the manufacturer's recommendations and used within the recommended shelf life.
- 5) SMFs shall be compacted in accordance with the manufacturer's recommendations or an agreed compaction regime obtained by prior development and testing.

A9.5 Outline Scheme for Approval Trials

A9.5.1 Introduction

- 1) It is anticipated that individual Undertakers or Authorities may wish to undertake or permit approval trials of ARMs for the purposes of development and/or performance assessment.
- 2) Trials may be carried out by the agreement of an Undertaker and Authority, in the form of an Approval Trial Agreement. This section outlines a scheme under which trials of ARMs can be carried out.

Section 9.5.2.1 gives general guidance relating to the organisation of an approval trial.

Section 9.5.2.2 describes special conditions relating to the scale of an approval trial and its effects on organisational and reporting matters.

Section A9.5.2.3 outlines the intended duties of each party to the approval trial.

Section A9.5.3 comprises a list of headings that describe the key requirements and stages of an Approval trial. The headings are considered to represent the minimum essential information required to ensure that the approval trials are carried out in a controlled and agreed manner. The additional information under each heading given in parentheses is for guidance only. The parties to the approval trials (normally an Undertaker (who would generally initiate or request the trial) and an Authority) may, by agreement, add, alter or omit any details that do not affect the legal standing of the Agreement.

A9.5.2 General Requirements, Special Considerations and Duties of Parties to Approval Trials

A9.5.2.1 General Requirements for Approval Trials

- 1) No approval trials shall be undertaken within a Type 0 or 1 road or high amenity or high duty footway, footpath or cycletrack, or a site of Special Engineering Difficulty.
- 2) Approval trials in carriageways should be conducted on a minimum of two separate sites, representing a range of traffic conditions. A range of positions within the carriageway (i.e. within and outside the wheel track, longitudinal and transverse orientation (for trench reinstatements)) should also be considered.
- 3) The duration of all approval trials shall be two years; the final inspection being completed within one month following the end of the two-year test period. The Undertaker shall notify the Authority of the inspection date at least 14 days in advance. The inspection measures should be carried out on the notified date or an agreed alternative date, regardless of whether the Authority has confirmed its attendance. Where the Authority does not attend the final inspection, the Undertaker shall provide the Authority with a summary within 28 days of the inspection. The Undertaker should keep a photographic record of the approval trial reinstatements at the time of inspection.
- 4) Core sampling and interim inspections of any type may be carried out on approval trial reinstatements at any time. Where required as part of the approval trial agreement, the Undertaker shall notify the Authority at least five days in advance of such works. Any holes created during these activities should be reinstated in accordance with the relevant requirements of this Specification.
- 5) Approval trial reinstatements may be accidentally damaged during the trial and rendered unsuitable for accurate assessment. It is therefore recommended that trials should include duplicate sites for each road type, category, position, orientation, etc.
- 6) Where an approval trial reinstatement requires remedial action, regardless of the reason, the Undertaker shall provide the Authority with details of the remedial measures within one month of completion. Where practicable, records of surface measurements, photographs etc taken before and after the remedial work should be kept by the Undertaker.
- 7) On completion of the Approval trial, and by agreement of the parties, some or all of the details of the trials may be forwarded to Area RAUC and or RAUC Scotland.
- 8) The further use of ARMs on the successful completion of the Approval trial shall be permitted only with the specific written approval of the relevant Authority. Such approval shall not be unreasonably withheld.

A9.5.2.2 Special Considerations for Approval Trials

It is recognised that the scope, extent and duration of ARM Approval trials may vary widely.

- 1) For small-scale approval trials intended to take place on a small number of sites and over a fixed time period (e.g. for specially prepared approval trial excavations), the Undertaker shall notify the Authority at least one month in advance of its start of the approval trial.

Specially prepared excavations should be of similar depth and plan dimensions to the Undertaker's routine excavations, and generally not less than 500 mm by 500 mm in plan, or not less than 200 mm wide for trench excavations. The total combined surface area of all approval trial sites should not be less than 2 square metres.

The location and position of the approval trial reinstatements should represent as wide a range as possible (see A9.5.2.1 2). If specially prepared sites are to be used, the site locations may be selected to achieve this.

The Authority shall confirm their intention to attend, or otherwise, within seven days of receipt of such notification from the Undertaker. The approval trial should commence on the notified date, or a mutually agreed alternative date, regardless of whether the Authority has confirmed attendance. Where the Authority does not attend, the Undertaker should keep a photographic record of the approval trial.

2) Approval trials of a larger extent, (e.g. trials that use an Undertaker's routine excavation sites as the approval trial sites) may take place over a longer time period and the Undertaker shall notify the Authority at least one month in advance of the start of the approval trial period. Arrangements for notification and attendance at these Approval trials should be included in the trial agreement.

Any restrictions as to the size, location and position, total number of approval trial sites and/or the period during which the approval trial reinstatements may be carried out, should also be included in the approval trial agreement.

The two-year approval trial period shall apply to each approval trial reinstatement, commencing on its date of installation. Any final review or reporting need not be carried out until the final approval trial site has reached an age of two years.

Any approval trial shall be completed within 6 months.

A9.5.2.3 Duties of Parties to Approval Trials

1) The initiator (usually the Undertaker) would be expected to have carried out documented development work to ensure confidence in the proposed process before the commencement of the approval trial. The results of such development work should not be unreasonably withheld from the Authority.

2) The Undertaker shall provide as much notice of the approval trial reinstatement operation(s) (e.g. location, date/time, excavation, mixing, reinstatement, sampling, post-construction activities etc) as practically possible, in accordance with the requirements of A9.5.3.1 of the approval trial agreement.

3) The Undertaker shall not unreasonably withhold information relating to any aspect of the approval trial from the Authority.

4) The Authority shall not unreasonably obstruct the commencement, progress, or cause the termination of, the approval trials provided they are carried out in accordance with the terms of the approval trial agreement.

5) Either party shall have the right to request confidentiality of any matter relating to the approval trial. Such a request must not be unreasonably refused by the other party.

A9.5.3 Suggested Information for Inclusion in Approval Trial Agreement

Prior to the commencement of the trials, the following information should be considered by both parties for inclusion in the Approval Trial Agreement.

A9.5.3.1 General Information

Parties to trial - names of Undertaker and Authority agreeing to approval trial

Confidentiality - parties (if any) to whom trial information may be divulged

Geographical extent of trial - county or district border, utility region or area boundary

Scope of approval trial - time period or total number of trial reinstatements

Start date/time limit for trial - start/end dates or maximum number of sites

Determination - conditions under which agreement may be ended, notice of termination etc

Signatories/witnesses - approved officers of appropriate seniority who are permitted to commit their organisation to the terms of the approval trial

A9.5.3.2 Procedural Information

Contemporary records - details of records required, responsibility for record-keeping

Notification details - notice periods, arrangements contacting relevant persons

Attendance at trials - parties who may attend, whether compulsory or voluntary

Review periods/meetings - dates, attendees, procedures for calling ad hoc meetings

Reporting requirements - organisations or persons responsible

Post-construction assessment - arrangements for periodic surveying, sampling, etc

A9.5.3.3 Technical Information

Type of trial site - routine utility excavations or specially excavated approval trial sites

Location of trial site - footway, cycletrack, (including road classification 0 to 4) etc

Positioning of trial site - “as excavated” or within wheeltrack, etc

ARMs to be trialled - SMR or SMF

ARM details - Mix formulation(s), binder details, other additives, mix formulation dependencies on site conditions or excavated/base material type and condition, details of prior development work

ARM preparation - batching, mixing and placement procedures

Quality control on site - any tests to be applied to ensure that the ARM has been prepared to the required formulation

Compaction regime - normally for NFSMRs and SMFs only

Sampling requirements - types of samples and sampling frequency

Testing laboratories - contact details of accredited laboratories

Remedial measures for “failed” sites - replacement with ARM or approved materials

Future of trial sites - remove after trial completion or leave in place, future monitoring

APPENDIX A10

Permanent Cold-lay Surfacing Materials – (PCSMs)

A10.1 Introduction

1) Conventional hot-lay bituminous materials generally require heated and/or insulated transport and are especially difficult to lay when the required quantity is small or the site is remote from the nearest coating plant. Cold-lay surfacing materials can be formulated to give a performance equivalent to hot-laid materials, yet remain workable for several days, at least, without degradation during storage and transport. Such materials may allow a higher degree of immediate permanent reinstatement in small or remote excavations that represent much of an Undertaker's workload. Such materials are termed Permanent Cold-lay Surfacing Materials (PCSMs).

A10.2 Permitted Usage of Approved PCSM Materials

1) The overall PCSM material formulation, manufacture and placement are limited only by the need to comply with the BBA/HAPAS guideline for approval and certification of Permanent Cold-lay Surfacing Materials (PCSM's) December 1999 which includes procedures for the testing of potential PCSM materials within the public road and formal approval procedures for their use within Scotland.

2) Approved PCSMs, laid and compacted in accordance with Appendix A8, may be used in substitution for any permitted bituminous material, at the discretion of the Undertaker, as follows:

- a) Deferred Set Material (DSM), at any position, in all reinstatements.
 - b) Permanent Cold-lay Surfacing Material (PCSM), at any position, in all reinstatements in footways, footpaths and cycletracks.
 - c) Permanent Cold-lay Binder Course (PCBC) in all reinstatements in Type 3 & 4 roads.
 - d) Permanent Cold-lay Surface Course (PCSC) in all reinstatements in Types 2, 3 & 4 roads.
- 3) Whenever a potential PCSM binder has begun a PCSM approval trial, regardless of aggregate or material formulation under trial, then any material manufactured using that binder shall be considered to be an approved Deferred Set Material to BS 4987 (DSM), for interim use only, with immediate effect.

A10.3 Unsuccessful PCSM Approval Trials

1) Where any PCSM material fails to meet the requirements for BBA/HAPAS approval at the conclusion of a carriageway trial, the following remedial actions shall be carried out:

- a) Where a PCSM material fails to meet the specified NAT test requirements, then the Undertaker, at the discretion of the Authority, shall normally be required to replace all failed PCSM materials with hot materials, in accordance with the Specification requirements. However, the Authority is recommended to consider the acceptance, within locations subject to light traffic only, of approval trial reinstatements that otherwise comply with the specified surface profile criteria.
- b) Where PCSM materials meet the specified NAT test requirements, then only trial reinstatements failing to comply with the specified surface profile criteria are liable to be replaced.

- 2) Where a PCSM material fails to meet approval requirements at the conclusion of a footway trial, then only individual trial reinstatements failing to comply with the specified surface profile criteria are liable to be replaced.
- 3) Where a PCSM material fails to meet approval requirements at the conclusion of an approval trial, BBA/HAPAS shall notify RAUC Scotland accordingly. RAUC(S) shall then inform area RAUC committees.

APPENDIX A11

Bitumen Binder Equivalence

A11.1 Introduction

In some road types, particular binder grades are not permitted or are not permitted for machine-lay. In general, hand laying is not recommended where the material is likely to be difficult to compact adequately, especially in cold conditions.

A11.2 Base (Roadbase) and Binder Course Materials

Binder grades permitted for base (roadbase) and binder course materials are shown in Table A11.1, provided that the layer thickness is amended to that shown in the table. Alteration in the layer thickness is permitted.

Table A11.1 Permitted (Roadbase)/Binder Course Binder Grades and Layer Thickness								
Material	Bitumen Stiffness	Combined Base (Roadbase)/Binder Course (mm)					Binder Course Only (mm)	
		Road Type						
		0	1	2	3	4	3	4
20 mm DBC	200 pen	NP	NP	NP	NP	155 H	NP	85 H
	100 pen	410 H	260	210	150	110	60	60
	70 pen	380	215	180	135	105	60	60
	50 pen	360	200	165	120	100	60	60
50/20 HRABC	100 pen	NP	NP	275 H	215 H	155 H	85 H	85 H
	70 pen	NP	NP	245	190	135	75	75
	50 pen	360	260	210	150	110	60	60

Notes:
 1 NP = Not Permitted
 2 H = Hand-lay only – not recommended for hot conditions & not permitted for machine-lay

A11.3 Surface Course Materials

Binder grades permitted for surface course materials are shown in Table A11.2. No alteration in the layer thickness is permitted.

Table A11.2 Permitted Surface Course Binder Grades						
Material	Bitumen Stiffness	Road Type				
		0	1	2	3	4
10 mm CGSC	200 pen	NP	NP	NP	✓ H	✓ H
	100 pen	NP	NP	NP	✓	✓
	70 pen	NP	NP	NP	✓	✓
	50 pen	NP	NP	NP	✓	✓
30/14 HRAWC	100 pen	NP	NP	NP	✓ H	✓ H
	70 pen	NP	NP	✓	✓	✓
	50 pen	✓	✓	✓	✓	✓
10 & 14 mm SMA	100 pen	H	H	H	H	H
	70 pen	✓	✓	✓	✓	✓
	50 pen	✓	✓	✓	✓	✓

Notes:
 1 **NP** = Not Permitted
 2 **H** = Hand-lay only – not recommended for hot conditions & not permitted for machine-lay

APPENDIX A12

Reinstatement of Modular Surface Layer

A12.1 Interim Reinstatement

Where an interim reinstatement is required, the existing modules should be reused, including the use of broken modules. Where damage has resulted in fragmentation or widespread breakage of modules, then bituminous material may be used for interim reinstatement, provided they meet the performance requirements of Section S2 and that compaction of such material does not result in further damage to adjacent modules.

A12.2 Permanent Reinstatement

- 1) Permanent reinstatement of modular surface layers should be generally carried out in accordance with BS 7533.
- 2) Permanent reinstatement of modules shall include all modules which are situated within or extend beyond the effective width of the excavation (W) described in S2.1.4 and shall also include any other modules which are disturbed in the course of carrying out the excavation.
- 3) Clean undamaged modules shall be re-used for permanent reinstatement; broken modules shall not be used for permanent reinstatement and shall be replaced.
- 4) Bedding material shall be sand or mortar, to match the characteristics of the existing type and thickness. Sand, mortar or other grouting, to match the performance of the existing, shall be applied to gaps between individual modules at the time of permanent reinstatement.

A12.3 Provision of Replacement Modules

- 1) Where insufficient modules remain for reinstatement use and identical replacement modules are no longer available, then a reasonably similar colour, shape and size shall be the preferred order of criteria in the choice of acceptable replacements.
- 2) Where replacement modules are required due to breakage at some time prior to the Undertaker's works, the Authority may provide suitable replacements to the Undertaker, free of charge.
- 3) Where replacements modules are required due to breakages caused during the course of the Undertaker's works, the Undertaker shall reinstate using modules purchased at the Undertaker's expense or purchased from the Authority at reasonable cost.
- 4) Authorities are recommended to retain stocks of modules used within their areas to enable them to provide replacements when required. Where no stocks of suitable replacements are available, Authorities should assist Undertakers in locating a source of suitable replacement modules.

A12.4 Pre-existing Surface Damage Outside Limits of Undertaker's Works

- 1) Some modular surfaces outside of the limits of the Undertaker's works may be broken or have settled or deformed. Where the existing profiles are near or exceed the current intervention and construction tolerances specified in S2, it will be difficult for the Undertaker to construct a complying reinstatement. Subject to the Authority agreeing to meet the costs of the works necessary to reinstate the surfaces outside the

limits of its works, the Undertaker shall extend its reinstatement works to include such surfaces. In the absence of agreement, the Undertaker shall be under no obligation whatsoever to extend its reinstatement works but shall use its best endeavours to ensure that the interface between its reinstatement and the adjoining surfaces avoid creating hazardous trips. In such situations, it must be recognised that it may be necessary to install different sized modules or fillets to minimise surface irregularities at the interfaces. The Undertaker shall use its best endeavours to match existing materials and profiles and meet the tolerances specified in S2.

2) Where the area of permanent reinstatement needs to be substantially extended, to include an existing area of broken or settled modular surfacing, the Undertaker shall notify the Authority prior to the commencement of works.

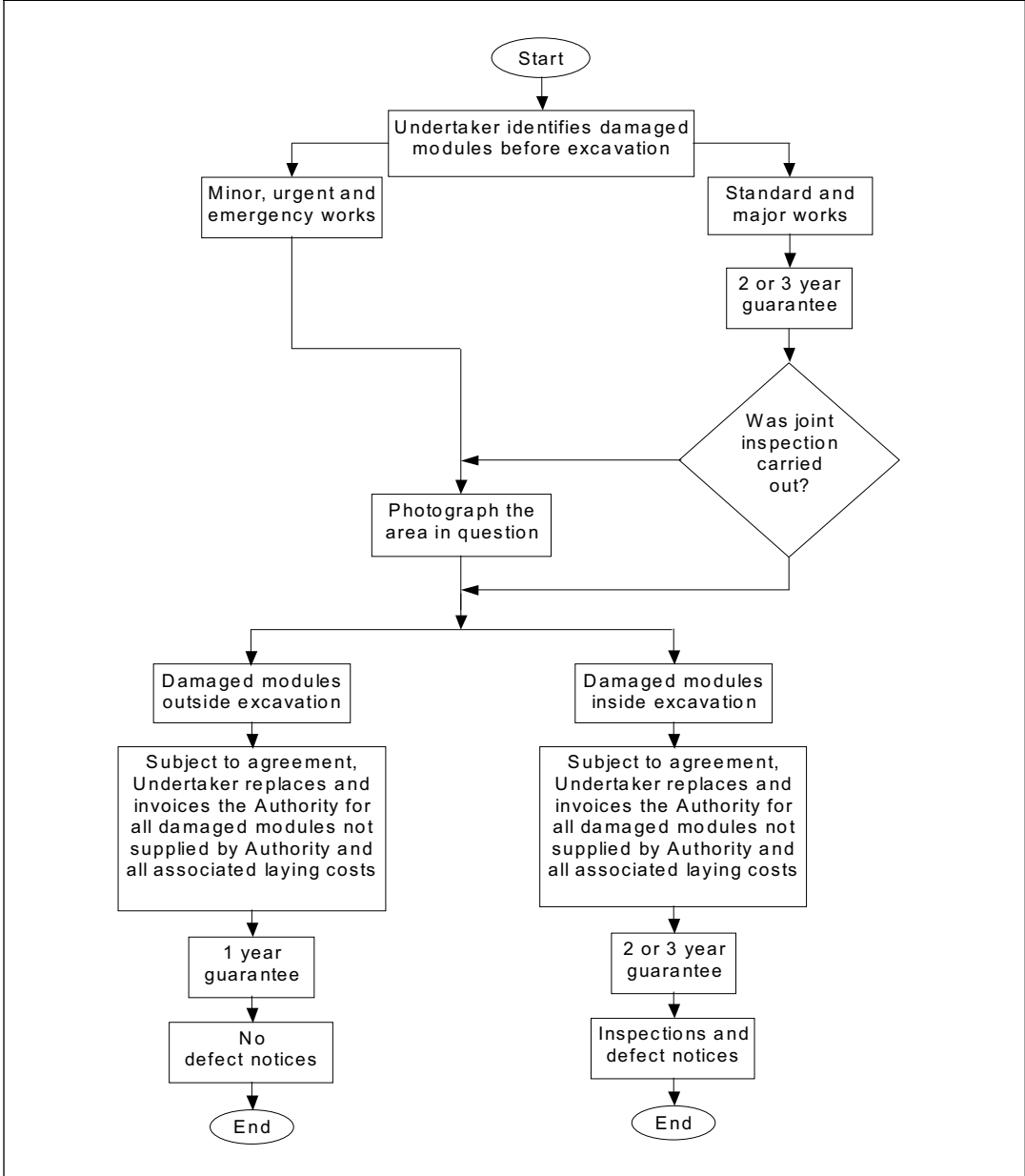
A12.5 Joint Inspections and Recovery of Costs

1) Within Limits of Undertaker's Works - Following notification from the Undertaker, a joint inspection shall be arranged prior to the commencement of all standard or major works to agree the extent of damaged, settled or deformed surfacing within the limits of the works. Where the Authority does not provide suitable replacements to the Undertaker in accordance with paragraph A12.3 2) above, it may contribute to the Undertaker the sum notified by the Undertaker as the cost of replacing the same.

2) Outside Limits of Undertaker's Works - Following notification from the Undertaker, a joint inspection shall be arranged to agree the need and extent of any remedial measures outside of the limits of the Undertaker's works. An apportionment of the additional costs, based on the relative areas of permanent reinstatement, shall be agreed. In the event of an Authority failing to agree to meet a proportion of the costs of reinstating modules, the Undertaker shall proceed in accordance with paragraph A12.4 1).

3) Prior joint inspections will usually be impractical for minor, emergency and urgent works. However, such works are usually small individual excavations and a proportion of such works will be inspected by the Authority, within the sample inspection regime. On completion of all minor, emergency and urgent works, the Undertaker shall be free, at its discretion subject to paragraphs A12.3 2) and A12.4 1), to recover all reasonable costs from the Authority, according to the procedure illustrated in Figure A12.1.

Figure A12.1 Procedure for Pre-existing Damage to Modular Surfaces



NOTES FOR GUIDANCE

NG1 Introduction

NG1.1 General

- 1) The primary objectives of this Specification are to ensure that all Undertakers' reinstatements, within roads, are completed to a permanent standard, as soon as is practicable and of a consistent high quality. Undertakers and Authority personnel should work together, in close co-operation, in order to achieve these objectives.
- 2) This Specification may require a joint inspection of any reinstatement site, depending on the existing site conditions, before the commencement of works. Such joint pre-inspections may be of an informal nature, by agreement, and should be carried out at the earliest convenience of both parties. Where either party fails to attend any agreed pre-inspection, or where existing site conditions warrant concern, it is recommended that the Undertaker retains a photographic record of the existing surfaces, prior to the commencement of works.
- 3) This Specification may require a formal notification of circumstances or other requirements, depending on the existing conditions of any reinstatement site, prior to the commencement of works. Such pre-notifications should be issued at the earliest possible opportunity. Undertakers shall comply with such notification issued at the road works notice stage, and should make reasonable efforts to comply with any notification issued thereafter.
- 4) Where this Specification allows several options, it is recommended, wherever practicable, to agree a preferred option from the alternatives available. This principle should be applied to all sections where alternatives are provided.

NG1.2 Guarantee Period

- 1) Where an Authority intends to resurface or reconstruct a section of road, the Undertaker may complete any reinstatement to an alternative interim standard, by agreement. The guarantee period shall thereafter be waived, unless the Undertaker's reinstatement can be shown to be grossly substandard. It is expected that agreement to this procedure will be conditional upon all savings in costs made by not carrying out a permanent reinstatement being shared, equally, between the Undertaker and the Authority.
- 2) Where site circumstances are considered to mitigate against a successful permanent reinstatement, an additional interim period of up to a further 6 months may be adopted, before it is necessary to complete the permanent reinstatement.

NG1.3 Road Categories

- 1) Road categories 0 to 4 are based on the number of millions of standard axles (msa) carried by the road over a 20 year period to a critical condition. Reinstatements are designed on this basis in accordance with national pavement design standards as follows:
 - a) Roads Type 0 & 1 - DoT HD 24/96
 - b) Roads Type 2 - Intermediate between HD 24/96 & LR1132
 - c) Roads Type 3 & 4 - TRRL LR1132 or TRRL RR 87

Some roads that have been constructed in recent years (particularly new housing estate roads constructed under the auspices of Section 21 of the Roads Scotland Act 1984) may have been designed and constructed to DOT HD/24/96 standards. In these cases the Authority shall notify the Undertaker, in advance of the works, and the Undertaker shall reinstate the excavation to match the existing construction thicknesses.

- 2) For any road, its msa rating gives the number of standard axle loads which it is expected to carry over a defined period of time. This msa rating is calculated using the following input data:
 - a) 24 hour annual average daily flow (AADF) of commercial vehicles in one direction. The use of one directional AADF data, averaged from two directional data, is recommended
 - b) Average vehicle axle factor over a 20 year service life
 - c) Actual sustained annual growth rate of commercial vehicles, averaged over several years, from valid census data

This data, processed in accordance with DoT HD 24/96 procedures, provides the maximum number of commercial vehicles per day, in each direction, for all road types. Table NG1.1 has been prepared in accordance with HD 24/96, showing the maximum annual average daily flow (AADF) in one direction, in commercial vehicles per day (cvd), for a single carriageway road, or for both lanes of a dual carriageway, for all road types, from 2002 onwards, for all likely traffic growth rates. Appropriate AADF rates for all Intermediate years within each five year period can be calculated by interpolation, pro rata.

Table NG1.1 Maximum Commercial Vehicle Traffic per Road Type						
Year of Traffic Count	Daily Traffic Flow – Commercial Vehicles/Day One Direction – Single or Dual Carriageway					Average Growth Rate %
	Type 4	Type 3	Type 2	Type 1	Type 0	
2002	66	240	638	1383	4499	0
2006	66	240	638	1383	4499	
2011	66	240	638	1383	4499	
2016	66	240	638	1383	4499	
2021	66	240	638	1383	4499	
2002	60	217	578	1253	4079	1
2006	62	226	601	1304	4245	
2011	65	237	632	1370	4461	
2016	68	249	664	1440	4689	
2021	72	262	698	1514	4928	
2002	54	196	521	1132	3960	2
2006	58	212	564	1225	3994	
2011	64	234	623	1353	4410	
2016	71	259	687	1494	4869	
2021	78	286	759	1649	5376	
2002	49	176	469	1020	3333	3
2006	55	198	528	1148	3751	
2011	64	230	612	1331	4349	
2016	74	266	709	1543	5041	
2021	86	309	822	1789	5844	
2002	43	157	420	916	3005	4
2006	50	184	491	1072	3515	
2011	61	223	598	1304	4277	
2016	74	272	727	1586	5204	
2021	91	331	885	1930	6331	
2002	39	140	375	821	2704	5
2006	47	170	456	998	3287	
2011	61	217	582	1274	4195	
2016	77	277	742	1626	5354	
2021	99	354	948	2075	6833	
2002	35	125	334	734	2430	6
2006	44	158	422	927	3068	
2011	59	211	564	1240	4105	
2016	79	283	755	1660	5494	
2021	106	378	1011	2221	7352	
2002	31	111	297	655	2180	7
2006	41	145	389	859	2858	
2011	57	204	546	1204	4008	
2016	80	286	766	1689	5621	
2021	112	401	1074	2369	7884	
2002	27	98	263	584	1953	8
2006	37	133	358	795	2657	
2011	54	196	526	1167	3904	
2016	79	288	772	1715	5736	
2021	117	423	1135	2520	8429	

- 3) Where the actual AADF rates for any road are significantly different for each direction and Table NG1.1 indicates different road types in each direction, the highest traffic category shall be applied in both directions.
- 4) Where one-way traffic systems and/or other traffic management schemes result in multi-lane traffic, standard growth rate predictions and lane correction procedures may result in an inaccurate road classification overall. In such cases, whenever reasonably practical, the flow of commercial vehicles should be monitored separately, and traffic calculations completed, for each traffic lane in question.
- 5) Where an existing road is near, or beyond, its working life, and is expected to be re-constructed within the foreseeable future, a temporary re-classification of the road will usually be appropriate, pending its re-construction. Such temporary re-classifications should be undertaken by agreement. Similarly, where roads are expected to be re-constructed within the guarantee period of the reinstatement, it will usually be appropriate to amend methods, materials or performance requirements for those reinstatements, by agreement.
- 6) The national network of roads carrying, up to 125 msa within a 20 year period, and classified as Types 0 to 4 roads according to the requirements of this Specification, will yield a distribution similar to that shown in Table NG1.2.

Table NG1.2 Estimated road Classification

Road Type	% of Total
0	< 1
1	< 1
2	< 5
3	< 9
4	> 84

- 7) It is expected that the roads in any Authority area will show a distribution similar to that shown in Table NG1.2, although there will be some local variations. In future years, there may be cases where traffic flows change, to such a degree, that re-classification will be necessary. It is expected that re-classification to a lower category will frequently occur, as well as re-classification to a higher category.

NG1.4 - NG1.5 There are no Notes for Guidance

NG1.6 Alternative Options

- 1) **New Materials**

Research into new or improved reinstatement materials is often undertaken by various organisations and such work may produce materials that perform as well as, or better, than those specified in this Specification. In order to allow such materials to be proven, by development testing, the materials and relevant layer thicknesses quoted in this Specification may be amended or supplemented, subject to prior agreement.

2) Local Materials

Materials may be available locally that have not been defined in any national Specification, but which, by experience, are known to give acceptable performance in service. In order to allow the use of such proven local materials, the materials and relevant layer thicknesses quoted in this Specification may be amended or supplemented, subject to prior agreement.

3) Alternative Compaction Equipment

Alternative compaction equipment, including any compaction devices not specifically permitted within Section S10 and Appendix A8, may be permitted, provided it has been proven to be capable of achieving the same degree of compaction as any other option permitted in Appendix A8.

- a) For all compaction plant not shown in Appendix A8, an approved operating procedure shall be established, by development testing, in an appropriate trench environment with the relevant material option, to prove equivalence with the compaction requirements of Appendix A8. The development testing shall be verified by an independent, accredited laboratory.
- b) Where alternative compaction plant is intended to be used on more than one type of material, as defined in Appendix A8, an approved compaction procedure shall be established, as defined in section NG1.6 3) a) above, for each intended category of material.

NG1.7 Immediate Works

The minimum thickness of bituminous surfacing material, required by Section S1.7.1 for the reinstatement of all immediate works, is 40 mm. A greater thickness may be required, in areas subject to frequent or heavy traffic, if further remedial works, during the 10 days permitted duration of immediate works, are to be avoided.

NG1.8 Apparatus within the Road Structure

- 1) Some apparatus may already be present at shallow depth, within many existing road structures and special requirements may apply to their reinstatement. Both the Undertaker and the Authority are likely to have particular criteria and this Specification may be altered, or supplemented, subject to prior agreement, to accommodate any such requirements.
- 2) Not all new apparatus will need to be installed to the full depth or width expected by this Specification; an example is small diameter cabling and/or ducting for telecommunications, traffic controls, etc. This Specification may be altered, or supplemented, subject to prior agreement, to accommodate these applications.

NG1.9 - NG1.11 There are no Notes for Guidance

NG2 Performance Requirements

NG2.1 There are no Notes for Guidance

NG2.2 Surface Profile

NG2.2.1 There are no Notes for Guidance

NG2.2.2 Edge Depression - Intervention

Freedom from excessive edge depressions, or ‘trips’, for all pedestrians and two wheeled vehicles, is considered to be one of the most important performance requirements. Given that pedestrians and various two wheeled vehicles are likely to use or cross any roads, footways and cycletracks, it is considered necessary to set a single limit for all edge depressions.

NG2.2.3 Surface Depression - Intervention

Excessive surface depressions will reduce ride quality and give rise to noise and vibration. The maximum depth of surface depression within the area of a reinstatement is limited to approximately 2.5% of the width of reinstatement, which represents a mean slope of 1 in 20 (5% gradient). In order to prevent excessive areas of standing water, it is considered necessary to limit the maximum depth of a surface depression to 25 mm, regardless of the reinstatement width.

NG2.2.4 Surface Crowning - Intervention

Excessive surface crowning will reduce ride quality and give rise to noise and vibration. The maximum height of crowning within the area of a reinstatement is limited to approximately 2.5% of the width of the reinstatement, which represents a mean slope of 1 in 20 (5% gradient). In order to prevent excessive surface irregularity, it is considered necessary to limit the maximum height of crowning to 25 mm, regardless of the reinstatement width.

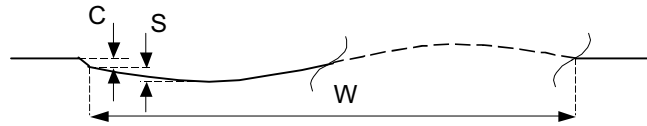
NG2.2.5 Combined Defect - Intervention

The intervention limits specified for surface depressions and surface crowning include a reduction in the intervention limit, to 80% of the tabulated value, subject to a minimum of 10 mm, where surface depressions and/or crowning and/or edge depressions abut. The individual features shall be measured, and the reduction applied, as follows:

1) Combination Depressions

Where an edge depression abuts an area of surface depression, then the area of abutting depression should be measured as shown in Figure NG2.2. Any surface crowning also abutting the area of combined depressions should be measured separately, as shown in Figure NG2.3. The permitted depth of a combination depression is further limited if the depression results in standing water.

Figure NG2.2 Combination Depression

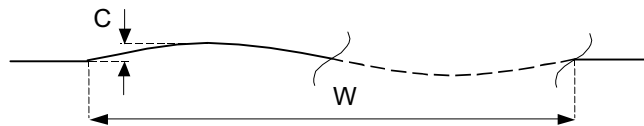


E = Edge Depression Contribution = 10 mm
 S = Surface Depression Contribution = 10 mm or 80% of tabulated value whichever is the greater

2) Combination Crowning

Where an area of surface crowning abuts an edge depression, or a surface depression, or any combination thereof, then the area of abutting crowning should be measured as shown in Figure NG2.3. The area of abutting depression should be measured separately, as shown in Figure NG2.2. The maximum height of combination crowning is further limited if the crowning results in standing water.

Figure NG2.3 Combination Crowning



C = Surface crowning contribution = 10 mm or 80% (whichever is the greater of tabulated value)

NG2.2.6 There are no Notes for Guidance

NG2.3 Fixed Features

Fixed features, e.g. kerbstones and related precast concrete products, channel blocks and drainage fixtures, surface boxes and ironware, should be bedded on a sound foundation, in accordance with the owner's requirements. In order to prevent excessive areas of standing water, it is considered necessary to set separate intervention limits for channel blocks, drainage fixtures, surface boxes and ironware.

NG2.4 Surface Regularity

Where the use of a rolling straightedge is not permitted, the surface regularity shall be assessed on an agreed basis. One method could be the use of a two metre or three metre straightedge.

NG2.5 Structural Integrity

- 1) Reinstatement materials and compaction requirements have been specified in order to safeguard the pavement structure, both within and adjacent to the reinstatement. Any substantial or rapid settlement within a reinstatement may therefore indicate a potential reduction in the stability of the adjacent pavement structure, as well as potential defects within the reinstatement.
- 2) There will be cases, in adverse circumstances, where the correct application of this Specification, in all respects, will still result in levels of settlement within the reinstatement that do not meet the requirements of Section S2.5, Structural Integrity. For example, the type and condition of the adjacent ground and/or pavement structure may limit the degree of compaction that can be achieved, so influencing the amount of settlement that could occur.
- 3) Any engineering investigation is intended only to determine the likelihood and extent of any further settlement, and the most cost-effective and convenient method of restoring the structural stability and surface performance of failed sections of a reinstatement, to a satisfactory condition.
- 4) In the case of large or to deep excavations, it may be appropriate for the Authority and the Undertaker to agree an extended interim guarantee period, with additional interim surfacing materials laid to restore the running surface. When no further consolidation or settlement is considered likely, a permanent binder course and surface course may be laid, and the permanent guarantee period initiated. In any event, the location and extent of any re-excavation should be mutually agreed, taking full advantage of any bound materials already in place.
- 5) The depth of unbound materials is the difference in vertical height between the underside of the base of the trench and the top of the surround to the apparatus.

NG2.6 Skid Resistance

- 1) An adequate skid resistance of the reinstated running surface must be maintained, by selection of the polished stone value (PSV), aggregate abrasion value (AAV) and texture depth of the aggregate exposed at the road surface. The exposed aggregate may be precoated chippings rolled into the surface (HRA), coarse aggregate within the surface course, coated material to BS 4987 or any chippings or other aggregate applied in any form of surface dressing or slurry sealing treatment.
- 2) Smaller reinstatements constitute a much lower degree of skidding risk, but the measurement of skid resistance, texture depth and surface regularity become progressively more difficult as the reinstatement width reduces. However, material requirements and laying conditions remain unchanged and it is expected that the skid resistance of smaller reinstatements will not be significantly different.
- 3) For the purposes of identifying reinstatement sites where the risk of skidding is potentially high (Site A), sections of carriageway of greater than 10% gradient should be identified from existing steep hill warning signs or by notification from the Authority. Similarly, bends of less than 100 metres radius in roads where the speed limit is greater than 40 mph (65 kph) should be identified from existing bend, double bend or chevron warning signs or by notification from the Authority.
- 4) Given good site conditions, it is possible to obtain reasonably representative measurements of skid resistance and surface regularity on narrower reinstatements but amended test procedures and/or extra care are required. The TRL Mini Texture Meter and TRL Rolling Straightedge should always be fully contained within the limits of the reinstatement. The actual minimum practicable width for these instruments will depend

on the trench alignment and radius of curvature. Measurements can be particularly difficult when testing on tight radius bends.

NG2.7 There are no Notes for Guidance

NG3 Excavation

NG3.1 There are no Notes for Guidance

NG3.2 Excavation

- 1) HSG 185 “Health and Safety in Excavations” gives guidance to those carrying out excavations.
- 2) Where possible, all excavations should be planned before commencement of works on site.
- 3) Work must be undertaken and supervised by properly qualified personnel.

NG3.3 There are no Notes for Guidance

NG3.4 Side Support

- 1) Where required, there must be sufficient quantities of appropriate materials available to provide safe trench support.

NG3.5 - NG3.7 There are no Notes for Guidance

NG4 Surround to Apparatus

NG4.1 General

- 1) It is often necessary for an Undertaker to require a specific type or quality of material, and/or special protective components, to be laid within the immediate vicinity of certain types of underground apparatus. This material is usually referred to as the surround to the apparatus, and may include fine unbound granular materials (usually termed 'finefill'), bound materials, tiles, covers, tubular shields, etc., or any combination thereof. The resulting surround may be required for a variety of reasons, including structural support, low corrosion potential, protection for non-metallic materials or special coatings, etc.
- 2) The nature of the Undertakers apparatus, and/or the protective features of the surround, especially any fine unbound granular materials used within the surround, may impose additional restrictions on the type of compaction equipment that can be used and the necessary operating procedures. However, the entire surround will effectively form a foundation structure for the remainder of the reinstatement and must be capable of providing adequate support for all loading imposed on the reinstatement surface, as well as the weight of the reinstatement structure.
- 3) In selecting a material for the surround to apparatus, Undertakers should be mindful of the potential for the migration of fines from the adjacent ground, and/or the overlying backfill, into any surround material that is open-textured. Such migration will normally result in settlement of the adjacent ground, and/or the backfill. Migration of fines can be prevented by using a close textured surround or, if this is undesirable, by enclosing the surround within a suitable filter membrane.

NG5 Backfill

NG5.1 Backfill Material Classification

The assumed limiting performance of the five classes of backfill material defined in Appendix A1 is shown in Table NG5.1.

Table NG5.1 Backfill Material Performance	
Backfill Material Class	Material Performance % CBR
A	Over 15
B	7 to 15
C	4 to 7
D	2 to 4
E	Less than 2

NG5.2 There are no Notes for Guidance

NG5.3 Additional Requirements

1) Frost Heave Susceptibility

The frost heave test described in BS 812: Part 124 is costly and time consuming and is not suitable for routine on-site control checks. The test is primarily intended as a method to establish whether an aggregate from a particular source is likely to be frost susceptible when used in road pavement construction. Material for the frost heave test must be representative of the source or sub-grade encountered. Authorities usually maintain a list of "Approved Suppliers of Non-frost Susceptible Materials" and should have knowledge of frost susceptible sub-grades in their locality.

The following notes on identification of potentially frost heave susceptible material are for guidance but are not, in themselves, exhaustive:

- a) Clay materials can be regarded as non-frost susceptible, particularly when the plasticity index is greater than 15%. Clay/silt mixtures are more difficult to assess and are likely to be of marginal frost susceptibility.
- b) Silts, particularly those with more than 10% passing a 75 micron (μm) BS sieve size, are likely to be frost susceptible.
- c) Cohesive/granular materials will often be frost susceptible; the quantity and type of granular aggregate and, to a lesser degree the silt fraction are the controlling factors. If the aggregate is a frost susceptible type, then it is very probable that the mixture will also be frost susceptible.
- d) Granular materials with more than 10% passing a 75 micron (μm) BS sieve size have a high potential for frost susceptibility and granular materials with more than 12% passing 75 micron (μm) are likely to be frost susceptible.
- e) All crushed chalks are frost susceptible and the magnitude of the frost heave will increase with the saturation moisture content of the chalk.
- f) Oolitic and magnesium limestones are likely to be frost susceptible, particularly those where the aggregate saturation moisture content exceeds 3.5%.
- g) Hard carboniferous limestones are unlikely to be frost susceptible unless they have been contaminated with clay or have more than 12% passing 75 micron (μm).

- h) Crushed granites will only be frost susceptible if the percentage passing 75 micron (μm) exceeds 12% and is partially plastic.
- i) 'As dug' sands and gravels are frequently frost susceptible especially if the percentage passing 75 micron (μm) BS sieve size is greater than 12% or if it is plastic. Sands and gravels won by "wet working" techniques are unlikely to be frost susceptible unless contaminated by a clay or a high silt fraction.
- j) Burnt colliery shales, slags, PFAs, etc. are secondary materials, and it is not possible to give general guidance to their potential for frost heave resistance. Each source is different and will need to be assessed by the frost heave test. The exception to this is graded bottom furnace ash produced by modern power stations, which has been found to be non-frost susceptible.
- k) Foamed concretes can generally be regarded as non-frost susceptible.

NG6 Flexible and Composite Roads

NG6.1 There are no Notes for Guidance

NG6.2 Sub-base Reinstatement

- 1) It may be reasonable to expect that an adequately compacted sub-base should achieve an in-situ CBR value in excess of 30%.
- 2) It is expected that a bituminous sub-base will only be selected where the base (roadbase) is also bituminous.
- 3) When placing bituminous material directly on to the backfill it is important to ensure that the exposed surface of the backfill has been compacted. This operation is essential to minimise the risk of a build up of pore water pressure causing the subgrade to become spongy. It is also imperative that construction is phased such that excavated areas are covered, on the same day, with the first layer of bituminous material, to prevent the ingress of water. Care should be taken in the compaction of this first layer. If pore water pressure builds up in the backfill at this stage, then rolling should cease and the material left overnight, or longer if necessary, prior to the placement of any further layers.

NG6.3 Base (Roadbase) Reinstatement

Overlaid Modular Layers

- 1) This Specification permits the re-use of cobbles and setts for the reinstatement of the relevant layer. However, it is often extremely difficult to achieve a performance from such reinstatements that is similar to that of the original, well interlocked and 'stress hardened' layer. Failure to achieve this structural stiffness could result in failure of the reinstatement and particularly any surfacing materials laid thereon.
- 2) The Specification does not permit the re-use of penning, in which the layer of modules is laid upright, in an interlocking manner, exhibiting a greater stiffness than an equivalent layer of cobbles/setts.

NG6.4 Surface Reinstatement

NG6.4.1 Hot Rolled Asphalt Surfaces

- 1) HRA design mixtures give better resistance to deformation where queuing of heavy traffic is likely to occur and may be more economical to lay.
- 2) Type C mixtures use fine aggregates of a coarser grading than Type F mixtures, usually associated with the use of crushed rock fines. Such mixtures tend to be stiffer and less well suited to the reinstatement of small excavations.
- 3) Type R mixtures have better fatigue and durability characteristics than type F or Type C mixtures but can be expected to have less resistance to deformation.

NG6.4.2 - NG6.4.5 There are no Notes for Guidance

NG6.4.5.2 High Friction Surfacing

Special friction surfacings are likely to be bauxite epoxy resin systems, special textured slurry seals or premium surface dressing applications. They will usually have been laid for safety reasons and their early reinstatement will be important.

NG6.4.5.3 Porous Asphalt

Edge sealing requirements specified in Section S6.5.2.2 may not be appropriate with porous asphalts.

NG6.4.5.4 Coloured Surfacing

- 1) Coloured surfacings are sometimes used for marking bus lanes, accident prevention measures, traffic prioritisation schemes, etc. The use of warning signs, e.g. "Temporary Road Surface", should be considered until the special surface can be restored.
- 2) It may not be possible to obtain coloured surfacings in a wide selection of colours and Authorities may have to accept limitations in colour matching. In addition, all coloured surfacings fade or undergo other changes in colour as the materials age.

NG6.4.5.5 Other Specialist Surfacing Materials

Texture depth requirements specified in Section S2.6.2 may not be appropriate for the increasing number of specialist surfacing materials currently being used by some Authorities.

NG6.4.6 Surface Treatments

In all roads, where the overall quality of existing surface dressings or surface treatments are to a high standard, it may be difficult to produce small excavations or narrow trenches with surface dressings or other surface treatments that closely and uniformly match the existing adjacent surfaces. Under such circumstances, some localised variation in surface quality may be acceptable to the Authority.

NG6.4.7 - NG6.4.10 There are no Notes for Guidance

NG6.5 Base and Edge Preparation

NG6.5.1 Base Preparation

Tack coating materials are generally based on rapid curing anionic or cationic bitumen emulsions to BS 434, with approximately 40% bitumen content. New tack coating materials are becoming available, and the trial use of more modern variants is recommended.

NG6.5.2 Edge Preparation

- 1) Edge regularity requirements are intended to provide a shape that will not hinder the compaction of material adjacent to the reinstatement edge. The final shape, when viewed from above, should be governed by the following general principles rather than by aesthetic considerations:
 - a) There is no requirement to trim the sides of trench excavations solely to provide a uniform width, provided that individual projections are not less than 250 mm length, measured parallel to the nominal centreline of the trench.
 - b) There is no requirement to trim a small excavation solely in order to provide a square or rectangular shape. Any shape, with included angles not less than 90° and with no projection less than 250 mm length, may be considered to be regular.
 - c) Where the existing surfacing material is sound at the corners of an excavation, there is no necessity to cut out to a corner; a regular chamfer may be preferable.
 - d) Where a 90° corner is to be cut out, overlapping cross cuts should be minimal and all cuts extending into the existing surface should be filled with sealant.
- 2) Edge sealant materials are generally based on rapid curing anionic or cationic bitumen emulsions to BS 434, typically 50 or 70 pen and approximately 70% bitumen content, or hot bitumens to BS 3690, typically 50 or 70 pen. An increasing number of high build and rubberised edge sealants are becoming available and, in general, are preferred. The use of high-build liquid sealants, sprays or solid sealing strips etc, is recommended, on a trial basis at least.

NG6.6 There are no Notes for Guidance

NG7 Rigid and Modular Roads

NG7.1 Reinstatement Methods

- 1) The requirements of this Specification shall apply to all rigid roads up to 125 msa traffic flow. All rigid roads with existing traffic flows exceeding 30 msa must be identified by the Authority, prior to the commencement of works, so that reinstatement requirements can be agreed.
- 2) Some modern concrete roads, constructed in accordance with current Government standards and specifications, may incorporate special design philosophies that are beyond the scope of this Specification. Similarly, there may be other existing rigid road designs that will also require the use of particular reinstatement methods. Such roads must also be identified by the Authority, prior to the commencement of works, so that reinstatement requirements can be agreed.

NG7.2 - NG7.6 There are no Notes for Guidance

NG7.7 Modular Roads

- 1) When excavating in modular roads, the existing modules shall be lifted carefully and stored for re-use.
- 2) It is particularly important to ensure that bedding and jointing sands should meet the performance demands in areas subject to heavy vehicular traffic.

NG7.8 There are no Notes for Guidance

NG8 Footways, Footpaths and Cycle Tracks

NG8.1 There are no Notes for Guidance

NG8.2 Sub-base and Binder Course Reinstatement

NG8.2.1 - NG8.2.3 There are no Notes for Guidance

NG8.2.4 Excavations Adjacent to Roads

The most heavily stressed area of a road is usually the inside wheel track adjacent to the road edge. Depending on ground conditions, it is often necessary to support the road edge by providing lateral restraint within the adjoining footway, footpath, cycletrack or verge. The most common form of edge support is a section of unbound or cement bound granular materials. This construction will most commonly be encountered when the horizontal distance, between the edge of the Undertakers' excavation and the edge of the road surface, is less than the expected depth of cover of the Undertakers' apparatus.

NG8.3 Surface Reinstatement

NG8.3.1 There are no Notes for Guidance

NG8.3.2 High Duty and High Amenity

1) In high duty footways, the durability of the wearing surface is of prime importance and simple cosmetic matching of materials may not be adequate. Specific grades of material such as York stone modules, or specific types of construction such as asphalt sand carpet/mastic, may have been laid in order to give an acceptable performance under extreme conditions. In these cases, similar or equivalent grades of materials will need to be reinstated.

2) In high amenity footways, the cosmetic matching of materials at the wearing surface may be of primary importance with durability of secondary importance.

NG8.3.3 Other Material to BS4987

A wide range of surface treatments exist and commonly these are less than 6 mm aggregate size. Where available, a similar surface finish will be reinstated. The surface course material may be reinstated using any of the allowed binder course or surface course materials, with a final surface treatment applied as soon as practicable following the laying of the permanent surface course.

NG8.3.4 There are no Notes for Guidance

NG8.3.5 Concrete Materials

1) In general, reinstatements in a concrete footway, footpath or cycletrack should match the existing surfacing as closely as is practicable.

2) Generally, the use of all flexible permanent reinstatements in overlaid concrete, mastic asphalt, asphalt carpet, sand carpet or other derivative surfaces etc., has proven to be entirely adequate in practice.

NG8.3.6 - NG8.3.8 There are no Notes for Guidance

NG8.4 - NG8.5 There are no Notes for Guidance

NG9 Verges and Unmade Ground

NG9.1-NG9.4 There are no Notes for Guidance

NG10 Compaction Requirements

NG10 Introduction

- 1) Research has shown that failure to operate and maintain compaction equipment in accordance with manufacturer's schedules and recommended practices is likely to result in inadequate compaction with serious implications for the short term performance of individual structural layers and the long term integrity of the entire reinstatement.
- 2) All compaction equipment covered by this Specification must be frequently checked, adjusted and maintained, as necessary, in accordance with the manufacturer's recommended practices, in order to ensure that the manufacturer's recommended operating frequency is maintained throughout each compaction operation.
- 3) All compaction equipment covered by this Specification must be used in accordance with the manufacturer's recommended operating procedures.

NG10.2 Reinstatement Materials

NG10.2.1 Unbound Granular and Cohesive Materials

For granular or cohesive materials, a vibrating roller may be unsuitable in small excavations because of the restricted manoeuvrability of large heavy rollers required to achieve adequate levels of compaction with an acceptable number of passes.

NG10.2.2 There are no Notes for Guidance

NG10.2.3 Bituminous Materials

With some combinations of compaction plant and certain types of bituminous materials if compaction is continued as the material approaches its maximum density the following may result:

- a) The migration of fines or binder to the surface.
- b) The development of shear surfaces and or crushing of aggregates.

Provided that the material has been laid and compacted within the appropriate temperature range, fewer passes will be required if any signs of distress become apparent.

NG10.2.4 There are no Notes for Guidance

NG10.2.5 Modular Surfacing Materials

Depending on the size and type of paving module to be laid, and/or the extent of the area to be surfaced etc., the use of additional mechanical compaction may become necessary.

NG10.3 Equipment Operation and Restrictions

NG10.3.1 Hand Rammers

- 1) Hand rammers may be used for initial tamping of fine fill material or immediately adjacent to street furniture, reinstatement edges etc.
- 2) In all cases, full machine compaction complying with Appendix A8 will normally be applied immediately after the required thickness of material has been built-up. However, hand ramming alone may be necessary around standpipes and other isolated fixed features.

NG10.3.2 Percussive Rammer

- 1) A percussive rammer is deemed to be a hand-held and/or pedestrian guided machine in which an electric, pneumatic or hydraulically operated reciprocating mechanism acts on a plate or 'foot'.
- 2) Percussive rammers may only be used to provide full machine compaction in areas where restricted access prevents the effective use of conventional compaction equipment.

NG10.3.3 Vibrotamper

- 1) A vibrotamper is deemed to be a free-standing, pedestrian guided machine in which a reciprocating mechanism, driven by an integral engine or motor, acts on a spring system through which oscillations are set up in a base plate or 'foot'.
- 2) Vibrotampers may be operated at reduced speed, for the first pass only, with cohesive materials.
- 3) Vibrotampers are not preferred for any permanent surface course application or any other application involving layer thicknesses of less than 50 mm.

NG10.3.4 Vibrating Roller

- 1) A vibrating roller is deemed to be a self-propelled, pedestrian steered machine with a means of applying mechanical vibration to one or more rolls.
- 2) Vibrating rollers should be operated in the lowest available gear, except for the first pass, which should be at maximum forward speed.
- 3) All compaction passes should be carried out with full vibration, except for the first pass, which should be carried out without vibration in order to nip in the material adjacent to the reinstatement edges and to prevent uneven displacement of material within the remainder of the reinstatement area.
- 4) Vibrating rollers are the preferred method of compaction for all permanent surface courses.
- 5) The use of twin drum rollers is preferred to single drum for the compaction of bituminous materials and will improve the quality of the permanent surface course. However, single drum vibrating rollers are permitted, as detailed in Appendix A8.

NG10.3.5 Vibrating Plate Compactor

- 1) A vibrating plate compactor is deemed to be a pedestrian guided plate equipped with a source of vibration consisting of one or more rotating, eccentrically weighted shafts.
- 2) Vibrating plate compactors should be operated in the lowest available gear, except for the first pass, which should be at maximum forward speed.

NG10.3.6 Other Compaction Equipment

Compaction plant not referenced in Appendix A8, including machine-mounted, modified and other alternative compaction equipment, may be permitted for the compaction of reinstatement materials, in accordance with the following relevant requirements:

- 1) Machine-Mounted Compactors

A machine-mounted compactor is deemed to be any compaction equipment that is mounted, as an attachment or accessory, to the chassis or front or rear booms of an excavator, tractor, skid-steer vehicle or other proprietary vehicle, for the purposes of compaction.

All machine-mounted compactors, whether integral to the vehicle design or special attachments for front or rear mounting to the chassis or booms of any excavator, tractor or skid-steer vehicle etc. should be operated in accordance with the recommendations of the compactor or attachment manufacturer, to the relevant compaction procedure required by Appendix A 8. However, other operational variables should also be considered prior to the operation of such plant as follows:

a) Compactor Downforce

The total downforce will vary depending upon the weight of the vehicle chassis or compactor frame, and any additional downforce applied by hydraulic rams etc. However, changes in the configuration of any vehicle, by the addition or removal of other accessories etc, changes in the width of the vibrating foot, roll or plate etc, movement of any boom resulting in a significant change of loading geometry or outreach etc, attaching of the compactor to other vehicles of differing types or weights etc, can all result in a significant reduction of compactive performance that is seldom apparent. All operators should be aware of the potential reduction in compactive performance resulting from such changes in configuration.

b) Applied Downforce

The mounting of compaction equipment to the front loader arms of an excavator, where the downforce is sensibly limited by the lifting of the front wheels, is preferred. All compactors mounted to the backhoe of an excavator should be fitted with a downforce-limiting device, correctly set, or with a simple indicating device allowing the amplitude to be estimated.

c) Compactor Set-up

Where vibration frequency or amplitude, or any other parameter affecting the dynamic output of a compactor, is expected to be adjusted on a routine basis, all parameters should be set in accordance with the manufacturer's recommendations unless specific testing, meeting the requirements of Section NG1.6.3, has shown other settings to be at least as effective.

2) Modified Compaction Equipment

Modified compaction equipment shall include any proprietary vibrotamper, vibrating roller, vibrating plate compactor, percussive rammer or other compaction plant which has been adapted, converted, revised or otherwise changed from the original manufacturer's Specification, resulting in a significant change to the original configuration, dimensions, operational weight or power output.

Modified compaction equipment shall be permitted, provided it is operated in accordance with compaction procedures meeting the following requirements:

a) The original manufacturer shall provide written confirmation that the modified compaction equipment, operated in accordance with the original compaction procedure, is capable of achieving the same degree of compaction as any other option permitted in Appendix A8;

or b) A revised compaction procedure is developed in accordance with the requirements of Section NG1.6.

3) Alternative Compaction Equipment

Alternative compaction equipment shall include all other compaction devices not specifically permitted within Section NG10.3. Alternative compaction equipment

may be permitted, provided it is operated in accordance with compaction procedures developed in accordance with the requirements of Section NG1.6 3).

NG10.3.7 Compaction Procedure (Note: There is no equivalent S10.3.7 for this section)

- 1) A single pass of any compaction plant is deemed to be completed when the foot, roll or plate of the compactor has impacted the entire surface area of the layer.
- 2) Where the excavation width is more than 50 mm greater than the foot, roll or plate width (i.e. side clearances between the compacting surface and the wall of the excavation exceed 25 mm per side), two or more traverses of the compaction device will be required to ensure coverage of the entire surface and all will be deemed to constitute a single compactive pass.
- 3) Compaction plant should be steered along a line offset from that steered on the previous pass so that alternate passes are run close in to each side wall of the excavation.
- 4) Small items of compaction plant will frequently be required and additional provisions must be considered for use in trenches of less than 200 mm width, small excavations and other areas of restricted access. In general, lightweight vibrotampers and poletampers are capable of achieving the same degree of compaction as the heavier items of plant specified in Appendix A8. However, small plant is usually not self-advancing and therefore more difficult to operate effectively. Currently there is no alternative equipment available for this application and the provisions included in Appendix A8 are proven in practice.

NG11 Ancillary Activities

NG11.1 Traffic Signs, Road Markings, Studs and Verge Markers

In the interests of safety generally and particularly in the interests of the disabled, all traffic signs, road markings, studs and verge markers removed during the course of the works should be replaced immediately following completion of works.

NG11.2 Street Furniture and Special Features

In the interests of safety generally, and particularly in the interests of the disabled, all street furniture, tactile paving and any other special features removed during the course of works should be replaced immediately following the completion of works.

NG11.3 Traffic Sensors

- 1) Examples of sensors include ice warning sensors, buried queue and traffic detectors, other electronic detectors and various data collection devices.
- 2) The replacement of some traffic sensors may require the use of specialist contractors.

NG11.4 - NG11.5 There are no Notes for Guidance

NG12 Remedial Works

NG12.1 – NG12.5 There are no Notes for Guidance

NGA2 Key to materials

NGA2

- 1) HRA design mixtures give better resistance to deformation where queuing of heavy traffic is likely to occur and may also be more economical to lay.
- 2) Type C mixtures use fine aggregate of a coarser grading than Type F mixtures - usually associated with the use of crushed rock fines. Such mixtures tend to be stiffer and are less well suited to the reinstatement of small excavations.
- 3) Type R mixtures have better fatigue and durability than Type F or Type C but can be expected to have less resistance to deformation.

£10

© Crown copyright 2003

Astron B32474 9-03

ISBN 0-7559-0973-9



9 780755 909735