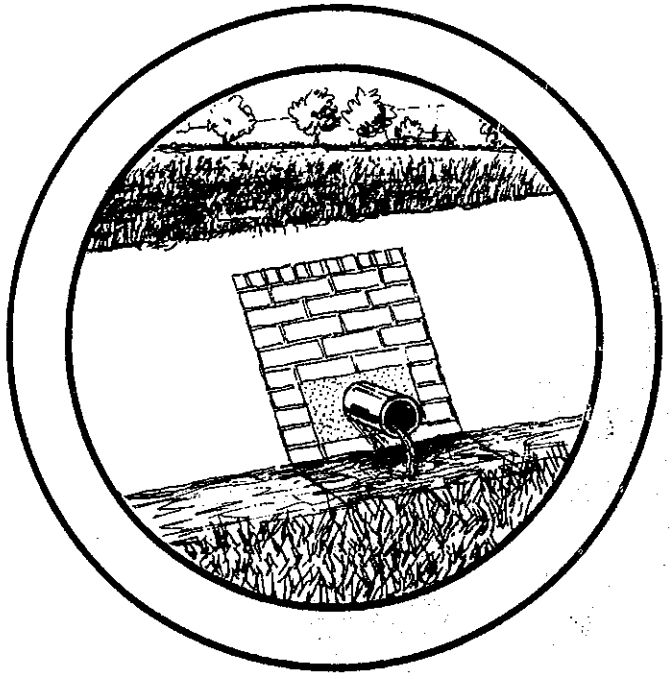
ADAS

FOOD, FARMING, LAND & LEISURE

Technical Note on Workmanship and Materials for Land Drainage Schemes



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This publication is based on the 1983 Ministry of Agriculture, Fisheries and Food "Technical Note on Workmanship and Materials for Field Drainage Schemes" which is gratefully acknowledged. The opportunity has been taken to carry out a major updating and include new chapters on Maintenance, Conservation and Pipelines. ADAS also acknowledges the assistance of many individuals, companies and suppliers in general and of the Land Drainage Industry in particular in the preparation of this publication.

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Whilst all reasonable care has been taken to ensure the technical correctness of this Technical Note ADAS can accept no liability for errors or omissions or for the consequences of any such errors or omissions.

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1 General

1.1 Introduction

The purpose of this Note is to provide guidelines on the standards of workmanship and materials which ADAS considers suitable in respect of the installation of land drainage schemes. It is not intended to be a complete specification. Because of geographical differences it is not practicable to lay down inflexible standards which can be applied to all schemes. This Note summarises minimum acceptable standards but higher standards may be necessary in particular cases. (See section 1.2).

It is intended to publish additional sections covering special design situations.

1.2 Statutory Authorities

The requirements of statutory authorities having any interest in any part of the works are to be observed and the provisions of this Note disregarded if these impose standards inferior to such requirements.

1.3 British Standards

Where a British Standard (BS) is specified it is to be the edition current at the time of carrying out the work. Selected British Standards relevant to land drainage are listed at Appendix A.

Pipes and ancillary fittings covered by a British Standard (BS) must be stored and supplied in full accordance with the requirements of the relevant standard. All products should carry the Kite Mark where applicable. However the delivery of Kite Marked materials to site must not be taken as a guarantee that they conform to the appropriate British Standard. Visual checks to confirm compliance with the BS should be made and the supplier informed immediately of any irregularities. If the supply of substandard materials is not rectified then the British Standards Institution should be informed.

Copies of British Standards can be obtained from British Standards Institution, Sales Department, 389 Chiswick High Road, London W4 4AL.

1.4 Proprietary Materials Outside British Standards

Materials outside British Standards must be shown to be suitable for the purpose specified.

1.5 Recommendations for Drainage Plans

All plans for both ditching and underdrainage schemes should be drawn using the standard symbols and colour codes and to the scales shown in Appendix C.

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2 Safety

2.1 Health and Safety at Work etc. Act 1974 (HSWA) - General

Attention is drawn to the requirements of this Act. The General Duty provisions require that systems of work shall be adopted and plant and equipment used, that are, so far as is reasonably practicable, safe and without risks to the health of persons at work and others who may be affected from the activities of persons at work. Where five or more workers are employed, employers are required to have a written statement of intent, or health and safety policy.

2.2 Important Safety Aspects of Land Drainage Works

Certain provisions of the HSWA apply to the installation of land drainage schemes, including in some circumstances, regulations originally made under the Agriculture (Safety, Health and Welfare Provisions) Act 1956 and the Factories Act 1961. These provisions are enforceable under the HSWA. Whether or not any of the regulations apply to a particular drainage scheme the standard of protection prescribed in them should be adopted for all land drainage works.

Attention is drawn to the importance of ensuring that anything which may create a hazard is controlled so far as is reasonably practicable. Machinery must be adequately guarded, excavations made safe and adequately supported. Temporary excavations should be covered or guarded when the site is unoccupied to reduce the risk of accidents, particularly to children.

Warning Signs

Where possible, land drainage sites should be clearly demarcated and warning signs erected (if appropriate) to highlight the hazards attendant at the site (see section 2.5. on Laser Equipment).

Head Protection

If there is a risk of head injuries then the site must be designated a "hard hat" site, notices erected to warn staff and visitors and head protection provided.

Clothing

If there is a risk of vehicles colliding with pedestrians then the issue and use of high visibility clothing to "BS 6629: 1985 class A or B to Appendix G or better" must take place.

2.3 Construction (Design and Management) Regulations

These Regulations will implement in Great Britain the design and management aspects of European Council (EC) Directive 92/57/EEC concerning the implementation of minimum health and safety requirements at temporary or mobile

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construction sites. Land drainage works are included within the scope of the Regulations.

The Regulations place specific health and safety obligations on clients, developers, designers, planning supervisors, principal contractors and other contractors. Duties are imposed at all stages of a construction project.

Following introduction all land drainage works must comply with the Regulations and associated codes of practice.

2.4 Underground and Overhead Services

Particular care should be taken with working practices in the vicinity of underground and overhead utilities and the requirements laid down by the utility owner or responsible authority must be adhered to.

Where land drainage operations are proposed in proximity to a buried service, the appropriate utility authority must be given prior notification in writing and their requirements adhered to. In every case the buried service will need to be located and exposed by hand digging before drain laying commences. Location, exposure and adjacent land drainage installations should take place only in the presence of a representative from the utility authority.

2.5 Laser Equipment

All laser levelling equipment is to be operated in a manner that does not constitute a health and safety hazard to staff, contractors or members of the public. A nominated person responsible for safety must be present at all times where such equipment is used.

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3 Workmanship and Materials

3.1 General

Workmanship, materials and methods of construction are to conform to good standards and practices. Materials should always be handled, stored or stacked so as to prevent or minimise damage. Where materials are liable to damage by extremes of temperature or sunlight suitable protection should be provided.

3.2 Bricks

Bricks used below ground level and in retaining walls shall be dense, strong and of uniform size such as hard burnt stocks or engineering Class B quality to BS 3921. Brickwork must always be properly bonded and all joints filled solid with cement mortar.

3.3 Concrete Blocks

Concrete blocks to BS 6073 are to be of regular and uniform shape and, except where used in the internal walls of a building, are to be composed of hard dense concrete without voids. Where hollow concrete blocks are used other than in the superstructure of a building above the damp-proof course, the blocks are to be filled solid with concrete as described for reinforced concrete in Table 1 (ii).

Blockwork must always be properly bonded and all joints filled solid with cement mortar.

3.4 Cement

Portland cement to BS 12 should be used except where certain adverse soil conditions prevail where it will be necessary for specific types of cement to be used, eg. where sulphate bearing groundwater is present. Where concrete is likely to be exposed to sulphate attack the type of cement used should comply with BS8110: Part 1. All cement is to be fresh and free from lumps.

3.5 Cement Mortar

Cement mortar is to be composed of 1 part cement to 3 parts clean building sand by volume, thoroughly mixed either by hand or mechanically to a uniform texture. A plasticiser or water- proofing additive may be used in accordance with the manufacturer's instructions.

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3.6 Concrete Aggregates

All coarse (gravel and stone) and fine (sand) aggregates for concrete should be good quality clean gravel, broken stone or sand, suitably graded and free from dust, dirt or other impurities, and comply with BS 882.

3.7 Water for Concrete and Mortar

Water used for concrete and mortar is to be clean and free from impurities.

3.8 Concrete Proportions

Concrete is to comply with the designated or standard mixes set out in BS 5328. For unreinforced concrete in non-aggressive soils, either designated mix Gen 3 or standard mix ST4 can usually be specified, dependent upon application. Similarly, designated mix RC30 or standard mix ST5 should be specified for reinforced concrete, again dependent on individual circumstances. Designated mixes will usually refer to supplied ready mixed concrete and standard mixes to on site mixing. Further details for site mixed concrete are given in Table 1.

Table 1. Recommended Proportions for Site Mixed Concrete

Concrete mix	By volume	By weight
i. Un-reinforced concrete: Mix ST4		
Cement	3 parts	50 Kg
Concreting sand	5 parts	115 Kg
Aggregates (maximum particle size 20 mm)	9 parts	195 Kg
Approx yield		0.17 cu m
ii. Reinforced concrete: Mix ST5		
Cement	3 parts	50 Kg
Concreting sand	4 parts	95 Kg
Aggregates (maximum particle size 20 mm)	7 parts	175 Kg
Approx yield		0.15 cu m

Special mixes will be required for concrete in sulphate-bearing soils.

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9 Mixing and Placing Concrete

Concrete materials need to be well mixed to a uniform texture and only just sufficient water used to produce a workable mix. Concrete is to be carefully placed and compacted within 60 minutes of mixing, protected from the weather and kept moist during curing. Ready-mixed concrete of suitable constituents may be used. Vibrating equipment should be used to compact concrete in larger structures.

10 Reinforcement

Reinforcing steel is to be clean and firmly held in position while concrete is placed. The concrete covering to reinforcing should not be less than 40 mm for water retaining structures and not less than 25 mm in all other cases.

11 Additives

Additives for use with concrete such as plasticisers, super-plasticisers, retarders, calcium chloride-free accelerators, air entrainers, surface hardeners and water reducing additives shall comply with BS 5075 and be used strictly in accordance with the manufacturer's instructions.

Work in Frosty Weather

oncreting, rendering, brick or concrete block laying or other work involving the use materials liable to damage by frost, is not to be carried out in frosty weather unless able anti-frost measures are taken.

ber for Structural Use

forming part of the permanent works shall be of good quality, straight, well ed and reasonably free from shakes and large knots. Timber which is in with the earth or exposed to moisture is to be suitably treated to retard rot. preservatives and methods of application should meet the provisions of 2, BS 5589 and BS 5707.

4 Ditching

4.1 Clearance Work Prior to Excavation

The conservation implications of any clearance of vegetation should be carefully considered before work commences. Operations during the bird nesting and breeding seasons are to be avoided.

Clearance work on hedges and banks shall be done in advance of excavation. Over-growth on the banks and in the ditch shall be cut down and grubbed out and hedges trimmed sufficiently to allow the ditch excavation work to be done properly. Tree branches are to be lopped with reasonable care to avoid damage to the trees or the local amenities. All trimmings and over-growth are to be burnt or carted away and not mixed with, or covered by the material dug out of the ditch.

4.2 Ditch Dimensions

Ditches are to be dug to appropriate and suitable dimensions and gradients so that a stable, self- cleansing channel is formed with minimal erosion risk. Ditch beds must be smooth and true to grade. Stepping ditch bottoms is to be avoided except where there is a requirement to create pools for conservation purposes. Guidelines for the side slopes (batters) of ditches and minor watercourses are given in Table 2.

Side slopes are to be neatly trimmed and finished. Loose material shall not be placed on the side slopes to fill hollows. Care must be taken to avoid endangering the stability of adjoining hedges, trees, buildings or roads etc.

The introduction of variable side slopes and meanders can help habitat creation without prejudicing the drainage characteristics of a ditch.

Table 2. Ditch Batters

Channel side slopes

Soil	Channels less than 1.3 m deep	Channels greater than 1.3m deep
Fen peat	Vertical	½H : 1V
Heavy clay	½H : 1V	1H : 1V
Clay or silt loam	1H : 1V	1½H : 1V
Sandy loam	1½H : 1V	2H : 1V
Sand	2H : 1V	3H : 1V

Key: H - Horizontal; V - Vertical

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4.3 Existing Pipe Drain Outfalls

The sides of the ditch are to be examined for old drain outlets. If functional, these are to be made good to the standard described in section 6.15.

4.4 Silt in Excavated Length

Accumulations of silt collecting in the excavated length during the course of the work shall be removed before the scheme is completed.

4.5 Slips

Slips in the side slopes that occur while work is in progress, or shortly after completion are to be made good, and all appropriate remedial measures taken to prevent their recurrence.

4.6 Bank Protection

Specific protective measures will be required where there is a risk of bank damage by erosion or soil instability. Suitable methods include grassing, faggots, stoning, planking and piling, pitching, stone revetment, concrete blocks and slabs, bagwork, gabions and geotextiles. The chosen form of protection should be compatible with the local environment.

4.7 Spoil from Ditch Excavation

Material dug from the ditch shall be deposited not less than 1000 mm from the edge of the ditch and spread evenly and thinly on the land surface adjoining the ditch as soon as possible in a manner suitable for normal cultivations. Large stones, roots and other materials of size and character abnormal to materials found in the surrounding area, which could damage implements or livestock, are to be removed. Where the material cannot be spread as excavation proceeds it is to be temporarily heaped along the side of the ditch not less than 1000 mm from the edge of the ditch so that it can be spread mechanically at a later date. Spoil should be spread, wherever possible, on the down-slope side of the ditch. If this is not feasible then grips must be made through the spoil to prevent surface water from being held on the adjoining land. In exceptional cases where spreading is not desirable or practicable (eg. roadside ditches with narrow verges) the material is to be carted away.

Where spoil is in such a condition at the time of working as to be unsuitable for spreading, it shall be heaped temporarily, with a view to spreading at a later date.

4.8 Fencing to Ditches

Where a guard fence is specified, it is to be erected to a standard not less than that given in the specification at Appendix B.

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5 Bridges and Culverts

5.1 Design

Typical designs for culverts up to 1500 mm deep in stable subsoil are shown at Figures 1-4. Materials commonly used in culvert construction are indicated in Table 3. When it is necessary to construct a clear span bridge, the design should be based on such maximum loadings as the bridge is likely to be required to carry, together with an appropriate applied safety factor. The approval of the National Rivers Authority must be obtained to construct or alter a culvert or bridge that would be likely to affect the flow of a watercourse. This is required in accordance with Sections 109 and 110 of the Water Resources Act 1991 for watercourses designated main river, and Section 23 of the Land Drainage Act 1991 for ordinary watercourses.

Table 3. Typical Materials for Culverts

Pipes	Headwalls	Pavement
Dense concrete	Concrete blocks	Consolidated hardcore or aggregate
Unplasticised PVC, polypropylene or polyethylene	Engineering bricks	Concrete
	Precaste concrete sections	Tarmacadam
	Natural local materials	
Vitrified clay sewer pipes	Turf	
	Earth bank with or without a low retaining wall	

5.2 Diameter of Culverts

The culvert diameter shall be capable of accommodating the anticipated design flows subject to a minimum 225mm internal diameter. Certain statutory organisations such as the National Rivers Authority and Highway Departments may specify mandatory minimum culvert diameters for works in which they have an interest.

5.3 Width of Culverts

A minimum usable width of 4000 mm is recommended where wheeled traffic will cross the culvert.

5.4 Pipes for Culverts

Suitable pipes are those with interlocking joints or forming a continuous pipe length and which comply with appropriate British Standards. Large diameter corrugated

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plastics pipes outside British Standard specifications shall only be used in full compliance with the manufacturer's recommendations.

5.5 Placement of Culvert Pipes

Pipes are to be set on a firm bed surrounded by selected bedding material as required and in proper alignment. The trench bottom is to be recessed where necessary to accommodate the collar of spigot and socket joints. Pipes are to be set so that the invert at the upstream end is a minimum 25mm below the bed level of the ditch. Where the total depth of cover is less than the diameter plus 300mm (subject to a maximum of 600 mm) the pipes are to be wholly surrounded by concrete at least 150 mm thick. Manufacturer's advice should be sought for any proposal to encompass plastics pipes with concrete.

In soft ground or where stability is endangered, special precautions, such as concrete bedding or haunching or the use of a continuous pipe will be necessary. Where the pipe manufacturer specifies precautions to be taken in laying pipes these are to be observed.

5.6 Pipe Gradient

Gradient of culvert pipes should be consistent and approximate to that of the adjoining ditch. The ditch bed is to be graded for a length immediately downstream in order to accommodate the deepening at the culvert.

5.7 Prevention of Erosion

Where erosion is likely at the downstream end of the culvert protective measures (eg. stone pitching, concrete slabs) are to be provided on the ditch bed and, if necessary, also on the ditch sides.

5.8 Backfilling Culverts

An appropriate method of pipe bedding must be selected taking into account the depth of cover over pipes, the total load imposed on the pipes and the actual pipe strength and class. The examples shown at Figures 5-7 assume at least 600 mm depth of cover except as indicated and are applicable to culvert and underdrainage pipes. Bedding factor values are given on an increasing scale of sophistication (from 1.1 to 4.8) with the comparative figures providing an indication of the standards of pipe support and protection afforded.

There are, not as yet, any definitive standards for flexible pipe beddings. The examples shown in Fig. 7 are therefore not exhaustive. Pipe manufacturer's advice should be sought for specific situations.

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As a minimum requirement for concrete and clay pipes, selected soil or imported granular material should be packed beside and to a depth of at least 300 mm above the pipes, ie a Class D bedding. Granular material requirements for pipe bedding are given in Table 4. All filling is to be put back in separate layers, each not more than 150 mm thick, and thoroughly consolidated. Initial backfill material in contact with culvert pipes should not contain large stones, rocks, tree roots, frozen soil or large objects which may cause damage either on impact or by subsequent pressure.

The fill surface is to be left 'crowned' above the level of the surrounding track or highway to allow for initial settlement and subsequently to permit surface water to be shed laterally.

Table 4. Granular Materials for Pipe Bedding

Nominal pipe size (mm)	Maximum particle size (mm)	Suitable aggregate materials: Aggregate type	Nominal aggregate size range (mm)
100	10	Single size	10
150	15	Single size Graded	10 or 14 14 to 5
225-525	20	Single size Graded	10, 14 or 20 14 to 5 or 20 to 5
Over 525	40	Single size Graded	10, 14, 20 or 40 crushed rock 14 to 5, 20 to 5 or 40 to 5

5.9 Pavement

A culvert pavement must be capable of supporting traffic without rutting and be compatible with any adjacent track or highway. The pavement should cover the usable width and extend onto undisturbed ground on both sides. Doming the pavement will prevent surface water collecting on the crossing. Culverts should be provided with a minimum 225 mm thick hardcore surface which can then be finished with a concrete or tarmacadam top layer if necessary.

5.10 Ditch Profile at Culverts

Ditch width may be reduced where a culvert is to be constructed in order to minimise the quantity of soil to be excavated and subsequently replaced subject to statutory requirements set out in section 5.1. This will also be advantageous in correspondingly reducing pipe loading.

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5.11 Headwalls for Culverts

Adequate provision is to be made to retain the backfill against the pressure of traffic using the crossing. In good ground conditions the headwall is to be built into each bank for a distance not less than 450 mm throughout its height. Where headwalls are to be built in other conditions they must be designed accordingly. Lintels should be provided within the headwall structure for pipes in excess of 300 mm internal diameter.

5.12 Culverts with Sloping Earth Ends

Where the design indicates that a full height headwall is not necessary and sloping earth ends, with or without low headwalls are used then the slopes are not to be steeper than 1.5 horizontal to 1 vertical or 1 to 1 if turfed. The length of the culvert is to be extended by a minimum 1000 mm at each end to allow a margin of 1000 mm between each side of the roadway and the top of the slopes.

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Main Culvert Types

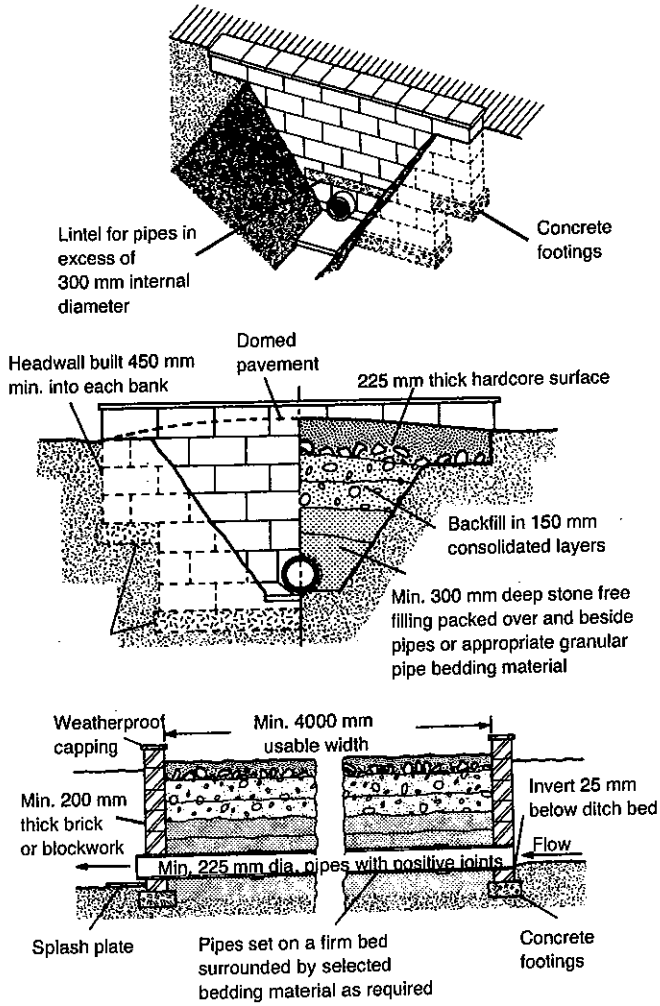

Fig. 1 Block headwall

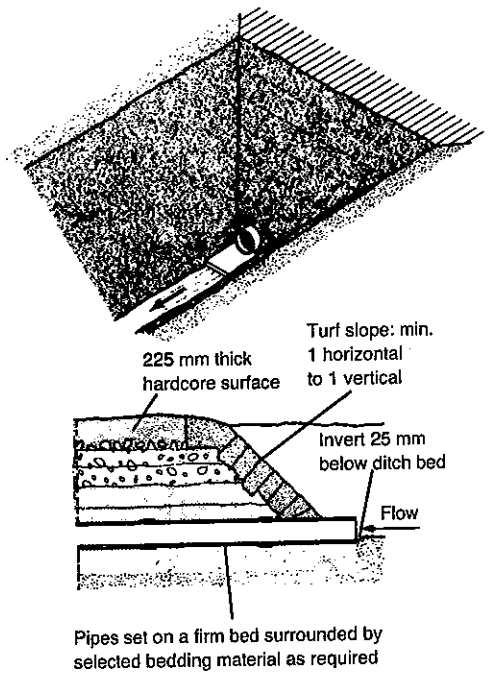

Fig. 2 Complete earth bank

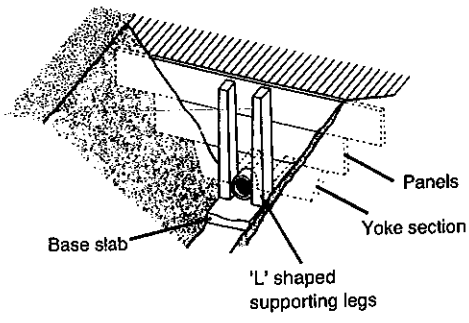

Fig. 3 Pre-cast concrete headwall

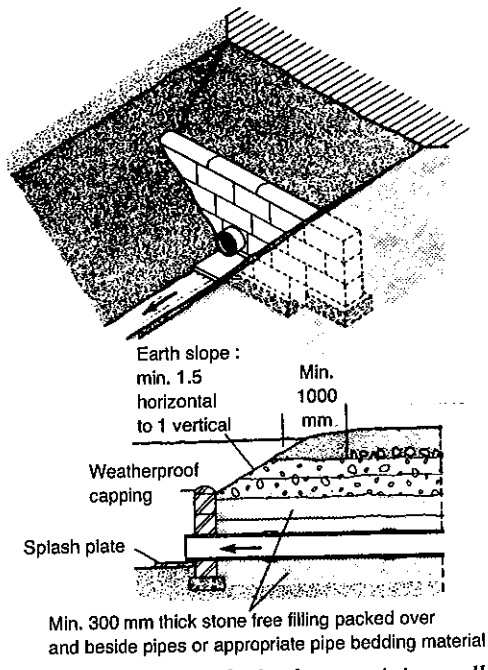

Fig. 4 Earth bank plus low retaining wall

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Examples of Pipe Beddings used in Land Drainage

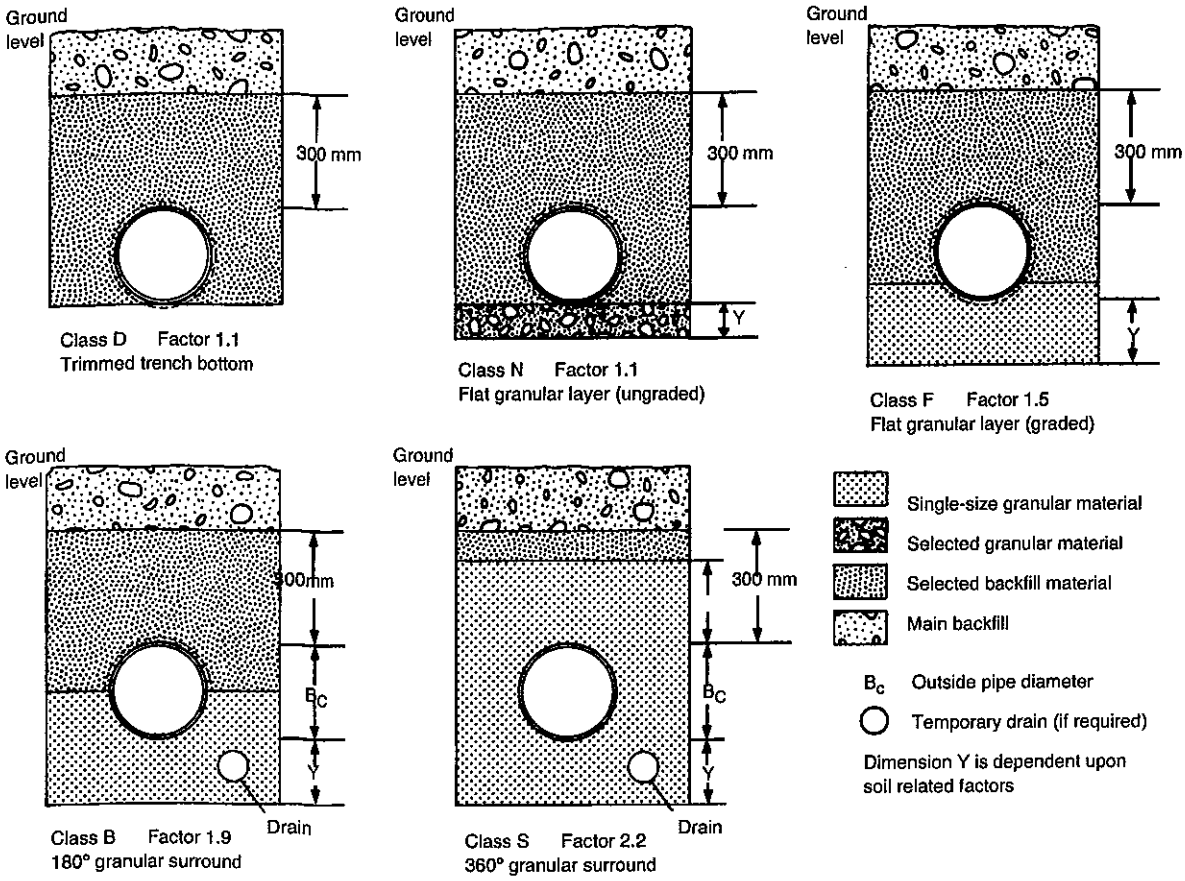

*Fig. 5 Granular beddings for rigid pipes**
(Primarily concrete, clayware or cast-iron pipes)

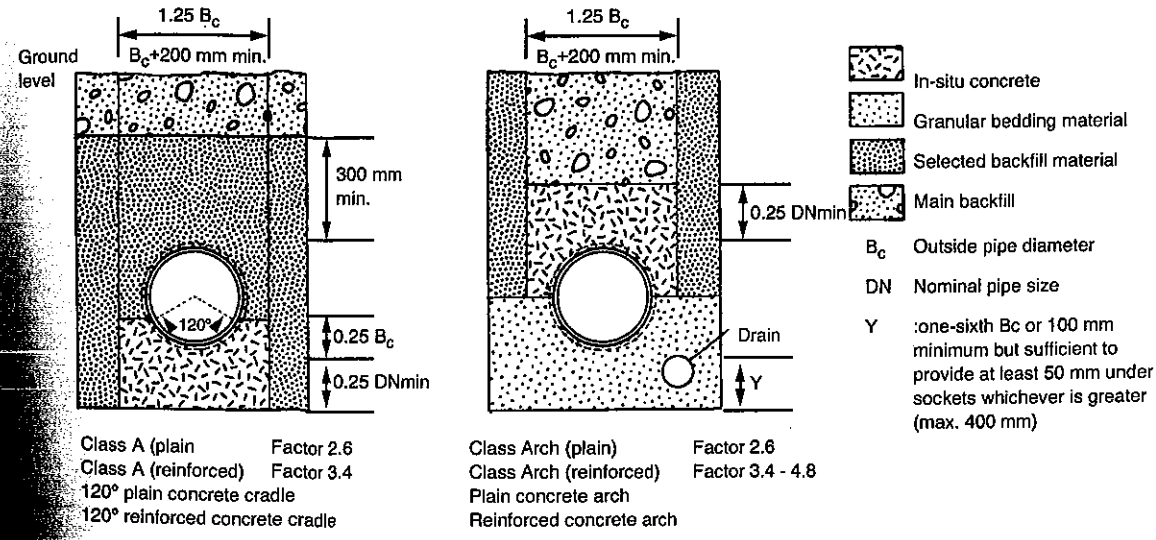

*Fig. 6 Concrete beddings for rigid pipes**

**Transport and Road Research Laboratory: Simplified Tables of External Loads on Buried Pipelines. HMSO. 1988*

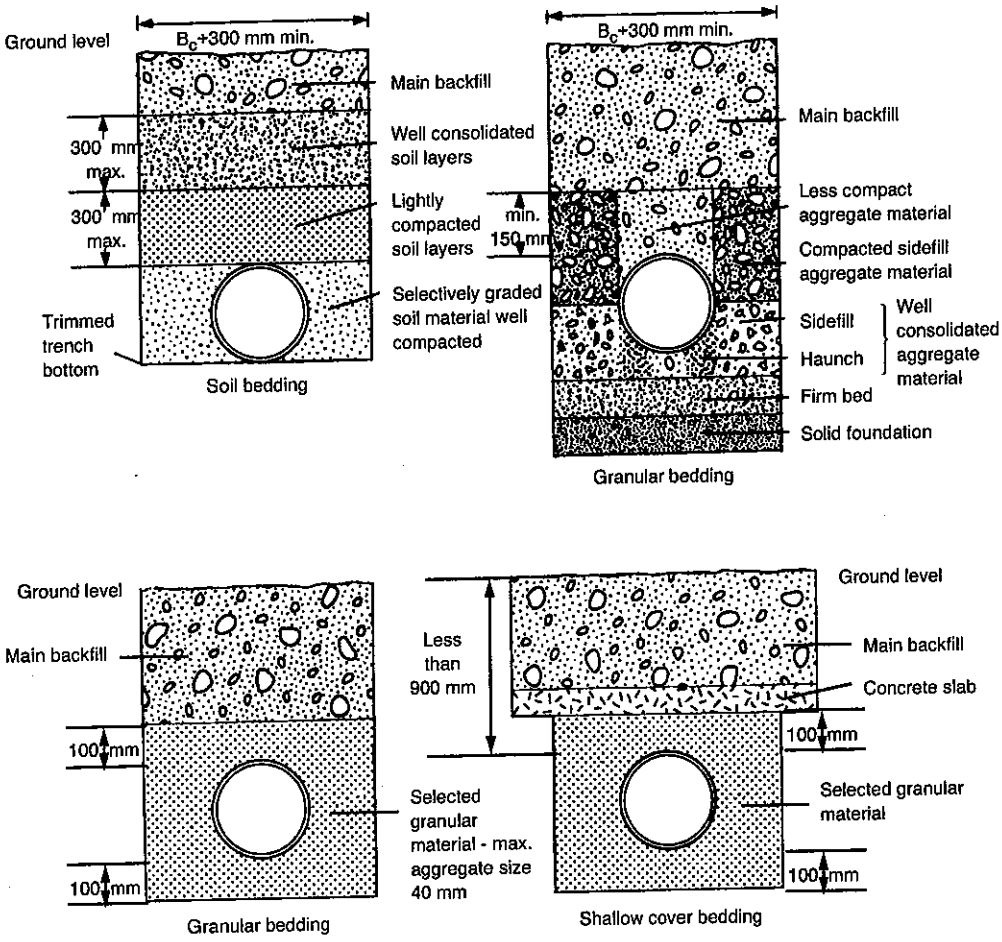

Fig. 7 Typical beddings for flexible pipes (Primarily plastics or steel pipes)

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6 Underdrainage

6.1 Pipes

All pipes used must be specific for the intended purpose.

Plastics Land Drainage Pipes

Corrugated and smooth plastics pipes and fittings (including connectors, reducers and end caps) up to a maximum design outside pipe diameter of 400 mm must conform to BS4962. Pipes greater than 400 mm diameter must be shown to be specifically suitable for the purpose designated.

Clay Pipes

Clayware field drain pipes and junctions in nominal pipe sizes of 75, 100, 150, 225 and 300 mm must conform to BS 1196. Vitrified clay pipes, fittings and junctions must conform to BS EN 295 and BS65.

Concrete Pipes

Unreinforced and reinforced precast dense concrete pipes and fittings with flexible joints in pipe diameters from 150 mm to 3000 mm shall conform with BS 5911: Part 100. Precast concrete pipes and fittings with ogee joints shall conform with BS 5911: Part 110.

Porous concrete pipes shall comply with BS 5911: Part 114.

Certain soils contain sulphates and acids which attack concrete. Therefore concrete pipes shall not be used in situations where:

i. The soils are known to be aggressive to concrete

ii. Household or industrial waste or clinkers have been tipped.

Concrete pipes made with High Alumina Cement are not suitable for land drainage. Concrete pipes made with Portland Cement to BS12 or Sulphate Resistant Cement to BS 4027 may be used subject to the following:

iii. Porous pipes (BS 5911: Part 114) - only when soil and groundwater tests have established that conditions are suitable for the use of porous pipes. These pipes have a large surface area and are much more susceptible than dense concrete pipes to attack by aggressive substances.

iv. Dense concrete pipes (BS 5911 Part 100 and Part 110) - tests required as in (i)

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above except where there is local experience that soil and groundwater are not aggressive to Portland Cement Concrete. Pipes made of normal combinations of cement complying with BS12 will facilitate resistance to sulphate attack equivalent to classes 1 and 2 sulphate levels as specified in BS 8110: Part 1.

Pipes made with Sulphate Resistant Cement may be used in certain conditions shown by tests to be unsuitable for ordinary Portland Cement. Sulphate Resistant Cement should be specified for all pipes where sulphate conditions are equivalent to BS 8110 Class 3.

Pitch Fibre Pipes

Fibre pipes impregnated with pitch used as rigid drain outfall pipes must be suitable for the purpose.

Steel Pipes

Where sections of steel pipes are required they should comply with BS 534.

Hard Plastics Pipes

Hard walled pipes and junctions should be to BS 4660 for permanent works.

Filter Wrapped Pipe

Wrapping material must be suitable for the purpose and securely fixed to the pipes. Fabric opening size shall be appropriate for the soil type encountered and of adequate permeability. Care must be taken to ensure that the filter wrapping is not damaged during installation and that no exposed areas remain, particularly in the vicinity of pipe junctions.

6.2 Sealed Joints

Pipes shall have a positive sealed joint, or preferably be continuous where they have to be laid:

- Unavoidably closer than 5 m to hedges and trees, other than fruit trees in orchards
- Through natural windbreaks
- Where leakage from the pipe could cause erosion of the soil around the pipe or actual pipe displacement.

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6.3 Air Temperature Restrictions on Plastics Pipe Installations

Pipes manufactured from UPVC (unplasticised PolyVinyl Chloride) shall not be installed when the air temperature is below 0°C. Pipes manufactured from polypropylene and polyethylene may be installed in temperatures down to a minimum of - 10°C. Similar restrictions apply to the placement of permeable backfill over pipes in these plastics materials.

Installing plastics pipes in high air temperatures must be done carefully so that the pipe lengths do not become stretched or subject to collapse.

Wherever plastic pipes are to be installed in extremes of temperature the manufacturer's advice must be sought in any cases of doubt.

6.4 Fin Drains

A fin drain consists of a central cuspated, pillar stud or mesh plastic core sandwiched between two geotextile filter fabric layers. The fabric may or may not form a continuous loop around an integral plastics drainage pipe at the base of the fin drain.

Care must be taken during storage and installation to ensure that fin drain integrity is not damaged.

The open ends of a fin drain system must be sealed with an end cap.

Lengths of fin drain should be joined using proprietary fittings or other methods such as stapling, or waterproof adhesive tape as recommended by the manufacturer.

6.5 Trench Excavation

Drain trenches are to be cut to the appropriate depth; true to line and gradient with the trench bottom shaped to bed, fit and secure the pipes. The width of the trench at the bottom is to conform as far as possible to the outside diameter of the pipe and should not exceed three times the pipe outside diameter except where further excavations are needed for junction installation. These requirements apply to both open-trench and trenchless installations - see Figure 8.

The depth of cover over any land drain is to be at least 600 mm. Otherwise appropriate protective measures shall be taken such as the introduction of a concrete slab as detailed in Figure 7. Where mole channels are to be drawn across lateral drains, the depth of pipes shall be such that the distance between the top of the pipe and the invert of the mole channel shall be not less than 100 mm. Permeable backfill should be placed on all pipe drains crossed by mole channels to an appropriate depth. In these circumstances the minimum trench width should be 100 mm.

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6.6 Drain Laying

Pipes are to be laid to a true line and gradient on a firm, smooth bed free from loose soil or other debris. Pipes must not be laid on soil backfill or in slurry. They are to be securely positioned to avoid displacement before backfilling the trench.

Wherever possible drain laying shall take place in good soil conditions so that smearing of the trench sides and surface compaction by machinery is minimised. Working in adverse conditions may well have an immediate reducing effect on the efficiency of the underdrainage system being installed.

Where plastic pipes are used the bottom of the trench shall be 'V' shaped as shown at Figure 8. On sites with difficult soil conditions where the trench bottom cannot be shaped to these requirements, a bedding practice to provide equivalent lateral support is to be used. An example is given at Figure 9. Purpose made connectors must be used to join together individual lengths of plastics pipe.

Clay and concrete pipes shall be carefully butted together so that no soil or permeable backfill material can enter at the joints.

All lengths of pipe drain shall be provided with an end cap or plug at the upper end (ie that furthest from the point of outfall) so that no ingress by soil or small mammals occurs.

Drainage Machines

All drainage machines (including trenchers, gravel trailers and loaders) are to be properly maintained and function correctly, with particular regard to the following:

- Only trained operators shall use drainage machinery
- Automatic and laser assisted levelling devices shall be in correct calibration and checked regularly
- Pipes shall feed freely through the pipe-laying chute
- Permeable backfill shall flow freely through the hopper and down into the drain trench.

6.7 Existing Underdrains

Existing pipe drains exceeding a nominal 50 mm diameter (including horseshoe

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drains) are to be positively connected to the new system via purpose made junctions. Other drains such as small diameter clay pipes, stone and rubble drains etc. can be connected to the new system via permeable backfill. Where permeable backfilling is to be used the depth of aggregate material should be sufficient to ensure that seepage from existing drains will be intercepted.

6.8 Permeable Backfill Materials

When permeable backfilling is specified it is to be clean gravel, stone chips, slag, foam slag, hard clinker, cintered pulverised fuel ash or other suitable hard and durable material having no dimension greater than 50 mm or less than 5 mm. The material used is to be clean, resistant to dissolving in water and free of contaminants such as dust, soil, organic matter and other extraneous small organic particles.

Permeable backfill must be carefully placed immediately over the pipes to the depth specified, any loose soil on the pipes being first removed. It should be placed in such a way that the pipes are not damaged or displaced. The use of purpose built gravel hoppers which can accurately control the depth of permeable backfill and prevent soil intrusion are recommended.

Where permeable backfill is specified on design plans the material should ideally be on site before the commencement of trench excavation and drain installation if possible. All loose soil on the pipes shall be removed and the permeable backfill must be placed as soon as possible after the drain laying and completed the same day. If permeable backfill is required as a connector for mole drainage then a minimum filled trench width of 100 mm shall be applied. The depth from ground level to top of permeable backfill prior to final backfilling of trenches shall be as specified on the design plans.

6.9 Backfilling Excavated Material

Pipe trenches are to be carefully backfilled with excavated material placed in such a way that the pipes are not damaged or displaced. Backfilling is to take place as soon as possible after pipe or permeable backfill placement and preferably on the same day. The fill is to be firm but not consolidated so much that it prevents the passage of water to the pipes (but see also sections 6.15 and 6.17). All trenches are to be filled to a level sufficiently above the surface of the ground to allow for subsequent settlement. Fill should exclude large stones, clay lumps, timber, frozen material or vegetable (eg grass, weed or stubble fragments) and other foreign matter.

6.10 Disposal of Surplus Trench Spoil

Surplus material which is not of an injurious nature is to be spread evenly on the land

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surface adjacent to the drain trench. Material such as large stones and roots likely to damage implements, cause injury to people or livestock or of a size and character abnormal to material found on the surface of the site, is to be removed.

6.11 Surface Heave Caused by Trenchless Drainage Equipment

The degree of surface heave left by trenchless drainage equipment may need to be reduced by additional work before normal field operations can take place. On grassland, surface heave can be diminished by immediate flattening using the drainage machine tracks or a heavy roller. It may occasionally be necessary to cultivate and re-seed the drain lines.

Trenchless heave must be consolidated where the pipe drain trenches will be crossed by mole channels so that the stability of the mole drains is not impaired.

6.12 Soft Ground

In peat, running sand, old ditch lines, pipeline trenches and other conditions where it is not possible to obtain a firm foundation on which to lay land drainage pipes, special provision is to be made to maintain the proper alignment of the drains. The following principles should be observed:

i. The number of ditch or trench crossings should be reduced to a minimum by the installation of a header (interceptor) drain along the higher side (refer to section 11.2 for definition).

ii. Where the ditch or trench to be crossed is only slightly deeper than the pipe drain an economic crossing can be made by backfilling the ditch or trench with selected and well consolidated excavation material followed by the laying of a continuous length of pipe on a suitable support. In the absence of appropriate backfill material, then lean mix concrete may be used. The support must be well bedded and extend at least 600 mm into undisturbed ground on both banks.

iii. Where the depth of the ditch or trench to be crossed is significantly below the depth of the pipe drain, one of the following methods should be used:

a. The redundant ditch or trench should be excavated to a firm base and filled with lean mix concrete to pipe drain level.

b. The crossing may be bridged by means of a suitable diameter heavy quality

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galvanised steel or cast iron tube laid to the existing pipe drain gradient and of length equal to the crossing width plus at least 1200 mm as shown at Figure 10. Pipe drains may either be sleeved inside a tube of larger diameter or positively connected to a tube of corresponding diameter. Secondhand materials can be used. In the case of a very wide trench the tube may have to be supported as described for method (c) below.

c. The crossing may be spanned by a hard plastic, pitch fibre or other pipe of similar character supported by means of a bridge, the length of support being equal to the trench crossing plus at least 1200 mm as shown at Figure 11. The pipe should be surrounded with a granular material of size 10 mm or less before completion of the backfill.

iv. The ditch or trench to be crossed must be filled and consolidated before the pipe drain is laid. Bridge supports should be hardwood timber, reinforced concrete beams or other suitable materials of appropriate length and thickness. Individual designs for bridging beams shall have regard to the bridging span, load bearing capacity of the anchorage points at each side of the trench, depth to bridging beam, diameter of pipe to be supported and pipe weight. The need for bridging beams to be supported by concrete seating at each end will be assessed on a site basis. Crossing pipes are to be secured to bridging beams using non-degradable products such as polypropylene rope or nylon straps.

6.13 Junctions Between Drain Pipes

All junctions between drains are to be made with purpose - made proprietary junction pipes or connectors except:

- as provided in section 6.7 or
- where an inspection chamber complying with this Note or suitable junction box is used.

Examples of plastic and clay pipe junctions are given at Figures 12 and 13 respectively.

6.14 Inspection Chambers

Inspection chambers may be either rectangular or circular, purpose built in a range of materials or acquired as pre-fabricated units and be of adequate strength to withstand imposed loads. Minimum requirements for chambers built in situ are given in Table 5.

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Table 5. Inspection Chamber Dimensions

Requirement	Rectangular Chambers	Circular Chambers
Minimum internal dimensions	760 mm x 1200 mm	1100 mm diameter
Base slab	In situ concrete not less than 100 mm thickness Precast reinforced concrete not less than 50 mm thick	As for rectangular chambers
Wall thickness	Brickwork - 200 mm Concrete block - 150 mm In situ concrete - 150 mm	Radial brickwork comprising 200 mm header
Cover above surrounding ground level	Removable reinforced concrete slabs at least 50 mm thick, preferably pre-stressed	As for rectangular chambers
Cover at or below ground level	Removable reinforced concrete slabs at least 65 mm thick preferably pre-stressed	As for rectangular chambers

The dimensions in Table 5 apply to chambers up to 1850 mm deep to outlet pipe invert. For chambers deeper than this appropriate larger dimensions will be necessary. Where the chamber is also acting as a catchpit, the floor is to be set not less than 300 mm below the lowest pipe invert. Further information on inspection chambers is given in Table 6 and Figures 14-16.

Table 6. Typical Materials for Inspection Chambers

Chambers	Covers
Concrete blocks	Removable reinforced concrete slabs
Engineering bricks	Specifically produced GRC products
Precast concrete	
In-situ concrete	
Cylindrical concrete units	
Glass reinforced cement (GRC) lightweight prefabricated units	

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Note that some pre-fabricated glass reinforced cement units may only be suitable for light loading situations.

Pipework

All pipes entering or leaving an inspection chamber are to be of rigid materials such as concrete, vitrified or salt glazed clayware or hard plastics.

Covers

Chamber covers must be capable of being manhandled and are to be provided with handles or lifting rings. They are to be of sufficient strength to carry the maximum loads imposed by traffic or backfill materials.

The top of a chamber should normally be slightly above ground level. Where this will interfere with field cultivations the top should be at least 450 mm below ground level. If the area is likely to be subsoiled or mole drained then the cover is to be not less than 700 mm below ground level.

When a chamber needs to be located on a path, track or private roadway then a heavy duty steel cover should be provided, fitted flush with the finished surface level. In areas of public access or where there is a risk of vandalism chamber covers must be securely locked.

Step Irons

Correctly spaced step irons or an access ladder are to be provided when chamber depth exceeds 900 mm as specified in BS 1247. Step irons are usually present in proprietary precast concrete manhole sections.

6.15 Underdrain Outfalls

A properly constructed outfall, of a type suitable for the particular location, is to be provided wherever a drain pipe discharges into an open channel. The last 1500 mm length of buried pipe should be of a rigid continuous and unperforated type. Suitable soil is to be packed into the trench and well consolidated around the last 2000 mm of underground pipe drain in order to prevent percolation of water outside the pipe. Permeable backfill should not be used over this length.

Where an outlet pipe projects from the channel bank or headwall it must be rigid and resistant to frost, heat and ultra violet light. The pipe invert at the outfall should be at least 150 mm above normal winter water level wherever possible.

Placing a marker post on top of the bank overlooking the outfall pipe will assist future location. Where headwalls and splash plates are used they must be securely anchored. Common forms of headwall anchorage are non-corroding mesh or non-degradeable rope. Splash plates will usually be a pre-cast concrete slab of minimum dimensions 600 mm x 600 mm x 50 mm laid on the bed of a watercourse. Outfall

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examples are shown at Figures 17-27. Choice of outfall structure depends on the volume of water to be discharged and location. Headwalls should be fitted on undisturbed soil, flush with the existing ditch batter wherever possible to facilitate mechanical mowing of the banks. There should be no protrusion of the headwall above bank level. Vermin grids (Figure 28) and flood flaps are to be fitted as necessary. Materials used in outfall constructions are indicated in Table 7.

Table 7. Typical Materials for Underdrainage Outfalls

Outfall Pipes	Headwalls	Anchorages	Vermin Gratings
Rigid plastics	Glass reinforced cement (GRC)	Non-corroding mesh	Cast iron
Concrete	Precast concrete	Non-degradable rope	Galvanised steel
Pitch fibre	In-situ concrete		Plastic
Vitrified or salt glaze clayware	Engineering bricks		
	Concrete blocks		
	Local stone		
	Earthbank/Turf		

Depending on circumstance, outfall structures may be subject to the consent of the National Rivers Authority or Internal Drainage Board under the requirements of the Water Resources Act 1991 or Land Drainage Act 1991 respectively.

6.16 Drains Taking Surface Runoff Via an Open Inlet

All inlets for the entry of water from an open channel or other surface flow into a pipe drain shall be provided with a silt trap and grating. Technical requirements and dimensions are shown at Figures 29-30 while Table 8 indicates typical materials. Designs based upon precast concrete chambers manufactured to BS5911 are acceptable in appropriate cases as are other proprietary units constructed of suitable materials.

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Table 8. Typical Materials for Drain Inlets

Chambers	Discharge Pipes	Gratings
Purpose built structure with walls constructed of either concrete blocks - minimum 1500 mm thickness or engineering brickwork - minimum 200 mm width. Precast concrete or glass reinforced cement (GRC) prefabricated units.	Sealed, unperforated pipes such as: Rigid plastics Concrete Pitch fibre Vitrified clay sewer products	Usually galvanised steel: Frame - 40 mm x 10 mm steel flats Bars - 12 mm diameter rods at 60 mm spacing

6.17 Replacement of Ditches with Pipes

Any trees, stumps, hedges and roots on the line of a pipe shall be removed and disposed of before the pipes are laid. Care should be taken to locate any existing functioning drains and to connect these to the new pipe system as described in section 6.13. In circumstances where the existing drainage scheme is extensive or the new drainline is likely to be subjected to high flow velocities or surcharge, special provision for connection to, or bypassing the new pipe must be made.

Pipes are to be laid on a firm bed and, with the exception of pipes that control watertable levels, clay or other selected material packed into the trench and consolidated to prevent water travel along the outside of the pipe. Particular attention must be given to pipe bedding requirements (see Figures 5-7).

6.18 Geotextile Fabrics

Where geotextile materials are used, they must be appropriate for the purpose intended as indicated by the manufacturer and in accordance with the design specification.

6.19 Land Drainage Installations Affecting Streets

The installation of land drainage pipes under or alongside streets must be carried out in accordance with the New Roads and Street Works Act 1991. In this context "street" refers to any highway, road, lane, footway, alley or passage within the jurisdiction of the local highways authority.

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Trench Beddings for Small Diameter Plastics Drainage Pipes

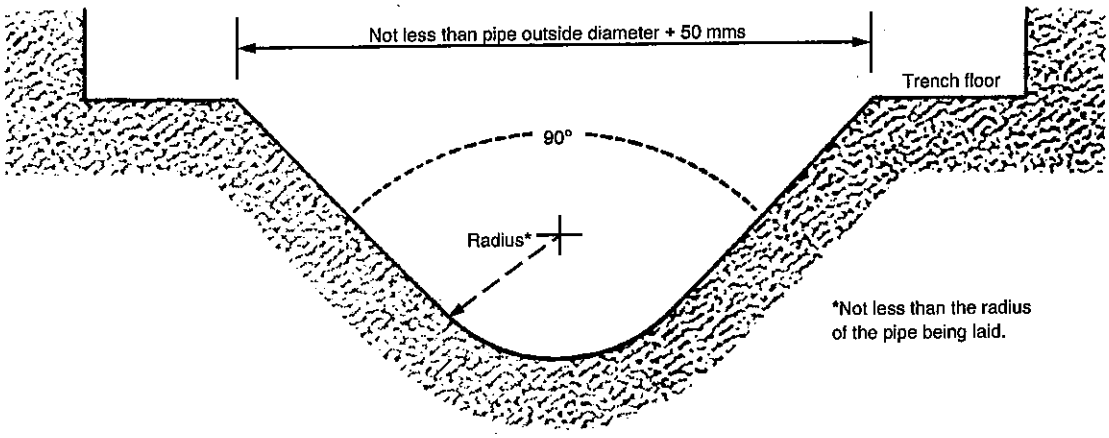

Fig. 8 Typical trench bedding conditions for smaller diameter plastics drainage pipes

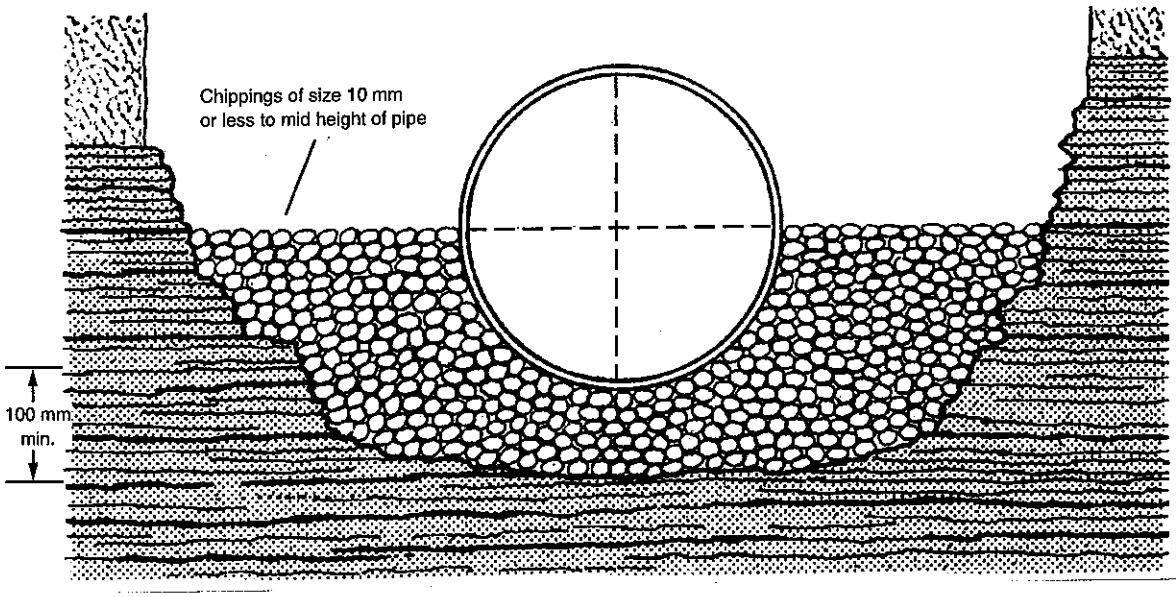

Fig. 9 Example of trench bedding for smaller diameter plastics drainage pipes in difficult conditions

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Trench or Ditch Crossings

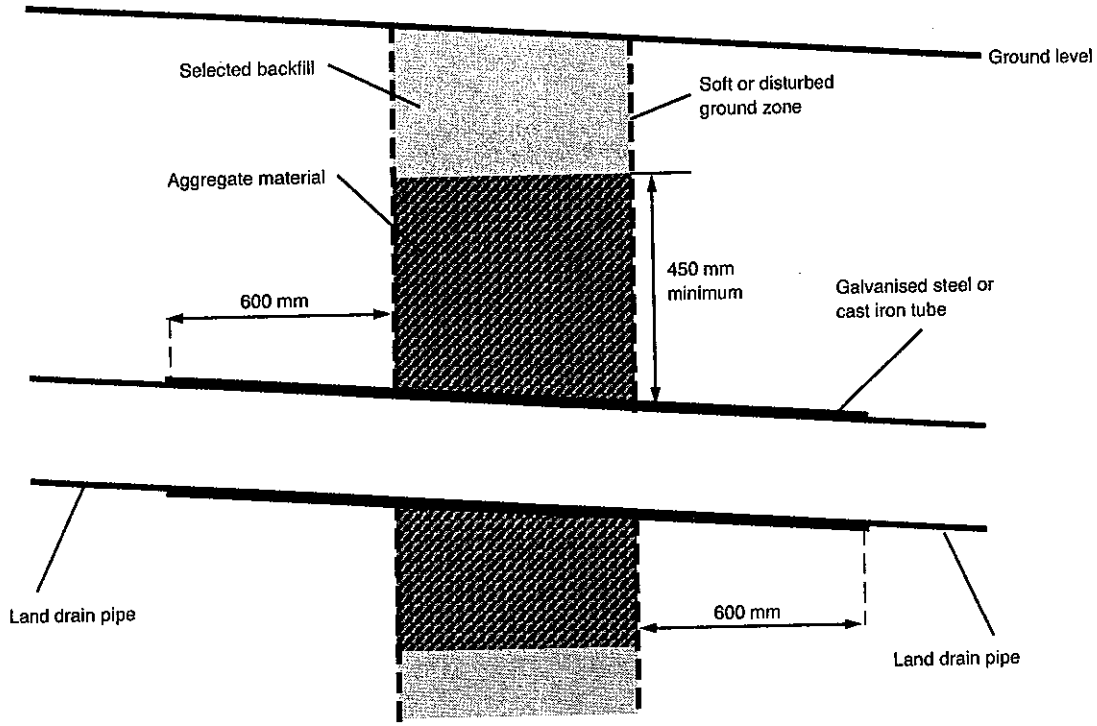

Fig. 10 Tube crossing

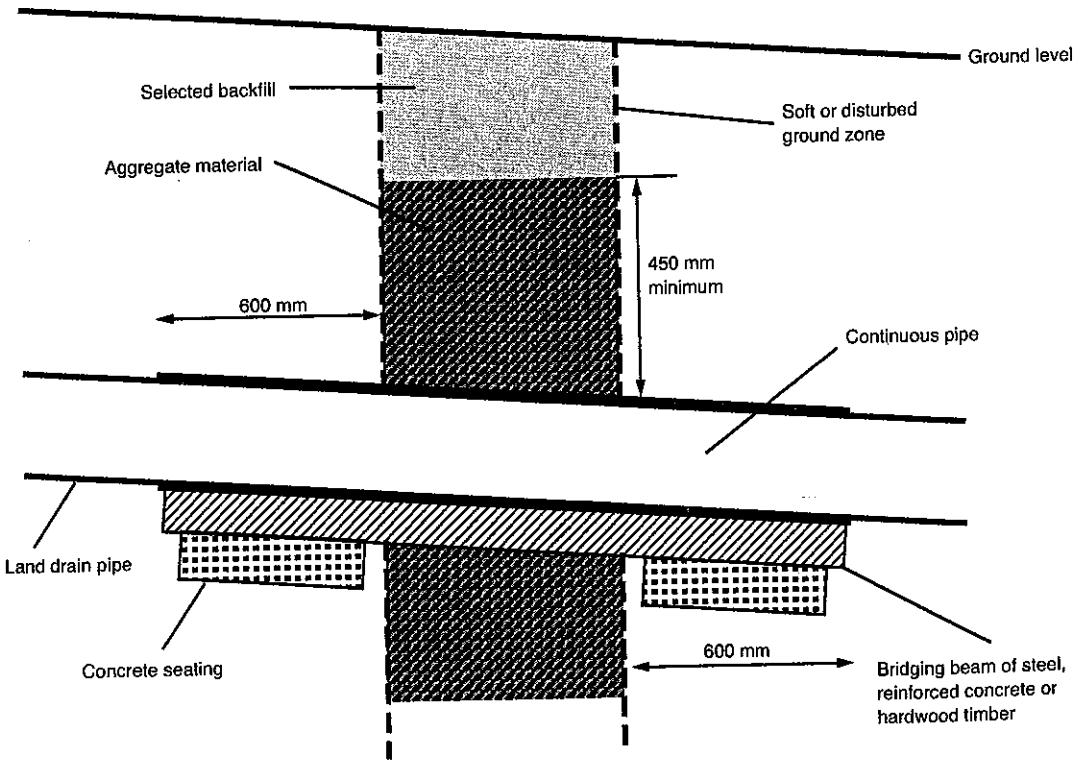

Fig. 11 Support beam crossing

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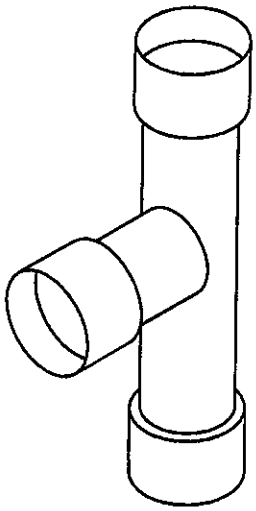
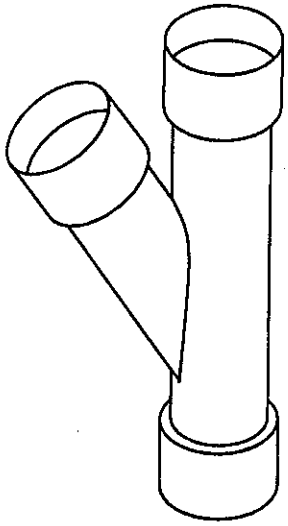
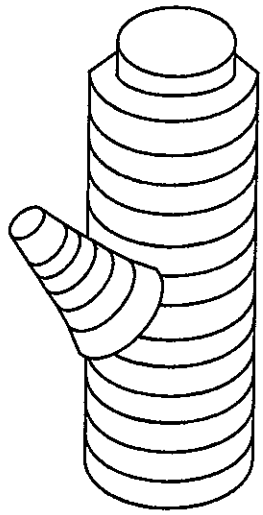
Purpose Made Drain Pipe Junctions



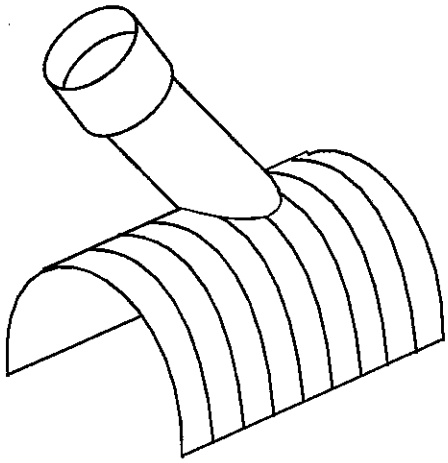
T junction



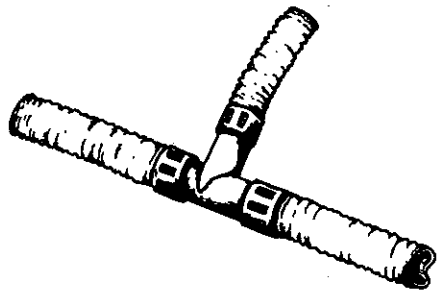
Y junction



Multi junction



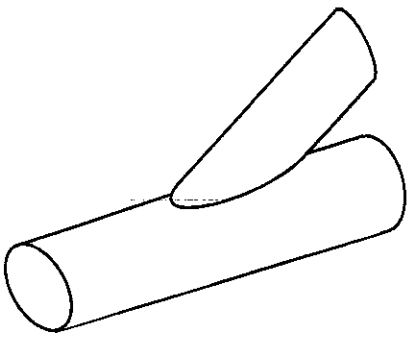
Saddle or clip-on junction



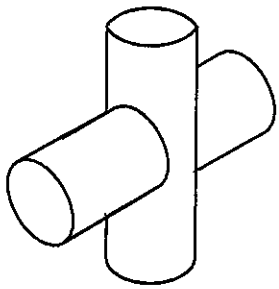
Plastics junction configuration

Note - There are numerous types of proprietory plastics drain junctions commercially available

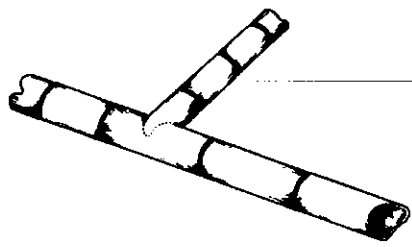
Fig. 12 Plastics land drain junctions



Single junction



Double junction



Clay pipe junction configuration

Fig. 13 Clayware land drain junctions

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Inspection Chambers

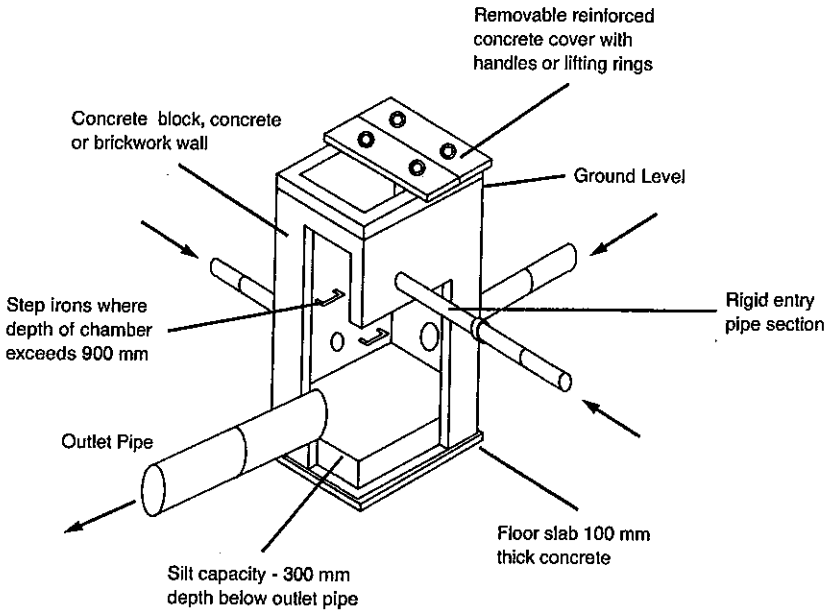

Fig. 14 Cross section

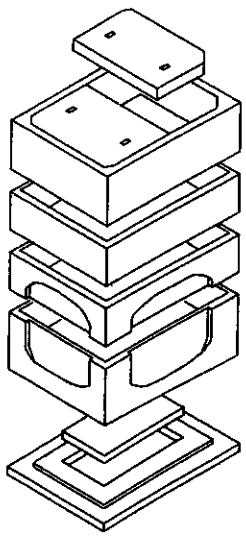

Fig. 15 Precast concrete

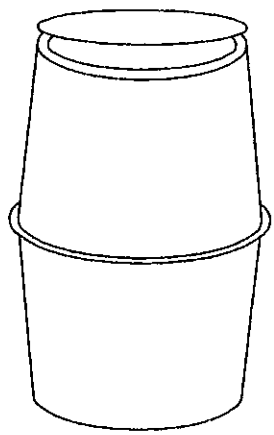

Fig. 16 Glass reinforced cement

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Underdrainage Outfalls

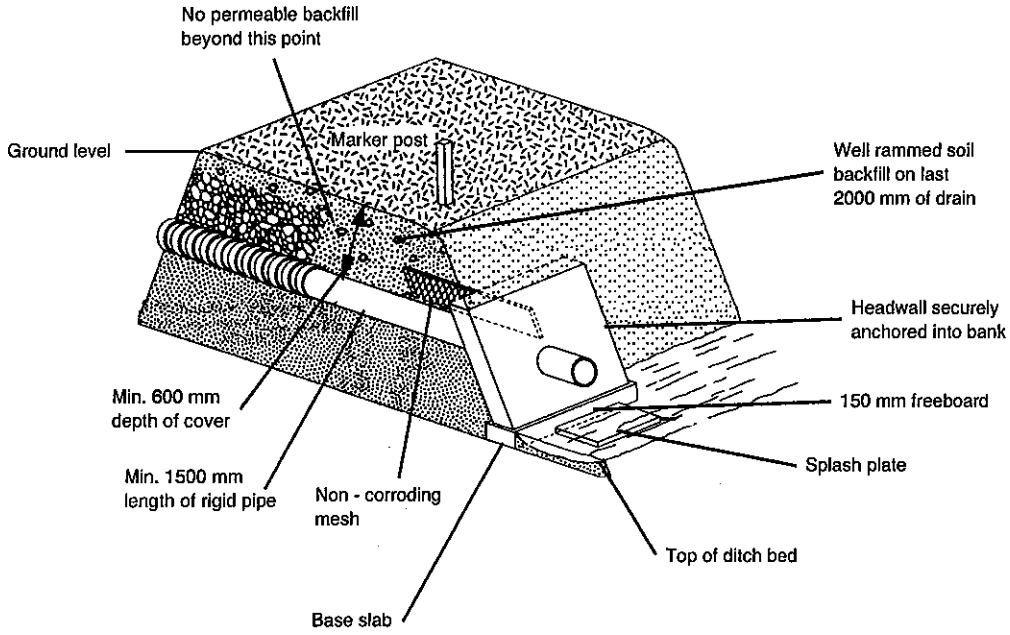

Fig. 17 Technical requirements and dimensions

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Outfall Types

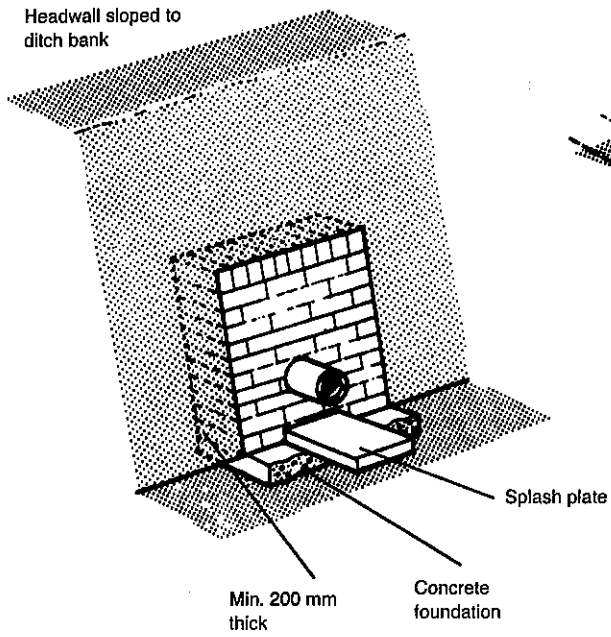

Fig. 18 Brick headwall

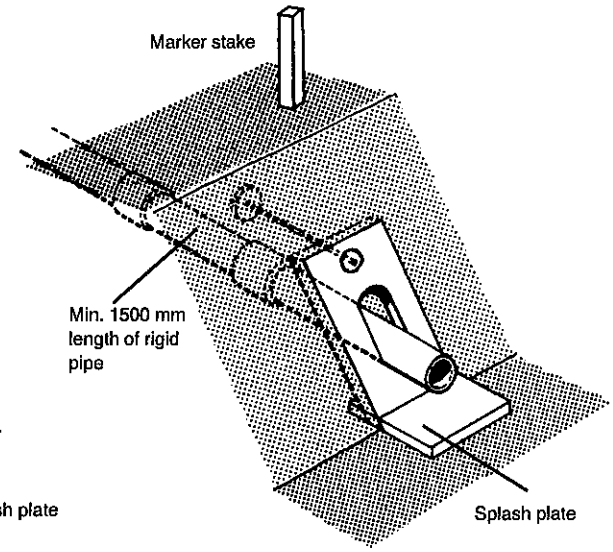

Fig. 19 Precast concrete headwall

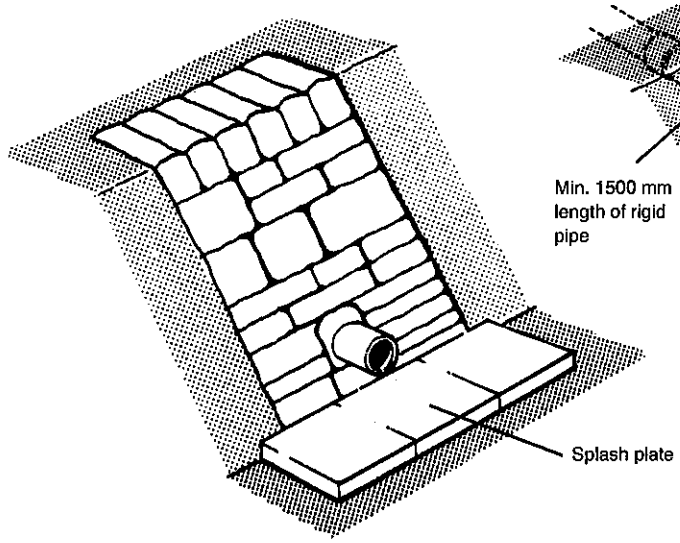

Fig. 20 Dry stone headwall

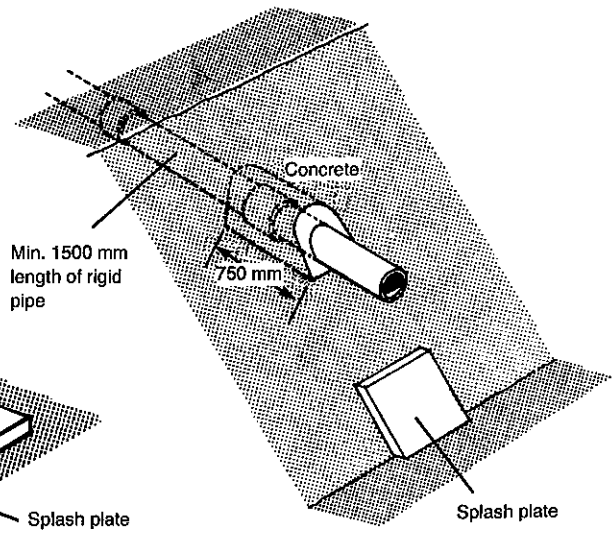

Fig. 21 High level outfall for pipes up to 225 mm diameter

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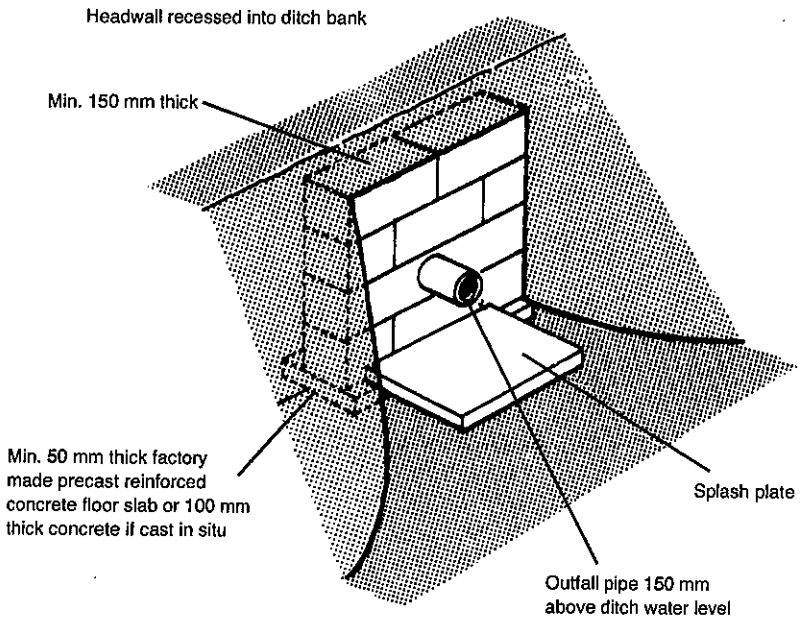

Fig. 22 Concrete block headwall

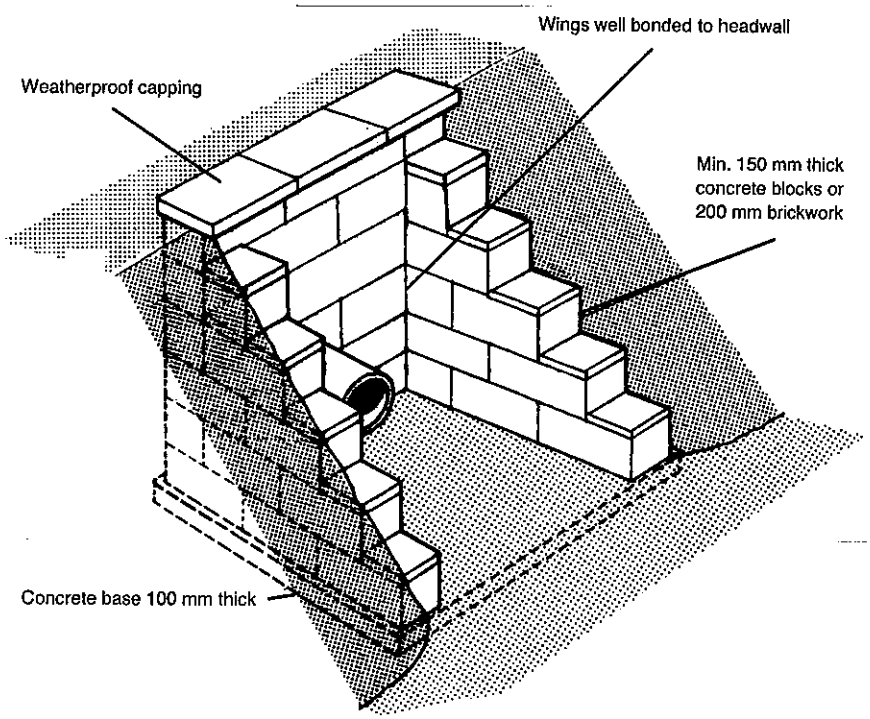

Fig. 23 Major outfall with wing walls

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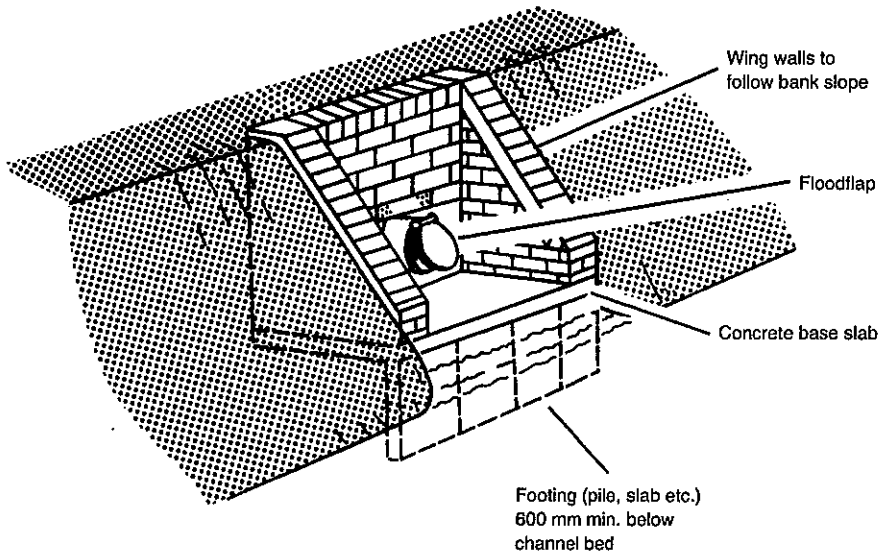

Fig. 24 Major outfall with flood flap

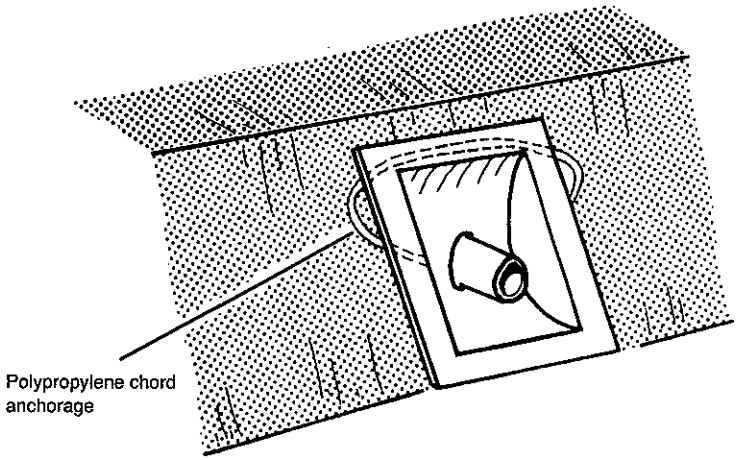

Fig. 25 General purpose type

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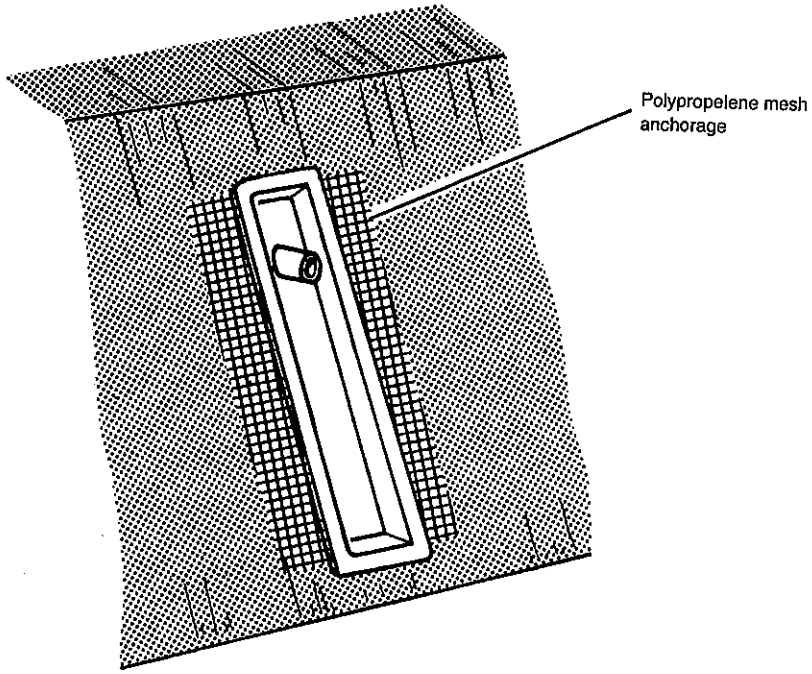

Fig. 26 Fenland or deep ditch type

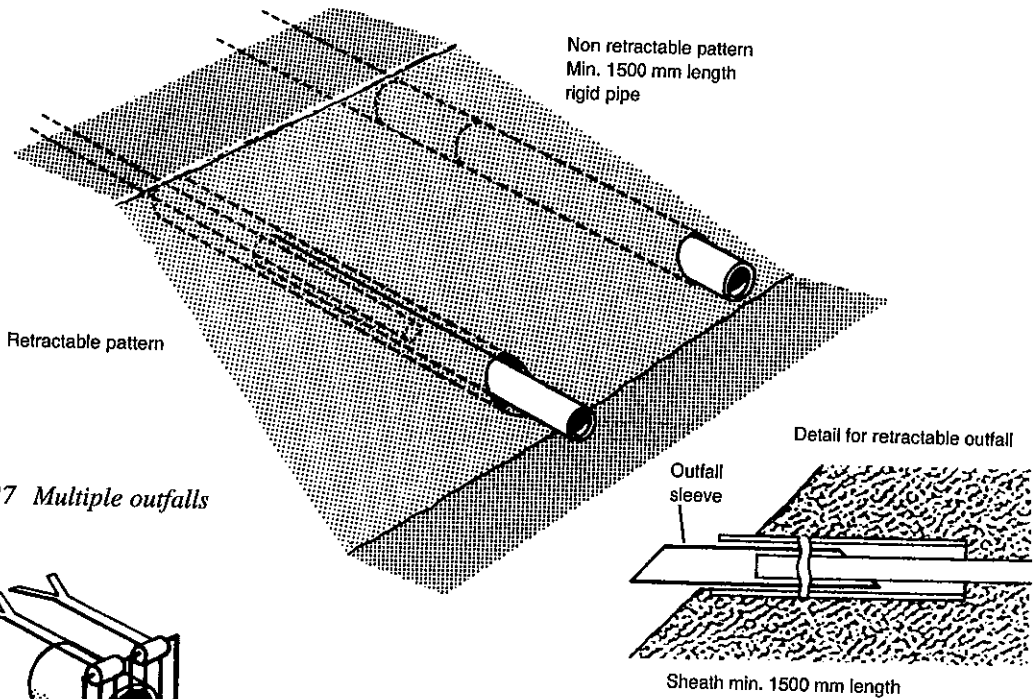

Fig. 27 Multiple outfalls

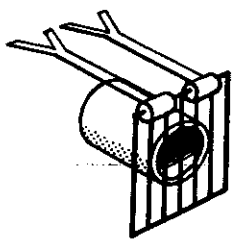

Fig. 28 Vermin grating

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Drain Inlets

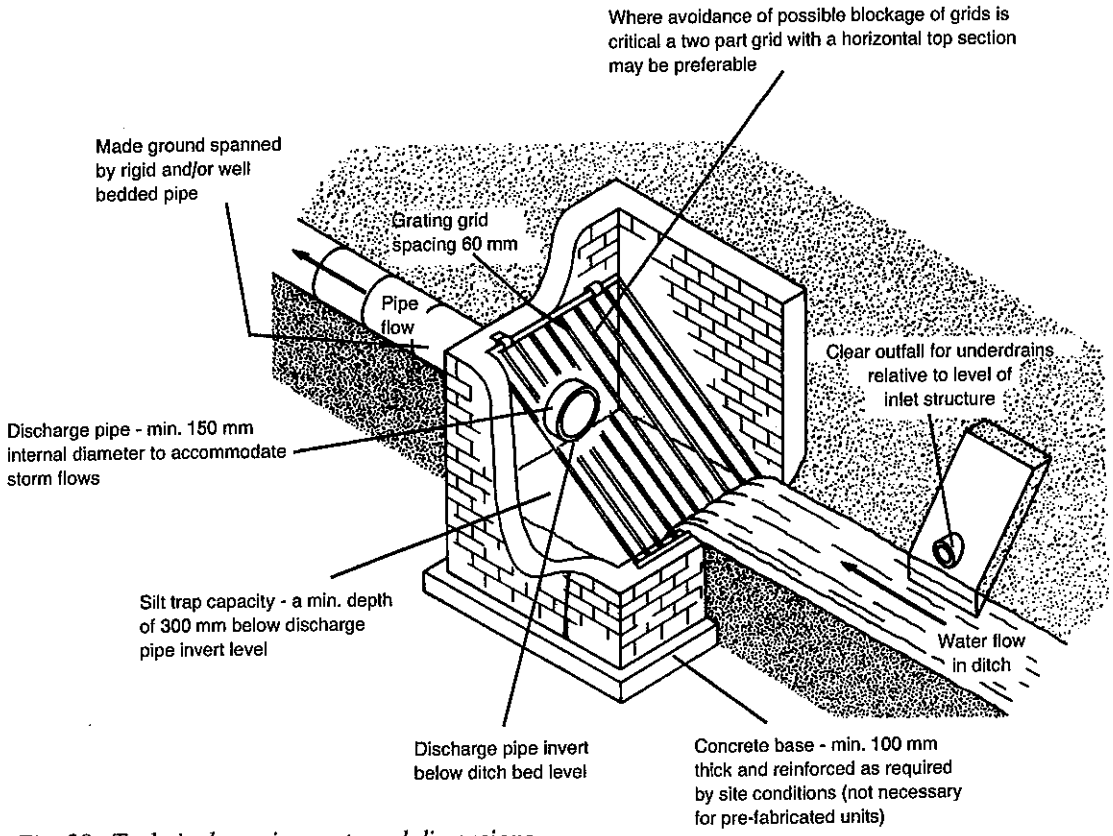

Fig. 29 Technical requirements and dimensions

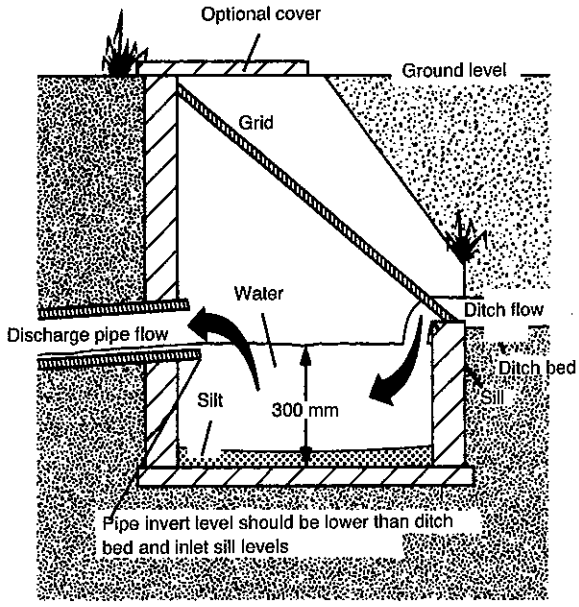

Fig. 30 Typical cross section

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7 Mole Drainage

7.1 General

Mole drainage should only be carried out over an appropriate permanent underdrainage pipe system with adequate permeable backfill. The practice is most suitable as a means of improving the drainage of clay soils. However mole channel life can vary between soils having comparable clay contents. Expert assessment of soil suitability for moling should be sought as necessary.

7.2 Soil Conditions

The timing of mole drainage operations and hence the soil moisture content is a critical factor influencing the effectiveness of the treatment. Conditions should be such that the surface of the land is dry enough for effective traction with the subsoil at treatment depth sufficiently plastic to form a smooth, circular and stable mole channel. Soil above the channel should be dry enough to allow fissuring. The subsoil is to be free of large stones. Excavation of mole channels should be carried out to prove the effectiveness of the operation.

7.3 Timing

Best results are achieved by moling when soils are in a drying cycle, in the UK usually in the period April/May to September/October. Working during this period can usually be satisfactorily achieved on grassland. For arable crops, moling through a growing crop can be considered as an alternative to later post-harvest treatments provided that appropriate conditions occur during spring.

The success of a mole drainage treatment is also dependent on the rainfall pattern immediately following the operation. Ideally channels should have a period to stabilise and not be subject to immediate stress as a consequence of heavy rainfall. For this reason moling during the period late autumn to early spring should be avoided.

7.4 Depth

The invert of the mole channel must not normally be less than 450 mm below ground level although shallower depths may be considered for special design situations such as some sport and amenity areas. It is essential that mole channel depth is sufficient to link with the permeable backfill over the pipe drains. A clearance of at least 100 mm is to be maintained between pipe drain top and mole channel invert.

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7.5 Mole Channel Spacing

The spacing of mole channels should not normally exceed 4.5 times the depth to invert. Actual spacing will depend primarily on soil type and the standard of drainage performance required.

7.6 Size and Shape of Mole Channels

Mole channels for field drainage are not to be less than 75 mm in diameter and circular in shape. Smaller diameters may be used for special design situations as appropriate.

7.7 Direction

Mole channels may be drawn both up and down slope but always in a manner which will intercept the permeable backfill placed over the underdrainage pipe system.

7.8 Lateral Pipe Drain Spacing

The spacing of the permanent underdrainage pipe system will usually depend on the subsoil clay content, land surface gradient, site usage and economic factors. Closer spacings will be required where the clay content is inconsistent at treatment depth and on uneven or steep sites. Spacing should be adjusted so that pipe drains are located in hollows to provide an outlet for mole channels.

7.9 Connection of Mole Channels to Pipe Drains

Mole channels are to be connected to the pipe drains by drawing them through permeable backfilling material placed over the pipes. Width of the permeable backfill band is to be not less than 100 mm. The top level of the permeable filling shall be at least 150 mm above the invert of the mole channel.

Where expander diameter is 100 mm or greater, consideration should be given to increasing the width of the permeable backfill band to 150 mm in order to ensure a satisfactory connection.

Further details of typical mole channel - lateral drain configuration are indicated at Figure 31.

One widespread traditional practice has been to place permeable backfill up to 375 mm of ground level and mole drain at 525 mm to mole channel invert. Research has now shown that an extra permeable backfill depth of at least 50 mm (ie. to within 300-325 mm of ground level) is beneficial to allow for natural settlement of the backfill material in the period after installation so that subsequent moling operations make an adequate connection.

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7.10 Mole Drainage Equipment

A tractor of sufficient power must be used to draw a mole channel evenly and continuously at the specified depth. Tractor units running on tracks are usually preferable.

The mole plough must be designed and operated so that the 'bullet' travels parallel to the general surface slope without being affected by minor surface irregularities, or by lurching of the tractor. Adjustment of both the tractor hitch and pitch of the mole plough leg must be possible to optimise draught and ensure correct alignment. A sharp leading edge to the bullet should be maintained at all times.

Research indicates that use of a taper-shaped expander rather than a barrel shape causes less disturbance of the permeable backfill band and therefore provides a better hydraulic connection.

The mole plough should be fitted with a disc or coulter forward of the leg where the build up of trash underneath the beam may cause grade irregularities and to reduce damage to a grass sward.

7.11 Mole Channels Drawn Through Disturbed Ground

Mole channels may be short-lived when drawn through disturbed soil such as that associated with infilled ditches, pipeline trenches and the heave caused by trenchless drainage equipment. In these circumstances the soil should be consolidated before moling in order to improve the effective life of the mole channels.

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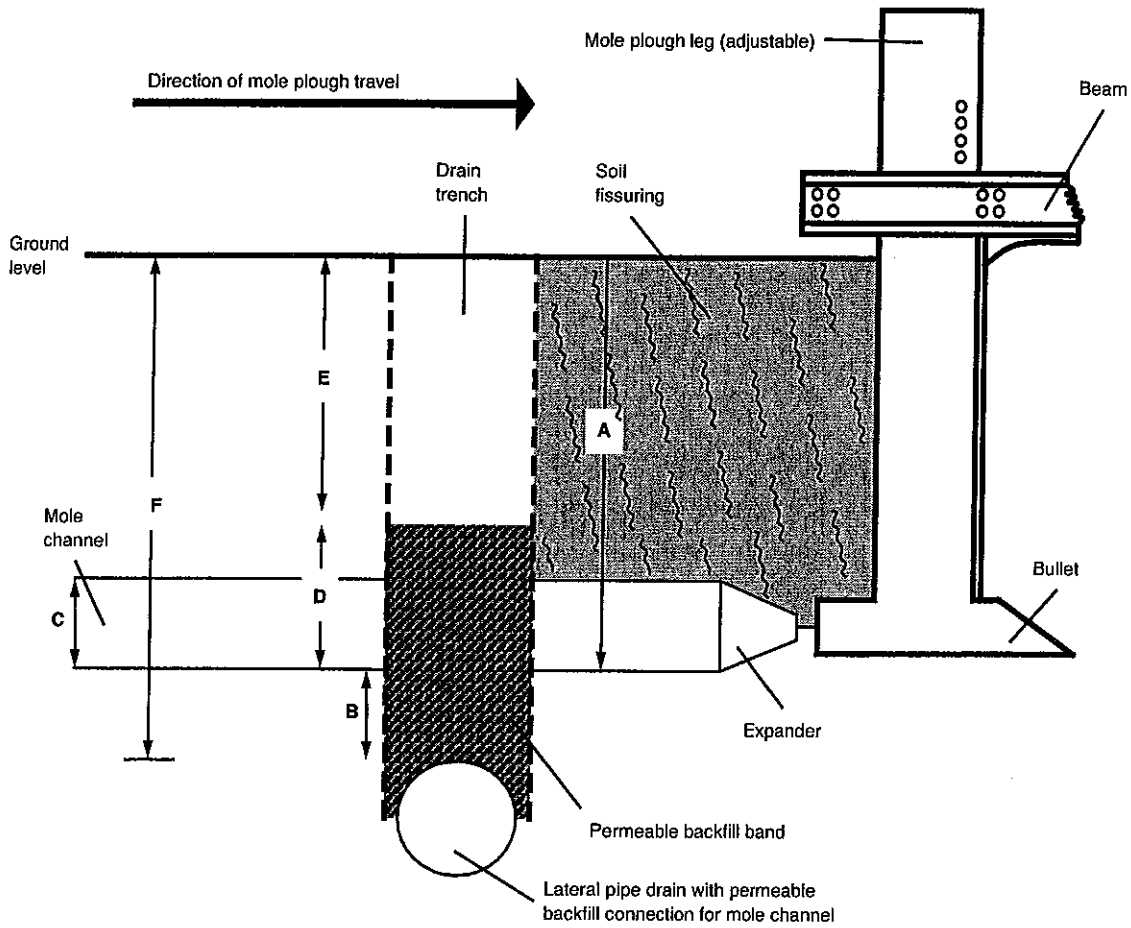
Mole Drainage



Recommended minimum dimensions		**mm**
A:	Depth to mole channel invert	450
B:	Clearance between pipe drain top and mole channel invert	100
C:	Mole channel diameter	75
D:	Top level of permeable backfill above mole channel invert	150
E:	Top level of permeable backfill below ground level	375
F:	Minimum depth of cover over lateral pipe drain	600

Fig. 31 Mole drain configuration

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8 Subsoiling

8.1 General

This part refers primarily to subsoiling or deep soil loosening undertaken as an operation to improve land drainage. In this context it should only be carried out over a suitable permanent underdrainage system. The basic principles can however be adapted to subsoiling operations aimed at alleviating soil pans and compaction above a naturally free draining soil.

8.2 Soil Conditions

Subsoiling will only be worthwhile if a definite need can be identified such as compacted soil layers. If necessary expert guidance should be sought. The subsoil at treatment depth must be dry enough to obtain adequate shattering and fissuring of the surrounding soil. If the soil is too dry, draught requirements will be excessive and the soil will break into large unfractured blocks; too wet and detrimental smearing will occur with considerable reductions in fissuring and cracking. The ground surface must be dry and firm enough for effective traction.

Indiscriminate subsoiling of clay soil can cause damage to soil structure. Mole drainage is usually a more effective means of draining clay soils. Subsoiling should only be carried out if the soil below compacted layers or pans is free draining or contains a suitable underdrainage pipe system.

8.3 Timing

Subsoiling should only be carried out when soil conditions are suitable. To reduce the possibilities of soil re-compaction, subsoiling should take place as late as practically possible in any cultivation programme (eg. after rather than before ploughing). Subsoiling grassland during very dry summer months should be avoided because severed roots are not likely to re-establish unless or until there is moisture present.

8.4 Depth

Subsoiling depth will be determined by the nature of the problem; the intention being to break up soil compaction or chemical pans, or to achieve the shattering or re-arrangement of the soil aggregates to improve drainage. In the UK maximum effective depth will not normally exceed 400 mm. Further details of a typical subsoiling configuration are shown at Figure 32. Where subsoiling is carried out for drainage purposes then the working depth should be sufficient to link with the permeable backfill over the pipe drains.

When subsoiling takes place over mole channels there must be a clearance of at least 100 mm between the top of the mole channel and the base of the subsoiling.

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8.5 Tine Spacing

Tine spacing shall be such that adequate soil disturbance takes place between successive passes of single leg subsoilers or between tines on multi-leg equipment. Excavations should be made to ensure the implement is working at the desired depth and tine spacing is appropriate to maximise soil disturbance.

8.6 Subsoiling Equipment

Subsoilers or deep soil looseners are available in a number of designs; single or multi-legs with or without wings or shallow leading tines. Compared to conventional equipment, winged subsoilers disturb significantly higher volumes of soil at the expense of relatively small increases in draught requirements. The addition of shallow leading tines will further increase soil disturbance and decrease draught requirements. Leading tines are not suitable for use on grassland. Surface disturbance of grassland can be reduced by using proprietary subsoilers designed for the purpose or by fitting disc coulters on conventional equipment forward of the legs.

The tractor unit must be of sufficient power to pull the subsoiler at the specified depth. Tine spacing must be adjusted so that optimum disturbance of the soil is obtained.

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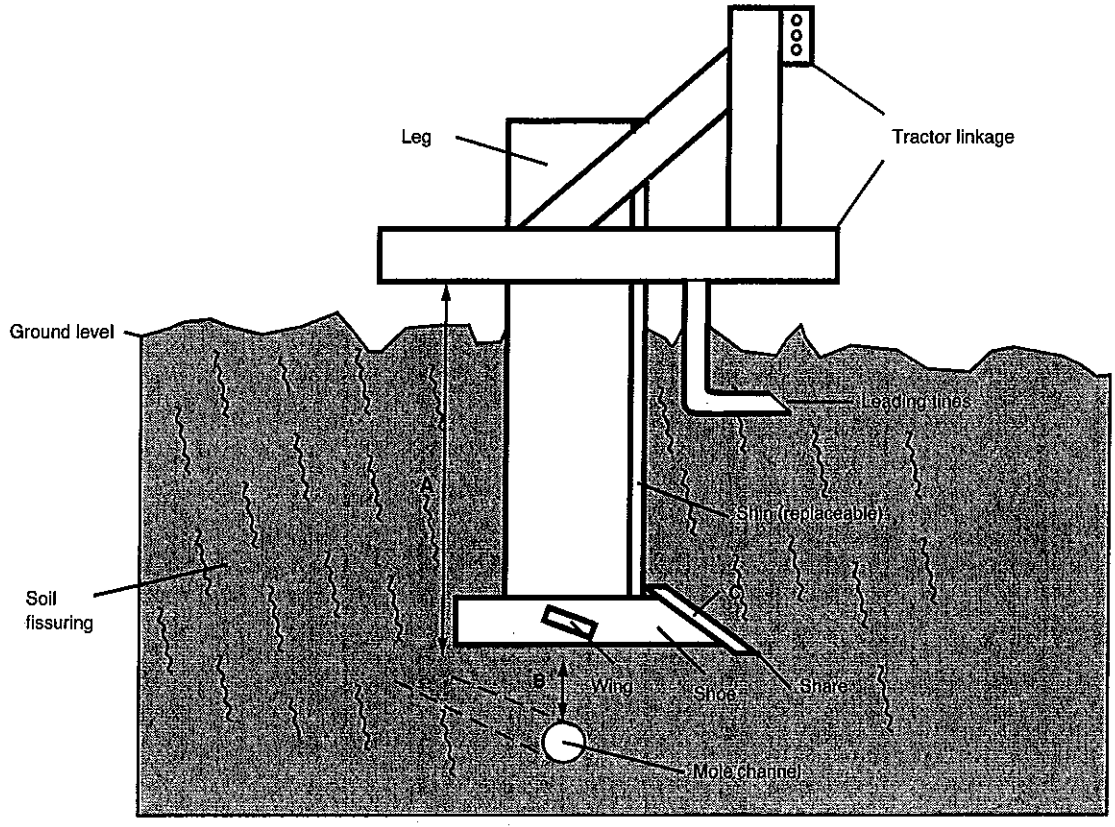
Subsoiling



Recommended dimensions		mm
A:	Maximum effective depth	400
B:	Clearance over mole channels (where appropriate)	100 minimum
C:	Share and Wing Angle: 25° - 30° to the horizontal	

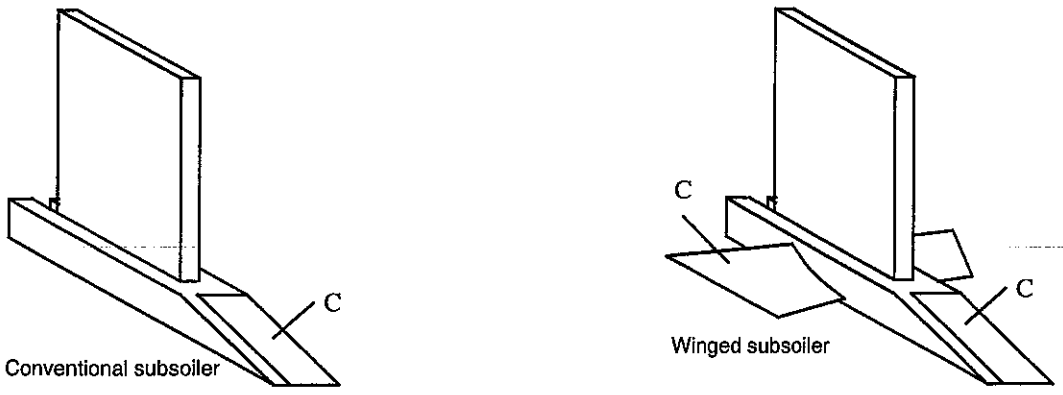


Fig. 32 Subsoiling configuration

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9 Maintenance

9.1 Ditching

Attention should be given to the following:

Aquatic Weed Growth

Excessive weed growth in ditches can either be cut mechanically or controlled by chemical methods. Herbicides should only be used very selectively, with great care and in strict accordance with both the manufacturer's instructions on the label and the recognised code of practice - MAFF booklet 2078: 'Guidelines for the Use of Herbicides on Weeds in or near Watercourses and Lakes'. The local National Rivers Authority should also be consulted.

Bank Slips

Where slips occur the bank slopes should be regraded to prevent future recurrence. See also sections 4.2 and 4.5.

Bank Vegetation

In order to reduce the effect on wildlife, ditch maintenance operations should be carefully planned so that unimproved channels remain near to newly improved sections to facilitate recolonisation. Maintenance work is to be timed so that disturbance to wildlife is minimised. For larger ditches, work should, if possible, be limited to one side of the ditch at any one time.

Herbicides are to be used selectively. Depending on the species to be controlled the actual timing of application during the growing season can be critical.

Accumulations of Silt and Debris in Ditches

All accumulations of silt in the vicinity of structures such as pipe culverts or single span bridges shall be removed. Any debris which forms a restriction to flow or which could cause blockages at culvert entrances shall be removed and properly disposed.

9.2 Underdrainage Systems

A programme of regular maintenance must be implemented to ensure the continued effectiveness of underdrainage systems.

Drain Outfalls

All outfall pipes must be allowed to discharge freely by being kept clear of vegetation and silt deposits. Headwall structures shall be securely anchored.

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Inspection Chambers and Drain Inlets

Silt accumulations and debris are to be periodically removed and the structures kept in sound order. Particular attention should be paid to the clearance of silt traps and debris screens at culvert entrances.

Pipe Cleaning

Drain jetting or rodding techniques can be used to clear accumulations of silt, iron ochre or other deposits inside land drain pipes. The type of drain jetting equipment used and its operation shall be appropriate for the purpose identified. For effective jetting, water flow and pressure must be sufficient to disturb and flush out the deposits but not so high that soil surrounding the pipes is eroded or displacement of the pipes takes place.

Mole Drainage and Subsoiling

Where the underdrainage system incorporates mole drainage or subsoiling these operations will need to be periodically repeated in order to maintain drainage efficiency. The frequency can only be determined by examination of the soil profile, observation of drain flow at the outfalls and by local experience.

Guard Fencing

Fencing along ditches and around any other drainage structures must be kept in good condition.

Record Plans

All drainage record plans need to be kept up to date - see also section 1.5.

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10 Conservation Aspects

10.1 General

The initial planning, installation and future maintenance of ditching and underdrainage works merits careful consideration so that the impact on the local environment is minimised. It is frequently possible that opportunities to create new conservation features such as ponds can be identified and integrated with the drainage operations.

10.2 Sites of Special Scientific Interest (SSSI's)

English Nature must be consulted when drainage works or ancillary operations are proposed in or adjacent to SSSI's. Where SSSI's are subject to designation as Special Areas of Conservation (SAC's) under the EC Habitats Directive, the level of protection attached to them will be enhanced and actions affecting them (as well as those taking place in or adjacent to them) will need to be planned with the SAC status in mind.

10.3 National Nature Reserves (NNR's)

Any land drainage proposals affecting a NNR must be notified in advance to English Nature.

10.4 National Parks

Land drainage proposals within a National Park must be agreed beforehand with the relevant National Park Authority or the Broad Authority in the case of the Norfolk Broads.

10.5 Environmentally Sensitive Areas (ESA's)

Holders of current agreements under the MAFF Environmentally Sensitive Areas scheme must consult their Project Officer on any proposals to undertake land drainage works within the ESA.

10.6 Ancient Monuments

Drainage works on designated ancient monuments will require scheduled monument consent issued by the Department of National Heritage.

10.7 Tree Felling

Before felling any trees the local authority should be consulted to establish whether or not the trees are covered by a Tree Preservation Order. At the same time, the Forestry Authority should be contacted in case a felling licence is required.

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10.8 Pollution

The consent of the National Rivers Authority must be obtained where there is any risk of polluted water being discharged from an underdrainage system.

10.9 Environmental Assessment

Formal environmental assessment is likely to be required under statutory regulations for major civil engineering projects where soils and drainage are key components. Examples include pipelines, new highways, mineral extraction and flood defence works.

10.10 Advice

Advice on the conservation aspects of land drainage proposals is available from ADAS.

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11 Soil Handling and Land Drainage Works for Pipeline and Other Underground Utility Installations

11.1 Codes of Practice

i. BS 8010: British Standard Code of Practice for Pipelines

The Code requires that watercourses, ditches, culverts and underdrains which are interfered with in any way by pipeline operations be maintained in effective condition during the construction period and be finally restored to at least as good condition as before the commencement of work. Similarly soils are to be moved and reinstated so that the pipeline route is restored as near as possible to original conditions.

ii. Model Code of Practice for the Exercise of Works Powers by Water and Sewerage Undertakers on Land.

Prepared in accordance with Section 182 of the Water Industry Act 1991, this code refers to pipeline installations by water and sewerage companies.

11.2 Definitions

Pipelines

A line of pipes of any length, without frequent branches but excluding piping networks such as process plant piping within refineries, factories or treatment plants.

Subject to certain exclusions, commercial pipeline installations (including oil and gas other than British Gas) must comply with the requirements of the Pipelines Act 1962. Exclusions include drains and sewers, pipelines used in agriculture, pipelines carrying water and pipelines owned by certain statutory bodies.

Pipelines which exceed 16.093 kilometres in length and are not excluded are defined by the 1962 Act as being 'cross-country pipelines' for which authorisation procedures are contained in Section 1 of the 1962 Act. Pipelines other than cross-country ones and which are less than 16.093 kilometres in length are referred to in the 1962 Act as 'local pipelines' for which notification procedures are set out in Section 2 of the 1962 Act. If an existing pipeline is extended so that the aggregate length exceeds 16.093 kilometres then it will be classified as a cross-country pipeline under the 1962 Act even though the extension itself may be less than 16.093 kilometres.

Easement

A legally binding agreement granted by a landowner to the pipeline promoter, either in perpetuity or for a long term, which sets out the rights and obligations of both

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parties (and their respective successors in title) in relation to the matter but under which ownership of the land remains with the landowner.

Wayleave

An agreement (similar in nature to but less specific than an easement) granted by a landowner to the pipeline promoter, permitting the promoter to execute works on the terms specified. The term "wayleave" has no special legal meaning.

Lease

A legally binding agreement granted by a landowner to the pipeline promoter for a determinable period of time, whereby essentially the ownership of the land is transferred to the promoter for use during that period.

Statutory Notice

A notice issued under an Act of Parliament by the pipeline promoter to a landowner, occupier or relevant authority stating the statutory powers which the promoter will exercise in surveying, installing, operating and maintaining a pipeline. Such notice is sometimes required to be displayed for public comment.

Working Width

A strip of land, usually wider than that covered by an easement, lease or wayleave, which is used by the contractor for the purpose of installing a pipeline.

Pipeline Spread

A continuous length of sequential pipeline installation on which the contractor is currently working (eg. from the start of temporary fencing to the point of subsoil backfilling).

Pre-Construction Drainage

Drainage work carried out after contract commencement but prior to topsoil removal and pipeline installation.

Post-Construction Drainage

Drainage work carried out after pipeline installation and either before or after topsoil reinstatement.

Header Drain

A new length of land drain, usually installed parallel to the pipeline on the upslope side, for the purpose of intercepting existing land drains severed by the pipeline and discharging to a suitable outfall. The header drain may also function as an interceptor of groundwater or surface water flows throughout its length. The design

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function will influence whether or not permeable backfill is advocated. A header drain may also be referred to as a 'cut-off', 'interceptor' or 'connector' drain.

Easement Drain

A new length of land drain on the downslope side of the pipeline to intercept drainage water emanating from the working width and discharging to a suitable outfall. An easement drain may also receive water from the reconnection of lateral drains across the working width. Requirements for permeable backfill will depend on individual site circumstances. An easement drain may also be referred to as a 'collector drain' or 'low side cut-off drain'.

Spur Drain

A drain trench containing permeable backfill either with or without a drainage pipe. Trenches are cut at right angles or diagonally across the total working width to facilitate moling or subsoiling. Spur drains can also be used to evacuate water collecting in natural depressions along the pipeline route.

Lateral Drain

Existing subsurface land drainage pipe which acts as a direct receiver of soil water continuously over its full length through gaps at the pipe joints or slots in the pipe wall.

French Drain

Drain trench, with or without a drainage pipe with permeable backfill to ground level.

Cross-Pipeline Connection

A new length of pipe drain to reconnect a severed existing drain across a pipeline.

Water Stop

A structure to prevent water flow down the pipeline trench, thereby reducing the risk of water erosion in the trench, preventing mass movement of saturated trench backfill and preventing seepage of water from the trench onto adjacent land.

11.3 Removal of Existing Crop Cover

Recently established crops or those in early growth stages may be included in the stored topsoil in their green state. More advanced crops should be reduced in stature before the residues can be included in stored topsoil. Suitable methods of reduction include grazing, cutting and carting for fodder and application of a herbicide spray followed by a desiccation period and subsequent mowing.

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11.4 Stripping and Storage of Topsoil

Unless otherwise agreed with the occupier, topsoil should be stripped from the whole working width apart from that area where topsoil is to be stored. The extent of the working width and depth of topsoil to be stripped will depend on individual site circumstances. Topsoil stripping should only take place when ground and weather conditions are suitable.

The height of stored topsoil should be limited so as to avoid compaction. If reinstatement is delayed beyond the current season then measures must be considered to prevent erosion and contamination of stored topsoil. This may necessitate grassing down the topsoil heaps and spraying them to prevent colonisation by weeds.

It is essential for good restoration that stripped topsoils and subsoils are kept separate and do not become mixed.

All soil management and agricultural aftercare operations (which includes land drainage) must comply with the MAFF Code of Good Agricultural Practice for the Protection of Soil.

11.5 Stripping and Storage of Subsoil and Unweathered Parent Material

During excavation of the pipeline trench the subsoil must be stored separate from the topsoil, wherever practical on the opposite side of the working width to the stored topsoil. Similarly subsoil should be stored separately to the parent material provided that there is sufficient space within the working width so to do. On no account should subsoil be placed on topsoil for storage.

Arranging soil storage so that material from the deeper parts of the excavation are closest to the pipeline trench will help ensure that the materials are replaced in the appropriate sequence.

In practice some mixing of subsoil and parent material is often inevitable during excavation works unless the individual horizons can be very clearly identified. Any such mixing should however be kept to the absolute practical minimum.

11.6 Replacement of Subsoils and Unweathered Parent Material

On completion of the pipeline installation, all constructional debris, tools, equipment or temporary works and litter are to be removed from site prior to the backfilling of the pipe trench with parent material and subsoil.

Backfilling operations should follow as soon as possible after installation of the pipeline and any imported pipe bedding material. Subsequent backfilling of soil material above the pipeline should be compacted to comply with design bedding

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requirements and sufficient to eliminate major voids thereby minimising future settlement. Topsoil or material harmful to the pipeline must not be used for this purpose. Excessive compaction of the backfilled materials closer to ground level is to be avoided since this could reduce the quality of the reinstatement and also adversely affect the integrity of the pipeline. Backfill should not contain any perishable material such as lush vegetation and scrub. As far as possible the soils should be replaced in dry conditions, in their original sequence and the land restored to original contours. Any requirement to loosen the subsoil across the working width before topsoil replacement will usually need to be subject to the agreement of all parties involved. Particular attention should be given to soil conditions under the running track where compaction may be more severe.

11.7 Disposal of Surplus Soil Materials

Wherever practical, acceptable surplus soil materials should be spread across the exposed working width and graded to an even finish with slopes consistent to those of the adjoining undisturbed land. Where the displaced volume of material, were it to be spread, might result in unacceptable rises in land levels across the working width, the excess is to be removed or used, by agreement with all interested parties, elsewhere in the working area. Surplus material must not include topsoil.

11.8 Replacement of Topsoil

Topsoil replacement will be dependent on ground and weather conditions but should be undertaken as soon as practicable after satisfactory reinstatement of the subsoil. The topsoil is to be left in a loose, friable and workable state to its original full depth over the complete working width. Any compaction resulting from topsoil replacement must be remedied in a manner agreed by all the parties concerned. After replacement the topsoil must not be traversed by traffic except for subsequent agreed agricultural and land drainage operations.

11.9 Pipeline Equipment

Equipment on tracks or low ground pressure tyres should be used wherever possible in connection with pipeline installation works in order to reduce soil compaction. Vehicular movements on the working width must be restricted to essential traffic only.

Prevention of Disease Spread

All operations should be planned not only to minimise soil disturbance but also to prevent the spreading of soil borne plant and animal diseases. Further guidance is provided in the booklet "Preventing the Spread of Plant and Animal Diseases - A Practical Guide" (MAFF 1991).

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11.10 Pipeline Depth of Cover

BS 8010 advocates a depth of cover not less than 900 mm in agricultural land.

11.11 Ditches and Watercourses

All drainage ditches and watercourses are to be maintained in an effective condition during pipeline installation works and, on conclusion, left in at least a comparable condition as that existing before works commenced. Flumes constructed across the working width as part of preliminary works must be of adequate strength and sufficient capacity to allow unrestricted flow at all times.

Where a pipeline passes underneath a trench, culvert, ditch or watercourse it should be suitably protected with concrete or other similar material having a minimum cover of 300 mm from the hard cleaned bottom of the ditch or culvert to the top of the protective layer. If a crossing has to be made above the bed of a ditch or across a culvert then the underside of the pipeline should be at a level above the ditch such that it will not form an obstruction to any flow which can reasonably be expected. In these instances reasonable depth of cover over the pipeline adjacent to the ditch should be provided. Normally 450 mm cover at a distance of 900 mm from the edge of the ditch is considered reasonable.

The number of times a pipeline crosses culverts, ditches or watercourses is to be kept to a minimum. Pipeline crossings of watercourses maintained by a statutory authority must conform to all the requirements of the relevant authority.

Ditch improvement work required to facilitate an outfall for pipeline drainage should comply with Part 4 of this Note.

11.12 Underdrainage

Existing Land Drains

All land drains exposed during the course of pre-construction drainage or actual pipeline installation are to be immediately marked and recorded. A written log should be made of the pipe type, condition, depth of cover, alignment, flow characteristics and degree of siltation. Every drain located is to be clearly marked by wooden pegs (or similar) placed at the edge of both sides of the working width.

Existing drains to be reconnected should first be cleaned as far as possible and at least across the working width. Cleaning may require rodding or jetting (see section 9.2 on Pipe Cleaning). All exposed drains should be protected against the ingress of silt and debris until ready for reconnection. This may require excavating and exposing existing land drains for a distances of at least 500 mm back from the point of severance.

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Any drain found to be completely blocked or otherwise obviously defective and which will not be intercepted by a header drain is to be sealed by a drain end plug in a manner agreed with the owner or occupier and the Site Engineer or representative.

New Land Drains

Underdrainage systems disrupted by a pipeline installation are to be reinstated or replaced, in full consultation with the owner or occupier, to at least the standard existing before disturbance. Remedial works may take the form of either header, easement and spur drains or direct reconnection of land drains across the pipeline trench. Header drains are generally preferred to cross-trench connections for both practical and economic reasons and may be installed prior to or immediately after the pipeline is commissioned.

If no pre-construction drainage work is carried out then the repair of land drains should keep pace with the pipeline installation so that underdrainage systems are only severed for a minimum period.

All land drainage works should only be carried out when site conditions are suitable.

Header Drains

All header drains are to be installed on the upslope side of the pipeline trench, preferably towards the edge of the working width. Drainage installation using the open trench method will allow existing land drains to be visibly exposed. Work standards shall be at least to those set out in Part 6 of this Note.

Header drains must be deep enough to intercept existing land drains and groundwater flows, subject to adequate pipe cover being provided. Minimum depth of cover should be 600 mm. In practice design drain depth will frequently need to equate to at least the depth of the pipeline trench but normally not deeper than 1800 mm below ground level. Header drains should be at least 50 mm below the depth of the deepest known drain to be intercepted. For permanent installations it is prudent to provide header drains of sufficient pipe capacity so that satisfactory linkage with future underdrainage systems can be achieved. Individual site design requirements will determine whether existing land drains are connected to the header via a permeable backfill band or if positive junctions will be needed. The number of times a header drain crosses the pipeline trench should be kept to a minimum.

Reconnecting Drainage Pipes of Differing Materials

Joining pipes of differing materials or shapes to a header drain is potentially problematical but can be achieved using proprietary junctions, and/or placing a sleeve over the existing drain. The sleeve should be wrapped in geotextile to exclude soil. Examples are shown at Figures 33-35.

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Easement Drains

All easement drains are to be installed on the downslope side of the pipeline trench, preferably towards the edge of the working width. Drain depth and pipe sizes are to be appropriate for individual site circumstances. The easement drains may be installed prior to or immediately after pipeline works.

Spur Drains

Ideally spur drains should be installed following topsoil reinstatement and a subsequent period of time to allow for settlement in the trench zone. Where this is not practical and a risk of settlement prevails at the time of drainage installation work then a rigid trench crossing will be required for each spur drain (see section 6.12). The spacing of spur drains is a matter for individual site determination but will normally be less than the spacing of underdrainage systems on adjacent undisturbed land of similar soil type.

Spur drains should either be connected into an easement drain or be provided with individual outfalls.

Permeable Backfill

Permeable backfill will need to be considered over all new pipe drains which intercept natural seepage, less active existing land drains, those land drain pipes of less than 50 mm internal diameter or equivalent dimensions (eg. for horseshoe drains) or where a link between a pipe system and moling or subsoiling is required. The width of a permeable backfill band should be at least 100 mm.

Existing active land drains having internal diameters of 50 mm or greater (including horseshoe drains or stone drains) are to be positively connected to a new pipe system via purpose-made junctions.

Mole Drainage

Existing mole channels will be damaged or terminated by pipeline installations. Where mole drainage is practised, land upslope of a pipeline will therefore normally require remoling after completion of the pipeline installation.

Mole channels drawn across the pipeline trench are likely to be short-lived until settlement has ceased. The actual settlement period will vary from site to site depending on soil type and the quality of trench reinstatement.

To reduce the incidence of mole channel collapse, the length of individual channels crossing the trench line should be kept as short as possible by strategic location of intercepting header, spur and easement drains.

Mole drainage is to be carried out over a suitable permanent underdrainage system with adequate permeable backfill (see Part 7) or over spur drains with permeable

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backfill in the working width area (see references to Spur Drains on pages 50 & 55). It may be initially desirable to reduce mole channel spacing within the working width compared to surrounding areas to take account of disturbed soil conditions.

Subsoiling

Subsoiling operations in association with pipeline works are to be carried out in accordance with Part 8 of this Note.

Drain Outfalls

All header and easement drains must be directed to a clear outfall or be connected to an existing functional land drain of adequate capacity and satisfactory condition.

Water Stops

On occasions a pipeline trench may collect and conduct water in a similar manner to a land drain. Where this happens or can be predicted to the extent that the pipeline installation and reinstatement are likely to be prejudiced then water stops across the trench line will need to be considered as a preventative measure.

Water stops are to be strategically located and are of particular relevance on continuous steep pipeline gradients or at subtle changes of gradient. Every water stop is to incorporate a drainage pipe to receive water entering a permeable pack and discharging to either an individual outfall or connected to an easement drain. The permeable pack serves to receive water infiltrating from the pipeline trench and upslope horizons.

There is no standard design for water stops but Figures 36 and 37 show the key requirements. A water stop (or 'impermeable' barrier) is intended to reduce but not completely eliminate water flow along a pipeline trench. It should consist of a supported vertical impermeable barrier constructed across the pipeline trench and incorporate a perforated drain pipe as described above. Sandbags are a common means of support.

Cross-Pipeline Connections

The recommended methods of laying land drains in soft ground as outlined at section 6.12 of this Note are appropriate to pipe drains crossing pipeline trenches where it is necessary to protect against displacement and settlement. Further details are given at Figures 38 and 39. Wide trench connections should only be considered where no suitable outfalls are available for header drains.

If a header drain is not used then all existing functional land drains will need to be reconnected individually across the pipeline trench.

The continuous section of pipe making the connection shall be compatible with the original drain in terms of size, depth, alignment and gradient. Where a crossing is

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achieved by sleeving a land drain inside plastics channelling (or similar) the latter must be firmly secured to the support.

Obliquely angled crossings and the use of inverted siphons to connect land drains across pipelines are to be avoided if at all possible.

The chosen method of reconnection should be in agreement with the Site Engineer or representative and in consultation with the landowner or occupier. Any temporary reconnections of severed land drains (eg. those which are flowing) must be made with watertight sealed pipes of adequate size and on suitable support. All temporary reconnections are to be replaced by permanent reinstatements at the earliest practical opportunity.

Drainage Works Outside the Working Width

The explicit agreement of all involved parties must be obtained for drainage works that will extend beyond the pipeline working width. Additional rights of access and easements may need to be negotiated.

Drainage Record Plans

All existing land drainage systems disturbed and all reinstatement or replacement drainage works are to be recorded on a record plan using the nomenclature at Appendix C.

11.13 Safety

All statutory requirements and regulations on health and safety measures in accordance with the Factories Act 1961, Health and Safety at Work Act 1974 and the Construction (Design and Management) Regulations must be adhered to - see Part 2 of this Note.

The use of mechanical excavators within 3m of a transmission pipeline will usually be prohibited by the pipeline owner or appointed agent. All excavation work within the easement strip of an operational pipeline must have the prior agreement of the pipeline authority. Mechanical excavators or power tools should not be used within 0.5 m of the indicated line of an electricity cable except with the prior agreement of the electricity company.

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Reconnecting Drainage Pipes of Differing Materials

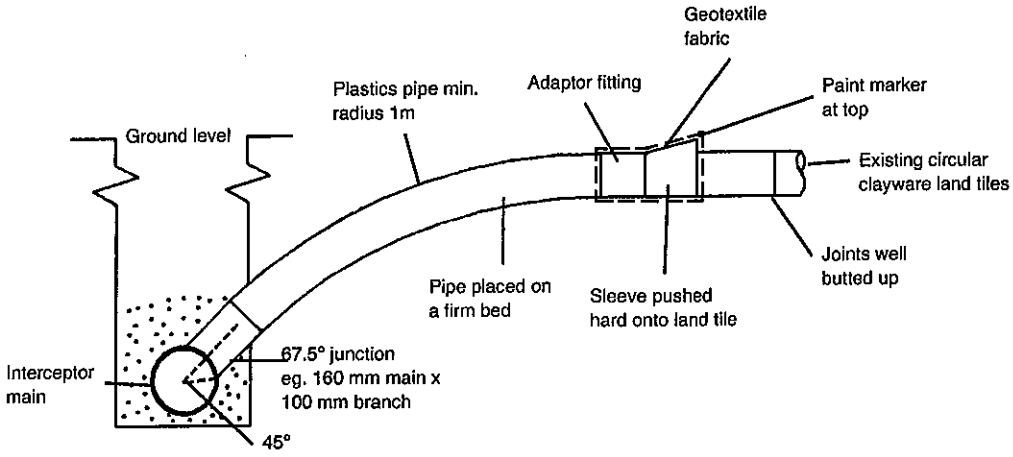

Fig. 33 Possible interceptor system for circular clayware pipes by a plastics main

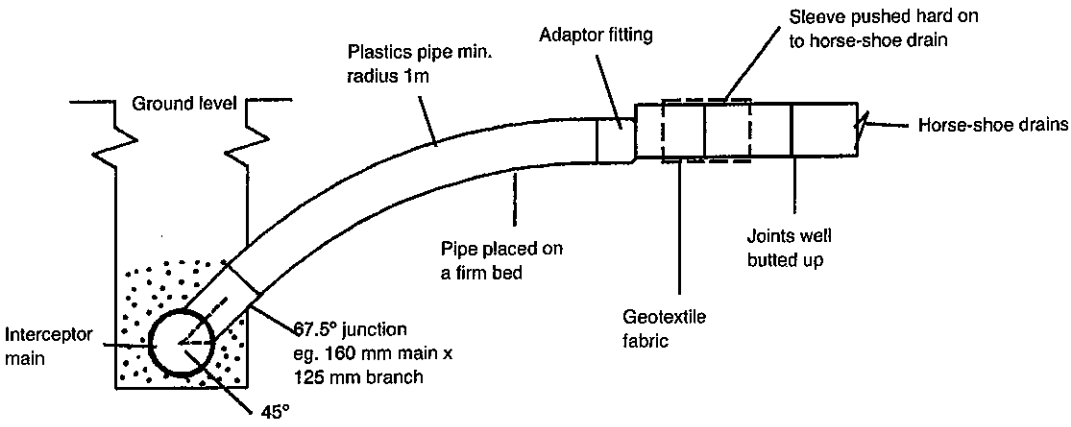

Fig. 34 Possible interceptor system for horseshoe clayware pipes by a plastics main

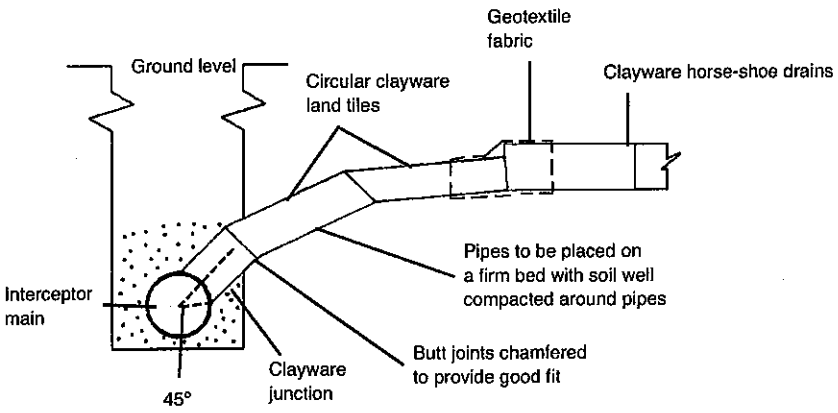

Fig. 35 Possible interceptor system for horseshoe clayware pipes by a clayware main

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Pipeline Water Stops

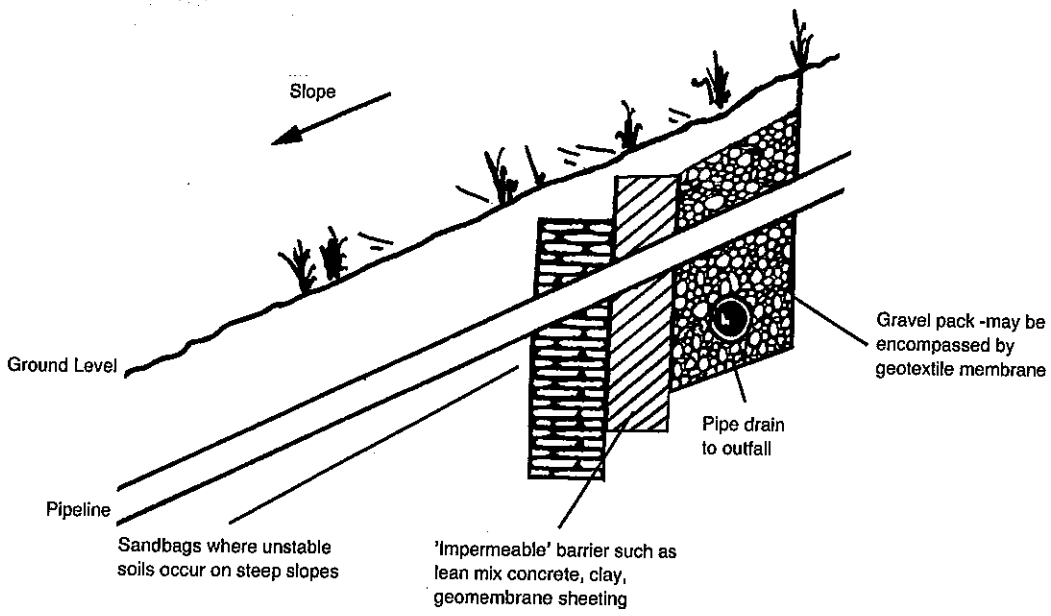

Fig. 36 Section

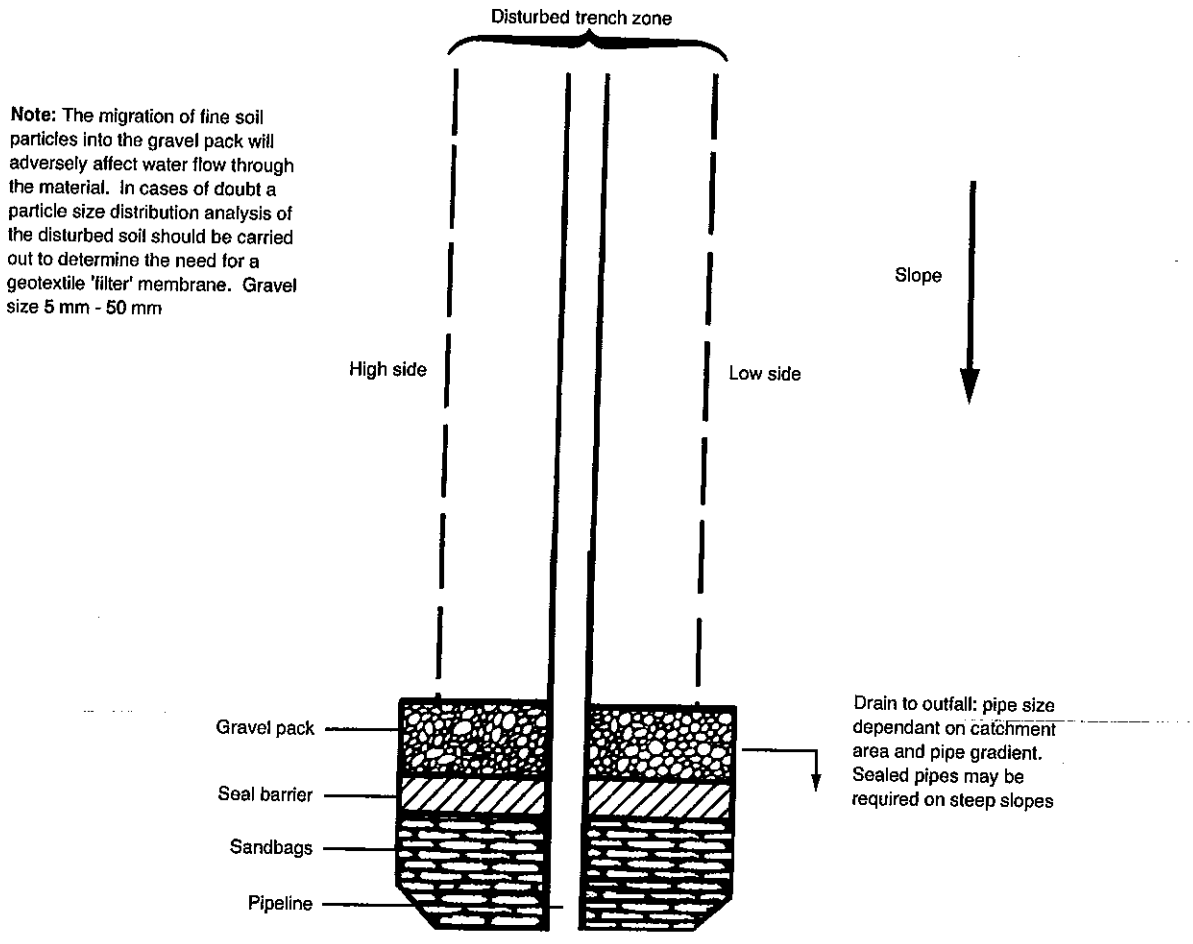

Fig. 37 Plan

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Cross-Pipeline Connections

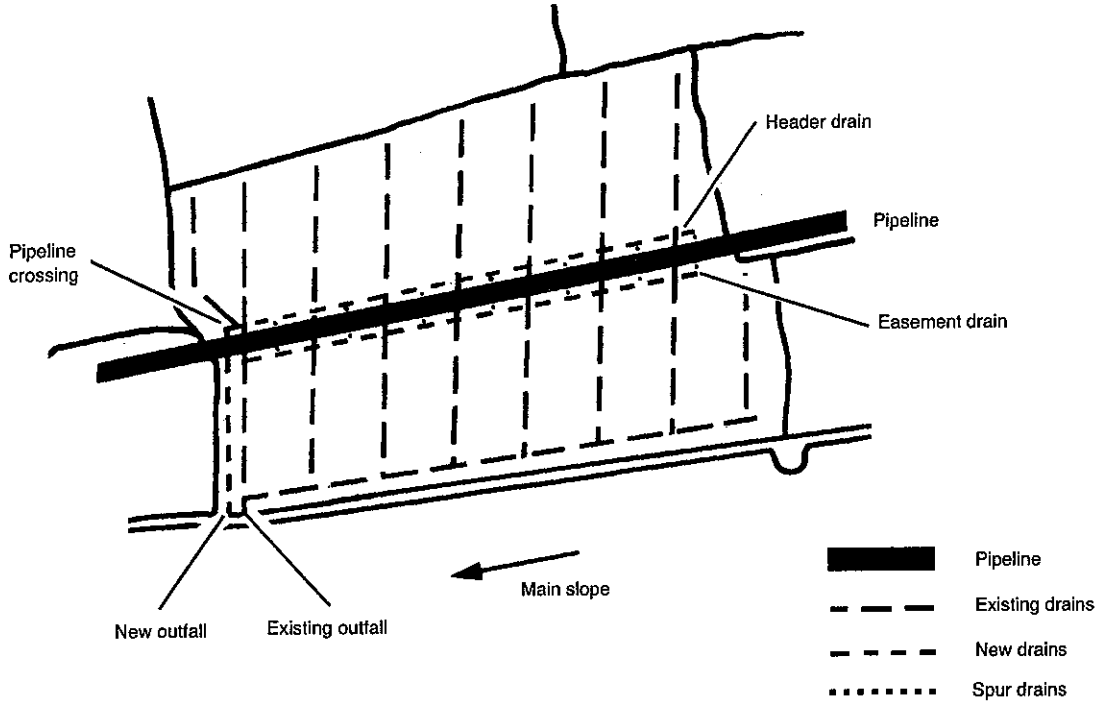
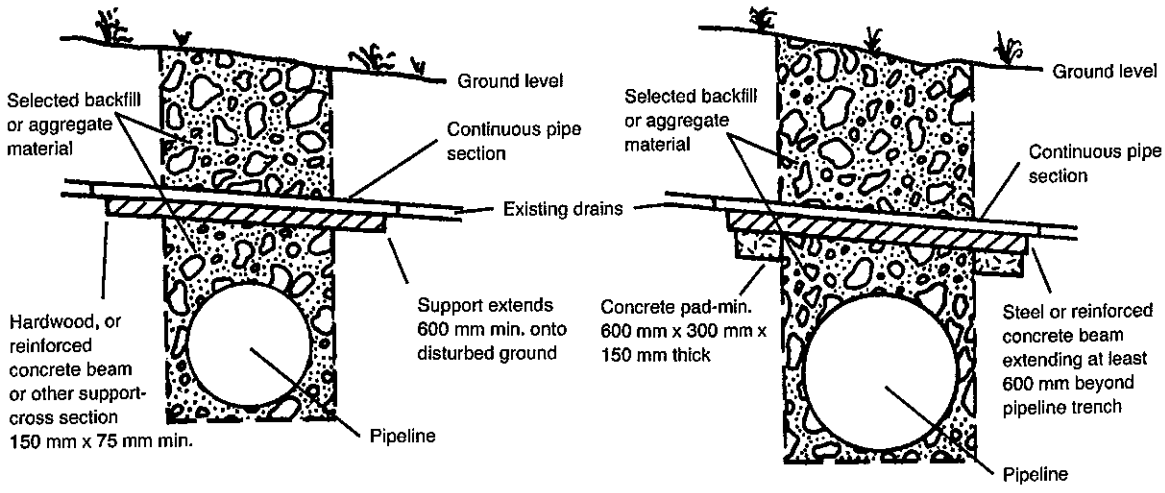


Fig. 38 Pipe drainage reinstatement



Note: Trench backfill must be well consolidated before the drain crossing is constructed. The drainage design may require permeable backfill being placed over and around drain pipes forming a crossing. See also Figures 10 and 11.

Fig. 39 Pipeline crossings

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12 Miscellaneous Items Relating to Ditching and Underdrainage

12.1 Hill Gripping

The channels of hill grip surface drainage systems are to be formed in a tapered section, being nowhere less than 375 mm deep, with a clean bed 150 mm wide and 450 mm top width. The excavated material should be placed on the downslope side of the grip not less than 550 mm from the near edge. The bed of the grip is to be continuously graded towards one or both ends of its length. The gradients are to be such that self-cleansing velocities are maintained under average discharge conditions but in no case are they to be so steep as to promote scouring. Each grip is to be connected to its outfall channel with sides and beds merging in a clean and undiminished cross-section.

12.2 Structures to House Pumps and Associated Equipment

Buildings to house pumps and associated equipment are to be properly designed and constructed for their purpose. Provision is to be made in buildings for adequate ventilation and lighting. The dimensions and design should allow easy access for inspection, servicing, repairs, installation and removal of pumping plant etc.

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Appendix A
Selected British Standards (BS) Relevant to Land Drainage

1 Pipes

BS 65 — Specification for vitrified clay pipes, fittings and ducts.

BS EN 295* — Vitrified clay pipes and fittings and pipe joints for drains and sewers.

BS 534 — Specification for steel pipes, joints and specials for water and sewage.

BS 1196 — Specification for clayware field drain pipes and junctions.

BS 4660 — Specification for unplasticised polyvinyl chloride (PVC-U) pipes and plastics fittings of nominal sizes 110 and 160 for below ground gravity drainage and sewerage.

BS 4962 — Specification for plastics pipes and fittings for use as subsoil field drains.

NB Applicable for sizes up to 400 mm outside diameter.

BS 5178 — Specification for prestressed concrete pipes for drainage and sewerage.

BS 5911* — Precast concrete pipes, fittings and ancillary products.

- Part 100: Specification for unreinforced and reinforced pipes and fittings with flexible joints.
- Part 101: Specification for glass composite concrete (GCC) pipes and fittings with flexible joints.
- Part 103: Specification for pre-stressed, non-pressure pipes and fittings with flexible joints.
- Part 110: Specification for ogee pipes and fittings (including perforated).
- Part 114: Specification for porous pipes.

2 Pipelines

BS 8010* — Code of practice for pipelines.

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Part 1:	Pipelines on land : general	
Part 2:	Pipelines on land : design, construction and installation.	
	Section 2.1	Ductile iron
	Section 2.3	Asbestos cement
	Section 2.4	Prestressed concrete pressure pipelines
	Section 2.5	Glass reinforced thermosetting plastics
	Section 2.7	Precast concrete
	Section 2.8	Steel for oil and gas

3 Aggregates

BS 812*	Testing aggregates.
BS 882	Specification for aggregates from natural sources for concrete.
BS 1047	Specification for air-cooled blast furnace slag aggregate for use in construction.
BS 1199 and 1200	Specifications for building sands from natural sources.
BS 3797	Specification for lightweight aggregates for masonry units and structural concrete.

4 Structures

BS 1247	Manhole steps.	
	Part 1:	Specification for galvanised ferrous or stainless steel manhole steps.
	Part 2:	Specification for plastics encapsulated manhole steps.
	Part 3:	Specification for aluminium manhole steps.
BS 3921	Specification for clay bricks.	
BS 4008	Specification for cattle grids.	
BS 5628	Code of practice for use of masonry.	
	Part 1:	Structural use of unreinforced masonry.

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	Part 2:	Structural use of reinforced and prestressed masonry.
	Part 3:	Materials and components, design and workmanship.
BS 5911*	Precast concrete pipes, fittings and ancillary products.	
	Part 2:	Specification for inspection chambers and street gullies.
	Part 200:	Specification for unreinforced and reinforced manholes and soakaways of circular cross section.
BS 6073	Precast concrete masonry units.	
	Part 1:	Specification for precast concrete masonry units.
	Part 2:	Method for specifying precast concrete masonry units.
BS 7263	Precast concrete flags, kerbs, channels, edgings and quadrants.	
BS 8102	Code of practice for protection of structures against water from the ground.	
BS 8110*	Structural use of concrete.	
	Part 1:	Code of practice for design and construction.
	Part 2:	Code of practice for special circumstances.

5 Cement and Concrete

BS 12	Specification for Portland cement.	
BS 146	Specification for Portland blast-furnace cement.	
BS 3892	Pulverised-fuel ash.	
	Part 1:	Specification for pulverised-fuel ash for use with Portland cement.
	Part 2:	Specification for pulverised-fuel ash for use in grouts and for miscellaneous uses in concrete.
BS 4027	Specification for sulphate-resisting Portland cement.	
BS 4246	Specification for high slag blast-furnace cement.	

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BS 4449	Specification for carbon steel bars for the reinforcement of concrete.	
BS 4482	Specification for cold reduced steel wire for the reinforcement of concrete.	
BS 4483	Specification for steel fabric for the reinforcement of concrete.	
BS 4887	Mortar admixtures.	
	Part 1:	Specification for air entraining (plasticising) admixtures.
	Part 2:	Specification for set retarding admixtures.
BS 5075	Concrete admixtures.	
	Part 1:	Specification for accelerating admixtures, retarding admixtures and water reducing admixtures.
	Part 2:	Specification for air entraining admixtures.
	Part 3:	Specification for superplasticizing admixtures.
BS 5328	Concrete.	
	Part 1:	Guide to specifying concrete.
	Part 2:	Methods for specifying concrete.
	Part 3:	Specification for the procedures to be used in producing and transporting concrete.
	Part 4:	Specification for the procedures to be used in sampling, testing and assessing compliance of concrete.
BS 6588	Specification for Portland pulverised-fuel ash cement.	
BS 6610	Specification for Pozzolanic pulverised-fuel ash cement.	
BS 6699	Specification for ground granulated blast-furnace slag for use with Portland cement.	
BS 7583	Specification for Portland limestone cement.	
BS 8110*	Structural use of concrete.	

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Part 1: Code of practice for design and construction.

Fencing

6

BS 1722* Fences.

Part 1: Specification for chain link fences.

Part 2: Specification for rectangular wire mesh and hexagonal wire netting fences.

Part 3: Specification for strained wire fences.

Part 7: Specification for wooden post and rail fences.

BS 2632 Specification for mains-operated electric fence controllers.

BS 3470 Specification for field gates and posts

BS 4102 Specification for steel wire and wire products for fences.

BS 5709 Specification for stiles, bridle gates and kissing gates.

Timber Preservation

7

BS 144* Wood preservation using coal tar creosote.

BS 1282 Guide to the choice, use and application of wood preservatives.

BS 5268* Structural use of timber.

Part 5: Code of practice for the preservative treatment of structural timber.

BS 5589 Code of practice for preservation of timber.

BS 5707* Solutions of wood preservatives in organic solvents.

Geotextiles

8

BS 6906 Methods of test for geotextiles and geotextile related products.

Part 1: Determination of tensile properties using a wide width strip.

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	Part 2:	Determination of apparent pore size distribution by dry sieving.
	Part 3:	Determination of water flow normal to the plane of the geotextile under a constant head.
	Part 4:	Determination of puncture resistance using the California Bearing Ratio (CBR) test.
	Part 5:	Determination of creep.
	Part 6:	Determination of resistance to perforation (cone drop test).
	Part 7:	Determination of in-plane water flow.
	Part 8:	Determination of sand-geotextile frictional behaviour by direct shear.
BS EN 30320	Geotextiles - Identification on site.	

9 Earthworks

BS 3882	Recommendations and classification for topsoil.
BS 6031	Code of practice for earthworks.
BS 6913*	Operation and maintenance of earth-moving machinery.

10 Miscellaneous

BS 6100	Glossary of building and civil engineering terms.
BS 6629	Specification for optical performance of high-visibility garments and accessories for use on the highway.
BS EN 414	Safety of machinery. Rules for the drafting and presentation of safety standards.
BS 6912*	Safety of earth-moving machinery.
BS 8301	Code of practice for building drainage.
NOTE	**** Not all parts of this Standard are listed.***

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Appendix B
Brief Specification for Guard Fencing to Ditches

1 Introduction

Guard fencing for ditches is intended as a deterrent to livestock; it is not expected to be completely stockproof.

2 Fence Design

The fence is to consist of one or two line wires, plain or barbed, erected on wooden posts. If one wire is used it is to be fixed between 700 mm and 800 mm above the ground. If two wires are used the top one is to be fixed between 700 mm and 800 mm and the lower one 300 mm to 450 mm above ground level.

3 Materials

3.1 Line Wire

Line wire should be zinc coated mild steel wire or zinc coated high tensile steel wire having a minimal nominal diameter of 3.15 mm, or 2.50 mm mild steel 2-ply twisted barbed wire. All to comply with BS 4102. The wire to be properly strained and fastened to the posts with galvanised staples.

3.2 Posts and Struts

These are to be of wood and are to have the following minimum dimensions:

Straining Posts

1650 mm long with a top diameter of 100 mm if round or 100 mm x 100 mm if sawn.

Struts

1400 mm long with a top diameter of 80 mm if round or 75 mm x 75 mm if sawn. This length is suitable for a strut fixed in level ground at an angle of 45°.

On sloping ground struts may have to be longer.

Intermediate Posts

1500 mm long with a top diameter of 65 mm if round or 75 mm x 75 mm if sawn.

Timber Treatment

All round and half round wood is to be treated with creosote or a waterborne preservative. The method of preservation can be impregnation under pressure or by hot and cold treatment in an open tank. All cleft and sawn wood should be similarly

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treated, unless it has been cut from the heartwood of oak, larch, sweet chestnut, yew or western red cedar.

4 Erection

1. The fence shall be parallel with the ditch and at least 500 mm from the edge of the ditch.

2. Straining posts should be set in the ground, not less than 750 mm when set in concrete and 1050 mm when not, be firmly strutted in the direction of the strain and placed at each change of direction, or acute variation in level and on the straight at intervals of not more than 150 m.

3. Intermediate posts should be set not less than 600 mm into the ground and placed at intervals not exceeding 5500 mm from centre to centre.

4. The top ends of struts should be cut and fitted to notches in the straining posts and the bottom ends set at least 450 mm below ground level and bearing against suitable base plates.

5. Line wires are to be strained tightly between straining posts. Plain wire is to be attached thereto by strainers at both ends. Barbed wire may be stapled to straining posts or attached thereto by strainers at one or both ends. Line wires are to be attached to intermediate posts by staples which are to be driven only as far as will allow the wire the minimum of freedom in the staple.

6. Unless some other form of protection exists the wire or wires are to be returned across the ditch at all gateways, culverts, other crossings and ends of ditches. Alternatively wooden rails may be provided. Drinking bays are to be fenced to prevent stock treading in the stream and to protect the sides of the ditch and drinking place.

7. Guard fencing is to be erected as the ditching work proceeds, to prevent damage to new work by stock.

NOTE** **This specification is for example purposes only.

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Appendix C
Recommendations for Land Drainage Plans

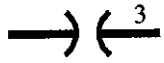
Standard Symbols and Colour Codes

Plans for ditching and underdrainage systems should be drawn using the following symbols and colour codes. Any variations from these standards must always be clearly indicated.

A plan may also include ditch dimensions (top width, depth, bottom width); fencing type and height; culvert diameter and width; type, length, depth, spacing of pipe drains; depth and spacing of mole drainage and subsoiling, plus any other relevant details.

Open ditch and direction of flow (Brown)

Back fence (Black)

Culvert (including sequential reference number) 

(Appropriate pipe diameter colours)

Plastics pipes

Diameter (external)	Colour
60 mm	Red
80 mm	Brown
100, 110 mm	Green*
125 mm	Purple
160, 170 mm	Blue*
200, 225 mm	Yellow*
over 225 mm	Black*

Clay or concrete pipes

Diameter (internal)	Colour
75 mm	Red
100 mm	Green
150 mm	Blue
225 mm	Yellow
over 225 mm	Black*

*State diameter

New pipes

Existing pipes

Sealed conduits

Pipe drain with permeable backfill

(Insert depth of backfill below ground level in mm eg. 375). Alternatively depths of backfill may be noted in the plan legend.

Use pipe drain colour code to denote permeable backfill

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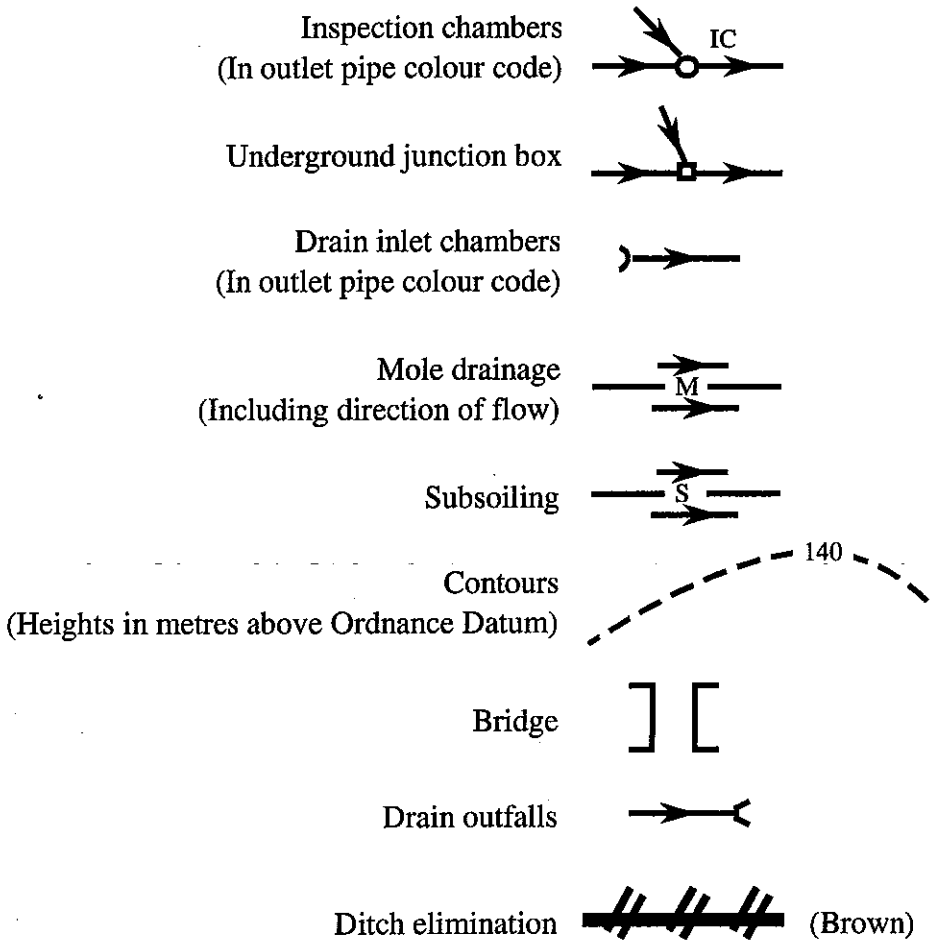

Plan scales: Ditching not less than 1 : 10000
Underdrainage not less than 1 : 2500

Land drainage plans should also show where relevant:

Ordnance Survey Edition
Ordnance Survey Sheet No.
Ordnance Survey National Grid Reference
Map Scale
Parish Name (or Village)
Field Numbers
North Point
Whether proposal or final record plan
Job or Contract reference
Designer/Surveyors name
Date
Signature

Note: Ordnance Survey maps are subject to copyright and may only be reproduced by consent.

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References

HMSO (1974) Health and Safety at Work etc. Act 1974. London. ISBN 010 543774 3.

European Council (1992). Council Directive 92/57/EEC. Implementation of Minimum Safety and Health Requirements at Temporary or Mobile Construction Sites. Luxembourg.

Health and Safety Commission (1992). Proposals for Construction (Design and Management) Regulations and Approved Code of Practice. Health and Safety Executive. London.

Transport and Road Research Laboratory (1988). Simplified Tables of External Loads on Buried Pipelines. HMSO. ISBN 011 550730 2.

HMSO (1991). Water Resources Act 1991. London. ISBN 0 10 545791 4.

HMSO (1991). Land Drainage Act 1991. London. ISBN 0 10 545991 7.

HMSO (1991). New Roads and Street Works Act 1991. London. ISBN 0 10 542291 6.

MAFF (1985). Guidelines for the Use of Herbicides on Weeds In or Near Watercourses. Booklet B 2078. Ministry of Agriculture, Fisheries and Food. HMSO. London

HMSO (1991). Water Industry Act 1991. London. ISBN 0 10 545691 8.

HMSO (1962). Pipelines Act 1962. London. ISBN 0 10 850098 5.

MAFF (1993). Code of Good Agricultural Practice for the Protection of Soil. PB0617 Ministry of Agriculture, Fisheries and Food. London.

MAFF (1991). Preventing the Spread of Plant and Animal Diseases - A Practical Guide. Ministry of Agriculture, Fisheries and Food. London.

HMSO (1961). Factories Act 1961. London.

NOTE *Those British Standards relevant to land drainage and referenced in the text are included in the full lists at Appendix A.*

MAFF references can be obtained by writing to MAFF Publications, London, SE99 7TP.

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