

Part A:

Introduction and Implementation

This Part introduces the Manual, provides an overview on the purpose of inspections of highway structures and establishes the need for an overarching consistent approach. The overall objectives and scope of the Manual are presented as is an overview of the recommended inspection regime. The general competence and training requirements for inspectors are outlined and the different parts of the Manual summarised.

Section 1

Background

1.1 THE ROLE OF HIGHWAY STRUCTURES

- 1.1.1 Highway structures represent a significant national investment, with most being publicly owned and many being prominent features in the local environment [1]. In the UK the inspection and maintenance of highway structures is undertaken by a variety of owners or agencies, e.g. local authorities, Trunk Road Agencies, Network Rail, BRB (Residuary) Ltd, Environment Agency, British Waterways, London Underground, Transport for London and many private owners. In this Manual they are collectively referred to as 'owner' or 'authority' as appropriate.



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- 1.1.2 Bridges and other highway structures are fundamental to the transport infrastructure because they form essential links in the highway network [1]. They are relied upon to remain in service year after year, and are carrying ever-increasing traffic flows. The *Highways Act* [2] (*The Roads (Northern Ireland) Order 1993* [3], and *The Roads (Scotland) Act 1984* [4]) places a statutory obligation on highway authorities to maintain the public highway. This has been interpreted in the *Code of Practice* [1] as embracing the two essential functions of *Safe for Use* and *Fit for Purpose*, where these are defined as:
- *Safe for Use* requires a highway structure to be managed in such a way that it does not pose an unacceptable risk to public safety.
 - *Fit for Purpose* requires a highway structure to be managed in such a way that it remains available for use by traffic permitted for the route.
- 1.1.3 The majority of highway structures are managed and maintained at public expense. It is therefore also important that their management minimises disruption, risk and consequential costs to road users, and makes economic and efficient use of resources. Fundamental to effective management is an inspection regime that provides timely, accurate and appropriately detailed information on asset condition and performance.
- 1.1.4 A key aspect of any inspection regime is the personnel involved. Guidance on the training and qualifications required by the inspectors and the Supervising Engineer are given in Section 4. In this Inspection Manual (hereafter referred to as the Manual) the term 'Inspector' is used to describe the personnel who actually carry out inspections irrespective of whether they are engineers, technicians or staff with other qualifications/experience. The term 'Supervising

Engineer' is used to describe the engineer who is in charge of the inspection regime.

1.2 THE PURPOSE OF INSPECTIONS

1.2.1 As set down by the *Code of Practice* [1], the overall purpose of inspection, testing and monitoring is to check that highway structures are safe for use and fit for purpose and to provide the data required to support effective maintenance management and planning. Inspections, and where required testing and monitoring, should:

- Observe and provide information on the current condition, performance and environment of a structure, e.g. severity and extent of defects, material strength and loading. This enables the safety, functionality and durability of structures to be assessed, and provides sufficient information for actions to be planned where structures do not meet these requirements.
- Inform analyses, assessments and processes, e.g. change in condition, cause of deterioration, rate of deterioration, identification and quantification of maintenance needs, effectiveness of maintenance and structural capacity. This informs management planning and enables cost-effective plans, which deliver the required performance, to be developed.
- Compile, verify and maintain inventory information, e.g. structure type, dimensions and location, for all the highway structures the authority is responsible for.

1.2.2 Although the scope, procedures and work undertaken varies considerably between different inspection types (and testing and monitoring methods), these core objectives remain. As such, the inspector should be able to identify structural defects and clearly document these deficiencies; recognise structural elements that need repair in order to maintain safety and avoid the need for costly replacement; and be on guard for minor problems that could lead to the need for costly repairs. By providing this information, inspectors alert the Supervising Engineer to any defects which might impact the safety of the road user or the integrity of the structure and enable timely corrective action to be taken.

Section 2

Purpose, Objectives and Scope of the Manual

2.1 PURPOSE OF THE MANUAL

- 2.1.1 The purpose of this Inspection Manual is to provide guidance on the inspection process for all staff involved in the management of highway structures. It is also considered that this Manual provides a sound basis for the development of formal inspector training courses.
- 2.1.2 This Manual aims to ensure that inspections are carried out efficiently, uniformly and to a high standard. The Manual is intended for use as guidance, outlining typical procedures and defining the normal requirements for the various categories of inspection. It is not intended to provide the definitive solution in all situations, as the party best able to decide on the appropriate course of action is the inspector or engineer undertaking the work.
- 2.1.3 This Manual supersedes the *Bridge Inspection Guide* [5] and is endorsed by the Highways Agency, Transport Wales, Transport Scotland, Department for Regional Development Northern Ireland (DRDNI) Roads Service, CSS Bridges Group and the London Bridges Engineering Group (LoBEG). To be agreed.

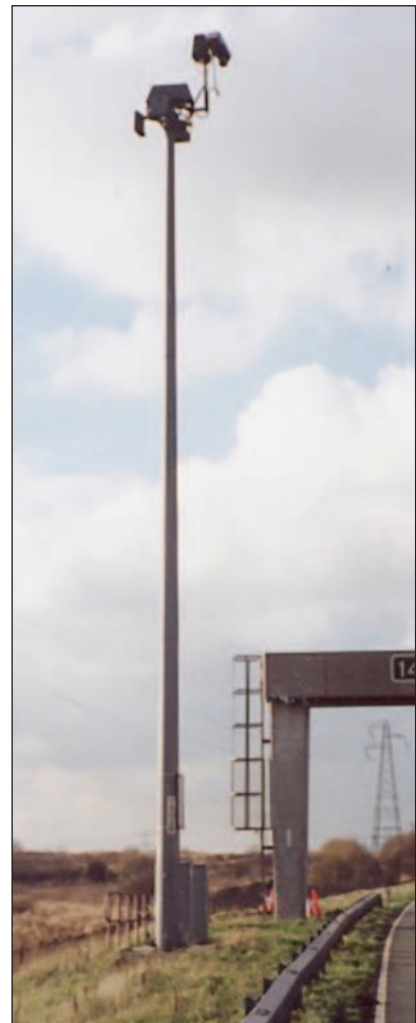
2.2 OBJECTIVES OF THE MANUAL

- 2.2.1 The objectives of this Manual are to encourage and assist inspection staff acting on behalf of an authority to:
- Develop and implement an inspection regime that ensures structures are safe for use and fit for purpose.
 - Develop and undertake inspection regimes that facilitate the collection of appropriate inventory data to enable the development of robust and sustainable maintenance programmes.
 - Harmonise procedures and practices in order to provide a more consistent approach to highway structures inspection throughout the United Kingdom.
 - Provide an authoritative account of inspection procedures and practices for highway structures encompassing current national and international best practice.
 - Be easy to understand and implement by a wide range of users, primarily inspectors but also Supervising Engineers, designers and planners.
 - Provide standard definitions for the different highway structures and their elements and give a glossary of terms relevant to the inspection of highway structures.

2.3 SCOPE OF THE MANUAL

- 2.3.1 This Manual covers structural (e.g. beams, columns) and non-structural (waterproofing, expansion joints) aspects of highway structures; fittings such as signs, lighting or electrical equipment are not normally included. This Manual does not cover mechanical and electrical (M&E) equipment that may form part of or are attached to a highway structure, for example M&E in tunnels and moveable bridges. Advice on the inspection of M&E equipment is provided in *BD53: Inspection and Records for Road Tunnels* [6].
- 2.3.2 Inspection includes all visual inspections, testing and investigations carried out to ascertain the condition of a highway structure or for other purposes associated with the management of the structure. It includes work associated with inspection or testing operations, such as traffic management and the provision of access equipment. However, it does not include carrying out repairs or refurbishment, other than making good any drill holes, excavations or other minor damage caused by the inspection.
- 2.3.3 The principles and procedures described in this Manual are applicable to the inspection of all highway structures and are equally applicable to structures on other transport networks, e.g. heavy rail, light rail and waterways. Highway structures are typically considered to include those structures within the footprint of the highway that align with the following definitions:

- Bridges, buried structures, subways, culverts and internal diameter greater than 0.9m.
- Earth retaining structures – structures associated with the highway where the dominant function is to retain earth with an effective retained height, i.e. the level of fill at the back of the structure above the finished ground level at the front of the structure, of 1.5m or greater.
- Reinforced/strengthened soil/fill structures with hard facings – structures associated with the highway where the dominant function is to stabilise the slope and/or retain earth with an effective retained height of 1.5m or greater.
- Structural aspects of all sign/signal gantries.
- Structural aspects of masts, e.g. cantilever mast for traffic signal, lighting masts of 20m or greater, masts for camera, radio, speed camera and telecommunication transmission equipment, catenary lighting support system, highway signs on posts.



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- Access gantries – defined as moveable structures providing access to a highway asset, typically for bridge inspection and maintenance. All access gantries should be subject to inspections in accordance with the Institution of Structural Engineers publication *The Operation and Maintenance of Bridge Access Gantries and Runways* [7].
- Structural aspects of tunnels – where a tunnel is defined as an enclosed length of road of 150m or more.
- Other structures that are within the footprint of the highway, e.g. service/utility crossings that provide crossings either above or below the carriageway.

2.4 DUTY OF CARE

- 2.4.1 The scope described above does not negate the inspector's duty of care under Health and Safety legislation to report any safety hazards they encounter that are outside the scope of their inspection, e.g. defects which may have safety implications on fittings, or in particular at their attachment to the structure. Inspectors should be careful to note any deficiencies at or near the structure that, in their opinion, may constitute a significant safety hazard. They should report these to the engineer in charge at the earliest possible opportunity. There may be instances where inspection of fittings is required, for example to ascertain their effects on the loading or capacity of the structure.

Section 3

Overview of the Inspection Regime

- 3.1.1 Cost-effective management of the maintenance of a structure relies on detailed, accurate and up-to-date information about its current condition and rate of deterioration. This objective can best be achieved through the development and implementation of an inspection regime tailored to meet the specific requirements of each structure [1].



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- 3.1.2 The inspection regime should include a combination of Safety, General, Principal and Acceptance Inspections of the whole structure; and more detailed Special Inspections or Inspections for Assessment, concentrating on known or suspected areas of deterioration or inadequacy. The inspection schedule for each structure may be unique to that structure but should be designed to provide the appropriate frequency and detail of information.
- 3.1.3 The principal features of each type of inspection are summarised in , with further guidance provided in Volume1: Part C: Section 2: Paragraph 2.2. Guidance on the inspection regime is also provided in the *Management of Highway Structures: A Code of Practice* [1] and *BD 63* [8].
- 3.1.4 Safety Inspections are undertaken at frequencies which ensure the timely identification of safety related defects but are not specific to highway structures; they generally cover all fixed assets on the highway network. Safety inspections may also be undertaken following notification of a defect by a third party e.g. the public or the police. Safety Inspections are normally carried out from a slow moving vehicle and provide a cursory check of those parts of a highway structure that are visible from the highway, in certain instances staff may need to proceed on foot.
- 3.1.5 General and Principal Inspections have set requirements, but differ in scope and intensity. General Inspections comprise a visual inspection [undertaken from ground level] of all parts of the structure that can be inspected without the need for special access equipment or traffic management arrangements. Principal Inspections, on the other hand, are more comprehensive than General Inspections, and comprise a close examination, within a touching distance, of all inspectable parts of a structure. A Principal Inspection should utilise as necessary suitable inspection techniques, access equipment, and/or traffic management works. Suitable inspection techniques that may be considered for a Principal Inspection include hammer tapping to detect loose concrete cover and paint and steel thickness measurements. All highway structures should be

subjected to a General Inspection not more than two years following the previous General or Principal Inspection; and to a Principal Inspection not more than six years following the previous Principal Inspection. Formal guidance on increasing or decreasing the aforementioned inspection intervals is provided in the *Code of Practice* [1] and *BD 63* [8] (also see Volume1: Part C: Section2: Paragraphs 2.2.20 and 2.4.18).

- 3.1.6 Special Inspections are undertaken for a wide variety of reasons but mainly to provide detailed information on a particular part, area or defect that is causing concern, which is beyond the requirements of the General/Principal Inspection regime. They may comprise a close visual inspection, testing and/or monitoring and may involve a one-off inspection, a series of inspections or an on-going programme of inspections. As such, Special Inspections are tailored to specific needs and are carried out when a need is identified or for some structures are programmed in advance.
- 3.1.7 Acceptance inspections are undertaken when necessary for exchanging information and documentation and agreeing the current status of, and outstanding work on, a structure prior to change over of responsibility for operation, maintenance and safety [1]. Acceptance inspections usually take the form of a Principal or General Inspection. However, the format content and timing depends on the circumstances (e.g. handover of a new structure, transfer of an existing structure, hand-back of a structure after a concession period) and on the specific purpose (i.e. Pre Opening Inspection, Defects Liability Inspection, or Transfer Inspection). The different types of Acceptance Inspections are described in more detail in *BD63* [8].
- 3.1.8 Inspections for Assessment are undertaken when necessary to provide the information required to undertake a structural assessment. *BD 21* [9] provides guidance on undertaking an Inspection for Assessment.

Table A.1 – Summary of Inspection Types		
Inspection Type	Nominal Interval	Description
Safety Inspection (or Routine Surveillance)	At frequencies which ensure timely identification of safety defects and reflect the importance of a particular route or asset.	Cursory inspection carried out from a slow moving vehicle, in certain instances staff may need to proceed on foot.
General Inspection	2 years.	Visual inspection from the ground level. Report on the physical condition of all structural elements visible from the ground level.
Principal Inspection	6 years.	Close visual examination, within touching distance; utilising, as necessary, suitable inspection techniques. Report on the physical condition of all inspectable structural parts.
Special Inspection	Programmed or when needed.	Detailed investigation (including as required inspection, testing and/or monitoring) of particular areas of concern or following certain events.
Acceptance inspections	When needed.	A formal mechanism for exchanging information prior to changeover of responsibility.
Inspection for Assessment	When needed.	Inspection undertaken to provide information required to undertake a structural assessment.

Section 4

Training and Qualifications

4.1 SUPERVISING ENGINEER

- 4.1.1 Inspections of highway structures should be carried out under the direction of the Supervising Engineer. The Supervising Engineer should be a Chartered Civil or Structural Engineer with appropriate experience in design, construction or maintenance of highway structures. The responsibilities of the Supervising Engineer normally include checking and countersigning all Principal and Special Inspection reports, including those prepared by other parties, to indicate agreement with their content.
- 4.1.2 The Supervising Engineer should give due consideration to the inspection requirements set down by the highways authority and ensure that all inspections are undertaken by personnel that satisfy the minimum health, experience and, where appropriate, qualification requirements for the particular inspection types.

4.2 INSPECTOR

- 4.2.1 The most important part of any inspection regime is the inspector, who is relied upon to perform their duties accurately, consistently, thoroughly and safely. At least one experienced inspector, who should give due consideration to the inspection requirements set down by the authority, should always be present on site during an inspection. The qualities of this experienced inspector should include, but should not be limited to the following:
- knowledge of the safe working practices and methods of access required for inspection;
 - ability to recognise and evaluate defects on highway structures;
 - an understanding of the behaviour of highway structures;
 - knowledge of the construction methods and materials used in the construction of highway structures;
 - knowledge of the causes of defects and suitable testing methods to identify, confirm or investigate these; and
 - ability to record defects accurately, clearly and consistently.
- 4.2.2 All the inspectors in a team should be in sound health and have a realistic appreciation of their own limits of experience and ability. Inspectors with limited experience should work under the supervision of experienced staff.



- 4.2.3 Particular training in safe working practices is essential for all those required to work in hazardous situations such as in confined spaces, at height or near railways (see Volume1: Part C: Section 3: Paragraph 3.5 in Part C). All members of the inspection team must be made aware of the particular risks associated with an inspection before starting work. This will normally take the form of a site-specific briefing by the team leader before starting work. Such a briefing is in addition to training in safe working practices and is intended to highlight particular features of the site.
- 4.2.4 In addition to any engineering qualifications, inspectors should receive appropriate training in inspection procedures and techniques, including any necessary formal training and accreditation. Inspectors should be encouraged to obtain other qualifications which could be useful during inspection work, e.g. training and qualifications in first aid, and qualifications and experience in specialised forms of access, notably diving and abseiling.

Section 5

Implementation of the Manual

5.1.1 The Manual contains a large body of information on the inspection of highway structures. Authorities should encourage all relevant staff to study, understand and use this information. Supervising Engineers and inspectors alike should seek to develop a sound understanding of the Manual, and undertake the activities listed below and outlined in :

1. **Examine the Manual** – authorities should encourage all personnel responsible for the inspection of highway structures to review the content of all parts of the Manual with the aim of using the advice and information contained in the Manual.
2. **Disseminate Key Advice** – the Supervising Engineer should maintain an overview of the whole Manual and should plan and hold internal workshops with relevant personnel to disseminate the guidance and key advice outlined in the Manual.
3. **Identify or Develop a Formal Training Programme** – authorities should encourage Supervising Engineers to identify and/or develop a formal training programme for inspectors based on the topics covered by the Manual. The training programme may be a combination of external and internal lectures/courses or on-the-job training; it may be prudent to develop training courses in collaboration with other authorities in order to share resources. The Supervising Engineer should seek continual improvement for the formal training programme and this should be subjected to a process of continual monitoring and review.
4. **Knowledge Gap Analysis** – with the support of the Supervising Engineer, inspectors should undertake a knowledge gap analysis using the contents of the Manual as a benchmark against which their current knowledge should be compared. The aim of the analysis would be to identify both current competencies as well as knowledge gaps requiring further development and learning. This activity should be undertaken periodically, for example, during an annual appraisal.
5. **Produce a Development Action Plan** – the outcome of the gap analysis should be a prioritised list of training activities aimed at closing the inspectors' knowledge gaps. Having prioritised their training needs, inspectors should be encouraged to prepare, in conjunction with the Supervising Engineer, a Development Action Plan detailing how their training needs will be met, i.e. the plan should include proposed training activities, necessary resources and appropriate timescales. This plan should take a balanced account of different aspects of the inspector's training needs, which should give due consideration to the requirements of the authority. Examples include short and long term development goals, and both technical and legislative components of performance.

6. **Attend Training Activities** – inspectors should be encouraged to implement their Development Action Plan by completing prioritised actions and by attending appropriate training activities. Where necessary inspectors should be encouraged to seek engineering qualifications or attend relevant NVQ courses.
7. **Record and Assess Training Activities** – once inspectors have attended/completed training activities, it is important that they not only record their attendance, but they also identify what they have learned, and with the support of the Supervising Engineer evaluate the benefits gained.
8. **Review the Development Action Plan** – with the support of the Supervising Engineer, inspectors should regularly review their development action plans to ensure that completed actions are signed off and new actions are added to reflect local and national developments or requirements and career development. The outcome of this review should be an updated prioritised list of training needs and activities.

5.1.2 It is an authority's best interest to adopt a formal approach to implementing the Manual, preferably in collaboration with other authorities. The benefits provided by adopting this Manual are likely to include improved quality and consistency in inspection information and more formal recognition of the important role of inspection staff.

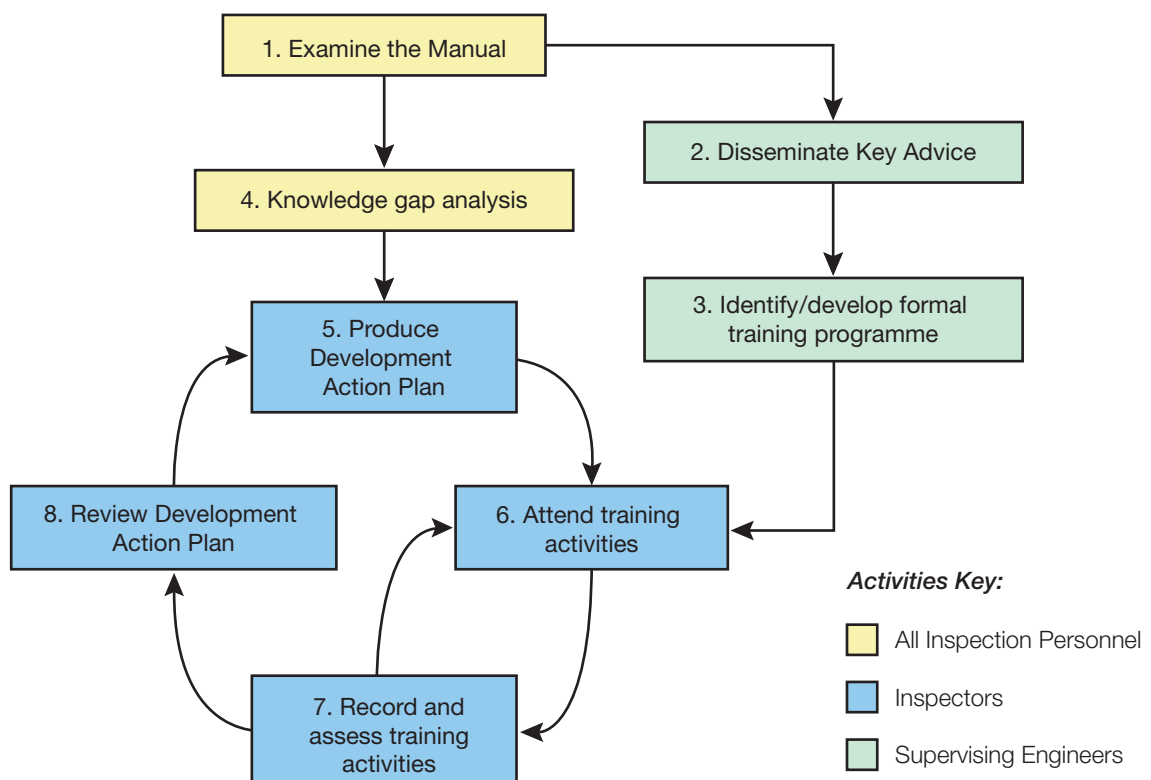


Figure A.1 – Process for the implementation of the Inspection Manual

Section 6

Layout of the Manual

6.1.1 The Manual is divided into two separate but complementary Volumes:

- **Volume 1: Reference Manual** – covers all aspects of highway structures inspection that both inspectors and engineers should be aware of.
- **Volume 2: Inspectors Handbook** – acts as a quick reference for inspectors on site.

6.1.2 Each of the two Volumes is sub-divided into several Parts that provide guidance on a wide range of issues. provides an overview of the purpose and content of each Part of the Manual.

Table A.2 – Layout of the Manual	
Part	Summary of purpose and content of each part
Volume 1: Inspection of Highway Structures: Reference Manual (A4 format)	
A. Introduction and Implementation	This part provides an overview of the Manual; includes an introduction to the role and need for the Manual, describes the purpose, objectives and scope of the Manual and how it should be implemented. It also offers an overview of the inspection regime and summarises the general competence and training requirements for inspection staff.
B. Behaviour of Structures	This part provides inspectors with an overview of the engineering topics that they should be aware of and offers a consistent basis for inspector knowledge development and training. It contains a summary of topics such as structural mechanics; structural materials and their properties; bridge elements; exposure environments, etc. It aims to provide organisations with a check list of criteria they should include on training courses but does not provide detailed coverage of the topics.
C. The Inspection Process	This part provides general information on scheduling inspections, planning and preparing for inspections, access considerations, health and safety aspects, and advice on performing inspections on differing types of structures.
D. Defect Descriptions and Causes	This part provides background information and guidance on describing and categorising defects. It describes the principal defects that are likely to be encountered in concrete structures, metal and metal/concrete composite structures, masonry structures, and structures built from other materials, with the emphasis placed on identification and likely causes.
E. Investigation and Testing	This part summarises a wide range of testing methods available for the investigation of particular material properties, defects, causes of defects etc. This aims to make inspection staff aware of the tests that may be used to inform structures management.
Volume 2: Inspection of Highway Structures: Site Handbook (A5 format)	
A. Inspector's Guide	This part highlights the key points from Volume 1 that inspectors should be aware when on site. Cross-references to Volume 1 are provided, enabling inspectors to quickly look up more detailed advice/guidance as and when required.
B. Defect Photographs	This part provides a library of photographs illustrating the different types of defects that are likely to be encountered on highway structures.

Section 7

National and Regional Variations

- 7.1.1 Some of the guidance contained in this Manual is subject to national and regional variations in legislation (e.g. environmental legislation), and to the requirements placed on each highway authority (e.g. specific variations to the DMRB [10]). As such, the guidance provided in this Manual should always be applied within the context of the authority's relevant (and latest) legislation and requirements.
- 7.1.2 The glossary of terms and definitions provided in Part B of this Manual relate to terms that are used in England and as such, it is prudent that the users identify and adopt each authority's the equivalent terms, e.g. 'highway' – 'road' etc.

Section 8

References for Part A

1. *Management of Highway Structures: A Code of Practice*, TSO, 2005.
2. *Highways Act 1980*, HMSO.
3. *The Roads (Northern Ireland) Order 1993* (SI 1993, No. 3160), HMSO.
4. *The Roads (Scotland) Act 1984* (SI 1990, No. 2622), HMSO.
5. *Bridge Inspection Guide*, Department of Transport et al., HMSO, London, 1984 (out of print).
6. *BD 53 Inspection and Records for Road Tunnels*, DMRB 3.1.6, TSO.
7. *The Operation and Maintenance of Bridge Access Gantries and Runways*, 2nd Edition, Institution of Structural Engineers, London, 2007.
8. *DB 63 Inspection of Highway Structures*, DMRB 3.1.4, TSO.
9. *BD 21 The Assessment of Highway Bridges and Structures*, DMRB 3.4.3, TSO.
10. *Design Manual for Roads and Bridges* (DMRB), TSO.

