Measuring Drainage Below Ground in Accordance with ARM4: an Introductory Demonstration

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DRAINAGE BELOW GROUND. ARM4 Section R Pages 144-149

Drainage below ground removes used and surface water from a building to a point of disposal or treatment. ARM section R covers drainage but distinguishes between disposal systems above and below ground level.

Above ground drainage; rainwater and soils and wastes are usually billed in a separate; rainwater and sanitary disposal installations Element (52)

These installations are governed by Part H of the Building Regulations, - The current Regulations were issued in 2010

Drainage below ground is usually billed as a separate section under Element (50) Site Services (Piped and Ducted).
About This Demonstration

The Building Regulations Regulation H1 requires surface water drains and foul water sewers to be kept separate.

**Note** ARM4 does not require the separation of the drainage systems – these may be aggregated to give an overall total of the various classes of drainage.

This study presents a simplified surface water drainage arrangement in order to demonstrate the basic principles of measuring drainage below ground. The 100mm and 150mm figures refer to the diameter of the drain pipe. A flat site has been assumed with a cover level of 100.00m. The 100mm diameter pipes have been laid to a fall of 1:50 and the 150mm diameter pipes to a fall of 1:100.

Branch connections have not been shown in the interest of clarity these, of course, need to be measured, and a gulley trap connection (indicated by o on the plan) has been taken with a run of 3 metres to each manhole in the example.

It is acknowledged that 100mm pipes would be capable of draining the scheme, however 150mm pipes have also been included for demonstration purposes.
The measurement of drainage installations below ground involves measuring the lengths of pipework and associated trench-work and inspection points/manholes from the point of entry into the ground to their eventual discharge into the public drainage system. The lines of drain runs and position of manholes will be shown on the drawings. If no manhole references or levels are given, the surveyor will have to give a reference number and work out the invert and cover level at each manhole. This can then be used to prepare drainage schedules.

Drainage schedules are used on all but the smallest or simplest of schemes. Most surveyors schedule foul and surface water runs separately. Colour clarifies! different sized pipes should be marked off in different colours on the drainage plan. Manholes, however, are usually taken separately. Make sure that all rainwater outlet and soil and waste pipes and gullies are shown connected into the system. Occasionally these are overlooked on drainage drawings.

**Information Required by ARM4**
ARM4 requires location drawings (i.e. the drainage layout) to be provided together with the ground investigation report with details of ground water levels. This would have been used previously in measuring the substructure elements of the building. Over or underground services would also need to be identified and requirements for handling and disposing of dangerous materials arising from the excavations must be stipulated.

**This exercise assumes that no complications in the ground will be encountered.**
Most surveyors prepare a manhole schedule first which can then be used to fill in information on the drain run schedule.

Schedules are usually prepared on a spread sheet application such as these examples. They can be easily adapted to suit the size and nature of the particular scheme

**Invert level** refers to the level of the bottom of the pipe at that location

**Cover level** refers to the finished ground level at that location

The **invert depth** is calculated by subtracting the invert level from the cover level for example in Manhole 1 above (100.41-98.74=1.67)

**Steps Irons** have been taken at 150mm centres from 450mm below cover to the footfall level (top of benching – 250mm above invert). This calculation is made by subtracting 700mm from the invert depth and dividing by 150 and rounding off the result.
The length of drain runs are taken as being measured between manholes.

The average dig depth of the trench is found by taking the average of the bottom invert and the top invert and adding for the thickness of the bed under the pipe \([0.70+0.90]/2+100\text{mm} = 0.90\].

Although not strictly accurate, in practice the length of the pipe trenches is often repeated when measuring bed, surrounds and the pipes. This approach is used in preparing this drainage schedule.

Note where a very high level of accuracy is required an adjustment must be made to the trench lengths where pipes are built into manhole walls. Likewise if the base of the manhole projects beyond the face of the manhole wall a similar adjustment will have to be made to the pipes and surrounds. – These adjustments have not been made here as the drawing is not to scale and would probably be considered to be excessive in instances where work is measured provisionally.

### Drainage Schedule

<table>
<thead>
<tr>
<th>Ref</th>
<th>Length</th>
<th>A Top Invert</th>
<th>B Bottom Invert</th>
<th>Av Dig ([(A+B)/2]+100)</th>
<th>0.50-1.00</th>
<th>1.00-1.50</th>
<th>1.50-2.00</th>
<th>100mm</th>
<th>150mm</th>
</tr>
</thead>
<tbody>
<tr>
<td>M1-M2</td>
<td>10.00</td>
<td>0.70</td>
<td>0.90</td>
<td>0.90</td>
<td>10.00</td>
<td></td>
<td></td>
<td>10.00</td>
<td></td>
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<tr>
<td>M2-M3</td>
<td>10.50</td>
<td>0.90</td>
<td>1.11</td>
<td>1.11</td>
<td>10.50</td>
<td></td>
<td></td>
<td>10.50</td>
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<tr>
<td>M3-M4</td>
<td>8.50</td>
<td>1.11</td>
<td>1.22</td>
<td>1.27</td>
<td>8.50</td>
<td></td>
<td></td>
<td>8.50</td>
<td></td>
</tr>
<tr>
<td>M4-M5</td>
<td>11.50</td>
<td>1.22</td>
<td>1.32</td>
<td>1.37</td>
<td>11.50</td>
<td></td>
<td></td>
<td>11.50</td>
<td></td>
</tr>
<tr>
<td>M6-M7</td>
<td>10.00</td>
<td>0.90</td>
<td>1.10</td>
<td>1.10</td>
<td>10.00</td>
<td></td>
<td></td>
<td>10.00</td>
<td></td>
</tr>
<tr>
<td>M7-M5</td>
<td>9.50</td>
<td>1.10</td>
<td>1.32</td>
<td>1.31</td>
<td>9.50</td>
<td></td>
<td></td>
<td>9.50</td>
<td></td>
</tr>
<tr>
<td>M5-Ex</td>
<td>6.00</td>
<td>1.32</td>
<td>1.80</td>
<td>1.66</td>
<td>6.00</td>
<td></td>
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<tr>
<td></td>
<td>66.00</td>
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<td></td>
<td></td>
<td>10.00</td>
<td>50.00</td>
<td>6.00</td>
<td>40.00</td>
<td>26.00</td>
</tr>
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</table>
Drainage is often measured provisionally in private sector works - i.e. it is measured on site on completion of the works.

Dimensions on drainage layouts are rarely fully set out and the drawings are often at a scale which make accurate measurement somewhat unreliable.

Adopting this approach means 100% accuracy is not envisaged – but it needs to be adequate nonetheless.

Building work rarely involves pipework in excess of 225mm diameter. Large diameter pipes are more generally associated with infrastructure and civil engineering projects. Where excavations for large diameter pipes are required, these are measured separately and categorised as pipes 250-450mm diameter and pipes exceeding 450mm diameter.

Occasionally separate foul and surface water drains or other pipework may be laid in the same trench. Where this is specifically required it is possible to measure such excavations separately describing them as trenches for multiple pipes stating the number and nominal size of the pipes. It is recommended, however, to avoid second guessing such situations and that it is more advisable to measure each service separately.
Excavating Trenches

- Drain trenches are measured in linear metres
- Trenches are classified together stating the average depth of the trench to the next 500mm in the description.
- Average depth is defined as the average depth between manholes.
- So, trench M1-M2 has an average depth of 0.90m would be billed as trenches 500-1000mm deep.

Information required by ARM4 for trench excavation
The starting level of the trenches must be stated – if not it will be assumed that this would be existing level. Materials for filling and method of compaction if not at the Contractor’s discretion must also be stated.
Trenches which are backfilled with special materials are so described stating the details. This occurs where selected or treated excavated materials, or imported materials are specified.
Trench excavation is deemed to include earthwork support, compacting trench bottoms, preparation of surfaces, disposal of surplus excavated materials, filling and compacting with excavated materials and working space.
### Excavating Trenches Continued

- The remaining trench lengths are billed direct from the drainage schedule.
Surface water is water on the surface of the site and the excavations. Where there is a high water table an additional item may need to be taken for disposal of groundwater – and shall be measured only when excavating below ground water level is also measured.
1.7.1.3 A drain trench should not be excavated lower than the foundations of any building nearby (see Diagram 13) unless either:

(a) where the trench is within 1 m of the foundations of the building, the trench is filled with concrete up to the lowest level of the foundations; or

(b) where the trench is further than 1 m from the foundation of the building, the trench is filled with concrete to a level below the lowest level of the foundation equal to the distance from the building, less 150 mm.

The Drainage Layout on Slide 2 shows the drains running parallel to the foundations. It is possible that concrete protection will be required to runs 3-4 and 4-5 depending on their proximity to the foundations. In the interest of clarity it has been assumed that the drains are sufficiently distant from the foundations to avoid the need for concrete protection.
1.3.7 Bedding and backfilling

1.3.7.1 The choice of bedding and backfilling depends on the depth at which the pipes are to be laid and the size and strength of the pipes

1.3.7.3 Flexible pipes:

Such pipes may become deformed under load and require support to limit the deformation to 5% of the diameter of the pipe. The bedding and backfilling should be as shown in Diagram 9. The minimum depth should be 900 mm under any road and 600 mm in fields and gardens. The maximum depth should be 10 m. For special protection where pipes are laid with less cover (see paragraphs 1.7.3.2 and 1.7.3.3).
Beds and surrounds to 150mm pipe must be measured separately to those on the 100mm diameter pipe.
Cutting and jointing pipes to fittings and providing everything necessary for jointing is deemed to be included.
Pipes and fittings

Where pipe runs are shorter than 3.00m they are enumerated and described as short lengths not exceeding 3.00m.

Pipe fittings such as bends, junctions, reducers, adaptors, ends and the like are enumerated and measured as extra over the pipe on which they occur.
Jointing accessories to pipes and bedding in concrete is deemed to be included in the rates.

<table>
<thead>
<tr>
<th>Pipe Accessories</th>
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<tr>
<td>gullies, back inlet</td>
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<td>gully; Wavin universal</td>
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<tr>
<td>gully or equal approved bedding</td>
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<tr>
<td>and haunching in concrete; coated</td>
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<tr>
<td>cast iron grating</td>
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- Pipe accessories, such as A.Js gullies, traps, inspection / access, fresh air inlets, non return flaps and the like are enumerated giving a detailed description.
Manholes and inspection chambers.  
Manholes and inspection chambers are enumerated giving a detailed description and stating the internal dimensions and depth in stages of 500mm. Depths of manholes etc are defined as cover level to invert level.

Inspection chambers are essentially shallow manholes and are usually made from plastic as the photo on the next slide

**Table 9 of Technical Guidance Document Part H of the Building Regulations**

Table 9 sets out the minimum internal sizes of inspection chambers and manholes:

**Inspection Chambers:**
- depth not exceeding 0.60m - 300x300mm,
- depth not exceeding 1.00m 450x450mm

**Manholes:**
- Manholes not exceeding 2700mm deep must be 1200x750mm.
- Manholes over 2.70m deep must be a minimum of 1200x840mm; shafts to such manholes must be a minimum of 900x840mm.
- Circular manholes not exceeding 1500mm deep must be a minimum of 1050mm diameter.
- Circular manholes in excess of this depth must be a minimum of 1200mm in diameter.
Inspection chambers are used when operating from surface level – they are not big enough for a person to enter. They normally extend down to a depth of 1m. Manholes, on the other hand, are large chambers which enable a person to test and clear obstructions at drain level. They can be constructed in brickwork, blockwork or precast concrete.

• Where proprietary units are used a detailed description must be given.
Manhole Sundries: Channels

- The following items are counted in manholes giving a detailed description including kind and quality of the materials:
  - Channels;
  - Benching;
  - Step Irons; benching.
  - Covers:
  - Intercepting traps
  - Backdrop Assemblies
  - Like Items

Main channels are usually half round in section and are described as being straight (at junctions or changes in levels) or curved (at changes in direction of flow); descriptions state the length of the channel.

<table>
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<tr>
<th>Description</th>
<th>Quantity</th>
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<tr>
<td>uPVC channels</td>
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<td>half round section: bedding</td>
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<td>in concrete</td>
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<tr>
<td>100 mm diameter x 1200 mm</td>
<td>3 Nr</td>
</tr>
<tr>
<td>straight</td>
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<tr>
<td>100 mm diameter x 1200 mm</td>
<td>1 Nr</td>
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<tr>
<td>curved</td>
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</table>
Branch channels; these are the connections into the manhole and are usually three quarter section.
The number of steps in each manhole can be calculated by subtracting 700mm from the invert depth (top step is 450mm below cover level and benching footfall is 250 above invert level). Divide this result by 150mm and round it off.
Covers for manholes come in a variety of shapes sizes and materials. The specification of manhole and access covers depends on the type of traffic they are exposed to i.e. lawns, paths, roads etc: Most covers comprise a frame and a lid. The frame is typically bedded in cement and sand mortar.
Connection Fee

A sum of €1,000 has been taken for demonstration purposes. This actual figure would be that charged by the Local Authority to carry out the work. ARM4 requires that connections to public mains, making good highways and any other work which may only be carried out by a Public Undertaking or Local Authority shall be given as a Provisional Sun.

Testing

An item is included for testing the drainage system. A detailed description should be provided indicating the various tests such as air, smoke or water testing. Provision of water, fuel, gas, electricity and other supplies for testing and commissioning are deemed to be included.
Completed Take Off

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Below Ground Trenching

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