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MILLOM IRON LINE
DRAINAGE SPECIFICATION

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Client Name: Cumberland Council

Client Address: Parkhouse Building, Kingmoor Business Park, Carlisle, Cumbria CA6 4SJ

Site Address: Hodbarrow Nature Reserve, Millom, Cumbria

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1 General

This Specification shall apply to all below ground foul and surface water gravity drainage systems.

This Specification does not apply to any pressure pipelines and process/chemical drainage unless specified by the Engineer.

The work is to be constructed strictly in accordance with the drawings (unless these have been modified by instructions from the Engineer) and is to be to the complete satisfaction of the Engineer.

Unless specified otherwise in this Specification the materials and workmanship shall comply with all relevant British Standards and Codes of Practices and associated Curtins Specifications, the principal of which are as follows:

Building Regulations 2010	**Approved Document Part H – Drainage & Waste Disposal (including 2015 update)**
BS 4660:2022	**Thermoplastics ancillary fittings of nominal sizes 110 and 160 for below ground gravity drainage and sewerage - specification**
BS 5911:2022	**Concrete pipes and ancillary concrete products - concrete manholes, inspection chambers and soakaways (complementary to BS EN 1917:2002) - specification**
BS EN 124:2015	**Gully tops and manhole tops for vehicular and pedestrian areas.**
BS EN 295 (all parts)	**Vitrified clay pipes systems for drains and sewers.**
BS EN 752:2017	**Drain and sewer systems outside buildings – sewer system management**
BS EN 1401-1:2019	**Plastics piping systems for non-pressure underground drainage and sewerage - Unplasticized poly(vinyl chloride) (PVC-u).**
BS EN 1433:2002	**Drainage channels for vehicular and pedestrian areas**
BS EN 12056:2000	**Gravity Drainage Systems Inside Buildings Parts 1-5**
BS EN 13101:2002	**Steps for underground man entry chambers - Requirements, marking, testing and evaluation of conformity**
BS EN 13598-1:2020	**Plastics piping systems for non-pressure underground drainage and sewerage**
BS EN 14396:2004	**Fixed ladders for manholes**
IGN-4-08-01	**Water Industry Information & Guidance Note. Amendment to: Bedding and sidefill materials for buries pipelines**

Items not covered by this Specification and items specifically to be adopted under Water Industry Act adoption agreements shall be carried out in accordance with ‘Sewer Sector Guidance Appendix C’ (latest edition) by the Water UK on behalf of its members to meet the requirements of Ofwat’s Code for Adoption Agreement.

1.1 Existing Drainage Invert Levels

It is advised that the contractor surveys all retained existing drainage prior to commencement to confirm the location and condition. Potential pre-cleansing to be undertaken in order to facilitate the survey, if required.

It is advised that drainage works are to be constructed from the outfall towards the head of run to ensure the outfall can be achieved. The Contractor shall check the location and invert levels of existing sewers at the proposed point of drainage connection and immediately advise the Engineer in writing of the levels found and any deviation in assumed position.

The local authority and utilities companies are to be notified by the Contractor prior to commencement of work on site.

All existing services to be located prior to commencement of any drainage works, and where necessary protection or diversions to be undertaken to avoid conflict with the proposed work. The contractor shall immediately advise the engineer of any services exposed which may affect the design.

1.2 Works on adopted/adoptable Drainage Systems

The Contractor must give adequate notice to the sewerage undertaker of the proposed works on existing adopted drainage systems and of new works which are to become adopted. The Contractor shall afford the sewerage undertaker access to inspect the works as required and shall ensure that appropriate agreements are in place as in Section 6 of this specification.

1.3 Protection of the Drainage System

The Contractor shall prevent discharges into the connecting existing system until the drainage system is complete and secure. In particular the Contractor should prevent overloading of pipes where final ground levels have not been made up and temporary covers to the drainage system should also be provided to prevent ingress of debris.

The contractor shall be responsible for ensuring that pipes are adequately protected from concentrated loading by construction traffic during the construction period.

The contractor shall allow for the protection, temporary and permanent support, and temporary and permanent diversion works, as necessary to all existing services.

1.4 Use of the Drainage System

The Contractor shall not be permitted to discharge foul water into the drainage system until all testing as specified in Section 8 has been satisfactorily completed.

The drainage system should also not be used for the wash-down of cementitious materials, and other wash-down activities should be approved by the engineer before implementing on site.

1.5 Health and Safety

Laying drains is a hazardous operation. The Contractor must adequately plan the works to enable safe methods of work to be undertaken.

Nothing in this specification should be taken as an instruction to adopt working methods which contravene the CDM Regulations, and all contractors/sub-contractors etc are responsible for ensuring safe procedures which comply with the Regulations.

The Contractor should note that it is their responsibility to manage all risks associated with the drainage works. The residual site-specific hazards identified by the Engineer are listed on the Curtins drainage drawings and/or Designer’s Hazard Register.

2 Materials

The materials used in the drainage works shall be in accordance with the design drawings and the following unless specified otherwise by the Engineer.

2.1 Pipes and Fittings

Generally, all sewers, unless otherwise agreed or stated, shall be:

- 100mm to 300mm diameter pipework and components to be vitrified clay.
- 375mm diameter and greater pipework and components to be class 120 concrete pipes.

However, as an alternative the contractor may use an approved unplasticised polyvinyl chloride (PVCu) with approval from the engineer.

All components shall comply with the following:

2.1.1 Rigid Pipes and fittings

- Perforated vitrified clay pipes for land drainage to BS 1196:1989.
- Concrete Pipes and Ancillary Products to BS 5911-1:2002+AR:2010 and BS EN 1916:2002.
- Vitrified Clay Pipes and Fittings to BS EN 295:2013 (all parts).
- Ductile Iron to BS EN 598:2007 & BS ISO 4179:2005.

2.1.2 Flexible pipes and fittings

- Plastic pipes for land drainage to BS 4962:1989.
- Plastic Piping Systems for Non-pressure underground drainage and sewage to BS EN 1401 & BS 4660 – Solid wall only, structured wall pipes are not acceptable for use in drainage systems unless agreed in advance with the Engineer.

2.1.3 Access chambers

- Precast concrete manhole units to BS EN 1917:2002.
- Plastic Inspection Chambers for Drains and Sewers to BS EN 13598-1:2010.

2.1.4 Other Fittings

- Gully and Manhole Tops for Vehicular and Pedestrian Areas to BS EN 124:2015.
- Drainage Channels for Vehicular and Pedestrian Areas to BS EN 1433:2002.
- Modular geocellular attenuation tanks to CIRIA Report C737

2.2 Coarse Graded Aggregates

These materials may be used as permeable sub-base and the main fill for filter drains, as specified on drawings.

2.2.1 4/20mm or 4/40mm Coarse Graded Aggregate

Material to BS EN 13242:2002+A1:2007.

Material to comprise crushed carboniferous limestone rock or concrete.

Property	Category to BS EN 13242
Grading	4/20 (preferred) or 4/40, G_c 85-15, GT_C20/17.5
Fines content	f_4
Shape	FI_{20}
Resistance to fragmentation	LA_{30}
Durability: - Water absorption to BS EN 1097-6:2013, Clause 7 for WA > 2% - magnesium sulphate soundness	 $WA_{24}2$ MS_{18}
Resistance to wear	M_{DE}20
Acid-soluble sulphate content	$AS_{0.2}$
Total sulphur - aggregates other than air-cooled blast furnace slag - air-cooled blast furnace slag	 ≤ 1% by mass, S_1 ≤ 2% by mass, S_2
Leaching of contaminants	Crushed concrete should meet the requirements set out in EA (2010) for inert waste when tested in accordance with BS EN 12457-3:2002

Table 1 Type 4/20mm or 4/40mm coarse graded aggregate properties

2.2.2 Type 2/6.3 for bedding layer and jointing material for permeable block paving.

Material to BS EN 13242:2002+A1:2007.

Material to comprise crushed carboniferous limestone rock or concrete.

Property	Category to BS EN 13242
Grading	2/6.3, G_c 80-20
Fines content	f_4
Shape	FI_{20}
Resistance to fragmentation	LA_{30}
Durability: - Water absorption to BS EN 1097-6:2013, Clause 7 for WA > 2% - magnesium sulphate soundness	 $WA_{24}2$ MS_{18}
Resistance to wear	M_{DE}20
Acid-soluble sulphate content	$AS_{0.2}$
Total sulphur - aggregates other than air-cooled blast furnace slag - air-cooled blast furnace slag	 ≤ 1% by mass, S_1 ≤ 2% by mass, S_2
Leaching of contaminants	Crushed concrete should meet the requirements set out in EA (2010) for inert waste when tested in accordance with BS EN 12457-3:2002

Table 2 Type 2/6.3mm material properties

2.2.3 Type 3 sub-base

As defined by the Specification for Highway Works Clause 805. Material to BS EN 13285.

Material to comprise crushed rock, crushed blast furnace slag, manufactured aggregates or recycled concrete aggregate.

Property	Category to BS EN 13285
Grading	0/40 , G_O
Fines content	UF_5
Oversize	OC_{80}
Resistance to fragmentation	LA_{30}
Durability: - Water absorption to BS EN 1097-6:2013, Clause 7 for WA > 2% - magnesium sulphate soundness	 WA_{24}NR MS_{35}
Total sulphur - aggregates other than air-cooled blast furnace slag - air-cooled blast furnace slag	 ≤ 1% by mass, S_1 ≤ 2% by mass, S_2

Table 3 Type 3 sub-base properties

2.3 Geosynthetics

2.3.1 Geotextiles as filtration and separation layers

To BS 8661:2019.

To be non-woven, high-extension geotextile with an elongation at break of equal to or greater than 30%.

Property	Value
Tensile strength [as defined by BS EN ISO 10319]	≥ 13 kN/m
Tensile strain at max. load [as defined by BS EN ISO 10319]	≥ 32 %
CBR push through force [as defined by BS EN ISO 12236]	≥ 2250 N
Minimum water flow discharge normal to the plane [as defined by BS EN ISO 11058]	≥ 27 l/m2/s
Characteristic opening size, O90 [as defined by BS EN ISO 12956]	50 ≥ O90 ≥ 150 µm

Table 4 Geotextiles properties for filtration and separation layers

2.3.2 Membranes properties for lining

Geomembranes are to be polymeric geosynthetic barriers in accordance with the current BS.

The membrane for lining SuDS features shall meet the following requirements:

Property	Value	Test method to:
Water permeability (liquid tightness)		BS EN 14150
Tensile strength		BS EN ISO 527 parts 1, 3 and 4, or BS EN 12311-2
Static puncture (CBR) resistance		BS EN ISO 12236
Resistance to weathering (UV)		BS EN 12224
Resistance to oxidation		BS EN 14575
Environmental stress cracking		BS EN 14576

Table 5 Membranes properties for lining

2.4 Filter Medium

The type of soil (or filter medium) is crucial to the successful operation of the bioretention systems (or rain gardens). The below requirements are based on CIRIA C753 The SuDS Manual, Box 18.1. Potential bioretention soils and test results should be assessed by the landscape architect and the civil engineer, so that the growth potential and hydraulic performance can be assessed.

Property	Value	Test method to:
Saturated hydraulic conductivity	100 to 300 mm/hr	BS EN ISO 22282-5:2012
Porosity	> 30%	BS 1377-2:1990
Organic matter content	3-5% (w/w)	
pH	5.5-8.5 (1:2.5 soil/water extract)	
Electrical conductivity (salinity)	<3300 µS/cm (1:2.5 soil/$CaSO_4$ extract)	

Table 6 Filter Medium – Material properties

Sieve size (mm)	% passing
6	100
2.0	90-100
0.6	40-70
0.2	5-20
0.063	<5

Table 7 Filter Medium – Grading guide

The grading specification in Table 7 is a useful guide for selecting an appropriate material only. It is not a requirement, nor does it preclude the need for in situ testing as described above. The filter medium should be well-graded and the composition should contain a limited particle size range.

2.4.1 Major plant nutrients

Property	Value	Test method to:
Total nitrogen	0.10-0.30%	BS 3882:2015
Extractable phosphorus	16-100 mg/l	
Extractable potassium	120-900 mg/l	

Table 8 Filter Medium – Major plant nutrients

2.5 Other Materials

All other pipes and fittings to Sewer Sector Guidance Appendix C (including local water company variations and addendums).

3 Excavation

Unless the requirements of Sewer Sector Guidance prevail for adoptable sewers, the excavation and backfill to drainage trenches shall be in accordance with the following and to the satisfaction of the Engineer.

3.1 Excavation for Trenches

Excavation for pits and trenches shall be taken out to the levels and dimensions shown on the drawings or to such other levels and dimensions as may be directed dependent upon site conditions. Where the type of subsoil encountered at the pipe or invert level differs from that indicated on the Site Investigation, the Contractor must advise the Engineer immediately. Trenches shall be excavated true to line, level and gradient and specified trench width as noted on the drawings.

Any pockets of soft or loose material shall be removed and the pockets so formed filled to formation level with the same material as the permanent work, which is to rest on that formation, properly compacted. Any void which results from over-excavation below formation level shall be refilled in the same manner.

3.2 Supports for Excavations

The sides of all excavations shall be adequately supported by timbering, trench sheeting, piling or other suitable means. Where ground conditions permit, trench support should not extend below the top of the pipe bedding to avoid disturbance of the bedding materials.

All materials used for supporting excavations shall be removed as the work proceeds unless otherwise directed by the Engineer.

3.3 Water in Excavations

Water shall not be allowed to accumulate in the trenches and where necessary adequate pumping shall be provided. Care shall be taken to ensure that pumping operations do not disturb the stability of adjacent soils and structures. The point and method of discharge to be agreed with the relevant outfall authority.

If the water is considered to arise from unexpected groundwater not anticipated from previous site investigations, the Engineer should be notified to allow the situation to be considered.

3.4 Disposal of Surplus Materials

All surplus excavated materials shall be deposited on the site in areas to be agreed or, if directed, shall be removed from the site following appropriate testing and certification, as required.

3.5 Undermining Adjacent Structures

The Contractor shall take due regard of existing and proposed structures during the planning and execution of trench excavations to prevent undermining of foundations. No excavation shall take place within the 45-degree spread below any foundation without written approval of the Engineer.

3.6 Combined Trenches

For trenches containing pipes at different levels, the whole trench width must be excavated to the depth of the lower pipe unless agreed in advance with the Engineer. Refer to the Engineer's details for backfilling to trenches which are not deemed to be narrow.

4 Laying and Bedding

4.1 General

All construction shall be in accordance with the working drawings and carried out to the satisfaction of the Engineer.

After excavation, trench bottoms shall be accurately formed to levels and gradients, care being taken to ensure a uniform profile along the length of the pipe. Local excavation is required for the sockets so that the pipe will be fully supported along the barrel.

If rock, large stones, or other local hard spots are present, or where concrete beds or granular materials are required, the trench bottom shall be over-excavated to accommodate the granular or concrete bed as appropriate.

All setting out references of whatever form shall be clearly marked.

4.2 Granular bedding materials

The class of pipe bedding is dependent on the site conditions and pipe setting and should be in accordance with the provided construction details on the design drawings unless specified otherwise by the Engineer.

4.2.1 Private, unadoptable drainage (to comply with Building Regulation)

Granular material to be used for bedding of pipes of Class S, B and F shall comply with one of the requirements set out below. The greater the proportion of fines in the material the greater is the care needed in compaction.

Compaction factor 0.3 is required for Class N & B and 0.15 for Class F. Refer to Section 14 for compaction factor testing procedure.

Nominal Pipe Diameter (mm)	Table B.15	
	Graded Aggregate Ranges (mm)	Single Sized Aggregate Sizes (mm)
Up to 100	10 - 5	10
150	14 - 5	14
150 -600	20 - 5	20
600 and greater	40 - 5	40

Table 9 Grading of granular materials for bedding classes S,B and F

All aggregate to be rounded unless agreed in writing by the Engineer.

Granular material to be used for bedding of pipes of Class N and T shall comply with one of the requirements set out below.

Nominal Pipe Diameter (mm)	**Table B.16**	**Table B.17**
	Limits	**Nominal Sizes (mm)**
Not exceeding 140	Overall Limits	10
Exceeding 140 but not exceeding 400	Overall Limits	10 or 20
Exceeding 400	Overall Limits	10, 20 or 40

Table 10 Grading of granular materials for bedding Classes N and T

All materials to be rounded aggregate unless approved in writing by the Engineer.

4.2.2 Adoptable Drainage (to comply with Sewer Sector Guidance)

Granular beddings and pipe surround to be in accordance with Sewer Sector Guidance Appendix C (including local water company variations and addendums) and Water Industry Specification (WIS) Guidance Note IGN 4-08-01, unless otherwise agreed with the approving sewerage undertaker.

4.3 Laying pipes on trench formation

When the pipe is to be laid directly on the formation any necessary adjustments to level after the formation has been prepared shall be only made by raising or lowering the formation. Adjustments shall never be made by local packing.

Where the formation is low and does not provide continuous support, it shall be brought up to the correct level by placing and compacting suitable material.

Socket and joint holes shall be as short as practicable, scraped or cut in the formation and deep enough to give a minimum clearance of 50mm between the socket and the formation.

4.4 Laying pipes on granular beds

The granular bedding material shall be placed to invert level and shall extend to the full width of the trench unless otherwise shown on the drawings. A shallow depression shall be formed for the barrel of the pipe and socket holes formed at each joint position. These should be deep enough to prevent the weight of the pipe bearing on the socket or coupling and leave a minimum depth of 50mm of granular bedding material beneath the joint.

The pipes shall be laid directly on the granular bed and adjusted to correct line and level. All temporary pipe supports shall be removed as the work proceeds and prior to completing the pipe surrounds. Side fill of either granular material or selected backfill material, depending upon the class of bedding specified, shall be placed evenly on either side of the pipe taking care not to disturb the line and level. Bedding material shall not be compacted in the socket holes. It is sufficient that they be filled as a result of the general placing of side fill.

4.5 Laying pipes with concrete protection

Wherever possible total concrete encasement should be avoided, and protective reinforced slabs provided over granular surrounds as a primary method of protection. These shall be constructed in accordance with construction details provided by the Engineer.

Where total encasement is required, the level of trench formation shall be as specified on the design drawings but to a minimum depth of 100mm below base of pipe. The pipes shall be supported clear of the trench bottom by means of blocks or cradles of compressible material placed under the pipes immediately behind each socket. Expanded polystyrene or impregnated fibre building board are examples of suitable material that will yield under load sufficiently to permit the barrel of the pipe to rest uniformly on its bed after normal setting shrinkage of the concrete has occurred. Alternatively, rigid temporary supports such as purpose-made folding wedges may be used but these shall be removed as the concrete bed is placed.

Where flexible joints are employed the overall flexibility of the drain shall be maintained by the provision of flexible joints in the concrete. These shall be formed through the full cross section of the concrete by providing compressible materials such as expanded polystyrene or impregnated fibre building board at the face of each pipe socket or sleeve.

The concrete shall be so placed that the pipes or lateral construction joints in the concrete are not displaced and the flexibility of the joint not impaired.

5 Jointing

5.1 Flexible joints

Flexible joints shall be made to conform to the pipe manufacturer's recommendations using the sealing ring supplied by the manufacturer. Where a lubricant is required, it shall also be used in accordance with the manufacturer's recommendations. The jointing surface and sealing rings shall be clean and dry prior to any application of recommended lubricant.

To allow for telescopic movement, a small gap shall be left between the spigot end and adjoining socket, or between pipe ends.

Care shall be taken to avoid disturbance of the bedding when placing and jointing the pipes.

Where small diameter pipes can be jointed by hand the pipe being laid shall be pushed into the socket of the previous pipe. Where a winch or other pulling device is necessary its anchorage shall be so placed to avoid disturbance of the pipes already laid, e.g. on the remote end of the pipeline.

Pipes of 225mm nominal bore or less can be adjusted true to line after jointing, but larger pipes shall be correctly aligned before jointing as they may be difficult to move afterwards.

During the making of rolling-ring joints the rings should roll evenly, and to facilitate this the axes of the two pipes shall be aligned. With rolling-ring types of joints the pipe shall be temporarily restrained to avoid the ring rolling back and forcing the spigot of the last pipe out of its socket.

5.2 Rigid joints for flexible pipes

When rigid joints are used with flexible pipes, such as plastics and pitch fibre, the manufacturer's jointing recommendations shall always be carefully followed, and care taken to avoid entry of jointing material into the pipe. If any solvent from a plastic pipe joint is spilled in the trench the polluted bedding shall be removed immediately and disposed of appropriately, otherwise the pipe may be attacked and weakened. Clean bedding material shall then be placed.

5.3 Rigid joints for rigid pipes

Clay pipe joints shall be filled with a 1:3 mix of cement sand mortar.

Concrete pipes shall have a ring of tarred yarn inserted into the correctly centred socket and driven home by a suitable caulking tool. The yarn in its final position shall occupy not more than one quarter of the depth of the socket which shall then be completely filled with 1:2 cement mortar, well rammed in and finished off with a neat fillet, levelled off from the outer rim of the socket to the barrel of the inserted pipe.

Cast iron joints shall be formed with approved gaskets and bolted flanges. Bolts, nuts and washers shall be protected by grease after making the joint. Cast iron pipes with open sockets shall be jointed with properly caulked lead wool.

5.4 Cutting Pipes

Where it is necessary to cut rigid pipes, this shall be done with a suitable pipe cutter to leave a clean end square to the axis of the pipe. Pitch fibre pipes can be cut with a coarse-tooth saw and plastic pipes with a fine-tooth saw. When required by the pipe manufacturer cut spigots shall be chamfered.

5.5 Jointing pipes and fittings of different materials

Where it is necessary to make joints between different materials a special adapter shall be used. Most pipe manufacturers supply suitable adapters.

6 Connections

A Section 106 agreement must be in place prior to any connections to a public sewer and the works must be carried out to the local sewage undertaker's requirements. If specialist proprietary adaptors are used, the contractor should obtain sewer undertaker approval in advance of a Section 106 application.

6.1 General

All connections should be made in accordance with the design drawings, and at a minimum of 90-degree angle to the direction of the flow in the drain or sewer to which the connection is made.

Unless otherwise agreed with the Engineer, or the approving authority, all connections should be made soffit to soffit i.e. with pipe soffits level.

Where a connection is made either direct, or by a drop-pipe to an open channel, the benching shall be carefully cut away and a suitable channel branch bend inserted, preferably three-quarters section, or an insitu entry channel formed. The incoming flow shall enter at the top of the channel in the direction of the main flow and without causing turbulence or backing up in the main or other branches. The benching shall be reinstated.

Where the connection is to a sealed system it shall be necessary to break out and replace the access fitting unless it already has a suitable spare branch.

6.2 Connection to a chamber

Where a connection is made either direct, or by a drop-pipe to an open channel, the benching shall be carefully cut away and a suitable channel branch bend inserted, preferably three-quarters section, or an in-situ entry channel formed. The incoming flow shall enter at the top of the channel in the direction of the main flow and without causing turbulence or backing up in the main or other branches. The benching shall be reinstated.

Where the connection is to a sealed system it shall be necessary to break out and replace the access fitting unless it already has a suitable spare branch.

6.3 Connection by a junction

To maintain a pipe continuity only sufficient length of pipe shall be removed to enable the junction to be inserted in the pipeline. Whether socketed or sleeved joints are used they shall be appropriate to the pipeline. Ensure accurate centring and concentricity about the pipe ends and provide an effective seal. The junction shall be fixed at the appropriate angle to receive the incoming branch drain.

Where a junction is provided for future use, it shall have an effective removable seal and its position shall be accurately measured and recorded.

6.4 Saddle connections

The pipe shall be cut into by the cautious enlargement of a small hole or by trepanning or, where practicable, by the use of a suitable saw and purpose-made template, taking care to prevent any materials from entering the pipe. The hole shall be accurately trimmed so that the saddle fits with at least half of the width of its shoulder bearing on the pipe over the whole circumference of the shoulder. The saddle shall be of the correct size for the pipe and connection and be secured by a method appropriate for the pipe material.

Where it is necessary to make joints between different materials a special adapter shall be used. Most pipe manufacturers supply suitable adapters.

7 Backfill

7.1 General

Backfilling to trenches shall be carried out strictly in accordance BS EN 752 and as indicated on the drawings. Care and attention is required to the placing and compaction of backfill particularly where it forms part of a load supporting system.

7.2 Selected backfill material

Selected excavated backfill material may be used subject to approval by the Engineer. It should preferably consist of uniform soil and can be readily compacted. It shall not include stones retained on a 40mm sieve, clay lumps larger than 75mm, tree roots, organic matter, rubbish and frozen soil. Cohesive soil that has been allowed to dry out on a spoil heap is not readily compactable and shall not be used.

For trench backfill material requirements above pipes laid within adoptable highways refer to drawings for specific requirements of fill material.

7.3 Sidefill and initial backfill

The specified bed or surround shall be first laid with placement and compaction by hand tamping.

As soon as possible after completion of the bed or surround place the initial backfill with hand compaction in 100 mm thick layers to give 300 mm of compacted material above the pipe crown.

The initial backfill material shall be as specified on the drawings.

7.4 Main Backfill

The main backfill shall be placed above the 300 mm of compacted material above the pipe crown by mechanical compaction.

The main backfill material shall be as specified on the drawings.

The method of compaction of the main backfill shall comply with the Specification for the Highway Works.

8 Testing of Drains

The drains shall be tested after laying and jointing and after sufficient surround (to mid-height) is placed to adequately support the pipe. Air or water testing, as outlined below, should be carried out in accordance with BS EN 1610:2015.

8.1 Testing sequence

The testing of drains shall generally be carried out in two stages.

First stage testing shall be carried out to locate and remedy any defects in soundness that may exist at the time of construction. Such tests shall take place immediately before the work is covered up to facilitate replacement of any faulty pipes or pipe fittings or to rectify any joint defect. Drains shall be tested in sections (from manhole to manhole). Inspection of the pipeline will reveal any defects in the support and bedding. The method of testing shall be either the Water Test or Air Test in accordance with sections Water test and Air test.

Second stage testing and inspection shall take place immediately before hand over when all relevant works have been completed. The method of testing shall be either the Water Test or Air Test.

8.2 Pre-test procedures

Before any tests are applied attention shall be given to the safety of the operatives and other persons involved in the testing operation. It is essential that proper means of access shall be provided to the area of work, and the sides of any trench or excavation in which work is to be tested should be adequately supported and free from hazards.

Where a water test is to be applied, drain stoppers and bags shall be properly secured in position and provision made for the final removal of the stopper or bag from surface level by means of a strong cord attached to the inlet ferrule.

All obstructions, debris and superfluous matter shall be removed from sections of pipeline inspection chambers, manholes, or similar underground chambers and they shall be flushed out before testing.

Care shall be taken when a chemical cleaning agent is used to remove deposits of cement mortar from the surfaces of benching and channel inverts. Protective clothing, including gloves and eye shields, shall be provided for operatives using or handling the chemicals. On completion of the work all treated surfaces shall be thoroughly hosed down.

8.3 Checking the bore

Where required by the Engineer and before any tests are applied, a disc or ball type profile testing device shall be passed through all drains and private sewers between inspection chambers, manholes or other suitable points of access and through all accessible branch drains.

8.4 Water test

Testing shall be carried out between inspection chambers, manholes or other suitable points of access and through any accessible branch drains.

Gravity drains and sewers up to and including 300mm diameter shall be tested to an internal pressure of 1.5m head above the invert of the pipe at the high end of the line and not more than 4m head at the lower end. Larger drains and sewers should be tested such that the test pressure is equivalent or resulting from filling the test section up to the ground level of the downstream or upstream manhole, as appropriate, with a maximum pressure of 50 kPa and a minimum pressure of 10kPa measured at the invert of the pipe.

Where the test head of water is in excess of 4m at the lowest point of the pipeline under test (including the minimum test head of 1.5m), the pipeline may be tested in sections by means of appropriately placed test branches. The test branches may be extended up to the finished surface with a suitable termination and used as additional points of access.

Solvent welded UPVC pipelines shall be allowed to stand for 1 to 2 hours before applying the test and shall be suitably anchored to prevent flotation when the test is applied before backfilling the trench.

Where cement mortar joints are used they shall be left for at least 24 hours before testing.

The test procedure shall be as follows:

1. Fit expanding plugs or bag stoppers, suitably secured to resist the full hydrostatic head, at the lower end of the pipe and in any branches as necessary.
2. Fit a similar plug or bag stopper into the top end of the pipeline together with a stand pipe or flexible tube leading from a container connected to the plug or bag.
3. Fill the pipeline with water making sure that there are no pockets of trapped air.
4. Fill the stand pipe or other test apparatus to a height of 1.5m above the pipe or channel invert.
5. Allow the pipeline to stand for 2 hours for absorption, topping up as necessary.
6. After 2 hours, measure the loss of water from the pipeline by noting the quantity of water needed to maintain the test head in the apparatus over a period of 30 min.

The test will be considered satisfactory if the rate of water loss does not exceed 1 litre/hour per metre diameter per linear metre run of pipe. For various pipe diameters this rate of loss over a 30 min period may be expressed as follows:

- 100mm nominal bore pipe 0.05 litres per metre run;
- 150mm nominal bore pipe 0.08 litres per metre run;
- 225mm nominal bore pipe 0.12 litres per metre run;
- 300mm nominal bore pipe 0.15 litres per metre run;

Note: The figures are equivalent to a loss of 1 l/h per metre diameter of pipe per metre run of pipeline.

Leaking or other defects which may be revealed during the test shall be made good and the test repeated until the pipe run proves satisfactory.

8.5 Air test

The air test is suitable for testing pipelines only. Air testing of manholes and inspection chambers can be dangerous for the personnel and should therefore be avoided. For manhole testing procedure refer to Section 12 of this specification.

All pipes shall be initially air tested after laying and placement of bed and surround.

The air test shall be carried out by inserting expanding drain plugs or inflatable canvas or rubber bags in the upper and lower ends of the pipeline and pumping air in under pressure. Where cement mortar joints are used the joint shall be left for at least 24 hours before testing. Solvent welded UPVC pipelines shall be allowed to stand for 1 hour before applying the test.

The test procedure shall be as follows:

1. Fit expanding plugs or inflatable canvas or rubber test bags into the ends of the pipeline and of all associated branches.
2. Connect a glass 'U' tube gauge (manometer) to one of the sealing plugs and a means of applying the air pressure to another sealing plug or stopper inserted in the section of pipework under test. The manometer and air pressure source shall be located at opposite ends of the pipework under test.

3. Apply pressure either by mouth or hand pump to achieve a pressure of slightly more than 100mm water gauge for pipelines, or where gullies and/or ground floor appliances are connected of slightly more than 50mm water gauge.
4. Allow 5 min for stabilisation of air temperature.
5. Adjust air pressure to 100mm or 50mm water gauge as necessary as outlined in point 3.
6. Monitor the loss of pressure over the time period specified below:

Material	Testing time (min) based on pipe size (mm)						
	DN100	DN200	DN300	DN400	DN600	DN800	DN1000
Unsoaked concrete pipes	5	5	5	7	11	14	18
Soaked concrete pipes and all other materials	5	5	7	10	14	19	24

Table 11 Testing times for air test based on pipe size and material

Note: DN is a numerical designation of internal pipe diameter, approximately equal to a manufacturing dimension in mm.

The drain run shall be considered satisfactory if, without further pumping, the head of water shall not fall by more than 25mm in a period of 5 min for a 100mm gauge test pressure and 12mm for a 50mm water gauge test pressure.

Should an air test not prove the run acceptable then a water test shall be carried out as described in Section 8.4.

8.6 CCTV inspection

Immediately before CCTV inspection, lift all manhole covers, inspection chamber covers and access point covers and remove all debris. Thoroughly flush the entire drainage system with water to remove all silt and check for blockages. Rod pipelines between access points to remove any debris and obstructions, which have not been removed by flushing. Securely replace all covers after cleaning.

It is recommended that all existing drainage to be retained which could be affected by the construction works, is CCTV surveyed prior to works commencing to identify any pre-construction defects.

All pipes of the drainage system are to be CCTV inspected immediately prior to handover.

CCTV equipment shall be of a type to satisfactorily record the condition of the drainage system using self-levelling cameras and adequate illumination.

Immediately prior to camera entry all pipes must be flushed with water to enable backfalls in the system to be identified.

No flows will be permitted into the system during inspection.

The Engineer must be afforded access to inspect the CCTV inspection from a suitable monitor during the site inspection. If site attendance is not possible the Engineer shall be given sufficient time to inspect CCTV footage before handover of the works.

The Contractor shall provide a file transfer (or alternative such as USB stick or DVD) containing all of the video files obtained during the CCTV inspection. A plan should accompany the findings and clearly reference each pipe and chamber. A written report shall accompany the findings from the investigation and should identify any defects and recommendations.

Any defect identified on the CCTV system must be rectified by the Contractor and subsequent CCTV inspection undertaken to prove the defect has been rectified.

8.7 Lase Line Profile and Level Testing

Where the specific pipe material dictates that laser line, profile and level testing is required for drainage systems adoptable under Water Act adoption agreements, the testing shall be carried out strictly in accordance with the relevant Sewage Undertakes requirement.

8.8 Connectivity

Dye testing shall be undertaken by the Contractor to prove that no inter-connectivity between the foul and the surface water system is present.

9 Tolerances

All pipes must be laid such that the position of the internal face of any pipe is within +/- 20 mm of the specified drawing line and levels providing that no pipe shall have a reverse gradient, and that no ponding occurs within any length of pipe. Any pipe outside the above tolerance must be re-laid correctly.

Any pipe which does not meet the above tolerances must be re-laid to achieve the specified tolerances.

10 Access Chambers

Manholes, inspection chambers and other access points shall be constructed in accordance with the design drawings and as a minimum should be located at any of the following:

A change of alignment, gradient, pipe size or material, OR at the head of all drains and sewers.

10.1 Brick Manholes

Brick manholes shall be constructed in engineering brick Class B English bond, using 1:3 Portland Cement mortar, on a base of Grade C20 concrete in accordance with Sewer Sector Guidance Appendix C. Each brick shall be well flushed and jointed up before mortar for the next course is spread. A sulphate-resisting cement shall be used where there is a danger of sulphate attack and where indicated on the drawings.

The ends of pipes shall be built into manholes with watertight joints. A single brick-on-edge arch shall be formed over all pipes exceeding 150mm in diameter.

Where the depth of the manhole exceeds 1m double-width, galvanised step irons to BS EN 13101:2002, shall be built into each third course, commencing at not more than at 675mm below the manhole cover.

Main channel inverts shall, wherever possible, be purpose-made half-round channels of the same material as the outgoing pipes from the manholes. Where channels are formed in-situ, they shall be formed to the required profile in high concrete strength Grade C25/ST2 and shall be rendered in 1:2 cement mortar trowelled smooth.

Side branches shall, where practicable, be brought into the main channel using half section or three-quarter section channels. Where the connecting angle (with the main channel) is greater than 45°, a three-quarter section branch should be used.

The channels shall be bedded in 1:1 cement mortar and connected to the main channel so that the discharge from the branch drain is in the direction of flow in the main channel. The benching shall rise vertically from the edge of the channel pipe to a height of not less than that of the soffit of the outgoing sewer and shall be sloped upwards from that point to meet the wall of the manhole at a gradient of between 1 in 10 and 1 in 30. It shall be floated to a smooth hard surface.

All branches shall be connected with the pipe soffits level to that of the main drain, unless specified otherwise.

Connect branches to the channel at half pipe level, with staggered connections so that discharge flows smoothly in the direction of the main flow, without turbulence.

Where the connecting angle (with the main channel) is greater than 45°, a three-quarter section branch should be used. Channels and branches should be benched up to at least the top of the outgoing pipe at a slope of 1 in 12.

Where channels are formed insitu, they shall be formed to the required profile in concrete Grade C25 and shall be rendered in 1:1 cement mortar trowelled smooth. Foul manholes will need plastic or clay channel pieces.

Where specified on the drawings sulphate resisting cement shall be used for the benching and rendering.

Cover slabs when required shall be reinforced concrete Grade RC35 with rebates where required for the cover frames. Concrete grade and design sulphate class noted on contract documents.

10.2 Precast concrete manholes

Precast concrete manholes shall be supplied with precast inverts shaped to accommodate incoming drains or cast in-situ inverts of high-strength concrete (Grade C25/ST2). Joints shall be made in a mortar mix having a 1:3 cement sand ratio. Alternatively, plastomeric or elastomeric seal conforming to BS EN 1917:2002 and BS 5911-3.

Where required for sewers adoptable under Water Industry Act adoption agreements, bases are to be formed as shown on the drawings using channel pipes and granolithic benching on Grade C20 concrete bases in accordance with Sewer Sector Guidance Appendix C (including local sewage undertake variations and addendums).

The precast concrete manholes shall be provided with a surround of concrete Grade GEN3/C20 of minimum thickness 150mm, unless agreed otherwise with the approving authority.

Any joints in concrete surrounds shall be staggered with the manhole construction joints.

Where specified on the drawings sulphate resisting cement shall be used for precast concrete manholes, their benching, rendering and surrounds.

Step irons to BS 13101 or ladders to BS EN 14396 shall be provided as detailed on the drawings.

10.3 Catchpits

Brick catchpits shall be constructed in common brickwork 225mm or 115mm thick as indicated on the drawings and laid in 1:3 Portland Cement mortar on a base of GEN3/C20 concrete.

Concrete catchpits shall be constructed in precast rings to BS 5911-3:2010 and BS EN 1917:2002 as indicated on the drawings generally in accordance with a standard precast ring manhole with a sumped section replacing the usual channelled invert.

Plastic catch pit chambers shall be formed using proprietary units with the bases formed of GEN3/C20 concrete or granular material as indicated on the design drawings.

Where plastic chambers are to be constructed below the water table the base and surround should be formed using GEN3/C20 concrete.

The silt trap section of the catchpit shall be formed and sized as shown on the drawings.

10.4 Inspection Chambers

Inspection chambers shall be constructed as indicated on the drawings.

The access cover shall be fitted with a 350mm diameter restrictor to prevent man access where the depth of chamber exceeds 1.2 metres in private drainage systems, and 1m in adoptable systems, unless agreed otherwise with the sewerage undertaker.

Where plastic chambers are located in vehicular areas the top of the chamber shaft shall be concrete surrounded in accordance with the drawings and fitted with a vehicle loading cover as shown.

10.5 Access Fittings

All access fittings, stacks, rainwater pipes (RWPs) and gullies to be roddable. All to have low level rodding access plates unless an alternative means of access is agreed. access point to be above any ground floor connected appliance spill level.

Large access fitting required above ground where greater than 12m up to 22m to a junction. Small access fitting required up to 12m to a junction.

10.6 Gullies and Channels

All gully and channel drain outlets and termination points to be trapped and roddable. Internal gullies and channel drains are to be specified by others.

10.7 Covers and Gratings

Covers and gratings shall be to the dimensions and gratings as shown on the drawings.

All internal manhole covers shall have mechanically jointed corners and be double sealed airtight units to prevent the egress of odours, as shown on the drawings and as detailed by the Architect - recessed to suit their specification of floor finishes, where necessary.

10.8 Access to Proprietary Chambers

Access points for proprietary tank units (including oversize pipes), petrol interceptors, suction wells and similar underground chambers shall meet any of the manufacturer’s system special requirements. For example, a concrete manhole access may not be appropriate for some geocellular systems.

11 Below Ground Attenuation Structures

11.1 Installation

Attenuation structures shall be installed in accordance with the product manufacturer's recommendations.

11.2 Waterproof Membranes

Where impervious geomembrane is required to prevent water movements between the attenuation feature and the surrounding ground, the membrane shall be installed in accordance with the manufacturer's recommendations. The membrane shall be minimum 1mm thick and have minimum density of 900kg/ m^2.

The Contractor shall ensure no damage arises to the geomembrane, with particular care applied during backfilling operations. Any geomembrane wrapping may need to be protected from backfill by a geotextile fleece.

11.3 Loading

The maximum allowable imposed load, which can safely be accommodated by the attenuation structure in line with the manufacturer's recommendations, must not be exceeded during the works.

The Contractor must confirm the maximum safe load with the manufacturer and shall prohibit the movement of construction plant across the storage tank and where necessary provide additional support and protection to the structure.

11.4 Cleanliness

The Contractor must prevent all debris/silt entering the attenuation structure during the works.

12 Testing of Manholes and Catchpits

12.1 Test Head

All new chambers shall be water tested in accordance with BS EN 1610:2015.

Inspection chambers and manholes less than 1.5m in depth to invert shall be filled with clean water to the underside of the cover and frame located at ground or surface level. Where the depth to the channel invert is 1.5m or greater the test head shall not be less than 1.5m. Testing of petrol interceptors, suction wells and similar underground chambers shall be carried out to manufacturer's specification.

Where the chamber is located below the groundwater level, the test head shall not be less than the highest expected seasonal groundwater level, or test heads specified above, whichever is greater.

12.2 Test Procedures

Tests shall not be carried out until the structures have reached sufficient strength to sustain the pressure from testing.

Open channel manholes, inspection chambers and other free surface water containing structures shall, whenever possible, be tested independently of any drain or sewer.

The external faces of a structure shall not normally be backfilled, or concrete surrounded before the chamber is filled with water to the specified test level. Adequate stability shall be ensured during the period of test and subsequent concrete placement and backfilling.

For the tests, a bag stopper shall be fitted in the outlet of the inspection chamber or manhole and expanding plugs or bag stoppers in all other connections. All plugs and stoppers shall be to resist the full hydrostatic head and means provided of safely removing the outlet bag stopper from the surface.

The inspection chamber, manhole, etc. shall be filled with clean water to the required test level and allowed to stand for up to 2 hours for absorption, topping up the level as necessary.

The criterion for acceptance shall be that the water level remains constant for 30 minutes. Where water can be observed issuing from the outside face of the structure at an identifiable point or points, such leakage shall be made good and the test repeated.

13 Testing of Below Ground Attenuation Structures

13.1 General

All sealed below-ground storage structures constructed in-situ, including geocellular tanks wrapped in impervious geomembrane, should be water tested following installation, as outlined in Section 8.4 and CCTV inspected prior to handover.

Testing of proprietary tank units (including oversize pipes), petrol interceptors, suction wells and similar underground chambers shall be carried out to manufacturer's specification.

All unsealed structures should be CCTV inspected and records provided to the Engineer for review prior to handover.

13.2 Water Test Procedure

Tests shall not be carried out until the structures have reached sufficient strength to sustain the pressure from testing.

The base and walls of the structure shall be backfilled prior to commencement of the test. Adequate stability shall be ensured during the period of the test and subsequent concrete placement and backfilling, as required.

For the test, a bag stopper or expanding plugs shall be fitted in all outlets of the structure or chamber from which the test is carried out.

The structure shall be filled with clean water to top of structure level and allowed to stand for 24 hours until stable level has been achieved, topping up the level as necessary.

Water levels in the structure shall be recorded over 48 hours, where the water drop should not exceed 50mm. If the drop-in water level exceeds 50mm, the structure shall be investigated for source of leakage, repaired and the test repeated until a satisfactory result is achieved.

14 Compaction Factor Test for Bedding and Surround Material

14.1 Apparatus

Where testing the bedding and surround material, the following apparatus shall be used:

1. Open-ended cylinder, 250mm long and 150mm + 10mm -5mm internal diameter (150mm diameter pitch fibre or PVC pipe is suitable).
2. Metal rammer with striking face of 40mm diameter and mass 0.8kg to 1.3kg.
3. Rule.

14.2 Test Procedure

The test procedure shall be as follows:

1. Obtain a representative sample more than sufficient to fill the cylinder (about 10kg) by heaping about 50kg of the proposed material onto a clean surface and dividing it with a spade down the middle into two equal sections.
2. Divide one of these and repeat this procedure until the required mass of sample is left. In the sieving, clumps of material that break up under light finger pressure may be helped through the sieve, but considerable force must not be used to squeeze over-size clumps through the mesh. It is important to ensure that the moisture content of the sample does not differ significantly from that of the main body of material at the same time of its use in the trench.
3. Place the cylinder on a firm flat surface and gently pour the sample material into it, loosely and without tamping. Strike off the top surface level with the top of the cylinder and remove all surplus spilled material.
4. Lift the cylinder clear of its contents and place on a fresh area of flat surface. Place about one quarter of the material back in the cylinder and tamp vigorously until no further compaction can be obtained. Repeat with the second quarter, tamping as before, as so on for the third and fourth quarters, tamping the final surface as level as possible.
5. Measure down from the top of the cylinder to the surface of the compacted material. This distance, in millimetres, divided by the height of the cylinder (250mm) is referred to as the compaction factor.

14.3 Suitability of compaction factor for use

Suitability of the compaction factor for use is as follows:

Compaction Factor	Suitability for Use
0.15 or less	Material suitable.
Between 0.15 and 0.3	Material suitable but requires extra care in compaction. Not suitable if the pipe is subject to waterlogged conditions after laying.
Over 0.3	Material unsuitable.

Table 12 Suitability of compaction factors

15 Land Drains

15.1 Pipe Materials

The type of land drain shall be in accordance with the drawings.

15.2 Filter and Bedding Material

Unless otherwise specified, the filter material surrounding the pipe shall consist of hard, clean, crushed rock, crushed slag or gravel having a grading within the limits shown in the Table below. The aggregate crushing value of the material as determined by the tests in BS EN 933-1:2012 shall not exceed 30%. The material passing the 10mm sieve shall be non-plastic when tested in accordance with BS 1377-1:2016 and BS EN ISO 17892-12:2018.

Filter materials shall be to DoT Filter Drain Material Type B (cl.505)

B.S. Sieve Size	Range of Grading Percentage by Weight Passing
63mm	100
37.5mm	85 - 100
20mm	0 - 20
10mm	0 - 5

Table 13 Filter material grading

15.3 Joints

Where pipes with unsealed joints are specified, a gap of 10mm shall be left between the end of the pipe and the inner end of the socket. The pipe shall be supported with tarred rope yarn or other suitable flexible jointing material within the socket over at least the lower third of the circumference so that there are no vertical steps between one pipe and another.

Where perforated or porous pipes are specified, the joints shall be prepared as recommended by the pipe manufacturer. Perforated pipes shall be laid with the perforations facing downwards unless otherwise specified on drawings.

16 Disused Drainage

Drains or sewers less than 1.5m deep which are in open ground should as far as practicable be removed. Where impractical or deeper than 1.5m, pipes should be sealed at both ends and at any point of connection/junction, and grout filled. Where a pipe connects to a public sewer or the sewers to be abandoned were previously classified as a public sewer, the advice of the relevant sewerage undertaker should be sought.

16.1 Grouting Procedure

Reference should be made to The Building Regulations Part H appendix H1-B for classification of pipes to be grouted.

Pipes to be grouted shall be filled with grout consisting of one of the following:

- Class G3 grout to consist of 1:10 cement: sand - mixed with the minimum amount of water to ensure fluidity.
- Class G4 grout to consist of 1:10 cement: PFA - mixed with the minimum amount of water to ensure fluidity.

The grout shall be introduced at the higher end of the length of sewer being filled. Grouting operations shall proceed such that no length of sewer shall be filled until all upstream communicating lengths have been completed.

The seals at the lower end of each run of sewer shall be fitted with a flexible breather pipe, fixed at the soffit of the sewer and turned vertically upwards to a height of 600mm above the soffit level of the higher end of the relevant sewer length.

The head of existing sewer lengths “cut-off” and exposed during excavations for new works shall be suitably sealed and a 150mm flexible injection pipe constructed through the seal at the soffit of the sewer. This shall be turned vertically and extended upwards for at least 1 metre.

On completion of grouting operations, the injection pipe shall be sealed with a plug of concrete at least 150mm deep and having 150mm bearing outside the injection pipe.

The shafts of manholes on abandoned sewers shall be broken down to a level of 1 metre below finished ground level and the remaining void filled with GEN0 concrete.

17 As Built Records

The Contractor must identify any as-built changes to the Engineer’s drawings. The Contractor must provide marked up copies of the Engineer’s drawings indicating any changes to invert levels, pipes, manholes etc. prior to Practical Completion.