

DRAINAGE AND SERVICE DUCTS

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Drainage and Service Ducts

NG 501 Pipes for Drainage and for Service Ducts

- 1 Pipes can be made of materials that deflect relatively little under load before cracking (rigid pipes) or of materials that will tolerate large deflections under load before inward buckling occurs (flexible pipes). Flexible joints enable either type of pipe to take up differential settlement within the ground.
- 2 The Specification includes a wide range of pipe materials. The Contractor should normally be offered in Appendix 5/1 the full selection of alternative pipe and bedding combinations as detailed in the NRA Road Construction Details for pipes up to 900 mm diameter. Advice on the determination of alternative pipe and bedding combinations can be obtained in the U.K. Department of Transport Advice Note HA 40. The Engineer should specify the required pipe stiffness and impact resistance for plastics pipes in Appendix 5/1. The requirements will normally be:
 - (i) ultimate pipe stiffness (STES) in excess of 1400 N7m² when tested in accordance with BS 4962; and
 - (ii) resistance to impact complying with BS 4962 except that the striker used in the test shall have a mass of 1 kg and a 25 mm hemispherical radius.

Drains exceeding 900 mm diameter should be designed as structures. A box culvert should not be specified where either a (concrete) box culvert or a (corrugated steel) piped culvert would be technically acceptable. Wherever possible, the Contractor should be offered a choice and the NRA consulted during the scheme preparation. Box culverts, piped culverts (and other drains) of clear span or internal diameter exceeding 900 mm are structures subject to NRA technical approval. The Engineer should ensure that there are no inconsistencies between any specific-requirements for a particular drain and the general requirements of the 500 Series. Where necessary. Contract-specific amendments should be included in Appendix 0/1 or 0/2 to achieve consistency.

Most of the pipes included in the Specification will normally be satisfactory from the hydraulic flow capacity factor. However some products, especially corrugated pipes, can vary from the norm (e.g. clay/concrete) and between manufacturers. The effect of a rougher pipe should be considered on the system as a whole and not

just on the length in question. A pipe which is not acceptable on a straight exchange basis may be acceptable if diameters on adjacent lengths are adjusted. The Engineer should provide in Appendix 5/1 the basis on which the Contractor is to submit his proposals for pipe types and makes.

- 3 Any tendency to attack by acidic ground water or sulphates present in the backfill or the ground should be taken into account when the use of concrete, steel or iron pipes is being considered for inclusion in the schedule of acceptable alternatives in Appendix 5/1. When acid soils (pH less than 6.5) are encountered expert advice should be sought. There is some evidence that pipes made of sulphate-resisting cement will tolerate a pH as low as 6.0. The limiting value may be reduced to pH 5.5 when a bitumen coating is applied to the pipe. Sulphate attack on concrete is dealt with in Building Research Establishment Digest 363. Protection to the lower third of the inside of corrugated steel piped culverts by means of an asphalt or in situ concrete coating will be required where stones and rocks are likely to be carried by the flow. Iron pipes are treated with a pitch or bitumen coating and have high durability in most soils, but when acid conditions are known to be present the additional protection of a polyethylene sleeve is desirable. Clay, pitch fibre and UPVC pipes are resistant to a wide range of groundwater- chemicals.
- 4 For corrugated steel pipes of lock seam fabrication with a diameter not exceeding 900 mm the Engineer should specify the metal thickness in Appendix 5/1. The tables issued by manufacturers recommend thicknesses corresponding to the diameter and depth of fill above the pipe.
- 5 Plastics pipes may deteriorate after a long period in sunlight. Where pipes have been manufactured and stored before being delivered to the Site, it may be necessary for the Contractor to cover them until they are installed.
- 6 Any individual cable duct under a road may have to accept a power or a communication cable although these are normally placed in separate ducts. Certain pipe materials have been excluded from the Specification for use as ducts because cables cannot be readily drawn through them. Clause NG 1421 gives further information on the use of ducts for electrical work. Ducts should be scheduled in a similar

way to pipes in Appendix 5/2. Any special requirements of Statutory Undertakers etc. should be stated clearly.

NG 502 Excavation for Pipes and Chambers

- 1 Agreement to the adoption of the alternative of battering slopes should not be withheld unnecessarily where this option is unlikely to affect adversely the Permanent Works and the basis of structural design of the piperench.
- 2 In the event of excavation to a greater depth than necessary the Contractor is obliged to reinstate. The use of concrete to remedy excess excavation should be restricted to areas where compaction is impracticable. Where the floor of the trench passes through a localised area of disturbed and uncompacted soil or softened clay it may be necessary to order further excavation and replacement with appropriate material to allow pipe laying to proceed.
- 3 Where pipes are to be installed beneath heavily trafficked existing roads, etc, where it is undesirable that the existing ground surface should be disturbed, consideration should always be given to the possibility of inserting the pipe by suitable thrustboring or jacking processes.

NG 503 Bedding, Laying and Surrounding of Pipes

- 1 Pipe bedding material should be readily obtainable since a wide grading envelope is permitted including most gradings complying with BS 882. It needs to flow readily and compact uniformly, thus a low coefficient of uniformity is necessary. In order to make savings in coarser granular materials a sand bed may be adopted. Surround to pipes should be in bedding material as appropriate to the alternatives shown in the NRA Road Construction Details. In some situations a lower provision of acceptable material (class 8) may be satisfactory.
- 2 A distinction is to be made between the requirements of bedding, haunching and surrounding and those of backfilling. The former comprise all operations of trench fill up to a level 300 mm above the top of the barrel of the pipe. Backfilling constitutes the remaining operations up to ground level in verges and open ground and up to formation or sub-formation level under carriageways. Work above

formation level constitutes construction or reinstatement of the pavement (see NG 706).

- 3 Concrete surround should be used exceptionally, e.g., for protection of pipes against mechanical damage from subsequent operations after construction of the pipeline and where remedial measures due to over excavation are required. Protection of existing pipes where necessary may take the form of a concrete arch or slab above the pipe.

NG504 Jointing of Pipes

- 1 Pipe joints for surface water drains, unlike foul drains, do not always have to be completely watertight. Small amounts of seepage as allowed in sub-Clause 509.7 can be tolerated particularly where pipes are laid in cuttings or below the water table. However, joints in pipes in soils that are predominantly fine sands or coarse silts should have watertight joints to prevent soil particles passing through the joint into the pipe leaving voids on the outside of the pipe. Where fine sands or coarse silts might be a problem but the more expensive rubber ring flexible joint is unwarranted, consideration can be given to certain proprietary wrap type joints that are available. These may also be specified where root penetration needs to be prevented. The Engineer should show his requirements in Appendix 5/1.
- 2 Most watertight joints will be flexible joints although rigid joints are occasionally used on clay pipes. In and under embankments, or if differential settlement is expected in compressible soils subject to non-uniform loading, then flexible joints and (except for pipes below the water table laid in non-erodible soils) watertight joints should be specified. The maximum length of pipe between flexible joints may have to be limited where considerable movement is expected. The limits of the exclusions should be shown in Appendix 5/1.

NG505 Backfilling of Trenches and Filter Drains

- 1 When soils to be drained require a particular grading of filter aggregate it should be specified in Appendix 5/1. Guidance on the design of filter materials is given in Transport Research Laboratory Report LR 346. The filter material in T&ble 5/5 is intended for use where the drain is designed to intercept surface water flowing to the pipe. Grit from the carriageway may slowly block this type of filter and it may require cleaning or replacement periodically.

NG507 Chambers

- 1 Concrete chambers, precast or cast in situ against forms, do not require strengthening with additional concrete surround. Access shafts in precast concrete should be strengthened, however, as a protection against loads from backfilling operations. Brick chambers, including shafts do not need a concrete surround for strengthening. It may however be necessary to backfill with concrete where space is insufficient to permit compaction of one of the earthworks acceptable materials. Inspection chambers are those that can be maintained from the surface and do not need to be entered. The types of brick to be used for brick chambers, and beneath chamber frames, in normal circumstances are specified in Clause 2406. Where a different type of brick is required this should be described in Appendix 24/1. The Engineer should ensure that any brickwork upon which chamber frames are seated is properly constructed.
- 2 Safety precautions require that chamber covers have a minimum opening of 600 mm diameter where personnel may be required to enter completely. In carriageways and hard shoulders where frequent heavy vehicles may be expected, chamber covers and frames should be Grade D and gully gratings should be Grade A. Reference should be made to IS 261 or BS 497 regarding locations where other grades of covers, gratings and frames will be acceptable.

NG 509 Testing and Cleaning

- 1 The testing of pipelines with flexible joints other than foul drains is not always required although the Engineer is able to specify tests in Appendix 1/5, or require tests to be carried out. The air test does not indicate the location of any large leaks that may be present. A water test may follow the failure of an air test.
- 2 Fall of the test water level may be due to one or more of the following causes:
 - (i) Absorption by pipes or joints.
 - (ii) Excessive sweating of pipes or joints.
 - (iii) Leakage from defective pipes or joints or plugs.
 - (iv) Trapped air.

Some pipes absorb more water or trap more air at the joints than others. Allowance should be made for this by adding water to maintain the test head for appropriate periods. While the

aim should be to commence the test period proper 2 hours after filling, the appropriate period may best be determined by conferring with the pipe manufacturers.

- 3 Closed circuit television (CCTV) inspection is a suitable alternative to the mandrel test and should always be used on foul sewers and connections to sewers. To avoid subsequent disputes it is essential to liaise with the drainage authority when checking connections to existing sewers to ensure acceptability of the work.
- 4 The test for partly watertight joints must be carried out before the pipe is laid because the water escaping from the joint has to be measured. The purpose of the test is to prove that the joint does not leak so excessively as to cause piping in any granular surround.

NG 510 Surface Water Channels and Drainage Channel Blocks

- 1 The Engineer should include his requirements for these in Appendix 5/3 compatible with the NRA Road Construction Details.

NG511 Land Drains

- 1 The Works are likely to disturb and render ineffective existing drainage systems in adjoining land; it will therefore be necessary for the Contractor to carry out without delay any such temporary or permanent remedial works as may be described in Appendix 5/1 or agreed by the Engineer. The designer should consider whether the most suitable arrangement for land drainage remedial works is to provide a system of drainage of land adjoining the road separate from the road drainage so that the reinstatement of the system is on the owners land and the matter falls to be dealt with as a matter of accommodation works. When such arrangements are not practicable or the cost is excessive, the existing land drainage system should be linked with the drainage system of the road.

NG 512 Backfilling to Pipe Bays and Verges on Bridges

- 1 Any special filling material, e.g. lightweight material, should be described by providing additional information on the Drawings, cross-referenced in Appendix 5/1.

NG 513 Permeable Backing to Earth Retaining Structures

- 1 For granular backing, where the Engineer wants a filter compatible with a particular type of filling he wishes to be employed adjacent to the structure, it should be specified in Appendix 5/1.
- 2 Fin drains are not allowed as permeable backing to structures because it is not yet possible to demonstrate that any of them will have the required design life of 120 years.

Uniformity Coefficient of $d_{Jd,Soil}$	Woven and Melt bonded Geotextiles	Needle-punched Geotextiles
1 to 5	$0J < k > = i$ to $P \ll / d \gg * 3$	$0 \wedge = 4$ to $0V d_m = 6$
> 5	$(Vd^*, < 1$ or $(Vd_{,,,} < 3$	$0_{90}/d_v < 1.8$ or $0Jd_m < 6$

$d_{,,} = n\%$ size in base soil ($n\%$ is finer)
 $0_{90} = 90\%$ opening (pore) size of geotextile
(90% of openings are smaller)

NG 516 Combined Drainage and Kerb Systems

- 1 The Drawings should show the location and gradient(s) of the combined drainage and kerb system, the position of access, silt trap, outfall and end units together with the position and invert level of the surface water outfall connection. The position of any movement joints required in the system, e.g.. at joints in bridge decks or concrete carriageways, should be shown. Details of any ducts, cabling, etc, required to pass under the kerb should be shown. The extent of the work to be designed by the Contractor should be clearly defined.
- 2 Combined drainage and kerb systems should be scheduled in Appendix 1/11 and cross-reference made to the design requirements given in Appendix 5/5.

NG 517 Geotextiles for Filter Drains

- 1 The pore size for the geotextile should be selected using filtration criteria to be compatible with the adjacent soil or construction layer in order to prevent the occurrence of piping. The following soil retention criteria may be used in determining $0'''$. Other criteria are available.

In general it will be sufficient to specify only the maximum value of $0'''$ that will satisfactorily retain the adjacent soil particles as the minimum $0'''$ size will be governed by the permeability requirements in sub-Clause 517.2(iv). However, with very fine grained soils such as clays, the use of the above criteria will result in such small pore sizes that sufficient permeability may not be obtainable. In such cases the cohesion of the soil particles themselves is relied upon to prevent migration and a maximum $0'''$ value of 100 microns may

be chosen. However, dispersive silts can present problems and in these cases the balance between the pore size and permeability requirements should be carefully considered. An $0'''$ value of 1 mm should be considered as the upper limit even with large grained material. The British Standard test to determine pore sizes (sub-Clause 517 2(iii)) is inappropriate for some geotextiles, such as needle-punched materials, if more than 20% of the glass beads are retained in the fabric. Pore sizes must then be obtained by other means such as wet sieving.

- 2 Sub-Clause 517.2(iv) requires the designer to specify the permeability of the geotextile. The permeability may be expressed independently of the geotextile thickness as a volume rate in litres/mV sec. It should incorporate a margin of safety to allow for reduction in permeability with time due to clogging. This margin should also include an allowance for the fact that the geotextile's quoted permeability is obtained from an unimpeded water flow test, whereas the filter material in a filter drain will block some of the geotextile. A value of 30 litres/mV sec is suggested for use against granular sub-base and capping. A smaller value would be adequate for soils and backfills.

NG SAMPLE APPENDIX 5/1: DRAINAGE REQUIREMENTS

[Note to compiler: This should include:]

- (i) the basis of the hydraulic design of the system on which the Contractor shall submit his proposals for pipe types and makes *[501.3I]*;
- (ii) a schedule of permitted alternative pipe and bedding combinations including those in the NRA Road Construction Details; *[which should be determined in accordance with UK Department of Transport Advice Note HA 40] [503.3]* and list of pipelines to be constructed other than in a trench *[608.8J]*;
- (iii) requirements for box culverts *[501.1I]*;
- (iv) values of pipe stiffness and impact resistance for plastics pipes;
- (v) plate thicknesses for bolted segmental plate pipes *[501.4(iJ)]* and minimum plate thickness for corrugated steel pipes of lock seam fabrication if different from sub-Clause 501.4;
- (vi) whether corrugated steel pipes are to have additional protection of hot-applied bitumen *[501.5]*;
- (vii) where sulphate-resisting Portland cement is required for concrete pipes *[Table 51U]*;
- (viii) details of materials in bedding, haunching and surrounding of filter drains if differing from the requirements of sub-Clause 503.3(v);
- lix) whether joints in surface water drains shall be watertight or partly watertight *[504.2I]*;
- (x) backfilling requirements differing from sub-Clause 505.2; level of backfill for trenches in carriageways or other paved areas if differing from the requirements of sub-Clause 505.2;
- (xi) grading limits for filter backfill materials in filter drains if differing from the requirements of Table 5/5 *[505.3/]*;
- (xii) references to drawings showing requirements for connecting existing drains to new drains and details of special connecting pipes *1506.1 /;*
details of connecting existing land drains *[511.1I]*;
whether severed mole drains are to be intercepted by construction of a land drain *[511.4/]*;
requirements for backfilling mole channels if different from the requirements of sub-Clause 511.4;
- (xiii) references to drawings which show chamber types *[507.1I]*;
- (xiv) requirements for concrete to cast in situ chambers if differing from the requirements of sub-Clause 507.4;
- (xv) particular requirements for corrugated galvanized steel chambers *[507.5I]*;
- (xvi) requirements for testing chambers for foul drains for watertightness *[507.8I]*;
- (xvii) details of chamber covers, gratings and frames *[507.9I]* and details for special duty covers for use in carriageways *[507.11/]*; requirements for minimum waterway area to gratings for catchpits *[507.12]*;
the sizes of cast iron and steel gully gratings *[508.4]*;
requirements for gully gratings if different from the requirements of sub-Clause 508.5;
- (xviii) requirements for setting existing covers and gratings to level if different from the requirements of sub-Clauses 507.16 and 508.8;
- (xix) whether gullies are to be trapped *[508.1/]*; details of in situ concrete gullies *[508.3J]*;

- (xx) references to drawings showing requirements for filling to pipe bays and verges if different from the requirements of sub-Clause 512.1;
- (xxi) requirements for permeable backing if different from the requirements of sub-clause 513.1.

NG SAMPLE APPENDIX 5/2: SERVICE DUCT REQUIREMENTS

[Note to compiler: This should include:]

- (i) details of duct construction [503.5]
[cross-reference should be made to the NRA Road Construction Details where appropriate];
- (ii) a schedule of service duct requirements /similar to those in Appendix 5/1 for pipes/;
- (iii) details of permanent marker blocks and location posts required for service ducts [505.5]
[cross-reference should be made to the NRA Road Construction Details where appropriate/.

NG SAMPLE APPENDIX 5/3: SURFACE WATER CHANNELS AND DRAINAGE CHANNEL BLOCKS

[Note to compiler: State here specific requirements cross-referring to drawing numbers where appropriate, including NRA Road Construction Details listed in Appendix 0/4]

NG SAMPLE APPENDIX 5/4 : GEOTEXTILES FOR FILTER DRAINS

[Note to compiler: This should include, if different than stated in specification:]

- 1 The maximum permissible D_{10} , determined from the pore size distribution curve of the geotextile [517.2(iii)].
- 2 The permeability of the geotextile [517.2(iv)].

NG SAMPLE APPENDIX 5/5: COMBINED DRAINAGE AND KERB SYSTEMS

[Note to compiler: Include here:]

- 1 Limiting dimensions:
 - (i) Maximum width and depth of units *[if applicable]*.
 - (ii) Kerb upstand.
 - (iii) Kerb profile *[if applicable]*.
- 2 Strength requirements
[units should normally be capable of bearing a wheel load of 11.5 tonnes]
- 3 Hydraulic design parameters
[roughness coefficients should not be specified]
- 4 Class of concrete or mortar bedding/surround.

**NG SAMPLE APPENDIX 5/6 : DRAINAGE AND SERVICE DUCTS:
NRA ROAD CONSTRUCTION DETAILS.**

Clause No.	Road Construction Detail
501.8	
503.3 (i)	
503.3 (iii)	
508.1	
509.9	
517.4	