Chapter 8
Method of Measurement for Highway Works

In the United Kingdom, responsibility for looking after the construction and maintenance of motorways and major trunk roads devolves to a number of 'overseeing departments'. In England, the Department for Transport (DfT) is the ministerial department responsible which operates via a government-owned company, namely, Highways England (formerly the Highways Agency). Wales, Scotland and Northern Ireland have their own authorities.

The 4300 mile arterial road network in England[1] is supplemented by other roads which are managed by local authorities which become the 'overseeing organisation' in the event that they use the Manual of Contract Documents for Highway Works (MCHW), and its accompanying Method of Measurement, for their highway projects.

8.1 Manual of Contract Documents for Highway Works

The MCHW[2] consists of seven substantial 'loose-leaf' ring binders:

- Volume 0: Model Contract Document for Major Works and Implementation Requirements.
- Volume 1: Specification for Highway Works (SHW).
- Volume 2: Notes for Guidance on the Specification for Highway Works.
- Volume 3: Highway Construction Details (HCD).
- Volume 4: Bills of Quantities for Highway Works.
- Volume 5: Contract Documents for Specialist Activities.
- Volume 6: Departmental Standards and Advice Notes on Contract Documentation and Site Supervision.

Volumes 1–4 were originally published by HMSO and Volumes 0 and 5 by the Department of Transport (DTp) on behalf of the then overseeing departments (now Highways England, Transport Scotland, the Welsh Assembly Government or the Department for Regional Development according to who is responsible for the looking after the specific project).

Each volume has its own schedule of Registration of Amendments which allows changes to be made to the documents as needed and thereby avoids the need to publish new editions of the documents from time to time as was hitherto the case.

Managing Measurement Risk in Building and Civil Engineering, First Edition. Peter Williams.
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As the MCHW is used for public sector projects that have to be advertised in the European Union (EU) Journal, amendments are subject to Directive 98/34/EC whereby member states are required to notify the European Commission of proposed changes to their technical regulations and standards at draft stage. This process places the proposed amendments in an EU Notification standstill period during which other member states may examine the drafts and react to them. Failing objections, the draft changes may be published after a 3-month wait.

The main driving force behind publication of the MCHW in 1991, and the Seventh Edition of the Specification in particular, was the need to remove 'barriers to trade' in accordance with Notification Directive 83/89 of the European Commission. In practical terms, this means that particular products or suppliers cannot be prescribed in specifications or on drawings as this might preclude the procurement of equivalent products or suppliers from EU member states. Additional reasoning was the need to make the highway documentation more user-friendly within a controlled system that recognised the need to move towards greater quality assurance both in design offices and on-site (Money and Hodgson, 1992).

8.1.1 *Volume 0: Model contract document for major works and implementation requirements*

Volume 0 contains typical contract documents and instructions for tendering for new trunk road contracts and for improvement and maintenance schemes in the United Kingdom and Northern Ireland. Originally based on the ICE Conditions of Contracts, the preferred contractual basis for such projects is now the New Engineering Contract (NEC) (both the Engineering and Construction Contract (ECC) and the Short Form).

A variety of procurement routes are available including full and partial contractor design, target contracts with pain/gain provisions and the use of the ECC Secondary Option Partnering Clause (X12). The preferred pricing document is the activity schedule, but bills of quantities (BQ) are envisaged in certain circumstances.

In this context, an unusual feature of the model contract is the option of **risk transfer in BQ** for projects that can be reasonably accurately quantified in advance and where the likelihood of remeasurement is low.

This feature is facilitated by use of a 'Z clause' (Z36), but subject to the proviso that *the project sponsor needs to be satisfied that the bill fully represents a true reflection of the project, even to the extent of erring on the generous side when fixing quantities. There is no intention of catching out a contractor by deflating quantities. The motivation behind the clause is to stop claims and to achieve certainty of price outcome.*

There are some 38 'Z clauses' in Volume 0, some of which are marked (M), meaning that they are mandatory. Other non-mandatory Z clauses include provisions for:

- Named subcontractors.
- Retention bonds.
- Bonus for early completion.
- Lane rental charges for late completion.
- Incentivised railway possessions.
- Value engineering.

The model contract document contains extensive project administration arrangements and pro forma documentation.

Whilst Highways England prefers to use the NEC (main and short forms) for its projects, Mitchell (2014) suggests that this is not necessarily the case with local authority clients who may still prefer to use the ICE Conditions (now the Infrastructure Conditions of Contract).

8.1.2 Volume 1: Specification for Highway Works

Along with the Highway Construction Details, the Specification is the heart of the Manual of Contract Documents.

The Seventh Edition of the Specification for Highway Works (SHW) is designed to be 'contract neutral' for use with a variety of procurement methods and forms of contract. The usual practice of including contract-specific terms, such as engineer's directions and/or approvals, has been avoided in line with the 'neutrality' policy of the Specification.

Despite the 'contract neutrality' of the SHW, British Standards (BS) and British Standard Codes of Practice may be incorporated in contracts unless they have been superseded by a European Standard (BS EN) or a harmonised European Standard (hEN).

hENs allow products to be given a CE marking, but, from 1 July 2013 under the Construction Products Regulation (CPR) 2011, it is mandatory for manufacturers to apply a CE marking to any products covered by a hEN or European Technical Assessment (ETA).[3] This UK legislation has been enacted as a result of EU Construction Products Regulation (EU) No 305/2011, a follow-on from the **Construction Products Directive (CPD) (Council Directive 89/106/EEC)**, which is now repealed.

8.1.3 Volume 2: Notes for guidance on the specification for highway works

The Notes for Guidance are purely intended to assist users in the interpretation and use of the SHW, but, unlike the Specification, are not intended to be incorporated into the contract. The Introduction to the Notes for Guidance emphasises the 'contract neutrality' of the SHW and that, other than when the ICE/ICC Conditions of Contract are used, the engineer's approval of workmanship and materials is not required.

Mitchell (2014) questions the extent to which the Notes for Guidance are used in practice and observes that they are often misapplied or ignored altogether.

8.1.4 Volume 3: Highway Construction Details

The drawings are of vital importance to the proper working of the MCHW because this is where the contractor has to look to see exactly what is expected in the contract. It is not good enough to simply look at the Specification and MMHW item coverages because these are generic and are designed to cover all of the work that might be required on any highway project. Clearly, not all projects will require every possible specification requirement.

The drawings in question consist of:

1. Project-specific drawings, including general layouts, plans and long sections, for the particular project in question.
2. Drawings/details contained in Volume 3: *Highway Construction Details* (HCD). This shows standard details for fencing, pipe beds and surrounds, manholes, gullies, carriageway pavement details and so on, but it must be emphasised that these standard details are also generic and each and every standard detail does not necessarily apply to each and every project.

Consequently, a specific contract may not require all the work covered by the Specification or the HCD or the items listed in the MMHW item coverage, and the precise requirements of an individual project can only be discovered by looking at the project drawings.

Taking a drainage item, for example, the item coverage for headwalls under Series 500: *Headwalls and Outfall Works* includes brickwork, copings, string courses and the like, but if the drawings only show headwalls as being concrete, then there is no requirement for the contractor to price for any brickwork. Similarly, specification clauses under Series 1800: *Structural Steelwork* will not be relevant if there is no requirement for structural steelwork shown on the drawings.

8.1.5 Volume 4: Bills of quantities for highway works

Volume 4 is slightly different to other volumes in the MCHW in that it is not a homogeneous document but rather is made up of three interrelated sections that come together to enable BQ to be prepared:

- Section 1 – Method of Measurement for Highway Works (MMHW).
- Section 2 – Notes for Guidance on the Method of Measurement for Highway Works.
- Section 3 – Library of Standard Item Descriptions for Highway Works (LSID).

Section 1 provides the rules of measurement and Section 3 the means of converting measurements into meaningful descriptions of the work required. Section 2 assists the bill compiler in interpreting the requirements of the method of measurement. However, the MMHW is somewhat idiosyncratic compared with other standard methods such as SMM7, NRM2 and the Civil Engineering Standard Method of Measurement (CESMM4) as there is no requirement to:

- Include specification information in the item descriptions.
- Make reference to drawn information.
- Make reference to other data such as subsoil reports or groundwater levels.

The ensuing BQ is purely a 'neutral' list of quantified work items that must be interpreted by the contractor in conjunction with Volume 1: SHW, Volume 3: HCD and the project-specific drawings. All of these documents are intended to be used in conjunction with the Model Contract Document for Highway Works in order to arrive at a complete set of procurement documents.

Figure 8.1 illustrates how particular components of the MCHW, along with the scheme drawings, come together to form a BQ.

Each component part is integral to the process, and both the bill compiler and the contractor's estimator need to cross-reference the BQ to each of them in order to acquire the complete picture of what the contract requires.

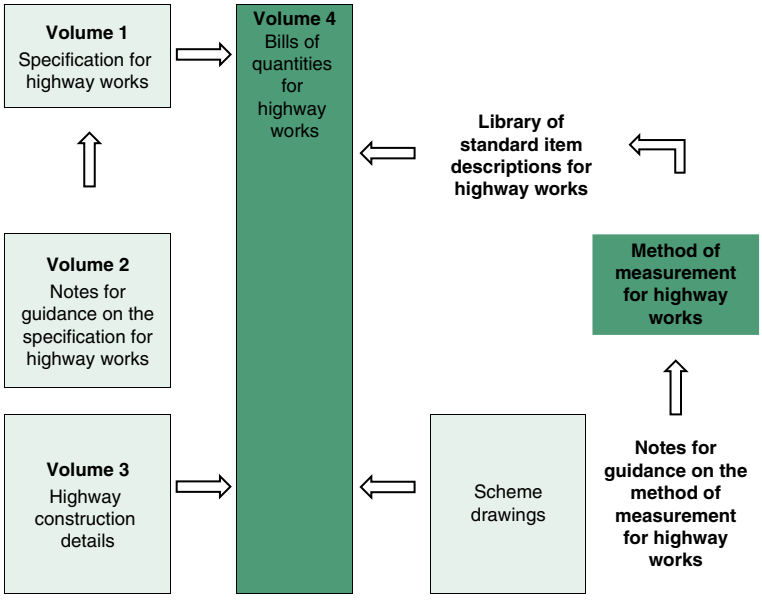


Figure 8.1 Documents required to compile a bill of quantities for highway works.

The Library of Standard Item Descriptions (LSID) is also an idiosyncratic feature of Volume 4 as the library consists of a number of 'root narratives' with numbered inserts which enable standard item descriptions to be compiled by selecting appropriate descriptions from numbered lists of variables.

In ordinary language, this means that the library has lots of standard item descriptions with numbered gaps and the gaps are filled in by selecting the appropriate description from a list according to the number of the insert. The consequence of this is that a number of similar (but nonetheless unique) item descriptions can be compiled from the one 'root narrative' which, in turn, means that the item descriptions so derived will be the same whoever compiles the description.

The 'root narrative' approach to item description ensures consistency in BQ production as, apart from 'rogue items', there is no room for individuality in describing the items. BQ may be produced manually or by using a computer package such as CATO or QSPro. The workings of 'root narratives' is explained in detail later in this chapter.

According to Money and Hodgson (1992), the MMHW was *poorly understood and often mis-used by those measuring and supervising contracts*, and this is the reason why the Notes for Guidance were reintroduced in the 1991 edition. Mitchell (2014) is also critical of the lack of understanding of users of the MMHW, and having had some experience of running practitioner training courses on the subject, this author has some sympathy with his views.

The Notes for Guidance are not particularly extensive but are sufficient to assist the bill compiler (or contractor) with some important matters of interpretation and correct practice.

8.1.6 Volume 5: Contract documents for specialist activities

Volume 5 comprises model contract documentation, specification requirements (including performance specifications), notes for guidance and methods of measurement for specialist activities in connection with highway works. This includes:

- Geodetic surveys (aerial surveys and digital mapping).
- Ground investigation.
- Mechanical and electrical (M&E) installations in road tunnels, moveable bridges and bridge access gantries.
- Trenchless installation of highway drainage and service ducts.
- Closed-circuit TV (CCTV) surveys of highway drainage systems.

The methods of measurement for ground investigation work and trenchless drainage and service ducts follow the principles of the main MMHW (Volume 4 of the MCHW), whereas other specialist activities are measured more simply. There is a model BQ for geodetic surveys, and a sample BQ to help bill compilers with the measurement of M&E work, but no complex measurement rules for either.

The nature of the work dealt with in Volume 5 is beyond the scope of this book.

8.1.7 Volume 6: Departmental standards and advice notes on contract documentation and site supervision

This volume contains standards and advice notes concerning such matters as the implementation of the Construction (Design and Management) Regulations 2015, the Use of Substances Hazardous to Health in Highway Construction, the New Roads and Street Works Act 1991, etc. These topics are beyond the scope of this book.

8.2 Design manual for roads and bridges

As stated elsewhere in this book, the fundamental starting point for calculating quantities is something from which to measure. At BQ production stage, this usually means a set of drawings – either hard copy or digital – or a model.

The drawings for highway projects are derived from two basic sources:

1. Project-specific drawings.
2. Highway Construction Details (HCD).

The HCD are contained in Volume 3 of the MCHW, whereas the project-specific drawings come from either:

1. Engineer design.
2. Contractor design.
3. Both.

Although not part of the MCHW, the Design Manual for Roads and Bridges (DMRB) is a *companion manual* intended to guide designers of highway projects, whether they be client-engaged engineers or contractors.

Originally published as a series of separate documents by the various UK overseeing departments (e.g. the then Highways Agency in England), the DMRB was first introduced in 1992 as a comprehensive manual of loose-leaf volumes containing current standards, advice notes, references and other documents relevant to the design of trunk roads. The manual comprises 16 volumes (Volumes 0–15) dealing with design issues such as highway structures, geotechnics and drainage, road geometry and environmental assessment, etc. Some of its features include the following:

- The DMRB represents good practice that is intended for use on trunk road schemes.
- The manual may be used or adapted by highway authorities for local roads and bridges projects.
- Some documents may be restricted where not applicable to Scotland, Wales or Northern Ireland.
- Some documents may be restricted to a particular overseeing organisation.
- Designers may relax the specified design standards where thought necessary, but such relaxations must be justified to the overseeing organisation.
- Referencing to the MCHW and, in particular, to the SHW and HCD.

As well as setting standards, the DMRB provides guidance in the form of advice notes, and there is also an extensive system of administrative and technical procedures dealing with document control and the issue of new and amended documents in order that a rigorous system of quality control is maintained.

8.3 Highways England procurement

Highways England is in the business of procuring a wide variety of highway projects from relatively small highway maintenance schemes to very large and often complex improvement schemes involving technical and logistical problems not associated with 'run-of-the-mill' construction work. River and rail crossings are often involved as well as complex earthworks, ground stabilisation and geotechnical work, large bridges and other structures.

Due to the size and intrinsic value of many highway schemes, procurement of such projects warrants careful consideration and an appropriate balance of risk between the parties befitting the constraints and degree of difficulty involved.

Within the confines of the MCHW, overseeing organisations, such as local highway authorities, are at liberty to choose procurement methodologies appropriate to their own projects. For major projects costing more than £20 million, Highways England uses a variety of NEC3 contracts for project delivery within a framework arrangement. A procurement strategy is developed for each project on a case-by-case basis, and the most appropriate contract model is chosen on that basis.

In this context, the procurement strategies employed by the Highways England include:

- Frameworks.
- Early contractor involvement (ECI).
- Design and build (D&B).
- Individual (discrete) contracts.
- Managing Agent Contractor (MAC and TechMAC).
- Private finance.

8.3.1 Frameworks

Frameworks are used to procure works, goods and services over a prescribed period of time. They are generally used where there are either known repeat requirements in developed, competitive markets or where there are variable demands and requirements that are best suited to a flexible procurement arrangement.

As far as Highways England is concerned, Major Projects from 2014 are procured on the basis of a *Collaborative Delivery Framework* of pre-qualified 'suppliers' of professional design, engineering and construction services. This replaces the previous *Major Projects Framework*.

The framework comprises four separate lots, one for engineering design services and three for small-, medium- and large-value construction projects, with a total value of £4–5 billion over 4 years and a possible 2-year extension[4]:

Collaborative Delivery Framework		
Lot 1	Professional design and engineering services	8–12 consultants
Lot 2	Medium-value construction works (<£25 million)	3–5 contractors
Lot 3A	High-value construction works (£25–100 million)	4–6 contractors
Lot 3B	High-value construction works (£100–450 million)	4–5 contractors

8.3.2 Early Contractor Involvement (ECI)

The Highways England procurement strategy accommodates both ECI and late contractor involvement where it is felt that input by a contractor prior to submission to the planning process would be beneficial. Late contractor involvement permits a contractor to be hired closer to construction commencement but nevertheless before submission of the scheme to the planning process.

When a contractor is hired after planning consents have been obtained or when planning consents are not required, an NEC3-based D&B contract is used.[5]

8.3.3 Design and Build (D&B)

D&B is used for substantial projects, beyond the threshold of Agency Frameworks (see Section 8.3.1), but where the ECI approach is deemed inappropriate. Larger highway renewal schemes may warrant this approach and also those where most design decisions are fixed in advance.

Design innovation is encouraged in order to generate time and cost savings and improved quality and value based on prior experiential learning.

8.3.4 Individual (discrete) contracts

Projects beyond the scope of frameworks, MACs and TechMACs, or where there is a specific need or requirement, are procured on the basis of an individual or discrete contract.

Such projects may involve a degree of contractor design, and the emphasis will be on delivering the appropriate balance of risk and value.

8.3.5 Managing Agent Contractor (MAC)

The preferred procurement route for maintenance works over £0.5 million is through 4-year works asset-management frameworks. The main contractual vehicle is the MAC (and TechMAC) contract on the basis of either:

- Managed works – where a number of main civil engineering contractors are given a task order for each scheme or
- Construction management – where several specialist contractors are appointed to complete a single scheme on the basis of task orders with the MAC acting as supervisor and principal contractor[6].

8.3.6 Private finance

Private finance contracts are the preserve of high-value strategic projects according to government policy using design, build, finance and operate (DBFO) contracts. Such projects are beyond the scope of the MCHW.

8.4 Measurement implications of procurement choices

The preference of Highways England is to use the NEC ECC, with its various options, and the NEC Short Form of Contract, as provided for in Volume 0: *Model Contract Document for Major Works and Implementation Requirements*.

As a consequence, the pricing documents available for use on highway schemes are as follows:

Contract	Type of contract	Pricing document
• ECC Option A	Lump sum	Activity schedule
• ECC Option B	Measure and value	Bill of quantities
• ECC Option C	Target	Activity schedule
• ECC Option D	Target	Bill of quantities
• Engineering and Construction Short Contract	Lump sum	Price list – unquantified
• Engineering and Construction Short Contract	Measure and value	Price list – quantified

Under NEC3, the use of an activity schedule/unquantified price list implies a lump sum contract, and a BQ/quantified price list implies a measure and value contract.

8.4.1 Activity schedules

Appendix H of Part 7 of MCHW Volume 0: *Model Contract Document for Major Works and Implementation Requirements* provides an illustrative activity schedule for highway works. This is shown in Table 8.1, but *Tenderers are responsible for inserting activity descriptions and* ***stage payment requirements***.

The use of the term 'stage payment requirements' is interesting as it resonates with the ECC *Guidance notes* which state that:

- Individual activities on the activity schedule are paid for when completed.
- Grouped activities are paid for when the whole group of activities is completed which *is how the ECC provides for milestone or stage payments*.

It could be interpreted, therefore, that the invitation to tenderers to state their *stage payment requirements* in Volume 0 of the MCHW is a tacit relaxation of the provisions of the ECC. This would make a great deal of sense because the sort of activities listed in the illustrative activity schedule, including site establishment and compilation of the health and safety file, are activities that would normally take several months, if not years, to complete and could otherwise pose a considerable cash flow problem for the contractor.

Table 8.1 Illustrative activity schedule.

No.	Activity	Price
1	Establish site	
2	Topsoil strip area A	
3	Topsoil strip area B	
4	Culverts	
5	Headwalls for culverts	
6	Earthworks for slip roads	
7	Earthworks for main line	
8	Drainage for slip roads	
9	Drainage for main line	
10	Environmental bund	
11	Ducts for slip roads	
12	Ducts for main line	
13	Milling	
14	Capping	
15	Sub-base	
16	Road base	
17	Basecourse	
18	Wearing course	
19	White lines	
20	Traffic lights	
21	As-constructed information	
22	Health and safety file	
	Lump sum fixed price (£)	

Source: Manual of Contract Documents for Highway Works – Volume 0.

When used in conjunction with the ECC, the illustrative activity schedule shown in Table 8.1 would be problematic. As discussed in detail in Chapter 4, the activity schedule should reflect

the accepted programme, but the detail provided in the illustrative activity schedule falls a long way short of the level of detail expected in the ECC.

For highway works, the contractor's programme will usually be presented in the form of a time–chainage diagram, which is more illustrative of the 'linear' nature of roadworks projects than the more ubiquitous linked bar chart. An example of a time–chainage diagram is given in Figure 8.2.

8.4.2 Bills of quantities (BQ)

BQ are traditionally used for the procurement of highway works, and the resulting contract is usually on a measure and value (or admeasurement) basis. Suitable forms of contract include:

- ICC – Measurement Version.
- ECC Option B.
- Engineering and Construction Short Contract.
- FIDIC 1999.
- ECC Option D (for a target contract based on a BQ).

The basis of the quantities for admeasurement contracts is the MMHW which places the measurement risk with the employing authority and the constructional risk with the contractor.

Consequently, if the quantities of work measured in the BQ are less than the final quantities, the overseeing organisation will 'foot the bill'. If, on the other hand, the work proves more difficult than expected, this risk lies with the contractor, but only up to the point where an experienced contractor could not have anticipated the circumstances prevailing.

Where there is some certainty about the quantity of work required, the overseeing organisation might choose to employ the Z36: *Risk transfer in bill of quantities* secondary option clause, where the quantity risk passes from the employer to the contractor.

8.5 Contractual arrangements

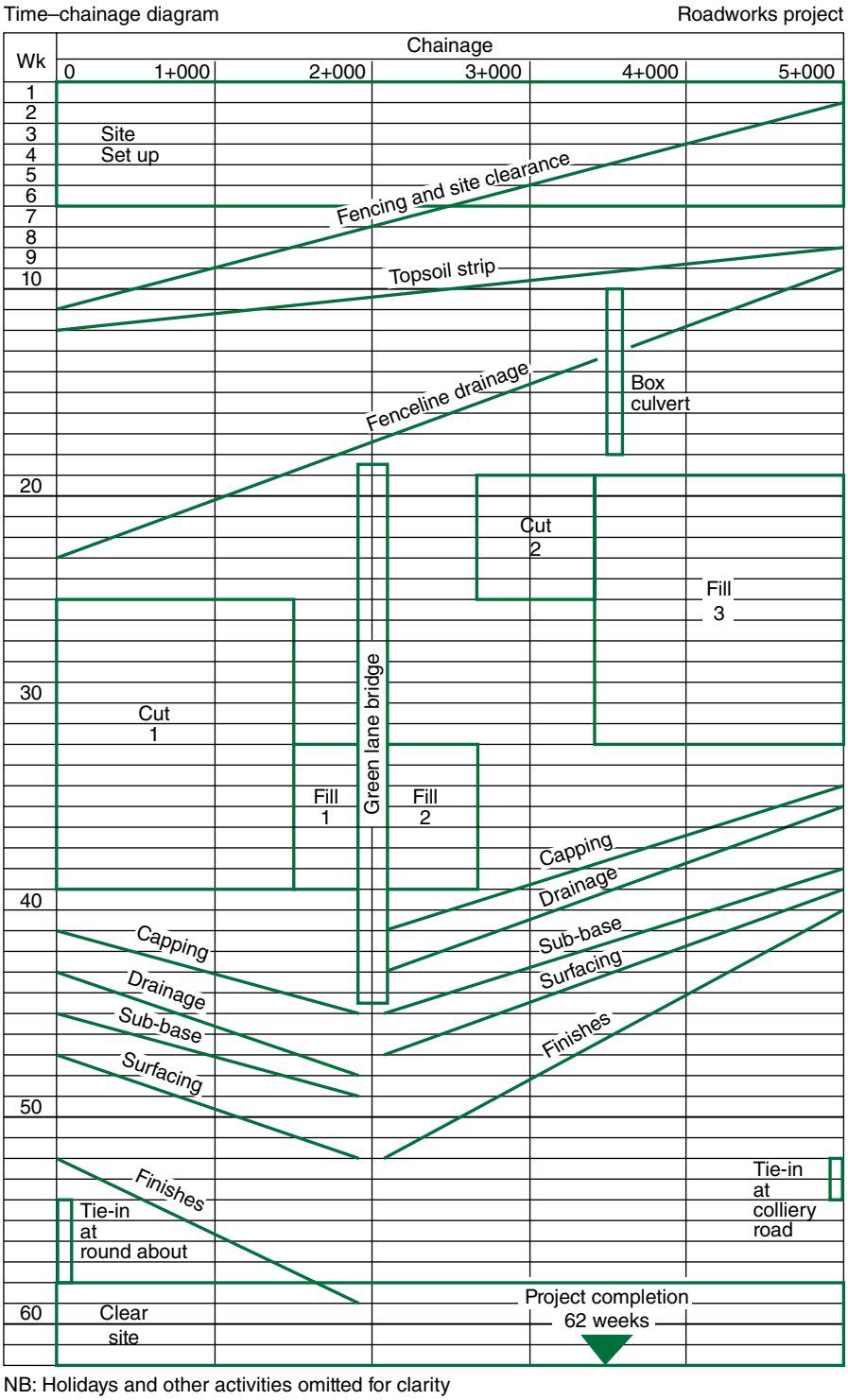
In keeping with other construction projects, highway schemes require an integrated and coherent infrastructure of documents in order to bring about an effective contract. The contract documents will be slightly different depending upon whether a traditional engineer-designed project is employed or whether the ECC is preferred. Table 8.2 illustrates typical contract documents for the ICE/ICC Conditions of Contract compared with their NEC equivalents.

Despite the different vocabulary between ICE/ICC and NEC contracts, it can be seen from Table 8.2 that, in each case, the specification and drawings, together with a pricing document of some sort, are employed. These documents are central to any contract, but the difference with the MCHW is the reliance on **standard documents** and especially:

- Volume 0 (Model Contract Document (MCD)).
- Volume 1 (Specification).
- Volume 3 (Highway Construction Details).
- Volume 4 (Method of Measurement).

Risk Issue

The documents contained within the MCHW are not contract documents. The *ensemble* is a means of creating a contract, but the various MCHW documents must be included in the contract by specific reference, that is, in preambles, and by ensuring that the method of measurement (i.e. the MMHW) is stated in the contract.



NB: Holidays and other activities omitted for clarity

Figure 8.2 Time–chainage diagram.
Figure 21.4 on page 479 of *Construction Planning, Programming and Control* by Cooke and Williams.

Table 8.2 Comparative contract documents.

ICE/ICC	NEC equivalent
The contract conditions	• Core clauses (ECC or Short Form) • Appropriate main and secondary option clauses
The Contract Appendices Parts 1 and 2	• Contract Data Part 1 (completed by the employer) • Contract Data Part 2 (completed by the contractor)
Form of agreement (optional)	Form of agreement (optional)
The form of tender	Form of tender (not an NEC document)
Formal acceptance of the contractor's tender offer	Formal acceptance of the contractor's tender offer
The priced bill of quantities	Priced activity schedule or bill of quantities
The specification The drawings	Works Information Site Information

An important point to remember is that the documents contained within the MCHW have the status of 'Standards', and therefore, *any variation or waiving of a requirement contained within a MCHW document shall be regarded as a Departure from Standard*.[7]

Consequently, for contracts based on the MCHW, there must be no divergence from the standard documents unless the reason for any change is approved by the overseeing organisation. In this context, Highways England must also be consulted for information regarding suitable contracts where D&B is contemplated, and other UK overseeing organisations, including local authorities, must endorse forms of contract to be used on any highway projects under their control.

As might be imagined, there is a system within the MCHW framework for incorporating changes to the standard documents. The reasoning for a strict and hierarchical system is twofold:

- Highway projects are usually public sector projects, and as such, the overseeing organisations need to exercise a suitable degree of control.
- Clarity and consistency in the contract documents produced are necessary especially considering the need to avoid barriers to trade for contractors and suppliers from the EU.

The Introduction to Volume 0 Section 1 Part 2 DG 01/08 of the DMRB also contains formal protocols for dealing with departures from design standards.

Amendments to the MCHW are issued from time to time, and subscribers receive loose-leaf replacement pages for the various volumes as appropriate. Amendments to Volume 2 (NG SHW) will include a *Schedule of Pages and Relevant Publication Dates* for Volume 1 (SHW), and amendments to Volume 4 will include a *Schedule of Pages and Relevant Publication Dates* relating to the MMHW. Each of these schedules is to be incorporated into the contract where the overseeing organisation deems that the contract should include such amendments. Amendments to Volume 3 will similarly include a *Schedule of Pages and Relevant Publication Dates* relating to the HCD.

The MCD for the ECC and the Short Form is to be found in MCHW Volume 0 Section 1 Part 7. This provides extensive procurement documentation, including Z clauses and guidance notes, as well as various pro formas:

- Form of tender.
- Instructions for tendering.
- Illustrative activity schedule.
- Contract Acceptance Letter and Contract Agreement.
- Contract Data Parts One and Two.
- Dual-envelope tendering arrangements.
- Quality/price tender assessment and scoring provisions.

Risk Issue

The illustrative activity schedule, which is intended to form part of the Contract Data Part 2 (which is completed by the contractor) is populated with a list of 22 very broad activities such as establish site, culverts, earthworks for main line, drainage for main line, capping, sub-base, etc.

In keeping with the philosophy of the ECC, the lump sum items priced in an activity schedule become due to the contractor only when the activity is completed. If the activity is part of a group of activities, then the entire group has to be completed before payment becomes due.[8]

8.6 Specification for Highway Works

Most standard methods of measurement not only quantify the work to be done by the contractor but also describe the nature and quality of work required. Where this is the case, BQ item descriptions may be supplemented by either a bespoke or standard specification (e.g. the Specification for the Water Industry). The MMHW does not work like this as BQ based on this method of measurement contain no specification information.

Unlike other standard methods of measurement, the MMHW operates in a highly structured and controlled infrastructure along with other interlinking documents. Central to these documents is the Specification for Highway Works (SHW).

8.6.1 Introduction

Along with the drawings, the SHW is of vital importance in a highway project as it is central to a number of important stages in the administration of a project:

- Preparation of BQ in accordance with the MMHW.
- Preparation of activity schedules by tendering contractors.
- Pricing the BQ/activity schedule at tender stage.
- Interpreting the requirements of the contract as work on-site progresses.
- The administration of variations to the contract.
- The compilation and administration of contractual claims.

Before continuing, it is essential to understand that:

- The SHW is a 'Standard' and as such should not be altered without authority from the relevant overseeing organisation.
- Unlike projects in the private sector, the SHW cannot be 'bespoked' in any way that the compiler wishes.
- Where it is desired to make the Specification 'contract specific', this must be done by using the system of appendices prescribed (this is explained in detail in MCHW Volume 2: *Notes for Guidance on the Specification for Highway Works*).
- The SHW is incorporated into a contract by reference, and thus, any alterations to the 'standard' must be made clear in the contract documents.

8.6.2 Structure of SHW

In its 'standard' form, the SHW consists of:

- 29 numbered series

  The numbered series consists of an Introduction (Series 000) and Preliminaries (Series 100) together with 27 other series such as Fencing (Series 300), Drainage and Service Ducts (Series 500), Earthworks (Series 600), Special Structures (Series 2500) and Maintenance Painting of Steelwork (Series 5000). Each series describes the quality of materials and workmanship required by the contract. Series 2200 is not used.

- 8 lettered appendices (A–H)

  The lettered appendices (A–G) to the SHW contain standard information and requirements relating to quality management, product certification and other approvals, whilst Appendix H specifies four categories of quality records (Categories A–D) that must be submitted to the overseeing organisation before, during and after completion of construction activities. All the lettered appendices are national requirements and, with the exception of Appendix F (publications referred to in the Specification), are intended to be used unaltered.

Additional and substitute clauses that appear in the numbered series or lettered appendices only apply to the overseeing organisations in Scotland, Wales and Northern Ireland, and these clauses are suffixed TS, NAW and NI for each country, respectively. These clauses replace each 'standard' Specification clause with the equivalent non-suffixed number. For instance, 601TS: *Classification, Definitions and Uses of Earthworks Materials* applies to projects in Scotland and replaces the 'standard' Series 601 specification. Additional and substitute clauses are deemed to apply unless otherwise stated in Appendix 0/5 (see later reference to this appendix).

8.6.3 Numbered appendices

Additional to the 'standard' Specification structure are the contract-specific numbered appendices which are employed to tailor the Specification to the particular contract. There are two types of contract-specific numbered appendices:

- The so-called 'zero-series' numbered appendices (0/1–0/5) which contain contract-specific information and requirements:
  - Appendix 0/1 is for incorporation of additional, substitute or cancelled clauses.
  - Appendix 0/2 is for incorporation of minor alterations to existing clauses, tables and figures and any alterations to Appendix F.
  - Appendix 0/3 contains a complete list of the contract-specific numbered appendices included in the contract:
    - List A contains those referred to in the national Specification.
    - List B contains any additional numbered appendices devised by the compiler relating to Appendices 0/1 and 0/2.
  - Appendix 0/4 contains a list of the drawings in the contract including those from the HCD.
  - Appendix 0/5 relates to special national alterations of the overseeing organisation of Scotland, Wales or Northern Ireland.
- Numbered appendices such as Appendix 1/10 and 1/11 which refer to contractor design of permanent structures and to contractor design of temporary works and temporary structures, respectively.
- Other numbered appendices beginning with 1/1 that are referenced to the appropriate numbered series. Therefore, numbered appendix 16/5 relates to Series 1600: *Driven Cast-in-Place Piles*.

The SHW Notes for Guidance suggest that the information contained in the contract-specific numbered appendices 0/1 to 0/5 and 1/1 onwards should be bound in one or more volumes in the tender/contract documents with a clear title indicating what they relate to.

8.6.4 Contractual issues

The SHW has been drafted to be 'contract neutral' in order that a wide variety of procurement methods and forms of contract may be used. Consequently, terms specific to particular forms of contract have been avoided, and no references are made to approvals and/or directions by parties (such as the engineer) that might appear in particular forms of contract.

For a typical highway project, the Specification is incorporated into the contract by specific reference, but it is not reproduced as a contract document either in whole or in part. Consequently, tendering contractors must have access to a copy of the SHW in order to be able to price the job – available online at http://www.dft.gov.uk/ha/standards/mchw/ free of charge. However, even if a contractor has the latest published version of the SHW, this is not necessarily up to date or concurrent with the specific requirements of a particular contract. This is because:

- Amendments to the SHW may be issued between the last publication date and the date of any specific contract.
- There may be contract-specific changes to the SHW for a particular project.

In order to ensure that contractors are pricing a tender based on the latest relevant Specification clauses, the *Schedule of Pages and Relevant Publication Dates* issued with the most recent update must be included in the contract. This will usually be done as a preamble, and the Notes for Guidance (NG Series 000) provide a *Standard Preamble to the Specification* in order to assist compilers to fulfil this requirement.

The *Schedule of Pages and Relevant Publication Dates* lists the publication date of each page of the SHW applicable to the contract, and the current schedule is included in Series 000 of the SHW. The Schedule of Pages should be bound into the contract documents, with the contract-specific numbered appendices, following the Preamble to the Specification.

The contract-specific numbered appendices to the Specification are drawn up for the contract by the compiler and are also included in the documents. Cross reference should be made in the contract-specific numbered appendices to any relevant drawing number(s) that might be appropriate.

It is important to note that the contract-specific Numbered Appendices 1/1 onwards should only be used to extend the information in Specification clauses, tables or figures and *not* to change them and they must not be used to alter the 'standard' SHW clauses. Some numbered appendices are partially drawn up by the complier and completed by the contractor, whilst others must be completed by the contractor and returned to the overseeing organisation.

Appendix 0/3 contains a complete list of numbered appendices to be included in the contract. This list is in two parts and comprises national specifications (List A), and numbered appendices (List B) put together by the bill compiler.

Risk Issue

Series 005/1 is important in terms of measurement and pricing in that it states that the thickness of items specified are intended to be the finished or compacted thickness.

8.7 Method of Measurement for Highway Works

As can be seen in Part 8.6 of this chapter, the SHW is much more than a 'static' standard specification, the like of which are common in the construction industry. The SHW is not only regularly amended via the *Schedule of Pages and Relevant Publication Dates* system, but it is also capable of being adapted to be 'contract specific', albeit within controlled limits, using the system of numbered appendices.

The same system of publishing a *Schedule of Pages and Relevant Publication Dates* applies to the MMHW. There is no system of numbered appendices, but great reliance is placed on the Preambles to Bill of Quantities wherein may be found any amendments to the Method of Measurement.

Risk Issue

Where applicable, the Method of Measurement for Highway Works will be the stated method of measurement in the contract. This information will be found in the Contract Appendix (ICE/ICC conditions) or in the Contract Data (NEC contracts).

However, the contract will not state the relevant edition of the MMHW (e.g. unlike CESMM, Fourth Edition) as this information is found the *Schedule of Pages and Relevant Publication Dates*.

There are downsides to this MCHW system because:

- Tendering contractors have to be alert to published changes to the 'standard' documents in their possession.
- It takes time for tenderers to scrutinise the Schedule of Pages to ensure that they are using the correct specification information.
- The tender period is a high-pressure time for contractors, and it is easy to overlook important changes to the specification.
- Accurate pricing of the BQ is heavily dependent upon having the correct specification requirements to hand.

Risk Issue

Checking published changes to the SHW is particularly important as the Method of Measurement for Highway Works does not provide for the inclusion of specification information in the item descriptions.

The importance of MCHW Volume 1: *SHW* and Volume 3: *HCD* to Volume 4 MMHW cannot be overemphasised.

8.7.1 MMHW structure and contents

The MMHW is to be found in Section 1 of Volume 4 of the MCHW – *Bills of Quantities for Highway Works*. It comprises four chapters:

(i) Definitions.
(ii) General Principles.
(iii) Preparation of Bill of Quantities.
Preambles to Bill of Quantities.
Schedules of Pages and Relevant Publication Dates.
(iv) Units and Method of Measurement.

BQ prepared under the MMHW are organised along traditional lines:

- Preambles.
- Main measured Work Sections.
- PC and provisional sums (where used).
- Final summary.

However, unlike other methods of measurement that tend to subdivided into 'Work Sections', the various measured sections of the MMHW are categorised into 'series' such as Series 500: *Drainage and Service Ducts* and Series 600: *Earthworks*. The various 'series' are to be found in Chapter IV of the MMHW.

The importance of the Preambles to the Bill of Quantities cannot be overstated. This is where some very important directions, rules and information are to be found that are of central importance to the contractor's pricing of the tender and to the interpretation of issues that might arise during construction of the works.

8.7.2 Preparation of BQ

Format and contents

It should not come as a complete surprise that the format and contents of BQ prepared using the MMHW is strictly controlled. This even extends to the format of BQ pages which must follow a standard layout as determined by Implementation Standard SD 3/92 (Annex A). If a particular word-processing package is unable to achieve the correct layout, approval to use a different layout must be sought from the relevant overseeing organisation.

Without going into unnecessary detail, BQ are structured using three levels as illustrated in Table 8.3. This structure is delineated in Table 1 of Chapter III of the MMHW wherein the main divisions (Level 1) of the BQ are listed as:

(i) Preliminaries.
(ii) Roadworks.
(iii) Structures.
(iv) Structures Where a Choice of Designs is Offered.
(v) Structures Designed by the Contractor.
(vi) Service Areas.
(vii) Maintenance Compounds.
(viii) Accommodation Works.
(ix) Works for Statutory or Other Bodies.
(x) Daywork.
(xi) PC and Provisional Sums.

Each level is further subdivided as necessary, for example:

(ii) Roadworks:
- Roadworks General.
- Main Carriageway.
- Interchanges.
- Side Roads.
- Signs, Motorway Communications and Lighting.
- Landscape and Ecology.

It can be seen that this layout is completely different to that used in CESMM4, for example, which employs a classification system based on classes of ***work*** *commonly encountered in civil engineering* which are then subdivided into three divisions. The classification system in the

MMHW is almost 'elemental' in nature albeit that the itemisation system used in the various series is perhaps a combination of the two approaches.

Table 8.3 Structure of bills of quantities.

Level 1 Division		**Level 2 Construction heading**	**Level 3 MMHW series heading**	
Division	**Subdivision**			
(iii) Structures	Structure in form of bridge or viaduct; name or reference	Special preliminaries		
		Piling	1600	Piling and embedded retaining walls
		Substructure – end supports	500 600 1100 1700 1800 1900 2300 2400	Drainage and service ducts Earthworks Kerbs, footways and paved areas Structural concrete Structural steelwork Protection of steelwork against corrosion Bridge expansion joints and sealing of gaps Brickwork, blockwork and stonework
		Substructure – intermediate supports Substructure – main spans Substructure – approach spans		As for end supports

Quantities

Quantities are presented in the eventual BQ in whole units except for those items measured in tonnes or hectares which are given to three places of decimals.

Special preliminary items

A peculiar feature of the MMHW is the use of the term 'Special Preliminary Items'. These items are included in the BQ purely at the discretion of the overseeing organisation, but, unusually, there is no provision for them in the method of measurement. Additionally, there is no obligation to include such items in the BQ, and, in any event, their inclusion or exclusion does not relieve the contractor from his obligations under the contract.

The point of Special Preliminary Items is that, for a particular contract, the cost of preliminaries associated with certain work may be considered as disproportionate to the value of the work

in question. Consequently, even though such work is not required to be measured separately, a case may be made that the contractor's preliminaries associated with that work merit special provision in the BQ. Should they be included, Special Preliminary Items must be *adequately covered in the documentation*, and the compiler must also ensure that a suitable item coverage is included.

Alternative types of pavement

It has long been the case with the MMHW (and its predecessor the MMRB) that contractors are offered a choice as to the type of pavement that they would prefer to employ. This was always a question of the relative economics of different pavement solutions, and this led to the existence of both macadam and concrete road surfaces on Britain's motorway network. In the 1970s especially, some contractors preferred concrete carriageways as they owned the necessary 'concrete trains' used for their construction and others preferred to sublet the surfacing work to 'tarmac' subcontractors. The eventual decision as to the pavement to be used was the overseeing organisation, but tenderers would invariably price the contract so that significant savings would emanate from their preferred pavement type.

Structures where a choice of design is offered

On occasion, the contractor is given the choice between pricing his tender on the basis of a structure designed by the overseeing organisation or one of his own designs. This may be for a small bridge, underpass or culvert, for example.

In such cases, the BQ must contain a bill for each alternative both prepared in accordance with the method of measurement. The difference between the bills is that one is measured and itemised in accordance with the appropriate series of the MMHW with the other, containing a single item only, being prepared in accordance with Series 2500: *Special Structures*. If the contractor decides to design the structure himself, then he prices the bill with the single item. Irrespective of the contractor's choice, only one of these bills may be used to compile the total of all the bills that make up the tender figure.

Structures designed by the contractor

In circumstances where the overseeing organisation wishes the contractor to design a structure(s), the drawings will show a designated outline of where the work is located. The contractor will price all the work included within the designated outline with the exception of any work scheduled by the overseeing organisation as *not to be included*.

For such work, the BQ will contain a bill with a single item measured in accordance with Series 2500: *Special Structures*. Work not included in the single item is to be included in other bills prepared by the overseeing organisation.

Landscape and ecology

This type of work, covered by Series 3000, includes all sorts of seeding, planting, pruning and maintenance of hedgerows and trees along with the management of wildlife species, aquatic plants and wildlife and the construction of wildlife tunnels and underpasses and so on.

Where required by the contract, this work is to be measured in a separate bill within the Roadworks bill. Payment for some of this work will be made in stages, and this is to be made clear in the contract documents.

8.7.3 Definitions

MMHW Chapter I is a 'must-read' chapter because it contains definitions of terms used in the MMHW that may either be unusual or not the normally accepted meaning. For instance:

- **Definition 1(c)**
  'Bill of Quantities' *means a list of items giving* ***brief identifying descriptions*** *and* ***estimated quantities*** *of work comprised in the execution of the works to be performed.*
  The BQ does not, therefore, describe the nature and extent of the work required which is the function of the drawings and the specification.
- **Definition 1(d)**
  Items designated 'Provisional' *are items for which the quantities of work to be executed* ***cannot be determined with the same degree of accuracy as other items*** *but for which it is deemed necessary to make provision.*
  Therefore, despite the fact that the BQ items are ***estimated quantities***, and thus subject to admeasurement, provisional quantities are deemed to be less accurate than 'estimated' quantities.
- **Definition 1(h)**
  'Hard Material' means the following:

  (i) *material so designated in the Preambles to Bill of Quantities; and/or*
  (ii) *material which requires the use of blasting, breakers or splitters for its removal but excluding individual masses less than 0.20 m^3;*

  This definition has changed over the years but is of profound significance as it determines whether or not the contractor will be paid additional monies for excavating materials that might be called 'more difficult than the norm'. The definition is further developed in MMHW Chapter III – *Preambles to Bill of Quantities*.
- **Definition 1(k)**
  'Designated Outline' means the designated outline shown on the Drawings.
  This unusual term is used in the MCHW to delineate parts of the works, such as structures or culverts, which are to be designed by the contractor or where a choice of designs is offered for contractors to choose from. Designated Outlines have implications as regards both measurement and pricing. This term should be distinguished from the term 'Earthworks Outline' which is defined in Series 600: *Earthworks*.

8.7.4 General principles

In order that tenderers are able to prepare a reliable and accurate tender and that the employer may depend upon the completeness of the price without fear of claims and cost overrun on the contract, certain basic principles are set out in Chapter II of the MMHW.

The first of these principles is that the MMHW is used for highway contracts using any form of contract. Secondly, unlike other standard methods of measurement, the nature and extent of the work to be performed is not contained in the BQ but is to be ascertained by referring to the drawings, specification and conditions of contract. Thirdly, the work covered by the respective items in the BQ is identified both by the various BQ subheadings and item descriptions **and** by the list of matters contained within the relevant 'Item coverage' marginal heading in the appropriate series of the method of measurement.

A further important principle is that tenderers are provided with full details of the construction requirements of the contract, which, in practice, means that:

- The tender documents are based upon a completed design.
- The design work is based on a complete site investigation.
- The full extent of work required by the contract is shown on the tender drawings.

The various parties to highway contracts will view these ideals with a degree of cynicism as they are rarely achieved in practice. Mitchell (2014) is especially critical of the standard of tender documentation and of the *cavalier approach* of compilers to their work.

The MMHW is based on the SHW and on the HCD published as Volumes 1 and 3, respectively, of the MCHW. However, amendments to the MMHW are sometimes required where additions or amendments to the SHW or the HCD are not adequately covered by the prevailing provisions of the method of measurement. Such amendments are accommodated in the Preambles to the Bill of Quantities as provided in MMHW Chapter III.

As far as BQ item descriptions are concerned, the guiding principle is that they are to be compounded from features contained in one or more of the groups listed in each series of Chapter IV of the Method of Measurement. The groups and features are to be found under the relevant marginal heading 'Itemisation'. *An item description may contain Features from as many Groups as necessary to identify the work required, but may include only one Feature from any one Group.*

8.7.5 Preambles to bill of quantities

Whilst the MMHW does not contain any specific 'rules of measurement', the 'standard' preambles that appear under the heading *Preambles to Bill of Quantities* in Chapter III come very close to being 'rules' without using that particular word.

Risk Issue

Being incorporated into the bill of quantities, the preambles assume contractual importance because the bill of quantities is usually a contract document.

Chapter III: *Preparation of Bill of Quantities* of the MMHW makes particular reference to the heading *Preambles to Bill of Quantities* which contains a number of matters that must be specifically included in the BQ as preambles. This includes several directions and statements that are important with regard to the contractor's pricing of the tender. In addition to the 'standard' preambles, any additional matters must be included as 'numbered' preambles, and any amendments to the method of measurement must also be listed.

There are 19 'standard' preambles with number 20 reserved for listing any amendments to the method of measurement. Some of the more important preambles are considered below:

Preamble 1

This states that the method of measurement shall be the MMHW, but, as previously mentioned, reference has to be made to the *Schedules of Pages and Relevant Publication Dates* to discover the method of measurement page number and date of publication that shall apply to the contract.

Preamble 2

Preamble 2 states that *the nature and extent of the work is to be ascertained by reference to the Drawings, Specification and Conditions of Contract*. This emphasises that the measured items in the BQ is purely a quantified list of items of work to be done and is not a complete description of the contractor's obligations under the contract.

Also in Preamble 2 is the first of what might be called 'measurement and/or coverage rules'. This informs the contractor as to what is deemed to be included in the rates and prices. This includes those that might usually be expected but also others that merit careful attention:

- Usual items
  - Labour, materials and plant including associated oncosts and the cost of fixing, erection and placing in position, waste, testing and checking, etc.
  - Establishment charges, overheads and profit although the distinction between establishment charges and overheads is not made.
- Unusual items
  - Significantly, temporary works are deemed included in the rates and prices because there is no separate provision in the MMHW (unlike CESMM).
  - The impact of anything *set forth or reasonably implied* in the tender documents on the phasing of the works or any element thereof.

Risk Issue

The MMHW makes no provision for method-related charges, either in the preliminaries or elsewhere. Such work is deemed included in the rates and prices.

Whilst Series 100: *Preliminaries* contains relatively few items, most contractors price temporary works and method-related charges here as there is both more opportunity to influence cash flow by doing so and such tactics reduce the risk of underpayment should the admeasurement process not work advantageously.

It is clear that Preamble 2 has implications for the contractor's programme, but specific constraints or requirements of the contract must be stated in Appendix 1/13 of the Specification.

Preamble 3

In this preamble under the heading of 'Measurement', the stipulation is made that *work shall be computed net from the dimensions stated in the Contract* unless otherwise indicated in the method of measurement. It is further stated that any work affected by 'pavements' shall be measured on the basis of the thinnest pavement construction. Other 'rules' are stipulated that relate to alternative specified designs, materials and options within types of pavement where the contractor is given a choice.

Preamble 4

This requires a rate or price to be stated against each item in the BQ. The use of 'nil' or 'included' is thus not acceptable, but a rate of £0.00 would be.

Preamble 6

This preamble raises the 'thorny' issue of public utilities such as gas, electricity and telephones and their infrastructure. The perennial question is, 'who is responsible for finding them and dealing with their support and protection during the works?'

In this preamble, the contractor is clearly reminded that it is his obligation under the contract despite any information that might be furnished in the tender documents. Therefore, whilst this information *is believed to be correct*, it is nonetheless down to the contractor to locate and deal with any existing services and to arrange with the appropriate utility company where existing services need to be interrupted. The preamble is silent on the issue of diverting any existing services that the contractor might have located during the works.

Preamble 9

Preamble 9 is important because it deals with the issue of water – both tidal and non-tidal open water. Dealing with existing flows of water and sewage is covered in Preamble 10.

Unlike CESMM, where excavation below a body of open water is measured, under the MMHW it is not. Additionally, no provision is made in the MMHW for the separate pricing of sheet piling, cofferdams and the like, whereas under CESMM the contractor has the opportunity to price a separate method-related charge.

Risk Issue

Contractors should be aware that their rates and prices are deemed to include *taking measures required* to work within and below tidal water and non-tidal open water as well as undertaking any investigations into water boundaries, levels or tidal and non-tidal ranges.

Preamble 10

Here, the MMHW states that the contractor must include for *taking measures to deal* with existing flows of water and sewage and the like in the rates and prices. This would include diverting flows, sandbagging and pumping as necessary. Again, this preamble is to be contrasted with CESMM where method-related charges would be provided in the BQ.

Preamble 13

Of prime significance in the *Preambles to Bill of Quantities* is Preamble 13 as this concerns the often contentious issue of Hard Material – formerly 'rock'.

Hard material is measured 'extra over' (EO) excavation because of the relative cost of removing such material, if encountered. Hard material is only measured in Series 300: *Fencing*, 500: *Drainage and Service Ducts* and 600: *Earthworks* although it is included in the item coverage in a number of other series.

Risk Issue

In series where the excavation of hard material is included in item coverages, but is not measured in that series in the bill of quantities, the contractor's rates and prices must include for the excavation of hard material where its presence can be reasonably inferred from the contract documents.

This is not to say that the contractor will not be paid for excavation in hard material if unexpectedly encountered but that there will be no measured item and no admeasurement.

Where the contractor believes that entitlement is due the matter will be subject to a 'claim' or 'compensation event'. The terms of the contract, and whether or not the contract documents were clear, will be key, and a great deal will also depend upon the ground investigation reports and the contractor's own site investigations.

Albeit hard material is subject to admeasurement in Series 300, 500 and 600, it is incumbent upon the overseeing organisation to ensure that the quantities of hard material included in the BQ represent, as accurately as possible, the circumstances that the contractor is likely to encounter as this has a direct impact upon his choice of construction method and pricing.

Hard Material is defined in MMHW Chapter I *Definitions* (Definition 1(h)) which states that it is:

(i) *material so designated in the Preambles to Bill of Quantities; and/or*
(ii) *material which requires the use of blasting, breakers or splitters for its removal but excluding individual masses less than 0.20 m^3;*

The definition of Hard Material in Definition 1(h)(i) is expanded in Preamble 13 to include:

a) ..... *strata*[9]*;*
b) *those deposits designated by limits shown on the Drawings;*
c) *existing pavements, footways, paved areas (but excluding unbound materials) and foundations in masses in excess of 0.20 m^3.*

a) Strata will be identified as granite, chalk, limestone and so on according to perusal of the ground investigation data.
b) Deposits designated by limits shown on the drawings will be interpolated from borehole records which will enable an 'assumed line' of hard material to be drawn.
c) Existing pavements, footways, paved areas, etc., whether buried or at surface level, should be shown on the drawings or, alternatively, will be obvious once encountered on-site.

This topic is further developed later in this chapter.

Preamble 15

Where parts of the permanent works are to be designed by the contractor, the rates and prices shall include for the costs of incorporating the design into the works. This includes the cost of design preparation, drawings and other data, certification, testing and sampling, etc. The contractor also has to allow for the time and cost implications of submissions of designs for approval and for any modifications and resubmissions necessary.

Preamble 16

For each priced BQ containing a single item with respect to structures to be designed by the contractor, the contractor must subsequently prepare a *priced schedule of quantities* for the structure in question showing quantities, rates and prices totalling to the single figure stated in the priced BQ submitted at tender stage. The contractor's priced schedule must be prepared in accordance with the MMHW.

The reason for this requirement is so that the post-contract issues of payment and valuation of variations may be correctly administered and for no other reason.

The same rules apply should the contractor decide to design a structure himself as opposed to one designed by the overseeing organisation.

The contractor shall include in the priced schedule of quantities all the parts of the works within the designated outline with the exception of those designed and scheduled by the overseeing organisation as not to be included.

Preamble 18

Highway works are subject to a great deal of testing both to verify workmanship, goods and materials incorporated into the permanent works and to test the permanent works in order to prove the overseeing organisation's design. The contractor's rates and prices are to include such tests as determined by Preamble 2(x).

Testing of existing structures and other investigative works shall be individually measured within the relevant series.

Should procedural trials, trial panels and trial areas be required in advance of the permanent works, they shall be included in the item coverage for the relevant series. The trial erection of structural steelwork is measured separately in accordance with Series 1800.

Preamble 19

Where works of Landscape and Ecology are required, the rates and prices in the BQ for new planting, seeding and turfing under Series 3000 shall include for all post-planting maintenance work required by the contract documents.

A *Staged Payments Schedule* is to be inserted in the Bill of Quantities immediately preceding the collection page for Landscape and Ecology that shall be used for assessing payments due. This provision is intended to reflect the scope and duration of the planting and post-planting requirements of the contract which differ from the normal run of highway works.

Preamble 20

Pursuant to Paragraph 1(b) of Chapter II *General Principles* of the MMHW, additions or amendments to the SHW or the HCD which are not adequately covered by the Method of Measurement require suitable amendments to be made. Preamble 20 is reserved for this purpose in order to bring such amendments to the Method of Measurement into a particular contract. The MMHW is thus deemed to be amended in accordance with the pages that appear in this preamble.

8.7.6 Chapter IV: Units and method of measurement

Volume 4 of the Manual of Contract Documents – *Bills of Quantities for Highway Works* – consists of three sections. The first two – *MMHW* and *Notes for Guidance on the Method of Measurement for Highway Works* – must be read in conjunction with each other in order to understand how the method of measurement is intended to work, and the third, *LSID*, is indispensable when forming descriptions of the work to be measured.

This is an unusual arrangement as most standard methods of measurement, to a large extent, combine all three in the one document. The CESMM, for instance, combines Volume 4 Sections 1 and 3 in the three divisions of each class of measured work and in the additional description rules, whilst Section 2 is to be found in the accompanying measurement and definition rules.

To a certain extent, this structure creates a problem with regard to defining the prevailing Method of Measurement in the Appendix to the Form of Tender (ICC – Measurement Version) or Contract Data (ECC with Options B and D) as the Method of Measurement is separate from the other two sections whilst, at the same time, being entirely reliant upon each of them. This distinction is made clear in Volume 4 Section 1 Chapter III: *Preambles to Bill of Quantities* which states that:

> *The Bill of Quantities has been prepared in accordance with the Method of Measurement for Highway Works published by The Stationery Office as* ***Section 1*** *of Volume 4 of the Manual of Contract Documents for Highway Works.*

From this, it is evident that Sections 2 and 3 are not intended to be contractual, and Mitchell (2014) confirms this view.

Risk Issue

Disputes concerning interpretations of the MMHW or the correct formulation of item descriptions could well arise between overseeing organisations and contractors who may find themselves disagreeing over whether or not non-contractual documents should be relied upon to clarify a 'grey area' of measurement detail.

8.7.7 Series

Rather than the usual 'work sections', the various measured sections in Chapter IV of the MMHW are categorised into 'series'. These series are numbered to coincide with the numbering system employed in Volume 1: *SHW*.

Series 100: *Preliminaries* is followed by Series 200: *Site Clearance* and culminates with Series 5000: *Maintenance Painting of Steelwork*. Other series include Series 500: *Drainage and Service Ducts*, Series 600: *Earthworks* and Series 1600: *Piling and Embedded Retaining Walls*.

Some series, such as 800, 900 and 1000, are 'not taken up' which means that the equivalent series in the SHW are not measured. This is because these series are purely 'specification' series and do not contain work items as such. Other series 'not taken up' are 2200, which is 'not used' in the SHW and 2600: *Miscellaneous* which contains specifications for bedding mortar, types of concrete and fencing which are either measured in other series or are included within 'item coverages' in other series.

Each series has a title (e.g. Series 1200: *Traffic Signs and Road Markings*) followed by a number of main headings which represent work to be measured (e.g. Traffic Signs, Remove from Store and Re-erect Traffic Signs, Road Markings and Road Studs, etc.). Each main heading has three subheadings (marginal headings) – that is, Units, Measurement and Itemisation. Under the marginal heading 'Itemisation', there is a list of separate items that shall be provided in the BQ. These items are categorised into discrete 'groups', and each group has at least one feature.

8.7.8 Groups

Each series in the MMHW is hierarchical which means that, for instance, *Traffic Signs* is a subset of Series 1200: *Traffic Signs and Road Markings*. *Traffic Signs* is then divided into seven groups (I–VII) which enable item descriptions to be built up for different types of traffic signs of different sizes and having different types of support structure. Each group has one or more features, but an item description can only contain one feature from each group.

8.7.9 Features

Group I of *Traffic Signs* has two features:

1. *Permanent traffic signs*.
2. *Prescribed temporary traffic signs*.

These two features could clearly not be combined in the same item description as a traffic sign could not be both permanent and temporary!

Within the marginal heading *Permanent traffic signs* is the 'item coverage' for that feature which lists what is deemed to be included in a BQ item for *Permanent traffic signs*.

8.7.10 Item coverage

Item coverage is a list of items that are deemed to be included in any item description to which they relate. This is illustrated in Table 8.4 which shows the item coverage for a Series 600: *Earthworks* extra over item of excavation in hard material.

Table 8.4 Item coverage.

Extra over excavation for excavation in hard material	**23** The items for extra over excavation for excavation in Hard Material shall, in accordance with the Preambles to Bill of Quantities General Directions, include for:
Item coverage	a. Preliminary site trials of blasting b. Blasting, splitting, breaking and the like c. Cutting through reinforcement d. Saw cutting and trimming e. Removal of existing paved areas by course or layer, cleaning surfaces, milling or planing, stepping out and treatment to bottoms of foundations

Risk Issue

It is important to remember that all the items in the item coverage 'list' are not necessarily required for a specific item on a specific contract. This is because it is the specification and drawings for that contract which determine the work required for that contract. This, in turn, determines the items that are deemed to be drawn from the list for that specific item of work.

Consequently, for the example shown in Table 8.4, the contractor must allow in his rates for cutting through reinforcement but only when the presence of reinforced concrete is indicated in the borehole logs or on the drawings.

It will be noted that the item coverages of the various series of the MMHW do not include the provision of labour, materials, plant, overheads and profit, etc.

Consequently, item coverages must be read in conjunction with MMHW Chapter III: *Preambles to Bill of Quantities*, General Directions, Paragraph 2, which provides a generic item coverage that applies to all items. This paragraph, coupled with a specific item coverage, makes the contractor's rates 'fully inclusive' of labour, material, plant, overheads and profit, etc.

Risk Issue

General Directions Paragraph 2 also includes Temporary Works and the effect on the phasing of the works or any element of the works *to the extent set forth or reasonably implied in the documents on which the tender is based*.

'Temporary Works' is not defined in paragraph 1 of MMHW Chapter I: *Definitions*, and care needs to be exercised when interpreting the specification, drawings and conditions of contract for a specific project as to what exactly the contractor is to deemed to provide.

The provision and removal of haul roads and the order and sequencing of operations, for instance, are not included in the item coverage for earthworks neither are there any method-related items measured in the Series 100: *Preliminaries* in the MMHW.

8.7.11 Written short item coverage

In a number of series of the MMHW, the item coverage is 'written short' either in whole or in part to varying extents. This means that the item coverage for a particular item of work refers to the item coverage of another item elsewhere for the detail as to what is deemed to be included in the item in question.

An instance of this appears in Series 1600: *Piling and Embedded Retaining Walls*, Paragraph 28, with respect to the item coverage for reinforcement for cast-in-place piles which shall include for:

a) Reinforcement (as Series 1700 Paragraph 26).
b) Bending projecting reinforcement.

The written short item (a) is expanded in Series 1700: *Structural Concrete* Paragraph 26 which states that items for reinforcement shall include for:

a) Cleaning, cutting and bending.
b) Binding with wire or other material.
c) Supports, cover blocks and spacers (except for steel bar supports to reinforcement where shown on the drawings).
d) Extra fabric reinforcement at laps.
e) Welding.
f) Mechanical connections.

Risk Issue

The principle that an inclusion in the item coverage only applies where stated in the specification or shown on the drawings applies to written short item coverages as well.

8.7.12 Units of measurement

The unit of measurement to be used for specific work items is given under the marginal heading 'Units' for each subheading of each series. Therefore, *Traffic Signs*, being a subheading of Series 1200: *Traffic Signs and Road Markings*, has a given unit of measurement which is stated as 'number'.

Approved units of measurement are given in Chapter III: *Preparation of Bill of Quantities* of Volume 4 of the MCHW which also lists the abbreviations to be used. Most units and abbreviations are those commonly used in other methods of measurement, but some are more unusual because they relate specifically to roadworks (e.g. vehicle week/v. week and vehicle day/v. day).

Chapter III also requires that *Quantities shall be expressed in whole numbers except for units of measurement of tonnes and hectares in which case the quantities shall be to three decimal places.*

8.7.13 Measurement rules

Unlike other standard methods of measurement, the MMHW does not have extensive 'measurement rules' in the sense that a great deal of prescription is given to what shall and shall not be measured and how. Such measurement rules as there are in the MMHW are to be found under the marginal heading 'Measurement' in each series, and they tend to be simple in nature. For example:

- *The measurement of precast copings, capping units, plinths and the like shall be the measurement along the centre line.*

- *The measurement shall be the area of formwork which is in contact with the finished concrete but measured over the face of openings of 1 m² or less and features described in (c) below.*

Whilst some series have fairly extensive 'measurement rules' (e.g. Series 600: *Earthworks*), others are minimalistic as the MMHW tends to place greater reliance on 'item coverage' and the drawings in order to convey what is 'ruled in' and 'ruled out' of an item of work. This is backed up by the specification together with any project-specific numbered appendices that might be included in the documentation.

There may well be dangers in this approach to measurement from a claims point of view and Mitchell (2014) is critical that a fundamental principle of measurement – clarity – is lost by virtue of the lack of measurement rules. Others might argue that less adversarial approaches to contracting mitigate against the need for extensive measurement rules and that a more 'crude' approach to measurement is the future for the 'BIM world' of a modern construction industry.

8.7.14 Relationship with contract

In common with other methods of measurement, the MMHW is not a contract document. Standard practice is to incorporate a method of measurement in the contract by specific reference, and this is how it works with the MMHW.

For instance, Clause 57 of the ICC – Measurement Version states that the method of measurement shall be the CESMM Third Edition 1991 *or such later or amended edition thereof as may be stated in the Appendix to the Form of Tender*. In the Appendix – Part 1, footnote 'e' requires *any amendment or modification adopted if different to that stated in clause 57* to be inserted in the space provided.

In the ECC (Options B and D), the method of measurement is that stated in the Contract Data Part 1 along with any amendments thereto.

8.8 Item descriptions

The modern trend in methods of measurement such as NRM2 and CESMM is towards brief item descriptions supplemented by drawings and other documents. This is the approach taken by the MMHW, but brevity is taken to a new level in this method of measurement. The absence of specification information in item descriptions contributes significantly to this because MMHW billed items do not attempt to fully describe the nature and extent of the contract works contrary to the approach taken by other methods of measurement.

MMHW item descriptions are derived in a different way to other approaches to measurement and instead rely upon:

- Groups and features listed in each series of Chapter IV of the MMHW.
- 'Root narratives' taken from the LSID.
- 'Item coverages' listed under each subdivision of each series of the method of measurement.

8.8.1 Groups and features

The first port of call for compiling item descriptions is the marginal heading 'Itemisation' under each subheading of each series of the method of measurement. This is where the 'groups' and 'features' reside which make up the hierarchy or 'family tree' of MMHW item descriptions.

A specific BQ item may comprise any number of groups required, but not more than one feature from each Group may be used in any one item description. In Table 8.5, it can be seen

Table 8.5 Itemisation of headwalls and outfall works.

Group	Feature	
I	1	Headwalls
	2	Revetments
II	1	Different types
III	1	Different materials
IV	1	Pipe not exceeding 100 mm internal diameter
	2	Pipe exceeding 100 mm but not exceeding 300 mm internal diameter
	3	Pipe exceeding 300 mm but not exceeding 600 mm internal diameter
	4	Pipe exceeding 600 mm but not exceeding 900 mm internal diameter

that the itemisation of **Headwalls and Outfall Works** in Series 500: *Drainage and Service Ducts* is categorised in four Groups.

Group I of the itemisation comprises two features, **Headwalls** and **Revetments**. Headwalls are structures used to terminate land drainage pipes and culverts at their inlet and outfall in order to minimise erosion of the banks of watercourses. Revetments are similarly used to line watercourses in order to prevent erosion especially at times of flooding or heavy seasonal rains.

Headwalls come in different shapes and sizes and are constructed from different materials with different diameters of inlet and outlet pipes. Consequently, further itemisation is needed to create a clear and comprehensive item description. This is provided in Groups II–IV.

Whilst the itemisation provided in the method of measurement could be used to construct an item description, it can be seen that the eventual description would lack consistency as each bill compiler would undoubtedly use different phraseology. Standardisation is provided by the LSID which is Section 3 of Volume 4 of the MCHW. The basis of this standardisation is the 'root narrative'.

8.8.2 Root narratives

The LSID is organised in 'series' that correspond to those contained within the MMHW itself. This is a master library which creates directly comparable BQ whether produced by manual billing or computer software packages.

Item descriptions based on the LSID are drawn from standard item descriptions that contain numbered inserts. These standard item descriptions are called 'root narratives'. By using a numbered variable from the appropriate numbered group, unique item descriptions can be produced for all standard work on a highway project.

Within each series of the LSID, the applicable root narratives are firstly listed, and these are then followed by a list of available 'variables'.

The root narrative for a headwall, for instance, is provided by Item 27 of the LSID. Headwalls are a subset of the **Headwalls and Outfall Works** subsection of Series 500: *Drainage and Service Ducts*. An extract from the relevant section of the library is illustrated in Table 8.6. For a revetment, Item 28 would be used.

Table 8.6 Root narrative.

Headwalls and outfall works		
Item	*Root narrative*	*Unit*
27	Headwall 22*23* to pipe 24*	No
28	Revetment 22*23* to pipe 24*	No

It can be seen in both cases that the root narratives contain three variables, 22*, 23* and 24*. These are listed in the LSID as Group 'variables' as shown in Table 8.7. Each variable allows the bill compiler to create a standard item description whilst retaining consistency of phraseology. The type (i.e. design configuration) of headwall or revetment will be shown on a drawing or standard detail, for example, Headwall Type A, B, C, etc.

Table 8.7 Group variables.

Group	Variable	
22*	(i) etc.	=[stated type]
23*	(0)	=no entry
	(i)	=in brickwork
	(ii)	=in mass concrete
	(iii)	=in reinforced concrete
	(ii) etc.	=[stated material]
24*	(i)	=not exceeding 100 mm internal diameter
	(ii)	=exceeding 100 mm but not exceeding 300 mm internal diameter
	(iii)	=exceeding 300 mm but not exceeding 600 mm internal
	(iv)	=exceeding 600 mm but not exceeding 900 mm internal diameter

In order to construct a BQ item for a headwall, the root narrative would be **Headwall 22* 23* to pipe 24*** where:

- Variable 22* is the stated type of headwall.
- Variable 23* is the material used to construct the headwall.
- The pipe diameter around which the headwall is to be constructed is given by variable 24*.

Consequently, Headwall Type A, constructed of reinforced concrete with an inlet/outlet pipe diameter of 750 mm, would be described using the standard phraseology of variables 22(i), 23(iii) and 24(iv). The eventual item description would be:

- **Headwall** Type A (**22***).
- In reinforced concrete (**23***).
- **To pipe** exceeding 600 mm but not exceeding 900 mm internal diameter (**24***).

NB: Where the bold type represents the root narrative.

This process is illustrated in Figure 8.3 using the MMHW Library of the QSPro software package.

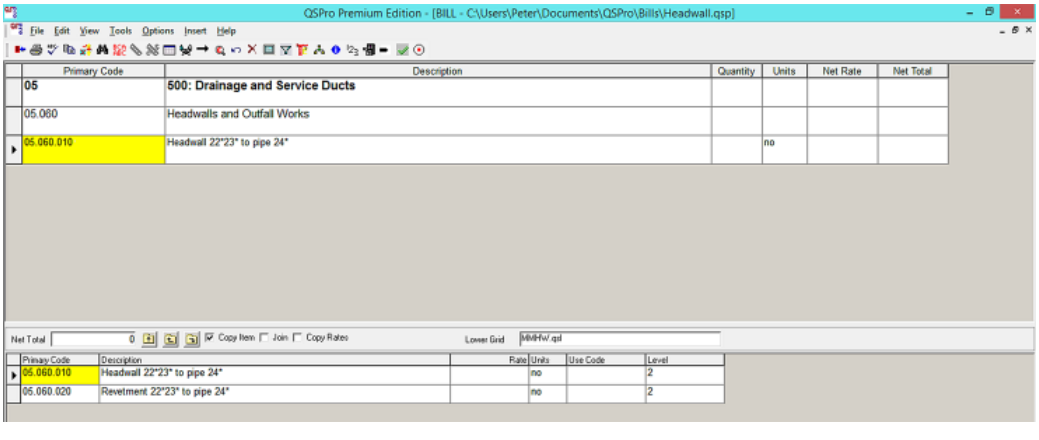


Figure 8.3 Root narratives.

The root narrative variables (e.g. 22*) would not appear in the eventual item description which would read:

> Headwall Type A in reinforced concrete to pipe exceeding 600 mm but not exceeding 900 mm internal diameter.

Where a variable is not listed in a group, but would naturally belong there, it may be added to the group and numbered sequentially.

Rogue items – that is, those which cannot be compiled from the standard root narratives in the library – may be drafted using the same principles as those upon which the library is based. Rogue items not included in the library but which consistently recur may be forwarded to the HA for evaluation and possible inclusion in standard amendments that may be issued from time to time.

8.8.3 *Item coverage*

As previously discussed, item coverage is a list of items that is deemed to be included in any item description to which it relates.

'Item coverage' appears as a marginal heading and normally relates to a specific Group I feature of each subsection of each series under the Itemisation marginal heading. Sometimes, the item coverage applies to all the Group I features of the subsection as is the case with Drainage and Service Ducts in Structures. This is illustrated in Table 8.8 and Table 8.9 which shows the item coverage for **Drainage and Service Ducts in Structures.** Table 8.9 demonstrates that each of the Group I features of this subsection of Series 500: *Drainage and Service Ducts* has the same item coverage.

Table 8.8 Drainage and service ducts in structures.

Group	Feature	
I	1	Drainage
	2	Service ducts
II	1	Substructure – end supports
	2	Substructure – intermediate supports
	3	Superstructure
	4	Reinforced earth structure
	5	Anchored earth structure

Table 8.9 Item coverage for drainage and service ducts in structures.

Drainage and service ducts in structures	**55** The items for drainage and service ducts in structures shall in accordance with the Preambles to Bill of Quantities General Directions include for:
Item coverage	a. Drains, service ducts, filter drains, fin drains and narrow filter drains and connections (as this Series Paragraphs 16, 22, 28 and 32) b. Chambers (as this Series Paragraph 37) c. Gullies (as this Series Paragraph 38) d. Pipework, gullies, downpipes, fittings and the like including brackets, hangers and straps, fixing to or building into the structure e. Making good protective system and waterproofing f. Permeable backing including compaction and supports g. Channels

The item coverages that appear in the MMHW emanate from the SHW and the HCD, but, contrary to common perception, the item coverage does not represent an estimator's 'shopping list'. The item coverage must be read in conjunction with the drawings and specification for each project in order to understand whether all, or just some, of the items listed are to be included in the contractor's rates and prices for that project.

Failure to understand this important principle can lead to considerable inaccuracies in pricing and potential claims that can foster ill feeling and disputes. However, misunderstandings can also arise because item coverages are not fully inclusive as they do not include:

- Items that are contingently and indispensably necessary.
- General obligations set out in the conditions of contract.
- Specific obligations set out in the *Preambles to Bill of Quantities*.

The first two bullet points raise the issue of completion and, in particular, the contractor's general obligation to construct and complete the works. The usual obligation is that the contractor will provide everything necessary for completing the works whether specified in the contract or to be reasonably inferred from it – such as cement in mortar and concrete and fixings for fencing, safety barriers and the like.

Therefore, provided that the rules of the method of measurement have been observed by the bill compiler, the contractor must carry out any work, whether described or not, which is obviously (or **indispensably**) necessary, on a true construction of the contract, to complete the works. Additionally, the contractor will be obliged to carry out anything **contingently** necessary, short of the impossible, in dealing with problems arising from the carrying out of the contract barring, of course, any relief granted by specific contract terms (Loots and Charrett, 2009).

The third bullet point signals the importance of referring to the *Preambles to Bill of Quantities* which is to be found in Chapter III of the Method of Measurement for Highway Works and, in particular, to Paragraph 2 thereof. This is where the contractor is alerted to the items that his rates and prices shall be deemed to include such as labour, materials, plant and equipment, overheads and profit and to his *general obligations, liabilities and risks involved in the execution of the Works*.

Risk Issue

It is vitally important to include the *Preambles to Bill of Quantities* in every contract, irrespective of whether the MMHW is amended or not, because it is via the preambles that 'item coverage' is incorporated into the bill of quantities as demonstrated by the wording of Paragraph 2 referred to above:

In the Bill of Quantities the sub-headings and item descriptions identify the work covered by the respective items, read in conjunction with the matters listed against the relevant marginal headings 'Item coverage' in Chapter IV of the Method of Measurement for Highway Works, these Preambles and the amendments to the Method of Measurement immediately following these Preambles.

When reading item coverages, attention must be paid to any references made to item coverages in other series of the method of measurement. This type of abbreviation, known as 'written short', tempts the reader to think that the 'written short' item coverage applies in its entirety to the original item coverage.

For instance, in Series 500: *Drainage and Service Ducts*, the item coverage for **drainage and service ducts** is provided in Paragraph 16. Within Paragraph 16, the following entry is found:

(j) Formwork (as Series 1700 Paragraph 15).

Reference to Series 1700, Paragraph 15, reveals an item coverage that includes the erection of trial panels, falsework and all sorts of labours and intricate details and finishings. Such requirements have no place in formwork for drainage work, and these particular elements of the item coverage would clearly not apply in practice. As is generally the case with item coverage, reference must always be made to contract-specific drawings and specification amendments to reveal exactly what is required under the contract. A dash of 'common sense' also helps!

8.9 Contractor design

On the face of it, a section on contractor design in a chapter about the Highways Method of Measurement may seem strange as, surely, any requirement for a contractor-designed element in a highway project would imply that the contractor will assume responsibility for preparing the quantities for the contractor-designed element. True, but, in the MCHW, contractor-designed elements have a significant influence on how the tender documents are prepared and, in particular, the tender BQ.

Procurement strategies for the design, construction and maintenance of UK highways have changed significantly since the early 1990s. Roadworks entirely designed by the employer's 'in-house' or consultant engineer have become a thing of the past, and DBFO roads are common. The United Kingdom has a number of privately financed toll bridges and tunnels, and the first toll motorway, the Birmingham Northern Relief Road, was opened in late 2003. Even highway maintenance is largely carried out on the basis of contractor design and delivery using a type of term contract.

There is a wide variety of choice available to overseeing organisations for contractor involvement in the design of highway schemes:

- Full contractor design
  - Contractor design of a highway scheme (e.g. a new bypass).
  - Contractor design within a DBFO scheme (e.g. toll bridge).
  - Contractor design and delivery of maintenance works.
- Partial contractor design
  - Design of proprietary structures within an engineer design (e.g. culvert).
  - Design of proprietary elements within an engineer design (e.g. bridge bearings).
  - Design of 'special structures' as an alternative to a non-proprietary engineer design (e.g. a small-span footbridge).
  - Design of temporary works (e.g. special temporary works such as falsework for major and complex structures, temporary works that are alongside or temporarily support or span live carriageways or railway lines, etc.).
  - Design of temporary structures (e.g. bridge lifting systems, demolition of existing structures, support systems and platforms over or adjacent to highways, railways, watercourses, etc.).

This chapter is concerned with the measurement and billing of partial contractor design because the MCHW, and the Highways Method of Measurement in particular, contain no provisions for full contractor design.

8.9.1 Contractor design involvement

Contractor design in highway construction was slow to 'catch on', largely due to the haphazard introduction of the implementation standards and advice notes needed by participants in order to understand the procedures (Mitchell, 2014), but the 'powers that be' were no doubt prompted

by the scathing criticism levelled at the DTp by the National Audit Office in its 1992 report *Contracting for Roads* (National Audit Office, 1992). Amongst a plethora of reproaches were observations concerning high project outturn costs, late completion and the proliferation of contractual claims on highway projects.

In the early days of large highway contracts, there was little or no design involvement on the part of the contractor and no limitation, apart from cost efficiency, on the engineer's design choices. A bridge design, for example, could include any combination of materials and methods for the supports and deck and any choice of structural elements, such as piles, bridge bearings and movement joints. Common practice was for the engineer to specify *Messrs ABC Precast Concrete Driven Piles* or *Messrs Acme Bridge Bearings* 'or other equal and approved', and this gave tenderers the chance to offer an alternative supplier, perhaps at a more competitive price.

This arrangement changed a little over the years, but it was not until 1992 that such practices were deemed to constitute a 'barrier to trade' and had to be stopped pursuant to the Single European Act of 1986. It was at this time that the engineer's hands became tied and the freedom to specify any preferred products or materials was curtailed.

8.9.2 The Single European Act

Highway schemes are normally large and complex projects comprising a wide variety of elements such as carriageways, bridges, culverts, underpasses, safety barriers, street lighting and communications installations, etc. These elements are specified in the various series of the SHW which assists engineers to design using their preferred combination of materials, products and methods.

The aim of the Single European Act was to prevent the specific naming of any 'proprietary' materials and structures in the tender documents in order that specified manufacturers and installers did not have an unfair advantage over their competitors. This meant that discrimination against Member States, whose materials and products could otherwise be eligible for use on highway projects within the EU, was outlawed in favour of a 'neutral' means of specifying and contractor choice. The impact of this was significant on the design, specification and measurement of highway works.

8.9.3 Barriers to trade

A barrier to trade is one where an unfair advantage is given to one product over its competitors or where EU member states are put at a disadvantage, due to the way that a design is presented and specified. It is also a barrier to trade where a design discourages innovation in product development.

Prior to 1992, contractors were able to tender for highway contracts on the basis of 'alternative specified materials' that were both approved and equal in every respect to those specified in the tender documents. This was, and still is, common practice in the construction industry as it provides a competitive element to tenders.

As far as Highways England is concerned, however, the concept of 'alternative specified materials' is thought to constitute a 'barrier to trade' on the basis that it does not comply with the Single European Act. Other public authorities, bound by the same legislation, take a different view of the law, and Mitchell (2014) believes that the Highways England approach amounts to *overkill*.

Nonetheless, the 'bottom line' is that, since 1992, the MCHW has contained complex arrangements to ensure that barriers to trade are avoided and this has made the measurement and billing of certain elements of highway projects quite complex and, in some instances, unworkable according to Money and Hodgson (1992) and Mitchell (2014).

Despite such eminent opinion, 'we are where we are', and so, in order to overcome the 'barrier to trade' problem, specifiers (e.g. the employer's engineer) must not only avoid stipulating specific 'proprietary' materials in their design, and leave the choice and design of such materials to the contractor, but also wrestle with complex measurement and billing issues.

8.9.4 Proprietary products

Proprietary products are those manufactured and supplied under a brand name (e.g. Acme Box Culverts) and are defined in the DMRB as ***a structure*** *with CE marking* ***or product*** *with CE marking manufactured to a system covered by a patent and/or a registered design.*

The issue with the MCHW is the avoidance of any implication in the engineer's design or specification that a particular proprietary material is preferred. There is no limitation on engineer-designed structures using non-proprietary materials (e.g. reinforced concrete), and the engineer is free to design a structure using non-proprietary materials, even where a proprietary structure could be used, provided that the design choice is made for sound engineering reasons.

8.9.5 SHW Clause 106

The need to avoid 'barriers to trade' prompted the introduction of Clause 106: *Design of the Works by the Contractor* in the 1992 SHW. This signalled an important change as it affected both the specification of materials for highway works and also introduced the idea of contractor design of structures, structural elements and other features where:

- Proprietary materials are habitually used.
- Proprietary materials could be proposed as a suitable alternative to a conventional design.

Consequently, because of the need to avoid barriers to trade (restriction of competition and discouragement of innovation), the choice and design of such products are not specified in the tender documents anymore but are left to the contractor. Just how this may be achieved in practice is not easy as not only are the resulting measurement and billing issues complex but also Highways England does not consider the following methods to be acceptable either:

1. A general arrangement drawing based on a proprietary product with the caveat 'or equivalent' (although other public bodies bound by the same legislation accept this method as legitimate).
2. A detailed design based on non-proprietary materials with the opportunity for the contractor to propose an alternative design based on a proprietary product.

Both methods are considered to be a barrier to trade because:

- Method 1 could imply preference for a particular manufacturer or product which is a 'barrier to trade'.
- Method 2 constitutes a disincentive to the use of proprietary products that could otherwise be employed and therefore also constitutes a 'barrier to trade'. The 'disincentive' is that tenderers may consider the *technical approval procedures* too onerous (Money and Hodgson, 1992).

There is an important caveat to Method 2 in that *where the Engineer considers that a non-proprietary design and a proprietary system are more or less equal in terms of cost and performance, then both possibilities are run in parallel but the tenderer only prices his choice* (Money and Hodgson, 1992).

8.9.6 Avoiding barriers to trade

The need to avoid 'barriers to trade' as and from 1992 created the atmosphere for partial contractor design of highway projects, and the MCHW was drafted in such a fashion that this may be achieved in three distinct ways:

Method 1
: Contractor design of proprietary manufactured structures (e.g. box culverts, retaining walls).

Method 2
: Contractor design of proprietary manufactured structural elements as part of a non-proprietary engineer design (e.g. the bearings and movement joints of a large-span bridge).

Method 3
: Contractor design of structures where there is a choice of designs (e.g. engineer design of a non-proprietary small-span reinforced concrete underbridge and a contractor-designed proprietary alternative).

The measurement and incorporation of partial contractor design in the BQ for each of these methods must be considered separately because, although Methods 1 and 3 are similar, there are differences and Method 2 is quite different and poses considerable problems for the measurement and billing process.

8.9.7 Contractor design elements

From a risk perspective, partial contractor design as part of an engineer design is a completely different proposition compared with a full contractor design. In the latter case, competition will be limited, and risk will be reduced, by using a multistage procurement process. In a competitive tendering environment, on the other hand, it is obvious that the cost of preparing full designs for large elements of an engineer-designed highway project, weighed against the chances of winning the contract, is a risk too far for even the biggest contractors.

Given this situation, therefore, design and construct solutions for highway projects require careful procurement choices by the overseeing organisation, and, consequently, traditionally procured projects will, at most, employ the partial contractor design of relatively small elements of the works. The more usual elements that may be realistically designed by contractors as part of a competitive tender include:

- Structures, such as small bridges and earth retaining structures.
- Buried structures, such as culverts and underpasses.
- Environmental barriers.
- Structural elements such as ground anchors, piles, combined drainage and kerb systems, drainage channels, bridge bearings and bridge expansion joints.

These are referred to in the MCHW as 'Special Structures', and provision is made for them in the Specification and Method of Measurement in Series 2500.

8.9.8 Forms of construction

The type of structure most appropriate for a specific situation on a highway project will be one of the following:

- A uniquely designed structure, based substantially on non-proprietary materials such as reinforced concrete or structural steel, perhaps using some components that may be proprietary products; this would be largely designed by the engineer with some contractor design involvement.

- A proprietary manufactured structure, such as a precast concrete culvert selected from a manufacturer's catalogue of products, designed entirely by the contractor.
- A structure whose form of construction could equally be uniquely designed or of proprietary origin; the non-proprietary design would be prepared by the engineer and the proprietary alternative by the contractor.

In order to avoid the risk of discrimination, the designer must be able to demonstrate to the Technical Approval Authority (TAA) that all three types of structure have been considered prior to making a decision. This is done at the outline approval in principle (O/AIP) stage. However, the designer is not obliged to adopt any particular design if, after considering engineering and/or aesthetic issues, any of the options is considered inappropriate or if one option has clear advantages over the others.

Complications can arise when planning authorities do not approve of a particular design and written justification for their decision needs to be sought.

8.9.9 Technical approval of the design

Technical approval (TA) for a highway structure is a certification process whereby contractor-designed elements are categorised according to the extent of design checking needed.

The process is rigorous and time consuming and involves submitting an O/AIP application for design proposals. Applications to the TAA have to be made before designs can be implemented. The TAA is the overseeing organisation and might be a local county council where the authority is, or is to become, the highway authority, usually assisted by a firm of consulting engineers.

The process follows several distinct stages that the contractor must allow for both in the planning and pricing of the project:

1. Acceptance of the approval in principle (AIP) document which agrees the form of the proposed structure and its principal details together with traffic loadings and the technical standards to be employed. The category of the design check is also established at this stage.
2. Acceptance of a Design Certificate.
3. Acceptance of a Check Certificate.
4. Acceptance of a Construction Compliance Certificate including submission of as constructed drawings and a maintenance manual incorporating the health and safety file.

The 'Standard' for the Technical Approval of Highway Structures, BD2, is contained in Volume 1 Section 1 Part 1 of the DMRB. This standard outlines the procedures necessary for the successful adoption of proposed designs. The procedures, format and terms used in BD2 are intended to be contract neutral and may thus be used with any method of procurement, with the exception of DBFO contracts.

8.9.10 Contractual implications of contractor design

Under the ICC – Measurement Version form of contract, once the contractor's design has been approved, the overseeing organisation becomes responsible for *the integration and co-ordination of the Contractor's design with the rest of the Works* (Clause 7(7)).

This *does not relieve the Contractor of any of his responsibilities under the Contract* (Clause 7(7)) which includes taking *all reasonable skill care and diligence in designing any part of the Permanent Works for which he is responsible* (Clause 8(2)). This is the same standard of design liability as that expected of a professional designer as opposed to the higher, fit for purpose, standard of a design-construct contractor.

Under the ECC form of contract, Clause 21.1 states that the *Contractor* is to design those parts of the works stipulated in the Works Information and this design is to be submitted to the *Project Manager* for acceptance under Clause 21.2. The *Contractor's* design responsibility is normally limited to the professional standard of *reasonable skill and care* by using Option Clause X15, and the *Project Manager's* acceptance of the design does not change the *Contractor's* liability for his design (Clause 14.1).

The contractual requirement for proprietary manufactured structures is included in the contract by means of the O/AIP form which stipulates the criteria that must be applied to the detailed design of a highway structure by the contractor.

8.10 Measurement and billing of contractor-designed elements

The incorporation of contractor-designed elements into the tender documents, and into the BQ in particular, poses certain difficulties that have not entirely been overcome in the MMHW. There are three procedures according to the three ways of incorporating partial contractor design into the contract, that is,

1. For the design of proprietary manufactured structures.
2. For the design of proprietary manufactured structural elements.
3. For structures where there is a choice of designs.

Clearly, in a BQ prepared by the overseeing organisation, a contractor-designed element cannot be measured and billed at tender stage because each tenderer will probably approach the design differently and, in any case, there will likely be a multiplicity of design choices available. Additionally, care must be taken to ensure that the BQ is not drafted in such a way as to create a barrier to trade.

Consequently, where tenderers are to be asked to design and price a proprietary structure or an alternative to an engineer-designed structure, Series 2500: *Special Structures* of the Method of Measurement for Highway Works, the LSID and the Notes for Guidance must all be referred to. The measurement and billing of proprietary structural elements, however, follow the measurement rules, standard item descriptions and guidance in the series relevant to that item. In this case, Series 2500 does not apply.

In order to appreciate just where 'Special Structures' sit in the context of the overall BQ for a project, it must be remembered that a highway scheme is made up of a number of different 'bills'. This means that a separate bill is needed for proprietary structures to be designed by the contractor and another for structures where there is a choice of designs even though both are categorised as Series 2500: *Special Structures*. Each of these separate bills will be further subdivided as necessary (see Chapter 16 for examples).

The measurement and billing of proprietary structures, or alternatives to engineer-designed structures, depends on the use of a '**designated outline**' which delineates the boundaries of the structure in question. There is no designated outline for proprietary structural elements, however, and this raises complexities in the measurement and billing of such items.

8.10.1 Designated outline

The idea of a designated outline is to effectively separate proprietary manufactured structures to be designed by the contractor, and structures where a choice of designs is offered, from other works that must be measured and billed by the overseeing organisation.

A simple example is shown in Figure 8.4 which illustrates a designated outline for a small-span underbridge. Items not to be included in the contractor's design (or price) are listed in a schedule of excluded items.

Schedule of excluded items
• Main carriageway drainage
• Service ducts
• Cables
• Pavements
• Safety barriers
• Road markings

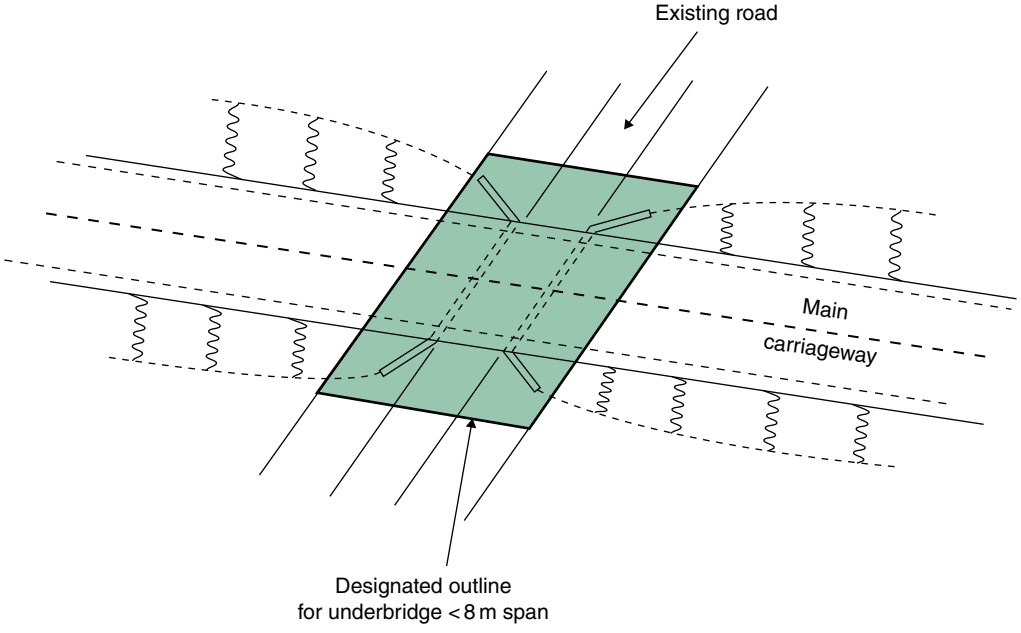


Figure 8.4 Designated outline.

The term 'designated outline' is defined, somewhat unhelpfully, in MMHW Chapter I: *Definitions* as:

- *the designated outline shown on the Drawings.*

However, this is followed by a note which, more helpfully, explains that:

A Designated Outline is shown as enclosing each structure to be designed by the Contractor and each structure for which a choice of designs is offered. The Designated Outline delineates the limits of measurement of work to be included for each structure (with the exception of those works scheduled as not to be included).

The *Notes for Guidance on the MMHW* is more expansive and lists several criteria that should be considered when selecting a designated outline:

- It should be given careful consideration.
- It should be clearly defined and fully enclosing.

- It should be sufficiently large to include any non-proprietary design of the overseeing organisation as well as all the possible options that the contractor might submit.

A designated outline is three-dimensional (3D) and, therefore, should define and fully enclose the foundations to structures and any special backfill requirements proposed by the contractor in response to the design requirements stipulated by the overseeing organisation. This may raise measurement and admeasurement issues as discussed later in the chapter.

Although beyond the scope of this book, requirements for the detailing of designated outlines may be found in Departmental Standard SD 4/92 and Appendices 1/10(A) and (B) of the Specification should contain details of the various options for special structures to be designed by the contractor.

Ideally, the designated outline should exclude common items such as pavements, kerbing, safety barriers, service ducts, cables, headwalls and the like. This is not always feasible though, and, if not, a schedule should be provided which lists the features that encroach into the designated outline but are to be excluded from the lump sum item. Such items shall be included elsewhere (e.g. in the Roadworks or other Bill) and priced as such.

Risk Issue

It should be carefully noted that all earthworks within the designated outline should be included in the contractor's price. This is because Paragraph 11 of Series 600: Earthworks specifically states that *Earthworks within Designated Outlines shall not be measured in this Series*.

Where common items such as those referred to above are integral to the structure to be designed, they should not be excluded from the lump sum item, and this should be made clear in the tender documentation.

Where a footbridge or small-span underbridge is to be designed by the contractor, the designated outline should be configured so as to ensure that the foundations are enclosed within it.

Risk Issue

Where the contractor's design requires alterations or variations, either to works outside the designated outline or to existing works, such alterations or variations shall not be included in any admeasurement as prescribed in Paragraph 16 of the Preambles to Bill of Quantities:

Unless specifically stated to the contrary in the contract the measurement of the works affected by the incorporation of the contractor's design shall be based on the tender documents and not on the works as amended and completed to incorporate the contractor's design.

8.10.2 Proprietary manufactured structures

Proprietary manufactured **structures** are essentially relatively simple structures such as box culverts, precast concrete small-span underbridges, crib and gabion walls and the like. Where such structures are required by the contract, they must not be specified in the tender documents but are left for the contractor to make the choice and carry out the design. This avoids the possibility of specifying or implying the adoption of a particular manufacturer.

Structures to be designed by the contractor are listed in the tender documentation in Appendix 1/10(A) of the Specification pursuant to Clause 106 of the SHW. Design criteria are stipulated on an O/AIP form *which records the agreed basis and criteria for the detailed design or assessment of a highway structure*. The contractor may then select a product that meets the O/AIP criteria which would then be subject only to checking and technical approval, should the contractor's tender be successful.

This arrangement is detailed in Annex D of BD2 *Design Manual for Roads and Bridges* which provides specific procedures for the approval of such structures. Proprietary manufactured structures may include:

- Various types of culvert.
- Small-span underbridges (up to 8 m span) in precast concrete.
- Various systems of earth retaining structures such as reinforced or anchored earth systems and crib and gabion walls.
- Lighting columns.
- Large sign supports (greater than 7 m high).
- Environmental barriers.

Some of these proprietary products will require Highways England-'type approval' pre-contract where this is not already the case.[10]

Because proprietary manufactured structures to be designed by the contractor cannot be measured and billed in the normal way like drainage, in situ concrete and surfacing, they must be included in the BQ in a special way:

- They must be listed in Appendix 1/10(A).
- They must also be identified and delineated in the contract by means of a **designated outline** shown on the drawings.
- They must be billed separately to other measured work.

Where proprietary structures are to be included in a contract, the following steps must be followed:

- The contractor must be free to choose and design proprietary structures in order to avoid a 'barrier to trade'.
- The location and extent of the work involved in each contractor-designed structure must be delineated on the drawings with a 'designated outline'.
- The designated outline must be extensive enough to include the extremities of the work envisaged including any foundations and special backfill.
- The work involved in proprietary structures must be billed separately from other non-proprietary work.
- Each structure to be designed by the contractor shall have its own BQ comprising a single item.

A worked example of how this might be done may be found in Chapter 16.

8.10.3 Structures where there is a choice of designs

In some situations, contractors will be invited to tender for a highway contract on the basis of providing a contractor design for a structure as an alternative to a design by the overseeing organisation. Consequently, where the overseeing organisation believes that there is little to choose between a proprietary and a non-proprietary design, the MMHW provides for the measurement and billing of such structures in Series 2500: *Special Structures*. Where this is the case, there will be no barrier to trade.

Series 2500 is the same one that is used for the measurement and billing of proprietary structures designed by the contractor, but the arrangements for measurement and billing are significantly different.

Structures that might be designed by the contractor as an alternative to one designed by the engineer are the same as those for proprietary structures to be designed by the contractor, with the difference that the engineer believes there to be little to choose between a proprietary and non-proprietary design. The structures in Series 2500 are:

- Buried structures.
- Earth retaining structures.
- Environmental barriers.
- Underbridges up to 8 m span.
- Footbridges.
- Piped culverts.
- Box culverts.
- Drains exceeding 900 mm internal diameter.
- Other structures.

The basis of this option for contractor design is fundamentally different to that for proprietary structures in that the contractor has choices to make and must decide:

- Whether to offer a contractor design or not (for proprietary structures, there is no choice other than to price the bill items or not submit a tender).
- Whether the time, effort and cost of preparing a design are commercially attractive.
- Whether the cost of preparing an outline design at tender stage is worthwhile considering the attendant risk of not winning the contract.
- Whether a design can be developed that is more cost efficient than that prepared by the overseeing organisation.

Risk Issue

It will be for tendering contractors to weigh these issues against the chances of winning the contract and to decide whether or not it is worth the additional cost of preparing a design in sufficient detail in order to be able to price the work involved into the tender bid.

Overseeing organisations have some choice as regards such designs, but, in the main, choices of materials are constrained by the need to avoid specifying proprietary products which would create a barrier to trade.

In common with proprietary structures designed by the contractor, structure(s) where a choice of designs is offered must be identified on the drawings by means of a **designated outline** that must fully enclose the design and delineate the limits of measurement of work to be included for each structure; the designated outline should define and fully enclose the foundations to structures and any special backfill requirements as before.

The major difference between designs for proprietary structures and designs for non-proprietary engineer designs is in the measurement and billing of the alternatives; this is determined by MMHW Chapter III: *Preambles to Bill of Quantities*, Paragraph 6:

- *where the Contract provides for a structure designed by the Contractor to be constructed as an alternative to the structure which has been designed by the Overseeing Organisation, a separate Bill of Quantities is to be provided for each of the two construction procedures permitted by the Contract.*

This means that two BQ are needed for each structure in addition to the main BQ for the remainder of the works, but only one of these additional BQ will be priced and included in the tender total pursuant also to Paragraph 6 which states that:

- *Provision is to be made for only the one Bill of Quantities which relates to the form of construction elected to be constructed by the Contractor to be priced and included in the Tender Total.*

A worked example of how this might operate is provided in Chapter 16.

Which additional BQ are included in the eventual contract depends upon whether:

- The contractor wishes to submit an alternative design for all or any of the structures listed in the appendix.
- An alternative design is more competitive than the engineer-based design.

Should the tender be successful and the contractor design adopted, Paragraph 16, *Structures Designed by the Contractor*, of the MMHW Chapter III: *Preambles to Bill of Quantities*, requires that:

- The contractor shall prepare **a priced schedule of quantities** in respect of each priced BQ comprising a single item for a structure designed by the contractor.
- This priced schedule shall be prepared in accordance with the relevant chapters and series of the MMHW.
- The priced schedule shall be submitted to the overseeing organisation.

Consequently, the contractor must be prepared for the time and cost of preparing a detailed BQ for each 'special structure' to be designed by him and must, furthermore, ensure that:

- The schedule of quantities is prepared according to the Method of Measurement for Highway Works.
- The extended total of the quantities, rates and prices in the priced schedule shall equate to the lump sum submitted at tender stage.

Paragraph 16 further states that the priced schedule of quantities shall only be used for:

- Payment applications.
- Valuation of variations ordered under the contract in connection with structures designed by the contractor.

8.10.4 Proprietary manufactured structural elements

Proprietary manufactured structural **elements** differ from 'Special Structures', whether designed by the contractor or the engineer, because they represent parts of a design and not a complete design in their own right.

Such elements include:

- Ground anchors.
- Piles.
- Combined drainage and kerb systems.
- Drainage channels.
- Bridge bearings.
- Bridge expansion joints.
- Etc.

Once again, the issue with proprietary manufactured structural elements is the avoidance of any implication in the contract that a particular product has preference over others that could equally well be selected. Therefore, structural elements, or other features of a design, cannot be specified where they are based on proprietary systems but must be designed by the contractor or a manufacturer and listed in Appendix 1/10(A) to the specification. This avoids the possibility of creating a 'barrier to trade'.

The procedures associated with proprietary manufactured structural elements are less complicated than for structures as there is no O/AIP requirement and no need to identify a 'designated outline', but the measurement issues created are more difficult to resolve. In fact, Money and Hodgson (1992) raised concerns over 20 years ago and suggested that the (then) DTp *must urgently address this issue and prepare a measurement mechanism for structural elements*. Mitchell (2014) observes that *still nothing has been done*.

The issue of proprietary manufactured structural elements arises in connection with designs prepared by the overseeing organisation. These designs are measured and billed according to the various series of the MMHW, and examples might include:

- The design of highway carriageways where combined drainage and kerb systems are needed.
- The design of a large-span bridge requiring proprietary bridge bearings and expansion joints.
- The design of a non-proprietary retaining wall needing proprietary piled foundations or ground anchors.

In each of these cases (and others), the engineer would need to ensure that the design did not include reference, either express or implied, to any proprietary product which, of course, would create a barrier to trade. Consequently, any requirement for a proprietary product in the design would have to be the contractor's choice, and the contractor would assume responsibility for the design of that part of the structure at tender stage and price accordingly.

The rules for the measurement and billing of such items are not clear in the MMHW, however. Proprietary products are not covered by Series 2500: *Special Structures* nor is there any other specific series dealing with these elements. For some clarification, it is necessary to resort to the *Notes for Guidance on the Specification for Highway Works* which states that:

- *The compiler should ensure that work items and elements based on proprietary products have not been specified in the contract. Such items and elements should be designed by the Contractor, or where appropriate, by the manufacturer and proposed by the Contractor.*[11]
- *Each work item or element for which a design is to be submitted by the Contractor should be listed in contract specific Appendix 1/10(A).*[12]

These requirements are also emphasised in the item coverages of the appropriate series of the MMHW. In Series 600: *Earthworks*, for example, the item coverage for ground anchors is given in Paragraph 132, and this includes:

a) *design;*
b) *provision of data and drawings;*
c) *certificates;*
d) *resubmissions and modifications;*
e) *amendments to the Works;*

Similar item coverages are given for piling (Series 1600), bridge bearings (Series 2100) and expansion joints (Series 2300).

The problem for the bill compiler is that the MMHW requires proprietary manufactured structural elements to be billed in specific units of measurement and not lump sums as with proprietary structures and structures where there is a choice of designs. Consequently, ground anchors and piles are to be measured in linear metres, bridge bearings by number and expansion joints by number with a stated length. It is obviously impossible to 'second-guess' what the

contractor's design will be, and thus, the number and length of piles, the number of bridge bearings and the nature and quantity of expansion joints are all unknowns at the billing stage.

The *Notes for Guidance on the Method of Measurement for Highway Works* provide no help to the bill compiler who is basically left to his/her own devices to provide a solution. In the absence of any guidance on the matter, either from Highways England or any other source, suggestions can only be made as to a way forward.

Mitchell (2014) offers the idea that a designated outline could be superimposed on the engineer's design where appropriate with details of the relevant proprietary structural elements left blank. This is illustrated in Figure 8.5.

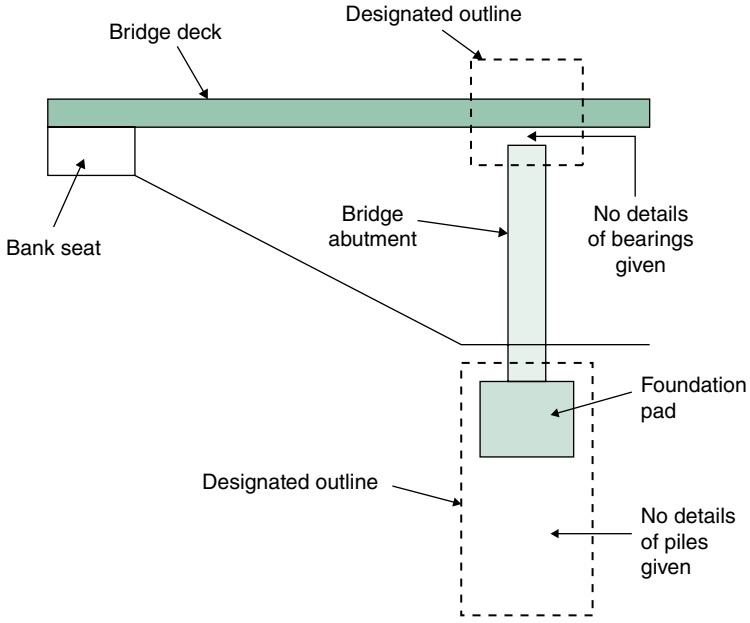


Figure 8.5 Proprietary structural elements. Adapted from Mitchell.

In this illustration, the unit of measurement in the BQ would be a single lump sum with the proviso that:

- The contractor would not be responsible for the design of the bridge deck, pier and pad foundation.
- These items would be listed in a schedule as not included.
- Changes to the engineer's design necessitated by the contractor's design (e.g. rebar) would be accommodated by the relevant series' item coverage which includes *amendments to the Works*.

However, Mitchell (2014) also suggests that there may be problems with this approach that the bill compiler would be unable to surmount, especially with regard to piling, where the depth and rake of the piles would be indeterminable.

A personal view is that measured items could be included in the BQ with the quantities left blank. The quantities derived from the contractor's design could then be completed by the contractor at tender stage in order to arrive at a tender price for the work concerned. Interface problems between the engineer's design and the contractor's design could be dealt with in the relevant item coverages as Mitchell (2014) suggests or as a variation or compensation event.

A worked example may be found in Chapter 16, but it must be emphasised that this is in no way meant to represent 'official' guidance or recommended good practice.

8.11 Measurement of highway works

The measurement of highway works using the Highways Method of Measurement is, *prima facie*, straightforward because fewer items have to be measured compared with other methods of measurement and the items that are measured are 'composite' in nature due to the principle of 'item coverage' that the MMHW employs.

It would be a mistake to think this way because the MMHW is, in fact, complex, both in the context of its relationship with the other documents that make up the MCHW and, as Mitchell (2014) observes, in the context of the *many of the problems associated with the MMHW* [that] *stem from* [the] *lack of proper rules or explanations, resulting in improbable interpretations* on behalf of the compiler.

Unlike other methods of measurement, the various series of the MMHW are not 'stand alone', and some series have to be read in conjunction with others. The influence of Series 600: *Earthworks* is particularly important because not only does the Earthworks Outline define the starting point for the excavation of drainage and other work items but also because it contains definitions that are cross-referenced in other series and item coverages that are 'written short' in other series.

Consideration of all the series in the MMHW in a book of this nature is impossible – it would require a book in its own right. Consequently, some key series are discussed which, hopefully, will assist the reader in interpreting the requirements of other series that have not been included. In this context, it may be helpful to think of a highway in terms of earthworks, roadworks and structures.

8.12 Series 100: Preliminaries

Anyone used to SMM7, NRM2 or CESMM4 will find the Series 100: *Preliminaries* section of the MMHW quite alien. There is a fairly short list of preliminaries items for tenderers to price:

- Temporary Accommodation.
- Vehicles for the Overseeing Organisation.
- Communication System for the Overseeing Organisation.
- Operatives for the Overseeing Organisation.
- Information Board.
- Traffic Safety and Management.
- Temporary Diversion for Traffic.
- Recovery Vehicles.
- Progress Photographs.
- Temporary CCTV System for the Monitoring of Traffic.
- Temporary Automatic Speed Camera System for the Enforcement of Mandatory Speed Limits at Roadworks.

There are no familiar items here and no contractual requirements or method-related charges as might be found in other methods of measurement. Mitchell (2014) points an accusing finger at the then Department of the Environment for *refusal to adopt* method-related charges way back in 1974 and for ignoring CIRIA Report 34 which largely underpinned the adoption of method-related charges in the CESMM.

8.12.1 Itemisation of preliminaries

In common with other series of the MMHW, each item in Series 100: *Preliminaries* has paragraphs that specify the units of measurement to be used, how itemisation is to be structured and an item coverage that specifies what each item is deemed to include.

Temporary Accommodation, for example, is measured by the 'item', and the itemisation structure is shown in Table 8.10.

Typical BQ items are illustrated in Table 8.11.

Table 8.10 Temporary accommodation.

Group	Feature	
I	1	Erection
	2	Servicing
	3	Dismantling
II	1	Principal offices for the overseeing organisation
	2	Principal laboratories for the overseeing organisation
	3	Portable offices for the overseeing organisation
	4	Portable laboratories for the overseeing organisation
	5	Offices and messes for the contractor
	6	Stores and workshops for the contractor
III	1	Provided by the overseeing organisation
IV	1	At the place of fabrication or manufacture
V	1	Until completion of the works
	2	After completion of the works

Note: Group IV and V features shall be applied only to items of temporary accommodation for the overseeing organisation.

Table 8.11 Typical BQ items for temporary accommodation.

					£	p
	SERIES 100 - PRELIMINARIES					
	Temporary Accommodation		(NA)			
	Erection of principal offices					
A	for the Engineer	ITEM				
	Erection of offices					
B	for the Contractor	ITEM				
	Servicing of principal offices					
C	for the Engineer	ITEM				
D	for the Contractor	ITEM				
	Dismantling of principal offices					
E	for the Engineer	ITEM				
F	for the Contractor	ITEM				

8.12.2 Pricing and interim payment

Taking the example of servicing the engineer's principal offices, the itemisation of what are effectively time-related charges can cause problems when it comes to interim payment. For instance, should payment be linked to the contract period or to the contractor's agreed programme, which might be quite different?

Another issue with Series 100 is the pricing of temporary works. In other methods of measurement, items are provided where the contractor can include monies that are effectively 'ring-fenced' and largely protected from admeasurement, but in the MMHW no such facility exists. Instead, the contractor must refer to MMHW Chapter III: *Preambles to Bill of Quantities – General Directions* Paragraph 2 which states that *the rates and prices entered in the Bill of Quantities shall be deemed to be the full inclusive value of the work covered by the several items*, and this includes *Temporary Works* (Paragraph 2(v) refers).

Risk Issue

In view of the high fixed cost of installing and removing temporary works, contractors should not risk pricing such items in rates that will be subject to admeasurement.

The pricing of temporary works, at least in the author's experience, is best included in the erection and dismantling items of temporary accommodation for the contractor (see Table 8.11) or such other 'ring-fenced' preliminaries items as may suit the purpose.

The itemisation structure adopted by the MMHW effectively encourages the 'front-loading' of preliminaries items and discourages a balanced approach to the valuation of variations.

8.12.3 Special preliminaries

An exception to the Series 100: *Preliminaries* itemisation rules is where there is a need to include provision for 'Special Preliminary' items in the BQ. Such items are 'contract specific' and therefore do not appear in Chapter IV: *Units and Method of Measurement*. They are included at the discretion of the overseeing organisation.

'Special preliminaries' are intended to be used for temporary works, cofferdams, accesses, advance operations and the like where the work involved is unusual in relation to the measured works and where:

a) *the magnitude of such work, not separately measured, is such as to be disproportionately high in cost in relation to the measured work with which it is associated;* or

b) *an operation, not separately measured, is required to be executed far in advance or after the main measured operation to which it relates*.

An example might be the construction of a launching gantry for the erection of the incrementally launched precast concrete deck units for a large bridge or the construction of a casting basin with manufacturing facilities for constructing immersed tube tunnel sections to be later floated into position (https://www.youtube.com/watch?v=GqpZamvvJnU).

The *Notes for Guidance on the Method of Measurement for Highway Works* also suggest that *consideration should be given to include a Special Preliminaries item* where temporary king post walls are to be constructed based on a design by the overseeing organisation.

In such instances, special Series 100: *Preliminaries* items will have to be drafted, complete with their own units of measurement, itemisation structure and item coverage, and a preamble is also required to follow Paragraph 20 of Chapter III: *Preambles to Bill of Quantities* of the MMHW.

8.13 Series 600: Earthworks

The importance of earthworks in a highway project, and its impact on other work activities, leads this to be the first of the 'measured work' series to be considered.

The quantities of earthworks for a highway project can run into the millions of cubic metres. For instance, the £485.5 million 44 km long M6 Toll (formerly Birmingham Northern Relief Road) in the United Kingdom required the removal of 1.3 million m^3 of topsoil, 9.2 million m^3 of excavation and 7.5 million m^3 of fill[13] – some 400 000 m^3 of 'muck shifting' per kilometre.

Earthworks operations influence much of what happens on a highway project both in terms of the way that construction work is planned and carried out and in terms of the measurement and billing process. Excavated material has to be moved from one part of the site to another, some has to be imported, some may have to be 'won' from borrow pits near the site, and some may have to be treated in various ways to render it acceptable to use for construction purposes. Haulage distances can be considerable, and there is the added complication of existing roads, rivers, canals and railways to contend with.

The 'earthworks balance' calculation and 'mass haul diagram' are critical in all this, but the presence of structures, such as bridges, retaining walls, culverts and underpasses, breaks up the bulk earthworks and influences its measurement. Contractor-designed structures also have to be considered because the earthworks within the designated outline of such structures are excluded from the bulk earthworks.

8.13.1 Classification of materials

In determining the disposition and quantities of earthworks, highway designers and bill compilers are greatly assisted by modern 3D ground modelling software and will be able to work from geological plans and long sections of the route showing the locations of borehole and trial pit data. Notwithstanding, expert help may be needed to interpret this data as great care is needed to avoid misrepresenting the quantities of acceptable and unacceptable materials in the design and the BQ.

Earthworks materials must be classified in accordance with Clause 601.1 and Table 6/1 of the Specification and any modification thereof determined by contract-specific Appendix 6/1. Despite not being a contract document, bill compilers are also required to pay attention to the classification flow chart at Table NG 6/1 in the *Notes for Guidance on the Specification for Highway Works*, that is, Volume 2 of the MCHW. By a process of elimination, this determines whether excavated material is available for use in the works or is for disposal off-site.

Risk Issue

The classification and measurement of earthworks is not a precise science. Judgements may well be based on reliable data, but borehole information is only representative of the immediate location of the borehole itself, and interpolation of the data is fraught with uncertainty.

Claims for additional payment abound in this area and changes in quantities can at least precipitate requests for tender prices to be 're-rated'.

Typical layouts for earthworks excavation and fill schedules are suggested in Series 600 of the *Notes for Guidance* as (partly) illustrated in Table 8.12. This shows the excavation side of a roadworks schedule which would be repeated for fill of different types. Another schedule would be developed for structures.

Table 8.12 Earthworks schedule (part).

ROADWORKS EARTHWORKS SCHEDULE																
EXCAVATION																
ACCEPTABLE						UNACCEPTABLE										
5A	3		Class 5A Other than Class 3 and		Total Acceptable other than Class 5A (to include processed U1A & U1B material)	U1A		U1B		U2		Total Excavation other than Class 5A	EO Hard Material	Processing of Class U1A	Processing of Class U1A	LOCATION
	Above Earthworks Outline	Below Earthworks Outline	Above Earthworks Outline	Below Earthworks Outline		Above Earthworks Outline	Below Earthworks Outline	Above Earthworks Outline	Below Earthworks Outline	Above Earthworks Outline	Below Earthworks Outline					
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	
																ROADWORKS Main Carriageway 0–500
																Main Carriageway 500–1000
																Interchange
																Side Roads
																Sub total
																ROADWORKS TOTAL

As well as obligations under the Specification, contractors have important contractual responsibilities for ensuring the acceptability of the finished earthworks. Under the ICC – Measurement Version, Clause 36(1) states that *All materials and workmanship shall be of the respective kinds described in the Contract* and ECC Clause 20 requires that the contractor *Provides the works in accordance with the Works Information*.

8.13.2 Principles of measurement

Contractors and earthworks subcontractors should be aware that the way in which earthworks are measured and billed *will often not correspond with the actual quantities on-site* (Money and Hodgson, 1992). Therefore, whilst the MMHW sets out precisely how earthworks shall be measured and what shall be allowed for in the contractor's prices, the complexities of earthworks operations on-site are left for the contractor to sort out. Money and Hodgson (1992) suggest that this is a deliberate policy to simplify and rationalise measurement of the work. Consequently, actual quantities of excavated materials on-site may vary due to:

- Overbreak:
  - From earthworks in Series 600.
  - From excavations in other series.
- Additional excavation for working space.
- Excavation arisings from other series (e.g. fencing, drainage, piling and embedded retaining walls, etc.).
- Acceptable material that is allowed to become unacceptable.
- Settlement beneath embankments.
- Excavations within designated outlines.
- Etc.

Compilers are not meant to 'second-guess' how the contractor will go about earth-moving operations, however. For instance, the contractor may opt to render unacceptable material acceptable for use in the works, rather than importing acceptable material. In such cases, the work should be measured as though the unacceptable material had been disposed of and acceptable material, of the class rendered acceptable, imported. In any event, the Preambles to the Bill of Quantities should draw the contractor's attention to the fact that the work will be admeasured as billed and not in accordance with how the contractor chooses to carry out the work.

The contractor has choices as to how to carry out earthworks operations but also has contractual obligations regarding the excavation, selection, handling, weathering, testing and filling of earthworks materials as determined by the SHW. The Specification is also influential in the contractor's choice of plant and whether finished earthworks operations are to be judged on the basis of prescriptive or end-product standards, both of which are used in the SHW.

8.13.3 Earthworks outline

The measurement of earthworks is contingent upon the Earthworks Outline which is defined in Paragraph 1 of Series 600, unless expressly stated otherwise, as:

- *the finished earthworks levels and dimensions (prior to topsoiling) required by the Contract for the construction, where specified, of:*
  - **a)** *carriageway, hard shoulder, hard strip, footway, paved area, central reserve, verge, side slope;*
  - **b)** *sub-base;*
  - **c)** *fill on sub-base material, base and capping;*
  - **d)** *contiguous filter material, lightweight aggregate infill;*
  - **e)** *surface water channels;*
  - **f)** *landscape areas, environmental bunds.*

In all cases of filter drains, except narrow filter drains, the Earthworks Outline shall be the top of the filter material.

Figure 8.6 illustrates the Earthworks Outline in three situations:

a) For a Type 1A flexible carriageway.
b) For a structural foundation.
c) For a retaining wall.

Figure 8.6a shows an edge of pavement detail taken from MCHW Volume 3: *HCD* which indicates the Earthworks Outline as top of capping layer. Where the quality of subsoil is such that a capping layer is not needed, road formation, and therefore the Earthworks Outline, would be the underside of sub-base.

Some situations are not covered in Volume 3, but, in any event, bill compilers need rules as to how the Earthworks Outline is to be used for measurement purposes. Such rules are provided in Series 600 Paragraphs 1–11 of the MMHW which define Earthworks Outline, Existing Ground Level and Subsoil Level as they apply in different situations. Measurement of earthworks is determined by these definitions.

The rule for measuring excavation for structural foundations is derived from MMHW Series 600 Paragraph 15(d), and this is illustrated in Figure 8.6b which shows that the measurement of excavation commences at the underside of blinding and extends up to the Earthworks Outline.

Where there is a structure such as an earth retaining wall, a rule determining where the Earthworks Outline is drawn is provided in MMHW Series 600 Paragraph 5 as illustrated in Figure 8.6c.

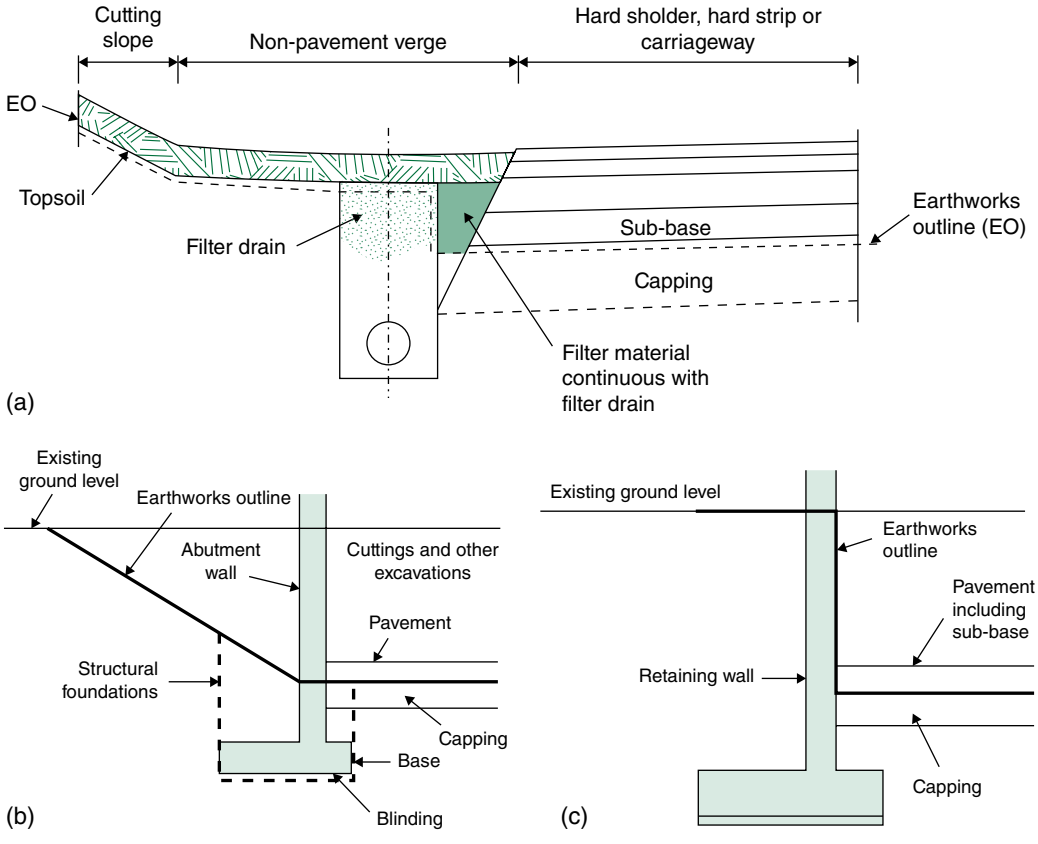


Figure 8.6 Earthworks Outline. (a) Pavement Type 1A (Flexible carriageway), (b) structural foundation and (c) retaining wall.

8.13.4 Earthworks boundaries

Bill compilers need to be aware that the MMHW imposes boundaries on earthworks measurement in addition to the Earthworks Outline and that excavation is categorised in three ways in the MMHW:

1. According to whether it is 'acceptable' or 'unacceptable' as defined by the Specification.
2. According to what type of excavation it is, for example:
   - **a)** Cutting.
   - **b)** Structural foundation.
   - **c)** Foundations for corrugated steel buried structures and the like.
   - **d)** Etc.
3. According to location in the works, for example:
   - **e)** Roadworks.
   - **f)** Structures.

The first two classifications are to be found in the itemisation table in Series 600 Paragraph 15 as illustrated in Table 8.13.

The third categorisation is given in Paragraph 1, Table 1 of Chapter III: *Preparation of Bill of Quantities* of the Method of Measurement which prescribes how the BQ is to be subdivided. This is illustrated in Table 8.14.

Table 8.13 Itemisation of earthworks.

Group	Feature	
I	1	Excavation
II	1	Acceptable material Class 5A
	2	Acceptable material excluding Class 5A
	3	Unacceptable material Class U1A
	4	Unacceptable material Class U1B
	5	Unacceptable material Class U2
III	1	Cutting and other excavation
	2	Structural foundations
	3	Foundations for corrugated steel buried structures and the like
	4	New watercourses
	5	Enlarged watercourses
	6	Intercepting ditches
	7	Clearing abandoned watercourses
	8	Removal of surcharge
	9	Gabion walling and mattresses
	10	Crib walling
	11	Caps to mine working, well, swallow hole and the like
IV	1	0–3 m in depth
	2	0–6 m in depth and so on in steps of 3 m

Table 8.14 Structure of bill of quantities.

BQ division		Construction heading	Series heading		Notes
			No.	Title	
Roadworks		Roadworks General	600	Earthworks	
Structures	Structure in form of bridge or viaduct; name or reference	Substructure • End supports	600	Earthworks	To include wing walls and paved areas beneath structures
		Substructure • Intermediate supports • Main span • Approach spans	600	Earthworks	To include piers and columns
		Superstructure • Main span • Approach spans • Arch ribs	600	Earthworks	
		Finishings	600	Earthworks	
	Retaining wall, culvert, subway, gantry, large headwall, gabion wall, diaphragm wall, pocket-type reinforced brickwork retaining wall and the like; name or reference	Main construction	600	Earthworks	
		Finishings	600	Earthworks	

In Table 8.14, it can be seen that the billing of earthworks must be subdivided into Roadworks and Structures and that 'structures' are to be billed as either 'bridge or viaduct' or 'retaining wall, culvert, etc.' with an associated name or reference.

The billing of earthworks to bridges or viaducts is further subdivided into substructure, superstructure and finishings, whilst bills for retaining walls and so on are to be billed as 'main construction' and 'finishings'.

In the case of bridges or viaducts, it will be noted that various supports and spans are to be identified. This is illustrated in Figure 8.7a.

8.13.5 Structures

In Table 8.14, it is clear that Substructure End Supports are to be billed separately, but it is not clear, either in the *Method of Measurement* or in the *Notes for Guidance*, whether substructures for other supports should be measured separately or collectively. Common sense would indicate that a judgement would be made according to the extent of such supports.

Exactly what 'Superstructure earthworks' are is not clear either, but it would make sense if this referred to bulk earthworks to structures. This would tie in with the requirement for bulk earthworks to be those above the Earthworks Outline and for Substructure earthworks to be those below the Earthworks Outline.

Figure 8.7b illustrates this interpretation as it applies to an overbridge. Here, it can be seen that the volume of earthworks to be removed is partly in cutting and partly in structural foundations. These items are measured separately as required by Series 600 itemisation structure (MMHW Series 600 Paragraph 16) and are indicated as being, respectively, above and below the Earthworks Outline.

However, where a structure interrupts the earthworks, bill compilers need to make it clear how they have measured the excavation items with regard to the bulk excavation in the Roadworks bill. Mitchell (2014) suggests that this is best done by indicating the limits of bulk earthworks and earthworks to structures on the drawings. This is illustrated in Figure 8.7c.

The rules for distinguishing the bulk earthworks (in cuttings and so on) from excavation for structural foundations are provided in Series 600 Paragraphs 15b(i) and 15d(i) and (ii), respectively. Both rules refer to the Earthworks Outline as the reference point for measurement.

8.13.6 Earthworks within designated outlines

In the case of Series 2500: *Special Structures*, the measurement of earthworks quantities depends upon whether:

1. The contractor is responsible for the design of a proprietary structure.
2. There is a choice of designs – engineer's design.
3. There is a choice of designs – contractor's design.

In all cases, the 'special structure' is distinguished from the remainder of the works by the designated outline for the structure. Within the designated outline for a contractor-designed structure, the contractor is responsible for quantifying the earthworks quantities. For a special structure to be designed by the engineer, the overseeing organisation is responsible for measuring and billing the earthworks quantities.

Risk Issue

Bulk earthworks within the Designated Outline for a Special Structure must be included in the quantities for that structure pursuant to MMHW Chapter III Paragraph 7. This says that *Earthworks within the Designated Outlines shall not be included in the Earthworks Schedules.*

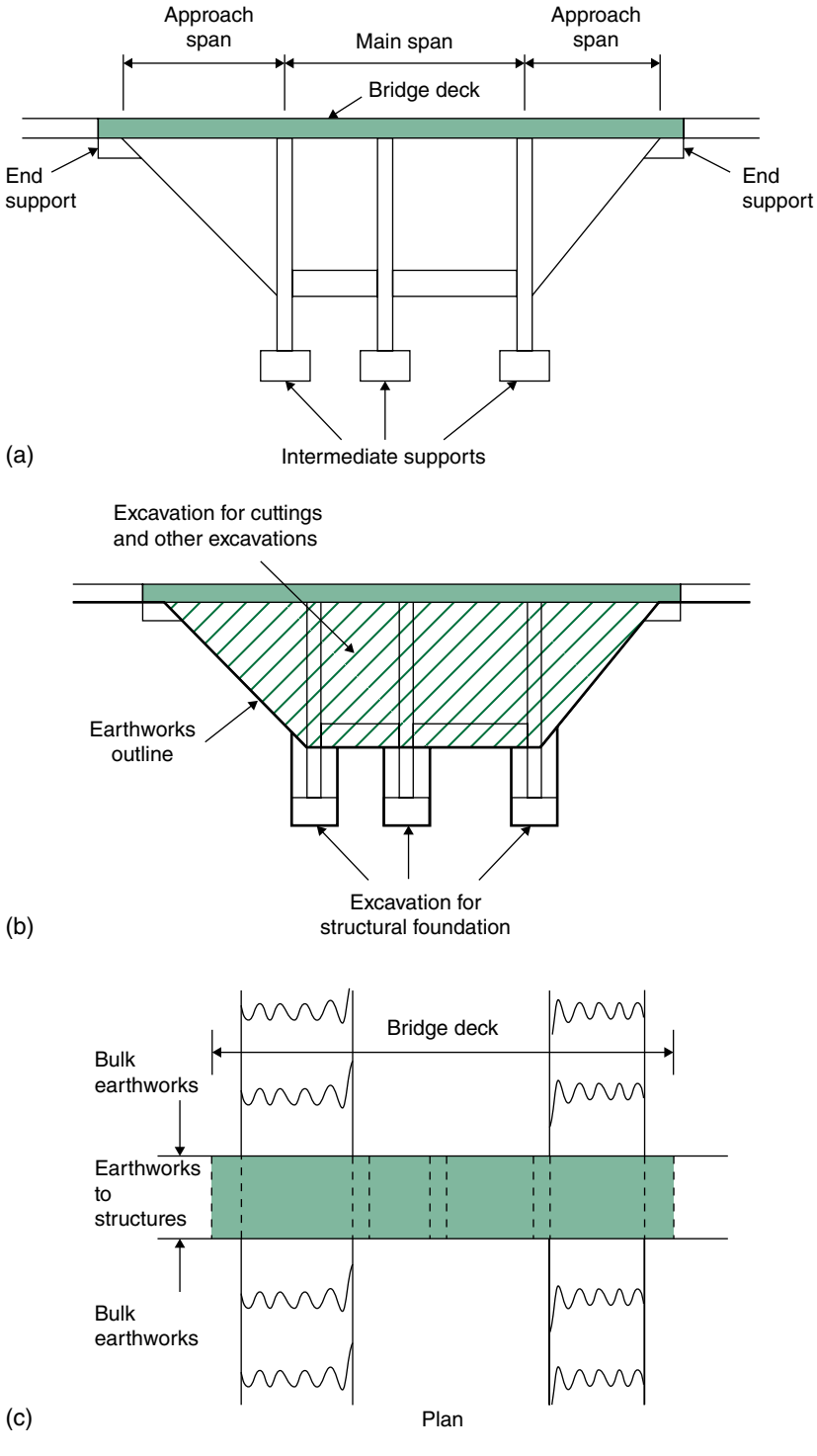


Figure 8.7 Billing of structures. (a) Billing headings, (b) billing of earthworks and (c) earthworks boundaries.

8.13.7 Dealing with water

With regard to the excavation of both topsoil and acceptable and unacceptable material, the item coverages in Series 600 Paragraphs 17 and 18 require the contractor to include in his rates for keeping earthworks free of water.

The measures that the contractor might be expected to take for dealing with water are not specified, or measured, in the method of measurement, but MMHW Chapter III Paragraphs 9 and 10, respectively, spell out that the contractor shall allow for:

- Taking measures required to execute work within and below non-tidal open water or tidal water and any investigations to ascertain actual boundaries, surface levels and ranges affected by non-tidal open water or tidal water (Paragraph 9).
- Taking measures to deal with the existing flow of water, sewage and the like (Paragraph 10).

Risk Issue

Such requirements place onerous obligations on the contractor to which there is no relief in the MMHW.

In circumstances where an experienced contractor could not have anticipated the prevailing circumstances, relief may be sought in the conditions of contract under a Clause 12 Claim (ICC – Measurement Version) or a Compensation Event (ECC Clause 60).

8.13.8 Capping layer

A 'capping' layer is required where the CBR (or other) test reveals that the ground bearing capacity beneath a road is inadequate for the designed traffic loading. If a capping layer is included in the contract, the surface level of the capping becomes the formation level of the road – that is, underside of sub-base – and also the Earthworks Outline.

Capping is not a measured item, and thus, the excavation, deposition and compaction of material to be used as capping are billed under the appropriate feature classification for the various specified classes of acceptable material available in the contract.

Where capping is specified in the contract:

- The void formed to accommodate the capping layer beneath the Earthworks Outline is added to the volume of excavation in *Cutting and other excavation* pursuant to Paragraph 15(b)(i) of Series 600.
- Excavation of structural foundations is measured to the Earthworks Outline according to Series 600 Paragraph 15(d)(i), that is, top of capping layer.

Where capping is to be stabilised with lime or cement, this is to be measured as soil stabilisation (Series 600 Paragraphs 53–56 refer).

8.13.9 Surcharge

The question of 'surcharge' arises where embankments are to be constructed in areas of soft ground. The idea is to put the embankment under load for a period (say, 6–12 months) so that it penetrates the soft ground causing settlement to occur prior to construction of the road pavement, thus avoiding later settlement of the road surface when in use.

Surcharging may be carried out with acceptable material arising on-site or with imported fill, but, being 'temporary', a quantity of material – not necessarily the original quantity of surcharge – is subsequently removed. Where there is a 'loss' of surcharge, this may be due to settlement of the embankment or the contractor's method of working.

The volumes of surcharge material to be placed and removed are given in the earthworks schedules, but only the removal of surcharge is measured as an item in the BQ. However, the tender documents must be suitably explicit such that surcharge requirements, and the likely loss of surcharge material, can be established both in the earthworks balance and to enable tenderers to price the relevant items. The contractor is responsible for the first 75 mm of ground loss under embankments pursuant to Series 600 Paragraphs 13, 33, 45 and 52.

The disposal of any surplus surcharge is not measured separately but is included in the volume of disposal of acceptable material off-site. However, the earthworks balance is initially calculated on the basis that surplus surcharge will be reused on-site whether or not the contractor decides to do so.

The item coverages for filling and compaction items include for dealing with surcharge, but, again, this is not measured in the BQ.

Paragraph 17 of Series 600: *Earthworks* of the *Notes for Guidance on the Method of Measurement for Highway Works* explains in detail how to deal with surcharge and provides worked examples of how to calculate the earthworks balance in three different situations.

8.13.10 Extra over

In the context of a 'base item' measured according to the MMHW, extra over (EO) is a means of measuring any *significant* ***additional*** *burden* of work *placed upon the Contractor to undertake* ***extra work*** *of much the same nature as the work covered by the base item* (the *Notes for Guidance on the Method of Measurement for Highway Works* Paragraph 2 of Chapters I, II and III refers).

On the face of it, therefore, if *Excavation of acceptable material excluding Class 5A in cutting and other excavation* is the 'base item', an item of *Extra over excavation for excavation in Hard Material in cutting and other excavation* reflects the additional work, over and above normal excavation, for the removal of hard material, such as rock.

The item of *Extra over excavation for excavation in Hard Material* is measured in m^3 and, pursuant to Series 600 Paragraph 21, *shall be the volume of Hard Material within the void measured under paragraph 15 of this Series* with a separate item provided for each excavation feature (e.g. cuttings, structural foundations, etc.). This is emphasised in the *Notes for Guidance* which state that *quantities to be billed for the EO items must be in respect of work included with the quantities for the base item*.

All of the foregoing resonates precisely with the commonly understood industry meaning of 'EO' which is that EO items *are not to be priced at the full value of all their labour and materials, as these have to a certain extent already been measured* (Lee et al., 2014) in the base item. Therefore, quite rightly, the item coverage of Series 600 Paragraph 23, *Extra over excavation for excavation in Hard Material*, is limited to the additional costs of excavating hard material, that is:

a) Preliminary site trials of blasting.
b) Blasting, splitting, breaking and the like.
c) Cutting through reinforcement.
d) Saw cutting and trimming.
e) Removal of existing paved areas by course or layer, cleaning surfaces, milling or planing, stepping out and treatment to bottoms of foundations.

However, the *Notes for Guidance* state that the item coverage in respect of the quantities for the EO item comprises a summation of item coverages for the base item and the EO item.

Risk Issue

If tenderers follow this guidance, they will be pricing the extra over (EO) item at 'full value' which conflicts with principle of 'EO'.

The reason for this guidance is not clear because the EO item coverage is not 'written short' (i.e. it does not refer to a further detailed item coverage elsewhere) and is a 'stand-alone' measurable item.

However, remembering the *Notes for Guidance on the Method of Measurement for Highway Works* definition of 'EO', this should signal to contractors that the EO rate is to be derived from the 'full value' rate for excavation of hard material *less* the 'full value' rate for normal excavation.

8.13.11 Hard material

The presence of hard material in earthworks can have a significant direct cost implication for contractors, but there may also be a considerable impact on working methods, choice of plant and equipment and upon the planning and sequencing of excavation operations. This is particularly the case when hard material arises unexpectedly or contrary to indications in geological reports.

The measurement of hard material is dealt with in all standard methods of measurement, and each one has its own way of defining exactly what constitutes 'hard material'. At the simplest level, hard material may be categorised as either:

- Naturally occurring hard material, that is, rock
  or
- Artificial hard material such as concrete, brickwork or bound material such as tarmacadam.

The *Notes for Guidance on the Method of Measurement for Highway Works* confirm that the MMHW recognises the cost significance of removing hard material and that such work should be measured *extra over normal excavation*.[14] They also recognise that a consistent approach is needed when dealing with the measurement issues arising from the presence of hard material in order to be fair to both overseeing organisations and to contractors. Such sentiment no doubt arises from the long history of disputes concerning payment for the removal of hard materials, and this partially explains why the definition of hard material has changed over the years.

The *Notes for Guidance* suggest that the current definition should be accepted by all parties and that its inclusion in the contract documents *effectively excludes all other forms of definition*. It is also suggested that the tender documents should clarify what material the contractor is expected to encounter and that the contractor should supplement this with his own inspections where required by the conditions of contract (e.g. ICC Conditions Clause 11(2)).

The *Notes for Guidance* furthermore conclude that the overseeing organisation *should designate which strata or deposits are to be measured as Hard Material* and that bound materials in existing pavements and the like will always be measured as hard material. This is made clear in the MMHW itself where the first part of Definition 1(h) of Chapter I: *Definitions* states that 'Hard Material' is defined as:

(i) *material so designated in the Preambles to Bill of Quantities*

The second part of the definition is that 'Hard Material' is

(ii) *material which requires the use of blasting, breakers or splitters for its removal but excluding individual masses less than 0.20 m³*

In this respect, the *Notes for Guidance* make an important point of clarification that:

- Sub-paragraph (ii) of the definition *outlines the means of determining the volume of Hard Material when circumstances preclude the use of sub-paragraph (i)* albeit that *these circumstances should be rare*.

Consequently, it may be concluded that sub-paragraph (i) is the preferred means of determining the volume of hard material and sub-paragraph (ii) is the 'fallback' definition.

Significantly, however, sub-paragraphs (i) and (ii) are separated by the expression '*and/or*', and this would seem to indicate that 'hard material' is defined as either:

- That which is so designated in the Preambles to Bill of Quantities AND which requires the use of blasting, breakers or splitters for its removal OR
- That which requires the use of blasting, breakers or splitters for its removal

Therefore, this means that:

- Where material is designated as Hard Material in the Bill of Quantities, the material so designated must also require the use of blasting, breakers or splitters for its removal to qualify as 'hard material'.
- Where the designation of hard material is precluded for some reason, 'Hard Material' is defined as that which requires the use of blasting, breakers or splitters for its removal.

This seems fair enough as it would be unreasonable for a contractor to expect payment for the removal of hard material if it were capable of being excavated along with other 'normal' material. The *Notes for Guidance* emphasise this point by stating that where, in the judgement of the overseeing organisation, material is likely to be encountered in bulk excavation that is capable of being removed by *conventional rippers*, then such material *should not be classed as 'hard material'*. An example of this would be using ripper tines attached to the rear of dozers to loosen hard materials for excavation by other plant such as back acters. In coming to this decision, *factors such as the location and extent of the excavation, the size of the project and other limitations* would have to be taken into account.

It must be said that the *Notes for Guidance* are not crystal clear on the subject of hard material, but on a reasonable construction, there is a considerable distinction to be made between the **measurement** of hard material for incorporation in the BQ at tender stage and the **admeasurement** of hard material during construction of the works. This conclusion may be drawn from three specific statements in the *Notes for Guidance*:

1. *Once a strata or deposit has been designated as Hard Material it is not subject to reclassification.*
2. *Where Hard Material is designated by reference to named strata alone the total quantity excavated from within those strata is subject to admeasurement.*
3. *Where deposits are designated by limits shown on the Drawings that volume is measured and paid for as Hard Material.*

From this, it may be concluded that the decision as to what is and what is not hard material at tender stage has a huge impact on the admeasurement of hard material during construction and that this places a considerable burden of risk on the overseeing organisation and a great deal of pressure upon the professional judgement of the bill compiler.

A further conclusion is that once the designation of hard material has been made, that is it – irrespective of the nature of the material encountered. This is confirmed by the *Notes for Guidance* which state that *if the material found during the course of construction is that which was shown at the time of tender, or could be ascertained by the Contractor's pre-tender inspection, then admeasurement should follow the same designations irrespective of the actual hardness of the material.*

8.13.11.1 The measurement of hard material

The whole point of a BQ is to provide the contractor with the most accurate possible calculation of the quantity of work to be carried out on-site. With a completed design, this can be done fairly precisely; otherwise, an approximation has to be made. Hard material, however, is difficult to

measure at tender stage because its location and extent is so unpredictable, despite the existence of borehole information.

Consequently, the BQ compiler needs to exercise considerable judgement to determine the quantities of such material for insertion in the BQ. The starting point is usually the borehole logs, but the problem here is that:

- The number of borehole logs available is limited by cost.
- Boreholes or trial pits are only representative of the ground conditions at their precise location.
- Interpolation of borehole and trial pit data is fraught with uncertainty.
- The interpretive data that accompanies ground investigations is an opinion and not a precise statement of fact.
- Geological reports relating to the presence of groundwater can be misleading due to subsequent climatic changes and the time of year.
- The contractor's ability to rip or otherwise dig hard material is dependent on many factors including the location and depth of the excavation and the size, type and condition of earth-moving plant.

The *Notes for Guidance* suggest that the two parts of the definition of hard material should, in general, be compatible. Remembering that the definition states '*and/or*', this means that material designated as 'hard material' in the Preambles to the Bill of Quantities (i.e. the first part of the definition) should be material that is interpreted as requiring the use of blasting, breakers or splitters for its removal (this is the second part of the definition).

Alternatively, if no designation of strata or deposits is made, the '*or*' part of the definition comes into play, that is, the hard material measured in the BQ shall be that which requires blasting, breakers or splitters to remove it. Consequently, the bill compiler should be looking at the borehole logs with a view to finding materials that correspond to the second part of the definition so that they can either be:

- Designated as hard material and measured as such in the BQ or
- Can be measured according to the second part of the definition.

The means of designating hard material for inclusion in the BQ is found in Paragraph 13(c) of the Preambles to the Bill of Quantities which sets out three methods of doing so:

a) Designated strata.
b) Designated deposits with limits shown on the drawings.
c) Existing pavements, footways, paved areas and foundations.

This designation of hard material is purely for measurement purposes and not for the technical classification of such material for incorporation in the works (e.g. as acceptable material for fill).

Risk Issue

The *Notes for Guidance* make it clear that *material similar to that designated as Hard Material in a deposit within defined limits shown on the Drawings,* found elsewhere on-site, will not necessarily be measured as Hard Material.

Naturally occurring hard material is rock of which there are three main types – igneous, sedimentary and metamorphic. Within these classifications is a bewildering array of different materials with different strengths and other characteristics which:

- Can be excavated with normal plant.
- Can be excavated with normal plant but with difficulty or with special teeth or ripping tines (i.e. hard dig).
- Require explosives, pneumatic breakers or other means of stressing to break the rock.

At tender stage, the bill compiler has to decide how to measure such materials in the BQ. This is usually done by a desk study of borehole logs and other information, perhaps supplemented by expert geotechnical opinion, and then a decision has to be made as to how this is to be represented in the contract by identifying:

a) **Designated strata**, which are natural layers of specific materials that are classified as 'hard material' such as granite, limestone, chalk, sandstone, gritstone, etc. Such materials will be identified in the borehole logs, and the relative disposition of such strata can be interpolated from the closest available log(s) as illustrated in Figure 8.8a.

   Consequently, when such strata are found on-site, these will be admeasured as 'hard material'.

b) **Designated deposits**, which are identified on the drawings as locations on-site where the material to be removed is thought to be 'hard', and these locations are indicated by means of identifying lines or 'assumed limits' as shown in Figure 8.9a.

c) **Existing pavements, footways, paved areas and foundations** are, by definition, 'hard material' and do not have to pass the test of needing blasting, breakers or splitters for its removal. Unbound materials, such as sub-base, within existing pavements are not regarded as 'hard material'.

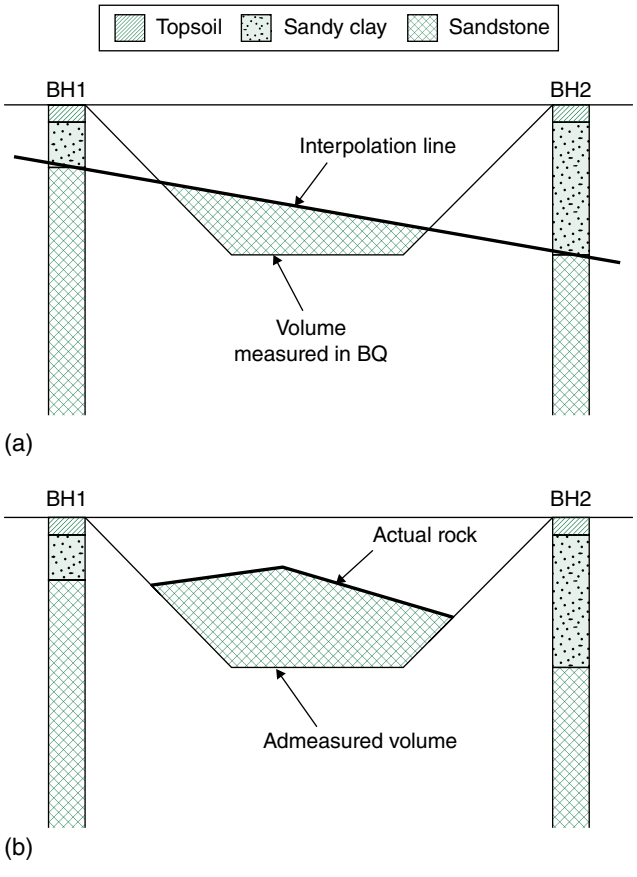


Figure 8.8 Hard material – designated strata. (a) Measurement situation and (b) admeasurement situation.

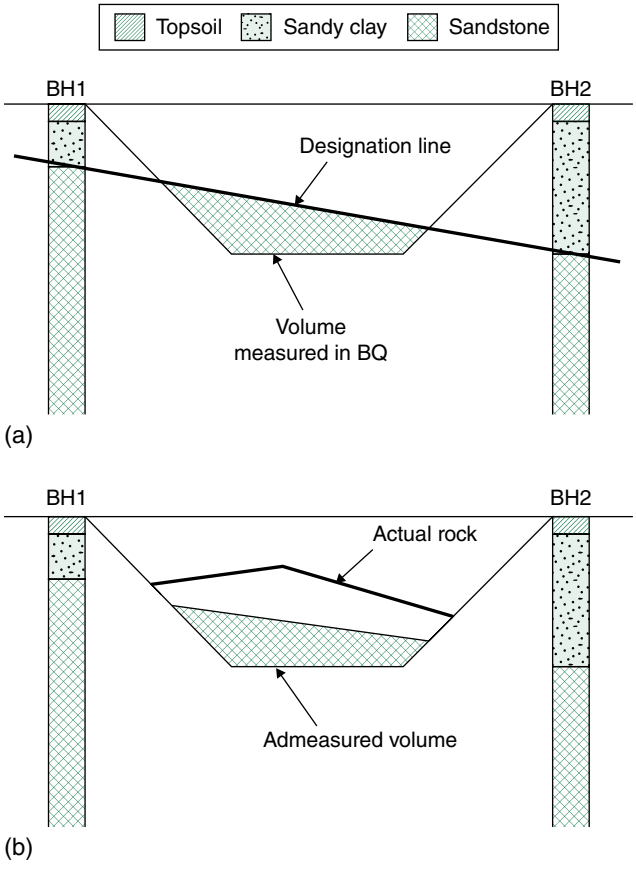


Figure 8.9 Hard material – designated deposits. (a) Measurement situation and (b) admeasurement situation.

At the time of tender, there is no practical difference between the designation of 'strata' and 'deposits' from a measurement perspective as can be seen from Figures 8.8a and 8.9a. In both cases, the disposition of hard material (i.e. rock) is the same as this is interpolated from the same borehole logs.

However, the decision of the overseeing organisation as to how the designation should be made will have a considerable impact when it comes to the admeasurement of the hard materials on-site, as illustrated in Figures 8.8b and 8.9b.

Bound materials in existing pavements and the like will always be measured and admeasured as Hard Material.

8.13.11.2 The admeasurement of hard material

Once construction work begins, the admeasurement of BQ items for *extra over excavation for excavation in Hard Material* becomes as necessity because:

- Traditional highway contracts are measure and value (admeasurement) contracts.
- BQ items are, therefore, approximate.
- BQ quantities of hard material are even more approximate due to the uncertain nature of geological data.
- The 'reality' of site conditions is rarely the same as the 'virtual reality' of drawings and borehole logs.

Accordingly, the means by which hard material is designated in the BQ conditions the approach to the admeasurement of such material because:

- The contractor's tender rates must be established on the basis of a consistent and fair definition of 'hard material' in order to be realistic.
- The admeasurement must be approached in such a way that the tender rates are not rendered inappropriate.
- There must be a means of distinguishing between the ground conditions likely to be encountered on-site and those which are unexpected and likely to give rise to a claim.

Remembering that the MMHW regards existing pavements, footways, paved areas and foundations as, by definition, 'hard material', other hard material (i.e. rock) must be designated with respect to either:

- Specific strata or
- Specific deposits.

This is illustrated by the measurement situations in Figures 8.8a and 8.9a. The distinction between the two designations is subtle but important in terms of admeasurement because the *Notes for Guidance* state that:

1. *Where Hard Material is designated by reference to named* ***strata*** *alone the total quantity excavated from within those strata is subject to admeasurement.*
2. *Where* ***deposits*** *are designated by limits shown on the Drawings that volume is measured and paid for as Hard Material.*

Before continuing, it must be stressed that material designated as 'hard material' in the Preambles to the Bill of Quantities, whether designated by strata or by deposits, retains its designation for admeasurement purposes. Once designated, hard material is not further subject to the test of whether or not its removal requires the use of blasting, breakers or splitters in the admeasurement situation.

The admeasurement of material otherwise measured in the BQ as 'hard material' (i.e. in series other than Series 600), because its removal is thought to require the use of blasting, breakers or splitters, will always be subject to this test because that is how the material is defined in Definition 1(h)(ii) of the Preambles to Bill of Quantities.

Risk Issue

The contract should contain information known about the existence and extent of hard material, and this includes the whereabouts of any existing buried roads and the like. However, whilst it would appear that the contractor is on 'easy street' with regard to the measurement and admeasurement of hard material, this is not the case.

The problem for contractors is that whilst the material encountered on-site may not be the same as that described in the contract, this may not give rise to a re-rate or a claim. This is because the conditions of contract will usually place a duty on the contractor to make his own interpretation of the likely soil conditions both from geological data supplied by the overseeing organisation and from his own investigations (e.g. arranging permission to dig trial pits at tender stage).

Consequently, any claims would be tempered by the need for the contractor to establish that the prevailing conditions could not have been reasonably anticipated by an experienced contractor.

Assuming that the hard material encountered on-site is the same material as that anticipated at tender stage, but its actual disposition is not as envisaged, then the admeasurement situation is

different for hard material designated by strata compared to that designated by assumed limits. This is illustrated in Figures 8.8b and 8.9b where it can be seen that:

- The designated strata is now disposed differently to that envisaged at tender stage and thus will only be measured as hard material according to its actual disposition on-site.
- The designated deposits of hard material will still be admeasured as being bound by the identifying lines on the drawings irrespective of what material is encountered.

This is confirmed by the *Notes for Guidance* which state that:

1. *If the material found during the course of construction is that which was shown at the time of tender, or could be ascertained by the Contractor's pre-tender inspection, then admeasurement should follow the same designations irrespective of the actual hardness of the material.*

Conversely, should the material encountered on-site be different to that envisaged in the tender documents, the contractor would have to argue that such materials could not reasonably have been envisaged and that additional cost had been incurred as a consequence.

This would then give rise to a claim under the conditions of contract, if permitted, as confirmed by the *Notes for Guidance*:

2. *If the material found in the course of construction is not as described in the tender documents or apparent by inspection, the Contractor may raise a claim if permitted under the Conditions of Contract. It will then be for the Contractor to demonstrate that the material could not reasonably have been foreseen and that extra costs had arisen, according to the terms of the Contract.*

Risk Issue

In practice, the disposition of soils can vary widely, and different soils can combine with others, thereby creating an indistinct 'grey area' between strata. Also, hard materials may fragment and merge with other soils.

In such cases, the *Notes for Guidance* suggest that admeasurement of hard material strata is *ascertained by the application of sub-paragraph (ii)* of MMHW Chapter I: *Definitions*.

8.13.12 Soft spots

Having nearly lost a Land Rover, whilst working as a site engineer on the M53 motorway in Cheshire, this author is fully aware of the presence of soft spots in highway projects!

Soft spots and other voids are measured in the MMHW in m^3 under the provisions of Series 600, Paragraphs 61–63, and they are measured separately from the main excavation or filling where the volume:

a) Below structural foundations, foundations for corrugated steel buried structures or in side slopes of cuttings if less than 1 m^3.
b) Elsewhere if less than 25 m^3.

Separate items are required for the excavation and filling of soft spots, and each is categorised according to whether they are (i) below cuttings or under embankments, (ii) in side slopes or (iii) below structural foundations and foundations for corrugated steel buried structures.

Soft ground above the Earthworks Outline (i.e. formation) is measured as unacceptable material, but, below this level, considerable volumes of such materials can be discovered

during earthworks operations – volumes much greater than the thresholds envisaged in the MMHW.

Risk Issue

For contractors, the way that soft spots are dealt with under the method of measurement is less than satisfactory because they can cause disruption to second-stage earthworks operations and may require the contractor to reschedule operations, change working methods or use different plant and equipment to that being used for the bulk muck shifting.

Nonetheless, Series 600 Paragraph 15(b)(i) states that the volume of bulk earthworks includes *the volume of the void formed by the excavation of material below* [the Earthworks] *Outline* and the only recourse is to argue for a 're-rate' should the quantities be sufficiently significant or a misrepresentation should the ground investigation prove erroneous.

8.13.13 Deposition and compaction of fill

The deposition and compaction of fill are measured separately in m^3 according to Paragraphs 29–33 and 46–52, respectively, of the MMHW.

Excavated material arising from the site, which is to be used for the construction of embankments, reinforced earth structures, anchored earth structures, landscape areas, environmental bunds and fill to structures, is measured as 'deposition of fill' provided that it is:

- Acceptable material.
- Unacceptable material processed to become acceptable.

The quantity of deposition of fill is given by the volume of compacted fill required, calculated in accordance with Series 600, Paragraphs 47–49, *less* the volume of imported fill. Compaction of fill includes the volume of imported fill and deposition of fill.

A distinction is made between the compaction of acceptable material, acceptable material Class 1C and acceptable material Class 6B **according to** Table 6/1: *Acceptable Earthworks Materials* of the SHW. A further distinction is made, pursuant to the itemisation table in Paragraph 51 of Series 600, as to the final destination of compacted fill such as embankments and other areas of fill, strengthened embankments and reinforced earth structures.

The volume of imported acceptable fill is given by the volume of compacted fill, calculated in accordance with Paragraphs 47–49 of Series 600, *less* the volumes of certain acceptable materials and other stated classes of imported acceptable fill.

The quantities and locations of fill are derived from the Roadworks and Structures Earthworks Schedules suggested in the *Notes for Guidance*.

8.13.14 Imported fill

Different types of imported fills are categorised in the MMHW according to Paragraph 44 of Series 600 which requires that separate items be given according to fill type and final destination (e.g. embankments, landscape areas, structures, etc.).

Quantities are given in m^3 and the item coverage in Paragraph 45(m) stipulates that imported fill resulting from settlement and penetration of landscape areas, environmental bunds and other areas of fill, and from the first 75 mm of settlement and penetration of embankments, shall be included in the contractor's rates.

8.13.15 Disposal

The measured item of 'disposal' is purely for unwanted excavated materials arising from the site categorised according to Paragraph 38 of Series 600:

- Acceptable material excluding Class 5A.
- Acceptable material Class 5A.
- Unacceptable material Class U1A.
- Unacceptable material Class U1B.
- Unacceptable material Class U2.

The volume of disposal is exclusively surplus material arising from the excavation of cuttings, structural foundations, foundations for corrugated steel buried structures and the like, new watercourses, enlarged watercourses, intercepting ditches and so on as itemised in Paragraph 16 of Series 600. This does not include arisings from fencing, drainage or cast-in-place piling, the disposal of which is included in the relevant item coverages of the respective series.

Unlike other methods of measurement, there is no item for the disposal of excavated material on-site. This is classed as deposition of fill.

8.14 Series 500: Drainage and service ducts

The drainage work for a highway project will normally comprise:

- Filter drains (often referred to as 'fenceline' drainage) for cutting off surface and groundwater from land adjacent to the highway, usually consisting of porous/perforated pipework in trenches filled with free draining filter media, carried out 'pre-earthworks'.
- Carriageway 'carrier' drainage for the removal of surface water from the road collected from gullies and drainage channels.
- Piped filter drains, fin drains and narrow filter drains alongside carriageways and, sometimes, in central reservations, filled with suitable filter media.
- Culverts, used to divert existing watercourses under the highway, which may also be considered as 'pre-earthworks' drainage.
- Associated chambers, including catchpits, manholes, gullies and headwalls.
- Lined and unlined ditches.

It should be noted that all drains exceeding 900 mm internal diameter, box culverts, piped culverts and all associated chambers, headwalls, outfall works and concrete bagwork are considered as 'structures' and should be measured in accordance with Series 2500: *Special Structures*.

A further exception is trenches and ducts for street lighting and communications cabling which are measured according to Series 1400: *Electrical Work for Road Lighting and Traffic Signs* and Series 1500: *Motorway Communications*, respectively.

Clearing existing ditches and constructing new and enlarged watercourses and unlined ditches are measured in Series 600: *Earthworks*.

Pre-earthworks drainage follows erection of the permanent fenceline and the topsoil strip over the site. This work, along with culverts, usually commences early in the project, and thus, there may be associated access problems and difficulties delivering materials to specific locations. This is not recognised in the method of measurement as pre-earthworks drainage is not separately itemised in the MMHW.

Drainage arisings – the spoil from drainage excavations – not required for filling trenches may possibly be acceptable as fill elsewhere on the site, or it may be unacceptable and require disposal off-site. This is not a measured item, either in Series 500 or 600, and it is the contractor's responsibility to deal with such arisings as part of the item coverages in Series 500.

Decision making as to the suitability of fills is the main contractor's/earthworks subcontractor's responsibility, and the drainage subcontractor will have problems at tender stage deciding what to allow for the disposal of arisings. In view of the expense of haulage, and especially tipping costs, it may be wise to qualify the tender accordingly.

When measuring and billing work in Series 500, it is important to remember that the definitions of Earthworks Outline and other surfaces in Series 600 apply equally well to Series 500.

8.14.1 Principles of measurement

The itemisation of drains and service ducts is determined by Paragraph 15 of Series 500.

Drains are measured separately from service ducts as are pipes of different diameters and design groups. Design groups determine the type of bed/surround to the pipe and the type of backfill, and this information may be found in the MMCHW Volume 3: *HCD*.

Drainage and service ducts are further categorised according to whether they are to be constructed in trench or heading or by pipe jacking or thrust boring and whether they are in side slopes of cuttings or embankments.

Depths to invert are given in 2 m stages with the average depth to invert stated to the nearest 25 mm.

Categorisation is shown in Table 8.15.

Drains and service ducts are measured along their centre lines and between any of the following:

a) The internal faces of chambers.
b) The external faces of headwalls.
c) The intersections of the centre lines at pipe junctions.
d) The centre of gully gratings (or where no grating is provided, the centre of the gully).
e) The position of terminations shown in the contract.
f) The point of change of stage depth.

Depths are measured between invert and existing ground level, but, where the Earthworks Outline is below existing ground level, the depth measurement is taken to the Earthworks Outline.

Table 8.15 Itemisation of drains and service ducts.

Group	Feature	
I	1	Drains
	2	Service ducts
II	1	Different internal diameters
III	1	Depths to invert not exceeding 2 m. The average depth to invert to be stated to the nearest 25 mm
	2	Depths to invert exceeding 2 m but not exceeding 4 m and so on in steps of 2 m. The average depth to invert to be stated to the nearest 25 mm
IV	1	Specified design groups
	2	Particular designs stated in the contract
V	1	Construction in trench
	2	Construction in heading
	3	Construction by jacking or thrust boring
	4	Suspended on discrete supports
VI	1	In side slopes of cuttings or side slopes of embankments

8.14.2 Earthworks outline

The starting point for the measurement of drainage and service ducts in carriageways is the Earthworks Outline. This is defined in Series 600: *Earthworks* Paragraphs 1 to 6 inclusive but applies equally to Series 500.

In practice, the measurement of drainage and the reality of how the work is to be carried out have consequences that need consideration at pricing and pre-contract negotiation stage.

Risk Issue

For drainage subcontractors especially, care needs to be taken with pricing drainage work because the starting level for excavation will invariably NOT be the Earthworks Outline.

In cuttings, the main contractor will leave a protective layer over the formation or may install the capping layer, or part thereof, in order to protect the formation. Consequently, trench depths will be deeper than those measured in the bill of quantities.

The extra cost would be marginal, but, where the drainage subcontractor is responsible for removing arisings, this would be more significant. Common practice, however, is for the earthworks subcontractor to pick up the arisings at a small marginal cost.

In embankments, the converse may be the case, and drainage excavation may commence at levels lower than the Earthworks Outline. This means that trench depths would be shallower than those measured in the bill of quantities.

Whilst that this might be seen as a 'plus', the downside is that the subcontractor would have to return to re-excavate filter drains in order to top up filter media prior to the laying of sub-base.

Drainage arisings that would normally have been picked up by the earthworks subcontractor would now have to be removed by the drainage subcontractor because the bulk earthworks would have finished.

It should be noted that the measurement of narrow filter drains and fin drains differs slightly from that of drains and service ducts. The vertical measurement is from invert to Earthworks Outline depth, but there is only one depth category, that is, not exceeding 1.5 m (Series 500, Paragraphs 25–28 refer).

8.14.3 Types of pavement

The measurement of drainage and service ducts in carriageways is influenced not only by the Earthworks Outline but also by the carriageway construction thickness. In the case of pre-earthworks drainage, existing ground level is used to determine trench depths.

Drainage and service ducts are measured according to the thinnest permissible construction thickness for any of the alternative types of pavement provided for in the contract according to Chapter III 3 (ii) of the MMHW. This is emphasised in the *Notes for Guidance on the Method of Measurement for Highway Works*, Series 500: *Drainage and Service Ducts*, Paragraph 3, which also confirms that *there is no requirement to provide separate drainage Bills of Quantities corresponding with each alternative Type of Pavement*. These rules also apply to the admeasurement of such work, but this is based on the thinnest permissible construction thickness for the alternative chosen by the contractor.

8.14.4 Tabulated billing

An unusual feature of the MMHW is the option to bill drainage work traditionally or using a tabulated layout. However, this is not an option provided by the MMHW itself but rather the *Notes for Guidance on the Method of Measurement for Highway Works* which suggest that the

billing of pipe runs of varying diameter and specification may create a lengthy Series 500 bill unless there are non-standard or small quantities when traditional billing *would be best*.

A suggested method of tabulation is provided in the *Notes for Guidance* which helps reduce repetition of item descriptions for pipe runs, manholes and chambers. Tables 8.16 and 8.17 illustrate the principles of tabulation suggested although there is nothing to prevent the bill compiler following another form of tabulation.

Table 8.16 Tabulated billing – drains.

Item	Description				Unit	Quantity	Rate	£	p
	'A' mm internal diameter drain specified design group 'B' in trench depth to invert exceeding 2 m, but not exceeding 4 m, average depth to invert 'C' metres Adjustment on this item for variation greater than 150 mm above or below the average depth of 'C' metres per 25 mm of variation in excess of 150 mm. Rate per metre 'D' (not to be extended)								
	'A' Diametre	'B' Design group	'C' Ave. depth	'D' Adjust. rate					
21	150	6	2.625		m	54			
22	225	7	2.950		m	18			
23	300	7	2.875		m	78			
24	450	8	3.275		m	157			

Note: Adjustment rate 'D' shall apply to both increases and decreases of average depth in excess of 150 mm and will result in either a positive or negative adjustment of the rate.

Table 8.17 Tabulated billing – chambers.

Item	Description						Unit	Quantity	Rate	£	p
	(05/01) Chamber-specified design group 'A' subtype 'B' with 'C' and 'D' and frame depth to invert exceeding 'E' metres but not exceeding 'F' metres										
	'A' Design group	'B' Sub-type	'C' Cover grade	'D' Type	'E' Depth min.	'F' Range max.					
76	2	—	Grade A	Cover	1	2	No	10			
77	3	a	Grade A	Cover	1	2	No	60			
78	3	b	Grade A	Cover	1	2	No	70			
79	3	c	Grade A	Cover	2	3	No	55			

Risk Issue

The *Notes for Guidance* is not a contract document, but there should be no conflict with the MMHW, provided that items are measured and billed strictly in accordance with the method of measurement.

8.14.5 Drainage and service ducts

Items for drains and service ducts, including sewers and piped culverts not exceeding 900 mm diameter, are measured according to Paragraph 15, Groups I–VI of Series 500, and in accordance with the features listed. This means that drains and service ducts, pipes of different diameters and those belonging to different design groups are required to be measured separately as well as pipes constructed by different methods and in different locations.

The item coverage for such items is to be found in Paragraph 16 where it will be noted that:

- Items for excavation, disposal, formwork and protective systems are 'written short'.
- There is a long list of 'deemed to be included items' such as:
  - Fixing draw ropes, removable stoppers, marker blocks and posts in service ducts.
  - Building ends of pipes into headwalls and outfall works.
  - Access shafts to headings and their subsequent reinstatement.
  - Thrust pits and thrust blocks for pipe jacking and their removal on completion.

Risk Issue

Hidden in the depths of Paragraph 16 is item coverage (e) articulated pipes and fittings. This is easily missed and/or misinterpreted because it refers to both (i) articulated pipes and (ii) to pipe fittings generally.

Consequently, pipe bends, junctions/branches and the like along the length of a pipe run are deemed to be included in item coverage 16(e).

The written short items for excavation of both 'acceptable' and 'unacceptable' materials (Series 600 Paragraphs 17–19 refer) include disposal whether or not such material is to be re-used on-site or removed to tips off-site. Not only should the contractor take this into account when calculating the earthworks balance, there is also an interface to manage at pre-subcontract stage between the earthworks and drainage subcontractors as to who carries the responsibility for removal of drainage arisings.

Risk Issue

Drainage subcontractors need to be aware that the removal of drainage arisings will be their responsibility under the subcontract unless undertaken by the earthworks subcontractor.

This is a pre-contract issue, with significant financial implications, that should be resolved before entering into a subcontract.

8.14.6 Drainage and service ducts in structures

Drainage and service ducts in structures are measured separately from 'normal' drainage items according to Series 500, Paragraphs 52–55. Such items should be clearly delineated on the drawings, and the relevant quantities should be scheduled and included either on the drawings or in an appendix.

In the case of structures to be designed by the contractor, and their associated drains and service ducts, they shall be measured in accordance with Series 2500 (Series 500, Paragraph 14 refers).

8.14.7 Filter drains

Narrow filter drains and fin drains are categorised separately from filter drains in the MMHW.

Depths of filter drains are calculated as for drains and service ducts with the proviso in Paragraph 19 that the depths of filter drains which have no pipe are measured to the bottom of the trench.

The item coverage for narrow filter drains and fin drains is 'written short' and refers also to the item coverage for filter drains (Series 500, Paragraph 22). This is where the excavation and disposal item coverage is to be found.

Within the itemisation features for filter drains is an item for *Filter material contiguous with filter drains*. This is a separately measured item for additional filter media – detailed in edge of pavement details in MCHW Volume 3: *HCD* – that occupies the void between the filter drain and the carriageway, hard shoulder or hard strip (see Figure 8.6a).

For narrow filter drains (filter media wrapped with a geotextile) and fin drains (a proprietary vertical cored filter membrane wrapped in geotextile), a similar item is measured for *Fill on sub-base material, road base and capping*.

In both cases, the measured item is additional to any filter media deemed included in the drain itself, but the item coverage does not include for any excavation or disposal.

Risk Issue

When filter drains and the like are 'topped up' to their final required level, this is usually done sometime after the installation of the drain itself. As such, subsequent earthworks and roadworks operations may have deposited unsuitable materials over the filter drain.

Any subsequent excavation and removal of such materials is not a measured item but must nevertheless be allowed for in the relevant drainage item and in the item for contiguous filter media and fill on sub-base, road base and capping.

8.14.8 Measurement of drains, sewers, piped culverts, etc.

Drains and the like are measured along their centre lines commencing at the outfall or lowest end. Pursuant to Series 500, Paragraph 12, depths are calculated every 10 m except for terminal lengths and lengths shorter than 10 m whose depths shall be calculated at their ends.

In Figure 8.10, a sewer comprising three drain runs is illustrated commencing at the outfall manhole F1 and finishing at manhole F4. Drain run F2–F3 has a terminal length of 7 m and drain run F3–F4 is only 9 m long.

The average depths of the three drain runs are calculated as shown in Table 8.18.

Risk Issue

It should be noted that the arithmetic mean of trench depths is not a weighted mean.

This means that it is possible for a drain run to have wildly fluctuating depths to invert along its length but a relatively low average depth.

This may prove to be significant in terms of the contractor's pricing, including the choice of excavation plant, the rate of forward travel (i.e. output/progress of the drainage gang) and the earthworks support requirements such as the type of temporary works needed, excavation overbreak and additional backfill and/or disposal.

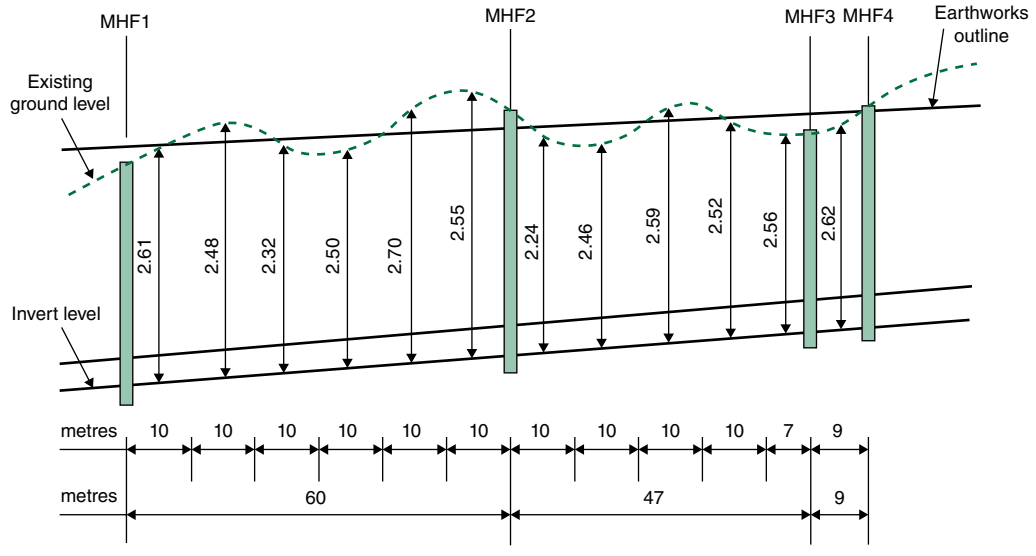


Figure 8.10 Average depths.

Table 8.18 Average depths.

Drain run	Length (m)	Depths (m)	No. of readings	Arithmetic mean (m)		Remarks
F1–F2	60	2.61 + 2.48 + 2.32 + 2.50 + 2.70 + 2.55 = 15.16	6	$\frac{15.16}{6}$	= **2.527**	Depth of final 10 m length taken at MH F2
F2–F3	47	2.24 + 2.46 + 2.59 + 2.52 + 2.56 = 12.37	5	$\frac{12.37}{5}$	= **2.474**	Depth of terminal length taken at MH F3
F3–F4	9	2.62	1	$\frac{2.62}{1}$	= **2.620**	Depth of short length taken at MH F4

8.14.9 Adjustment items

An unusual feature of Series 500 of the MMHW is the provision of an adjustment item to accompany billed items for drains and service ducts and filter drains, but not narrow filter drains and fin drains, as shown in Table 8.19.

The adjustment item recognises that drains and the like will, in all likelihood, be admeasured on completion and that a new rate will have to be established in order to value items where there has been a change in average depth.

Therefore, for each item which includes Group III Feature 1 or 2 (i.e. a drain run where the average depth is stated), *an associated item shall be provided for adjustment of the rate for each 25 mm of difference in excess of 150 mm where the average depth to invert calculated from site measurement varies from that stated in the Bill of Quantities*.

This is illustrated in Figure 8.11.

The adjustment applies to both increases and decreases in the average depth in excess of 150 mm and may result in either a positive or negative adjustment of the BQ rate. A worked example is shown in Table 8.20.

Table 8.19 Adjustment item.

		Qty	Unit	Rate	£	p
	500: Drainage and Service Ducts					
	Drains and Service Ducts (excluding Filter Drains, Narrow Filter Drains and Fin Drains)					
A	300mm diameter drain; specified design group 7; in trench; Depth to invert not exceeding 2 metres average depth to invert 1.875 metres	1076	m			
B	Adjustment on last item for variation greater than 150 mm above or below the average depth of 1.875 metres per 25 mm of variation in excess of 150 mm		m			

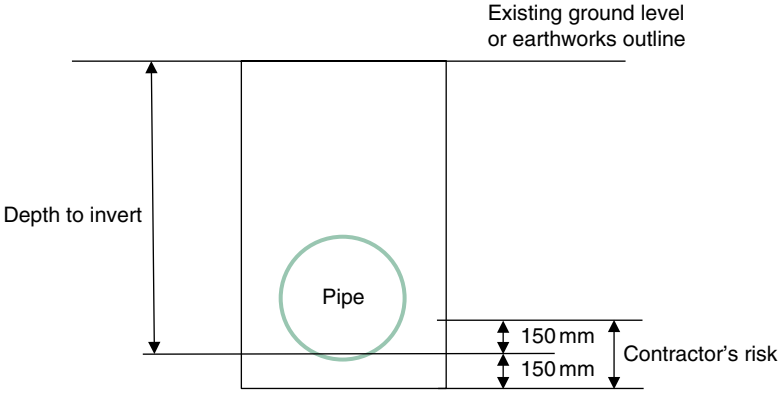


Figure 8.11 Adjustment item.

Table 8.20 Pricing of Adjustment item.

Actual average depth		3.290	
BQ average depth		2.780	
Difference ±	+	0.510	
Less			
Non-adjustable element		0.150	
No. of depth increments	0.025	0.360	14.4 = 14
New rate			
Original rate			£37.76
Adjustment rate		£0.19	
Adjustment factor	14	×	2.66
New rate			**£42.42**

It will be noted that the adjustment will be based on-**site measurement** and not on revised drawings or drainage schedules.

Risk Issue

The site measurement of drainage can be problematic for a number of reasons:

- The average depth of drains is the arithmetic mean of depths taken every 10 m (or part thereof) measured form the outfall.
- This can only be done when the drainage work is being carried out and before surrounding or backfilling pipes.
- Drainage work is done before, during and after earthworks, and there is no guarantee that there will be an Earthworks Outline to measure from (capping may be incomplete, for instance).
- Drainage is not an exact science and may not necessarily be installed to the precise levels shown on the drawings.
- Site measurements are notoriously inaccurate.
- Remeasurement of drainage, even on a relatively small highway project, is a significant and time-consuming task.

In all practicality, it is unlikely that the adjustment will be based on **site measurement** notwithstanding the provisions of the method of measurement.

8.14.10 Chambers and gullies

Chambers and gullies are itemised in the MMHW (Series 500, Paragraphs 33–38), and the measurement is for the complete chamber or gully. Channels, fittings, benching, building in pipes and fin drain connections are included in the item coverage.

The relevant specified design group must be referred to in the item description which relates to the standard details provided in MCHW Volume 3: *HCD*.

Apart from the design group, such items are distinguished by their depth, stated in 1 m stages, depths being taken from cover level to channel invert or to base slab in the case of catchpits, and by the specification of the cover or grating.

Risk Issue

Standard highway construction details usually require a short length of pipe to be built into the inlet and outlet sides of chambers. These are called 'articulated pipes' in the SHW/MMHW but are commonly referred to as 'rocker pipes'.

Rocker pipes are not measured separately, but, being considerably more expensive than standard length pipes, they demand an 'extra over' allowance to be built into the contractor's tender.

This might be conveniently included in the pricing for each chamber but must be remembered in the 'take-off list' when preparing 'builders' quantities' for such items at tender stage.

8.14.11 Headwalls and outfall works

Headwalls and outfall works to pipes less than 900 mm diameter are measured in accordance with Paragraphs 40–42 of Series 500. For pipes above this diameter, Series 2500: *Special Structures* applies.

Headwalls, revetments, etc. are enumerated, and, therefore, tenderers need to carry out additional quantification at tender stage to determine the quantities of excavation, concrete, formwork and brickwork.

Risk Issue

The majority of the item coverage for headwalls and outfall works is 'written short', and special care is needed when pricing such items, particularly if they are in proximity to rivers and tidal waters.

8.14.12 Soft spots

Separate items are required for the excavation of soft spots and other voids, and the filling of soft spots and other voids are classified by the different types of fill specified.

Risk Issue

Measurement of soft spots is the volume of the void *directed to be excavated or filled*, and thus, the contractor would be unwise to undertake such work without an instruction or without confirming a verbal instruction in writing.

There are no limitations as to the volume of soft spots measured under Series 500, as there are under Series 600: *Earthworks*, but there are limitations as to the width of the excavation to be taken:

- For drains, service ducts and filter drains, it is the internal diameter of the pipe plus 600 mm.
- Where there is no pipe, it shall be taken as 600 mm.
- For chambers, gullies and the like, it is the horizontal area of the base slab or, where no base slab is required, the bottom of the excavation.

The item coverage for both excavation and filling of soft spots is 'written short'. For excavation, the relevant paragraphs are 17–19 and 39 of Series 600: *Earthworks* and, for filling, Paragraphs 33 and 52 of Series 600 and Paragraphs 5 and 15 of Series 1700: *Structural Concrete*.

Risk Issue

Excavation of soft spots includes upholding the sides of excavations, dealing with water, disposal and, importantly, overbreak and making good.

8.14.13 Extra over

Notwithstanding the shortcomings of the MMHW approach to EO items, as previously discussed in 8.13.10, items measured as 'EO' in Series 500: Drainage follow the same principles as Series 600: *Earthworks*.

However, whilst the principles are the same, practical issues arise with regard to hard material in drainage work, and this issue is discussed in 8.14.15.

8.14.14 Dealing with water

The item coverage for the excavation of drains and service ducts (including culverts <900 mm diameter) and filter drains are 'written short' to Series 600: *Earthworks*, Paragraphs 17 (topsoil), 18 (acceptable material) and 19 (unacceptable material). For narrow filter drains and fin drains, the item coverage is 'written short' to Series 500: *Drainage* Paragraph 22 which, in turn, refers to Series 600.

This means that the contractor shall allow in his rates and prices for drainage work for working within and below non-tidal open water or tidal water, for dealing with the existing flow of water, sewage and the like and for carrying out investigations in order to establish water boundaries, levels and fluctuations.

Risk Issue

The consequence of this is that the contractor is deemed to have included *keeping earthworks free of water* in his rates. In common with Series 600: *Earthworks*, this is a general obligation, with no limits, save for the test of what an experienced contractor could have expected having visited the site and perused the contract documentation.

8.14.15 Hard material

The excavation of hard material in drainage is measured as EO the excavation in which it occurs, with the unit of measurement in m^3, as illustrated in Table 8.21.

The measurement is the *volume of the voids formed by the removal of the Hard Material*, but this is qualified in Series 500 Paragraph 74 such that:

- For drains, service ducts and filter drains (except fin drains and narrow filter drains), the width measured is the internal diameter of the pipe plus 600 mm or, where there is no pipe, 600 mm.
- For fin drains and narrow filter drains, the width measured is 300 mm.
- For chambers, gullies and the like, the area measured is the horizontal area of the base slab or, where there is no base slab, the area of the bottom of the excavation.

The item coverage for excavation in hard material is 'written short', and Series 600 Paragraph 23 therefore applies.

However, a problem arises when it comes to the admeasurement of EO for excavation in hard material because the EO item coverage includes the extra cost of removal, such as blasting,

Table 8.21 Excavation of hard material.

					£	p
	SERIES 500 - DRAINAGE AND SERVICE DUCTS					
	Excavation in Hard Material		(NA)			
	Extra over excavation					
A	for excavation in hard material	900	m^3			

splitting, breaking, etc., and does not include for the additional costs associated with the void caused by the removal of hard material (i.e. 'overbreak and making good').

The additional excavation, disposal, pipe bedding and backfilling can be considerable, as is illustrated in Figure 8.12, because no one can accurately predict how rock will break or what sizes or dispositions the rock or artificial hard material will be in.

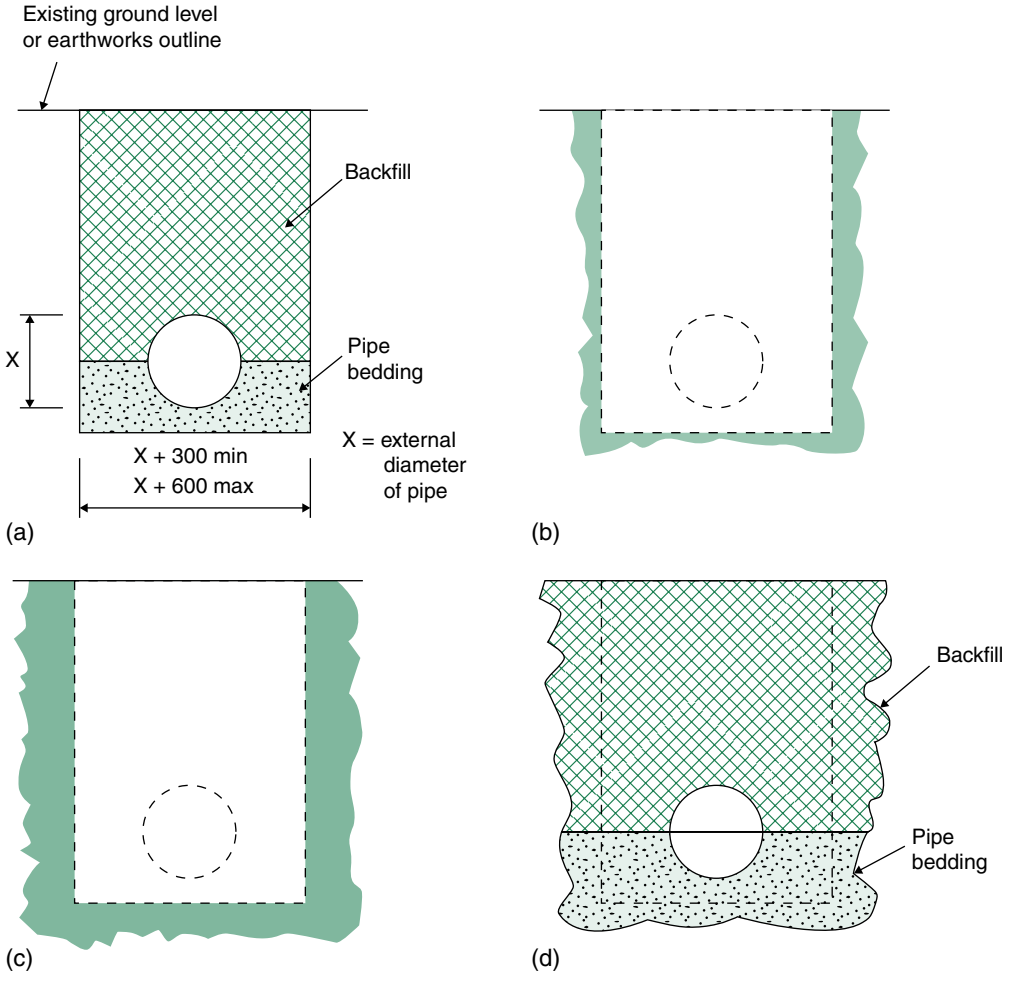


Figure 8.12 Overbreak in hard material. (a) Standard detail, (b) 'Normal' overbreak, (c) overbreak in hard material and (d) completed drain trench.

Consequently, reference must be made to Series 600 Paragraphs 18 and 19 (which is also written short) to find that it is in the relevant drainage item where the overbreak is deemed to be included.

From the borehole logs, superimposed on the long sections, tenderers may be able to interpolate where the hard material is likely to arise and, roughly, which drain runs are affected. In this way, the measured quantity of EO for excavation in hard material can be related to the length(s) of drain runs involved, and a suitable allowance can then be made in the relevant BQ rate(s).

Risk Issue

If the actual quantity of hard material is significantly more than that billed, the contractor could find that the additional cost of excavation, disposal, pipe bedding and backfilling, due to the overbreak, is not reflected in the rates for drain runs, as the 'extra over' item coverage excludes overbreak.

One way round this issue is for the contractor to price an enhanced rate for the extra over item to allow for the additional costs that would otherwise not be recovered, notwithstanding the item coverage. This, however, would increase the tender price, and consideration may have to be given to this issue in the contractor's 'commercial opportunity' and tender risk assessments.

8.15 Series 1600: Piling and embedded retaining walls

This series deals with:

- Precast concrete piles.
- Cast-in-place piles.
- Steel bearing piles.
- Steel sheet piles.
- Diaphragm walls.
- Secant pile walls.
- Contiguous bored pile walls.
- King post walling (e.g. steel 'H' beam sections, set into 'wet' cast-in-place piles, with precast concrete panels between).

There are some unusual features of this Series.

8.15.1 Piling plant

For precast concrete piles, bored cast-in-place piles, driven cast-in-place piles, steel bearing piles and steel sheet piles, Series 1600 Paragraph 4 requires a measured item for *establishment of piling plant* (item), and each type of pile, except steel sheet piles, requires an item for *moving piling plant* (number).

The establishment of piling plant is measured once only for each structure (e.g. a bridge) but shall not be admeasured to suit the contractor's method of working. The measurement of moving piling plant shall be measured once only per pile, but the moving of piling plant for steel sheet piling shall not be measured. This is illustrated in Table 8.22.

Table 8.22 Piling plant.

		Qty	Unit	Rate	£	p
	1600: Piling and Embedded Retaining Walls					
	Piling Plant					
A	Establishment of piling plant for 450 mm diameter; bored cast-in-place piles; in main piling; Bridge 16A		item			
B	Moving piling plant for 450 mm diameter; bored cast-in-place piles; in main piling; Bridge 16A	42	no			

The item coverages for 'establishment' and 'moving' piling plant include, *inter alia*, site preparation, levelling and access ramps, but, although the construction of piling 'mats' is not specified, it may be implied.

The provision for 'piling plant' seems somewhat out of step with the philosophy of the MMHW and a 'nod' in the direction of method-related charges. Whether this is to avoid arguments should a variation instruction require more piles, and subsequent moving, or even remobilisation, of the piling rig, is unclear. In the majority of instances, of course, piling will be a contractor-designed proprietary structural element, and so the problem as to whether the bill compiler should 'second-guess' the contractor's intentions as regards the number of piles raises its head again!

8.15.2 Cast-in-place piles

Where bored piles require casings or linings, these are included in the item coverage given in Series 1600 Paragraph 23 and are regarded as temporary *unless the Contract states specifically that they are to be left in place*. This is a provision of the *Notes for Guidance* and not the method of measurement itself.

Empty bores are only measured where the contract specifies a particular commencing level from which boring shall begin and shall be the length of empty bore measured from the finished level of the pile to the specified commencing level.

The measurement of reinforcement to cast-in-place piles requires the following itemisation:

- Bar or helical reinforcement.
- Nominal size 16 mm and under and 20 mm and over.
- Different types and grades of steel.
- Bars not exceeding 12 m in length.
- Bars exceeding 12 m in length but not exceeding 13.5 m and so on in steps of 1.5 m.

Consequently, rates are very much an 'average' in terms of bar diameter, and tenderers, therefore, need to undertake additional measurement at tender stage in order to determine the correct weightings.

8.15.3 Embedded retaining walls

For embedded retaining walls – diaphragm walls, secant pile retaining walls and contiguous bored pile walls – an item for the *establishment of embedded retaining wall plant* shall be given, and the unit of measurement shall be 'item'.

This measurable item shall be given only once for each embedded retaining wall.

As might be expected, the excavation of acceptable/unacceptable material is 'written short' in the item coverages, as per Series 600 Paragraphs 17–19, as is excavation in hard material (Series 600, Paragraph 23) and disposal (Series 600, Paragraph 39).

For complex-shaped diaphragm walls, the *Notes for Guidance* suggest that the wording of Series 1600, Paragraph 63 (i.e. the unit of measurement – m^2) may need to be amended as a departure from the method of measurement with, perhaps, an indication of the developed length given on a drawing for clarity.

Should an embedded retaining wall have a finishing thickness, such as brickwork, this should be separately measured in accordance with relevant series. Cleaning and treatment of the embedded retaining wall face are included in the item coverage in Paragraphs 65, 69 and 73 of Series 1600 and are not required to be measured separately.

8.16 Series 1700: Structural concrete

8.16.1 In situ concrete

In situ concrete to structures is measured in m^3 and itemised according to its class or design, if a designed mix is specified, as shown in Table 8.23.

Table 8.23 Structural concrete.

Group	Feature	
I	1	In situ concrete.
II	1	Different designs.
	2	Different classes.
III	1	Blinding concrete 75 mm or less in thickness.

In billing such items, it is important to follow the provisions of Chapter III: *Preparation of Bill of Quantities*, Table 1, which requires bridges or viaducts to be identified with a name or reference and for each structure to be separated into substructure end supports, substructure intermediate supports, superstructure and finishings.

Effectively, this provides all the locational information that the contractor needs to price the concreting items as illustrated in Table 8.24.

Table 8.24 Typical bill items for structural concrete.

Bridge 16A

		Qty	Unit	Rate	£	p
	1700: Structural Concrete					
	Substructure End Supports					
A	Insitu concrete; Class C40	108	m^3			
B	In situ concrete; Class C10; in blinding 75 mm or less in thickness	5	m^3			

Establishing the boundary between structural concrete in substructure and in superstructure is an interesting question as the MMHW does not provide a rule.

For the excavation of structural foundations, the boundary is the Earthworks Outline, but adopting this for the measurement of structural concrete would mean apportioning a bridge pier or abutment wall between substructure and superstructure as illustrated in Figure 8.13.

Measuring the foundation and pier or abutment wall together would be another option with 'superstructure' being limited to the bridge deck and support beams albeit that this would not be a 'strict' separation of substructure and superstructure.

8.16.2 Formwork

Series 1700 requires the measurement of (i) formwork (m^2) and (ii) void formers (linear metres). Group II features of the itemisation table provide for the separate measurement of horizontal, inclined,

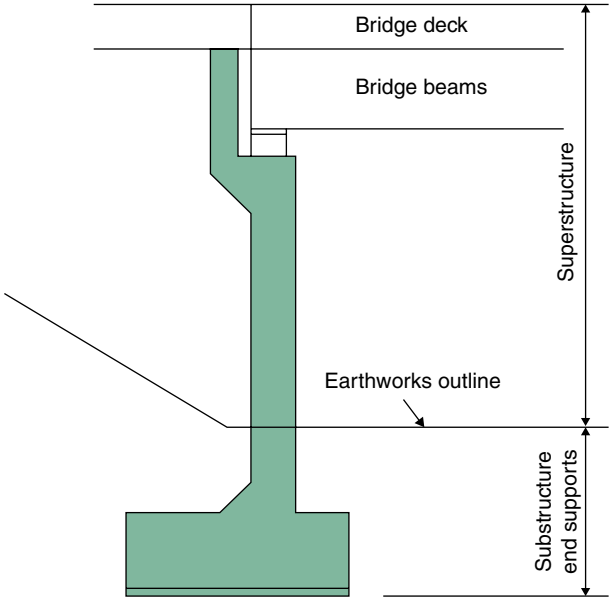


Figure 8.13 Structural concrete.

vertical and curved formwork and for void formers of different cross sections. Formwork of all types is measured as 300 mm wide or less and more than 300 mm wide, but all are measured in m^2.

Different classes of surface finish to concrete must be measured separately, but there is no classification given in the method of measurement. Surface finishes are determined by the SHW which specifies:

- Formed surfaces F1–F5.
- Unformed surfaces U1–U5.

Formed surfaces are those created by formwork, and the quality of the finish is made explicit in SHW Series 1708: *Concrete – Surface Finish*, Paragraph 4(i). The desired finish, and not the means of achieving it, is specified for each of the formed surfaces F1–F5, F5 being the most exacting standard. Unformed finishes do not require formwork.

The measurement of formwork is the area which is in contact with the finished concrete, measured over the face of openings of 1 m^2 or less and over certain listed features.

Formwork to concrete in structural foundations, other than blinding concrete, is measured to the sides of the foundations irrespective as to whether or not formwork is used, but, where stated on the drawings that the concrete is to be cast against the soil face, no formwork is measured.

Patterned profile formwork is accorded its own Group.

Risk Issue

An important point to remember with formwork under the MMHW is that the item coverage includes, *inter alia*, for falsework which is, therefore, deemed to be included in the rates per m^2.

Falsework is the temporary works needed to support the formwork itself and is defined as *any temporary structure used to support a permanent structure while it is not self-supporting* (British Standards Institution, 2011).

Such temporary structures can be significant cost items, but, as there is no separate method-related charge, a check on the quantities of formwork measured in the BQ would be prudent at tender stage should the contractor decide to price the falsework in with the formwork item.

8.17 Series 2700: Accommodation works, works for statutory undertakers, provisional sums and prime cost items

As with most other construction projects, highway works are never completely designed and detailed at tender stage, and some issues will remain that need to be resolved during the contract.

In order to cater for such work, the normal procedure is to include provisional quantities or provisional sums in the tender BQ so that instructions may be issued with regard to the quantum of such work or the expenditure of the provisional sums included. This is confirmed by the *Notes for Guidance* for Series 2700, Paragraph 1, which provides that:

- *Where accommodation works and works for privately and publicly owned services and supplies are known prior to tendering they should be billed in accordance with Chapter III and with the various Series of the MMHW.*
- *It might be appropriate to insert provisional quantities as provided for in Chapter I.*[15]
- *If neither of these options can be used and accommodation works and works for privately and publicly owned services and supplies are anticipated but cannot be defined then a Provisional Sum may be included in the Bill of Quantities.*

Such provisions in the contract bills ensure that instructions regarding the expenditure of provisional sums and the admeasurement of provisional quantities are covered by express contract terms and are not reliant on extra-contractual agreement with the contractor as would otherwise be the case.

8.17.1 Accommodation works

In view of the 'land take' required for a highway project, it is inevitable that land and property will be disturbed by the proposed works, especially in urban areas. Areas disturbed will have to be reinstated or modified by the contractor as part of the contract, and works may be required to divert watercourses; reconnect sewers and drains; reinstate gardens, paths and pavings and landscape disturbed areas; erect fencing to re-establish boundaries or to contain cattle or sheep; and so on.

Provision for such works is made in the contract bills by the inclusion of a bill of accommodation works. There is no provision in the MMHW as to where this bill shall appear except that the method of measurement *shall be in accordance with the various Series of this Method of Measurement.*

Problematically, at tender stage, the majority of accommodation works requirements will not have been resolved in sufficient detail to be measured, and, therefore, provisional quantities or a provisional sum will have to be included in the tender bills to allow for such works.

Remembering, however, that Highways England has adopted the ECC as its preferred form of contract, and that there is no mechanism in this contract for provisional sums as is the case with the ICC – Measurement Version form of contract, the bill compiler is faced with the problem as to how to include such provisions in the tender bills.

8.17.2 Works for statutory undertakers

Similar principles apply to works for statutory bodies as those for accommodation works with the additional problem that the whereabouts of statutory services may not be known or may not be where they were expected to be.

The traditional way of providing for investigative work is to include a daywork schedule in the contract which establishes competitive rates for time-based payments for work instructed by the contract administrator.

Again, however, the ECC form does not provide for daywork, and such matters are normally resolved by way of compensation events valued in accordance with the *Shorter Schedule of Cost Components*.

8.17.3 Provisional sums, etc.

The *Notes for Guidance* for Series 2700, Paragraph 2, draws the bill compiler's attention to the fact that *certain Forms of Contract do not support the inclusion of Provisional Quantities, Provisional Sums, Dayworks or Prime Cost Items. Reference should be made to the specific Form of Contract to be used before such items are included in the Bill of Quantities*.

This 'guidance' is no help whatsoever for contracts where the ECC form is to be used because, notwithstanding the use of a method of measurement that provides for such items, there must be an accompanying provision in the contract to empower the contract administrator to:

- Admeasure provisional quantities and adjust rates, where appropriate.
- Expend provisional sums, issue appropriate instructions and establish how the work shall be valued.
- Require the submission of daywork records, verify their correctness and value the work recorded.
- Expend prime cost sums for the carrying out of work or for the provision of goods, materials or services for the works.

It would appear that the ECC compensation event procedure, including the option to instruct the contractor to submit quotations for compensation events, is the only way to resolve the question of provisional or unforeseen work, together with the Clause 10.1 provision that the parties shall act *in a spirit of mutual trust and co-operation*.

8.18 Other works

Compared with CESMM, the MMHW is somewhat limited in the types of work covered.

True, there is a series for everything required for a standard highway project but not, it is submitted, for situations where tunnels, immersed tubes, railway trackwork and small building work may be required.

8.18.1 Building work

Where small building works, such as administrative and public buildings, public toilets and the like, are required, the MMHW lacks a suitable series for measurement purposes.

Creating a 'bespoke' series would be a considerable task as this would not only require the creation of a specific method of measurement but also a specification, standard construction details and notes for guidance.

Using other methods of measurement such as SMM7, NRM2 or CESMM (Class Z: *Simple building works incidental to civil engineering works*) is more attractive, but, in solving one problem, others may be created:

- BQ with items measured in the detail required of SMM7/NRM2 would create disproportionately lengthy documents and would be against the ethos of the MMHW.
- Introducing a second method of measurement into the contract would require careful attention with regard to drafting the contract appendix or works information and with regard to the amendment of Clause 57 of the ICC – Measurement Version form which states the default method of measurement.
- A designated outline to distinguish between works measured under the MMHW and another method of measurement might be needed.

8.18.2 Other civil engineering work

It is not uncommon to find highway projects with elements that are not included in the MMHW. Where a tunnel is required, for instance, there is no suitable series provided as a basis for measurement.

Amending the MMHW or adopting another method of measurement is an option to overcome this problem, but neither is ideal or without difficulties (see 8.18.1), neither is Series 2500: *Special Structures* **designed for** highway schemes incorporating large road tunnels and the like.

Fortunately, the availability and popularity of non-traditional procurement methods come to the rescue as such projects are often undertaken by consortia of engineers and contractors on a D&B basis.

Notes

1. https://www.gov.uk/government/organisations/highways-england (accessed on 6 April 2015).
2. http://www.dft.gov.uk/ha/standards/mchw/ (accessed on 6 April 2015).
3. http://www.constructionproducts.org.uk/publications/industry-affairs/display/view/construction-products-regulation/ (accessed 29 April 2015).
4. http://www.constructionenquirer.com/2013/10/24/race-starts-for-5bn-highway-agency-framework/ (accessed 29 April 2015).
5. https://www.gov.uk/government/organisations/highways-england/about/procurement (accessed 29 April 2015).
6. https://www.gov.uk/government/organisations/highways-england/about/procurement (accessed 29 April 2015).
7. Model Contract Document for Highway Works, Volume 0, Paragraph 1.11.
8. Model Contract Document for Highway Works (England), Chapter 4 *Instructions for Tendering*.
9. To be completed by compiler as appropriate.
10. Notes for Guidance on the Specification for Highway Works, NG 104 Paragraph 25 – *Statutory type approval is granted by the Secretary of State. Where the Contractor designs part of the works and makes application for approval, he should forward the information to the Overseeing Organisation in sufficient time for approval to be given, taking into account the programme for the works. Where statutory type approval is given, one copy of the approval certificate should be returned to the Contractor.*
11. Notes for Guidance on the Specification for Highway Works, NG 106 Paragraph 7.
12. Notes for Guidance on the Specification for Highway Works, NG 106 Paragraph 1.
13. http://www.ciht.org.uk/motorway/m6toll.htm (accessed on 6 April 2015).
14. Notes for Guidance on the Method of Measurement for Highway Works, Series 600, Paragraph 7.
15. Chapter 1: *Definitions*, Paragraph 1(d) – *items designated 'Provisional'*.

References

British Standards Institution (2011) *Code of practice for temporary works procedures and the permissible stress design of falsework* (BS 5975: 2008 + A1:2011), British Standards Institution.

Money B. and Hodgson G., (1992) *Manual of Contract Documents for Highway Works – A User's Guide and Commentary*, Thomas Telford, London.

Loots P., Charrett D., (2009) *Practical Guide to Engineering and Construction Contracts*, McPherson's Printing Group, Australia.

Mitchell H., (2014), *Managing with the MMHW*, Chartered Institution of Civil Engineering Surveyors.

Lee, S. Trench, W. Willis, A. (2014) *Willis's Elements of Quantity Surveying* Twelfth Edition, Wiley-Blackwell, Chichester.

National Audit Office (October 1992) *Department of Transport – Contracting for Roads (HC 226)*, HMSO.