



TMH 19

**MANUAL FOR THE VISUAL
ASSESSMENT OF ROAD
STRUCTURES**

**PART A: ROAD STRUCTURE MANAGEMENT
INFORMATION**

**Committee Draft Final
April 2016**

Committee of Transport Officials

**TECHNICAL METHODS
FOR HIGHWAYS**

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Compiled under auspices of the:

Roads Coordinating Body (RCB)
Committee of Transport Officials (COTO)
Road Asset Management Systems (RAMS) Subcommittee

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Synopsis:

TMH 19 provides guidelines for the visual assessment of the condition of road structures at network level for use in structure management systems. Different road structures are defined. Assessment procedures and requirements for road structure inventory data are specified. Different defects are classified and detailed descriptions of the degree of defects (including photographic plates illustrating defects) for each of the structural elements of the various road structures are given. TMH 19 is a companion document to TMH 22 on road asset management systems.

Withdrawal of previous publication:

Not Applicable

Technical Methods for Highways:

The Technical Methods for Highways consists of a series of publications in which methods are prescribed for use on various aspects related to highway engineering. The documents are primarily aimed at ensuring the use of uniform methods throughout South Africa.

Users of the documents must ensure that the latest editions or versions of the document are used.

When a document is referred to in other documents, the reference should be to the latest edition or version of the document.

Any comments on the document will be welcomed and should be forwarded to coto@nra.co.za for consideration in future revisions.

Document Versions

Working Draft (WD). When a COTO subcommittee identifies the need for the revision of existing, or the drafting of new Technical Recommendations for Highways (TRH) or Technical Methods for Highways (TMH) documents, a workgroup of experts is appointed by the COTO subcommittee to develop the document. This document is referred to as a Working Draft (WD). Successive working drafts may be generated, with the last being referred to as Working Draft Final (WDF). Working Drafts (WD) have no legal standing.

Committee Draft (CD). The Working Draft Final (WDF) document is converted to a Committee Draft (CD) and is submitted to the COTO subcommittee for consensus building and comments. Successive committee drafts may be generated during the process. When approved by the subcommittee, the document is submitted to the Roads Coordinating Body (RCB) members for further consensus building and comments. Additional committee drafts may be generated, with the last being referred to as Committee Draft Final (CDF). Committee Drafts (CD) have no legal standing.

Draft Standard (DS). The Committee Draft Final (CDF) document is converted to a Draft Standard (DS) and submitted by the Roads Coordinating Body (RCB) to COTO for approval as a draft standard. This Draft Standard is implemented in Industry for a period of two (2) years, during which written comments may be submitted to the COTO subcommittee. Draft Standards (DS) have full legal standing.

Final Standard (FS). After the two-year period, comments received are reviewed and where appropriate, incorporated by the COTO subcommittee. The document is converted to a Final Standard (FS) and submitted by the Roads Coordinating Body (RCB) to COTO for approval as a final standard. This Final Standard is implemented in industry for a period of five (5) years, after which it may again be reviewed. Final Standards (FS) have full legal standing.

Preface

Road authorities in South Africa have an obligation to plan, design, construct and maintain the road network, to protect the public investment in the road infrastructure, to ensure the continued functionality of the transportation system and to promote the safety of traffic on the road network. Authorities also have the obligation to provide a reliable, effective, efficient and integrated transport system that supports the sustainable economic and social development of the country.

Road structures are an integral part of the road network. This Manual provides the official requirement for the visual assessment of road structures on the South African road network. It provides requirements and supporting information for the inventory data capturing, explains the inspection methodology and describes how and by whom inspections for the visual assessment of road structures have to be carried out. It further addresses repair costs calculations.

Structures covered by this manual include:

- Bridges;
- Culverts;
- Retaining Walls;
- Gantries;
- Tunnels;
- Low level bridges;
- Light Masts; and
- Low level river crossings.

The inspection methodology described in this manual is a defects-based system and involves the identification of visual defects on structures and rating these defects in terms of degree, extent of occurrence and relevancy.

The relevancy of defects is very important in the rating process and is considered in terms of structural and functional integrity and the safety of the road user.

This manual is a companion document to the TMH 22 Manual on Road Asset Management. The TMH 22 manual includes sections on how inspection ratings are used to calculate condition indices for road structures at network level and how to calculate the current asset value of these road structures.

Overview of the Manual

TMH19 consists of two separate parts, Part A and Part B.

Part A: Road Structure Management Information covers the following topics:

- Structure Class and Type Definitions;
- Overview of Structures Management System (SMS);
- Inventory Information;
- The DER Rating System;
- Overview of Defects on Structures;
- Inspection Items and Inspection Sheets;
- Inspection Procedure and Quality Assurance; and
- Repair Cost Calculations.

The following additional information is supplied in the appendices:

- Detail of the inventory information that can be captured per structure type, indicating required and optional items;
- Inspection forms to be used for the various structure types; and
- Remedial work activity lists for the various structure types.

Part B is a visual assessment manual intended for use as reference document by structure inspectors to reduce the amount of subjectivity involved in the inspection process. It can also assist in the training of inspectors. It includes sections with photos of defects on the structural elements for the various structure types. These photos are intended to mainly illustrate the Degree rating, but the Extent, Relevancy and Urgency ratings are also shown as examples of these ratings. Descriptions of the various defects are provided.

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1 Structure Class and Type Definitions

1.1 Introduction

This manual covers the following road related structures:

- Bridges;
- Culverts;
- Retaining Walls;
- Gantries;
- Tunnels;
- Low level bridges;
- Low level river crossings; and
- Light Masts.

Road structures are defined in terms of structure class and structure type. The structure class defines the magnitude of the structure and the risk associated with the structure, while the structure type defines the characteristics of the structure and therefore the type of inventory and inspection sheets that are used to capture inventory data and to carry out inspections. The structure classes and structure types covered by this manual are presented in Table 1.

Table 1 Structure Classes and Types

Structure Class	Structure Type
Bridge	Bridge (General)
	Bridge (Arch)
	Bridge (Cable)
	Bridge (Cellular)
Major Culvert	Culvert (Major)
Retaining Wall	Retaining Wall
Gantry	Gantry
Road Tunnel	Road Tunnel
N/A	Culvert (Lesser)

1.2 Structure Classes

1.2.1 Bridge

A structure is classified as a bridge if one or more of the following criteria are satisfied:

- Any single span (as measured horizontally at the soffit along the road or rail centre line between the faces of its supports) is equal to or greater than 6 m; or
- The individual clear spans (as measured horizontally at the soffit along the road or rail centre line between the faces of its supports) exceed 1.5 m and the overall length measured between abutment faces exceeds 20 m; or
- The opening height, which is the maximum vertical distance measured from the streambed or structure floor at the inlet or from the top of any base, to the soffit of the superstructure, is equal to or greater than 6 m; or
- The total cross-sectional opening is equal to or larger than 36 m²; or
- The structure is a road-over-rail, or rail-over-road structure, even if the span is less than 6 m.

Refer to Figure 1 for a visual representation of the classification criteria for a bridge.

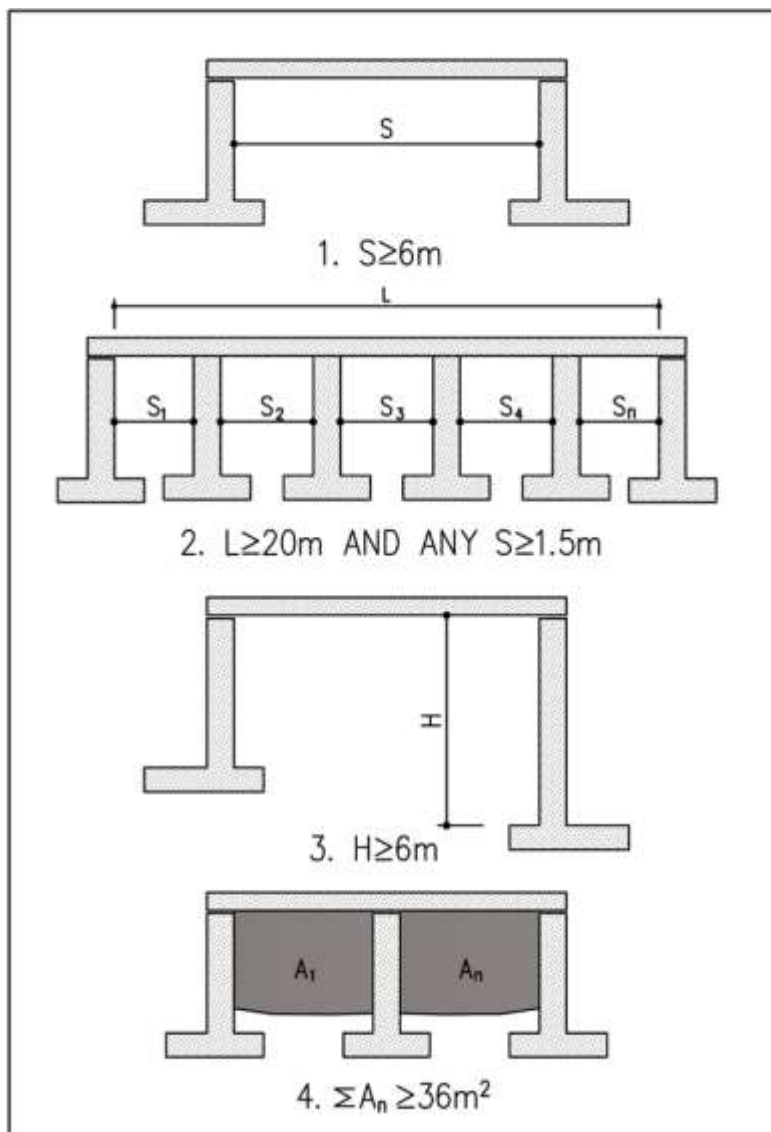


Figure 1 Bridge Classification

1.2.2 Major Culvert

A culvert is a structure (normally “buried” with road fill or road slabs on top) consisting of “cellular” units. A cellular unit can typically be described as an “opening” where, in general, the overall cell length is greater than the cell width. Elements such as separate deck slabs, abutments/piers, foundations, etc. are not clearly identifiable while elements such as invert slabs, apron slabs, cut-off walls etc. are normally present.

A Major Culvert is a cellular structure with dimensions less than those defining a bridge, but with any clear span length (as measured horizontally at the soffit perpendicular to the faces of its supports) equal to or larger than 2.1 m, or diameter equal to or larger than 2.1 m, or a culvert with a total cross-sectional opening equal to or larger than 5 m². A visual representation of the classification criteria for a Major Culvert is presented in Figure 2.

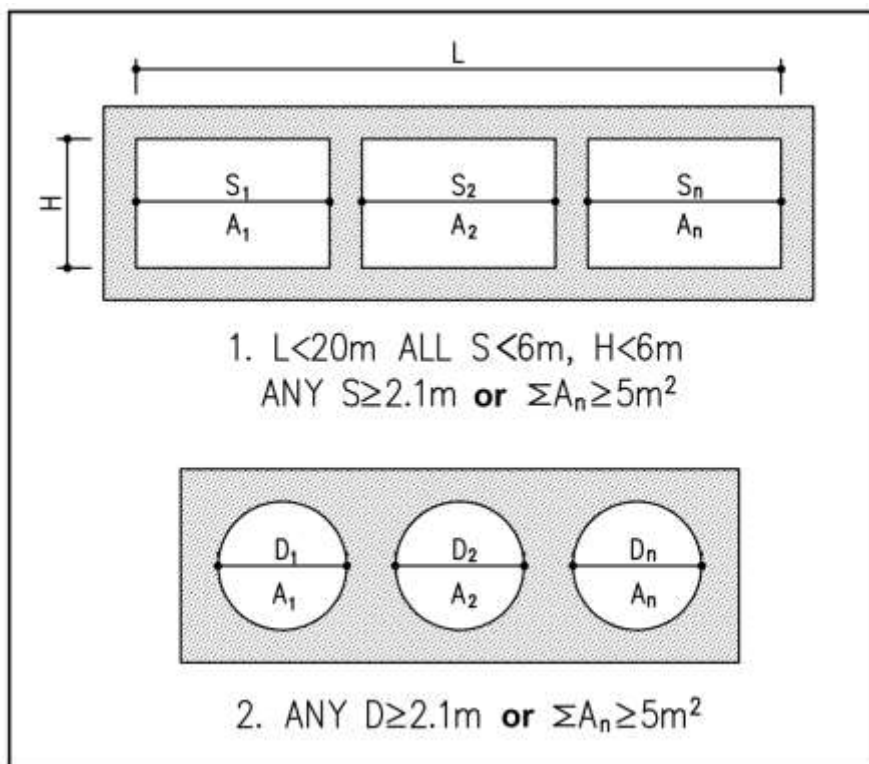


Figure 2 Major Culvert Classification Criteria

All culverts smaller than that defined as a Major Culvert are classified as **Lesser Culverts**. Lesser culvert is not a structure class, as these small culverts are considered a component of the road asset class. The structure type Culvert (Lesser) is however included in this manual in order to provide guidance to road maintenance staff that have to inspect lesser culverts as part of routine road maintenance inspections.

1.2.3 Retaining Wall

A retaining wall is a structure that resists the lateral pressure of soil when there is a change in ground elevation. When the angle of the wall to the horizontal exceeds 70°, the structure is generally considered to be a wall; otherwise it is considered to be a slope. In the context of road structures, a

wall with a height in excess of 2.0 m is considered a retaining wall for the purposes of this manual.

Sloped walls (angle of the wall to the horizontal does not exceed 70°) are generally the precast block or gabion wall type and assessment of such structures may require the input of a geotechnical engineer.

Design codes generally require retaining walls to be designed to ensure stability against overturning, sliding, excessive foundation pressure and water uplift. They are normally designed for a safety factor of 1.5 against lateral sliding and overturning.

Typical retaining wall types include:

- Gravity
- Cantilevered
- Piling walls
- Anchored walls
- Patented earth retaining systems e.g. block walls
- Soil nailed walls (normally in combination with sprayed concrete) with or without facades
- Soil strengthened or stabilized
- Gabions meshes
- Mechanically stabilized earth (Reinforced Earth or geotextile reinforced earth)
- Cellular confinement systems (Geocells)
- Stone pitching or other slope stabilization paving system

1.2.4 Gantry

A gantry, generally an overhead road sign structure, is a traffic sign assembly on which various information signs or signals are mounted. Gantries are usually built on highly trafficked roads with several lanes, where signs posted only on the side of the road would be difficult for motorists to see.

Gantries may be cantilevered or one sided or they may be bridges with support columns on both sides.

1.2.5 Road Tunnel

For the purposes of management and inspection of road structures, a road tunnel is a structure that accommodates road vehicles and is defined as a bored tunnel constructed in-situ without removing the ground above.

Long cut-and-covered tunnels constructed in a shallow trench may, in special cases, be defined as a road tunnel by the Road Authority.

1.2.6 Light Mast

A light mast comprises a tall pole, mast or column with light fittings at the top that illuminate a designated area. Light masts are also sometimes called high masts or lighting towers.

The assessment of light masts described in this manual relates to structural integrity. The electrical

installations, etc. are excluded.

Similar masts may be assessed as a group, for example, masts within a one kilometre distance or masts at a specific interchange.

A light mast should be assessed as a single mast if its height exceeds 40 m.

1.3 Structure Types

1.3.1 Structure Class Bridge

For inspection purposes, the following bridge types have been identified:

- Bridge (General);
- Bridge (Arch);
- Bridge (Cable); and
- Bridge (Cellular).

Bridge (General)

A general bridge type structure is a structure consisting of separate and clearly identifiable elements such as deck slabs, deck expansion joints, abutments, piers and foundation footings. Elements such as invert slabs, apron slabs, cut-off walls are normally not present. A bridge type structure normally has a concrete deck as roadway.

Bridge (Arch)

An arch bridge type structure includes solid spandrel filled arches; open ribbed spandrel arches; and open spandrel arches.

Bridge (Cable)

A cable bridge type structure includes suspension bridges; cable stayed bridges and extradosed bridges.

Bridge (Cellular)

A cellular bridge type structure is a bridge consisting of “cellular” units, but complying with the classification criteria for a bridge (see Section 1.2.1 **Error! Reference source not found.**). A cellular unit can typically be described as an “opening” where, in general, the overall cell length is greater than the cell width. Elements such as separate deck slabs, abutments/piers, foundations, etc. are not clearly identifiable while elements such as invert slabs, apron slabs, cut-off walls etc. are normally present.

1.3.2 Structure Class Major Culvert

The structure class Major Culvert contains only one structure type, namely Culvert (Major).

1.3.3 Retaining Wall

The structure class Retaining Wall contains only one structure type, namely Retaining Wall.

1.3.4 Gantry

The structure class Gantry contains only one structure type, namely Gantry.

1.3.5 Road Tunnel

The structure class Road Tunnel contains only one structure type, namely Road Tunnel.

1.3.6 Low-level River Crossings

A low-level river crossing is a submersible road structure designed in such a way so as to experience no or limited damage when overtopped. This type of structure is appropriate when the inundation of a road for short periods is acceptable. The types of low-level river crossings are low-level bridges, causeways and drifts.

Low-level Bridges

A low level bridge for crossing a river is a special case of either the Bridge (General) or the Bridge (Cellular) types. This type of bridge normally has kerbs or guide blocks instead of handrails or parapets. For purpose of inspections either the “Bridge (General)” or “Bridge (Cellular)” form should be used and Item 11 “parapet/handrail” will normally be marked as “Not Applicable”. If kerbs or guide blocks are present, these can be inspected under Item 10 “kerbs/sidewalks”.

Causeways and drifts

A causeway consists of a suitable submersible surface layer over which vehicles may drive when crossing a river. The structure has openings under the roadway allowing the passage of “normal” river flow underneath. The openings may be circular, rectangular, arched, semi-circular or similar in shape. These structures are also referred to as vented fords in the literature.

A drift or a ford is defined as a specially prepared surface for vehicles to drive over when crossing a river. A drift does not contain any constructed openings underneath the riding surface for the passage of water.

The floods that can pass over these structures are normally quite high and comparable with the floods passing through major culverts. For purpose of inspections a “Culvert (Major)” form should be used where the inspection items include for example apron slabs, scour protection works, road slabs etc. Reference should be made to Table 9 in Section 6.2. In the case of drifts the “Cell” items” will be marked as “Not Applicable”.

2 Overview of Road Structure Management Systems

2.1 General

A comprehensive database is the first building block and heart of a Road Structures Management System (RSMS). The database must provide for the storage and retrieval of the following types of data:

- Inventory data;
- Inspection data;
- Condition analysis data;
- Deterioration analysis data; and
- Remedial activities and repair cost data.

2.2 Inventory Data

The first step in the implementation of a structures database is to compile an inventory of all structures. The inventory consists of a list of all structures within the network with comprehensive details of the type and location of the structure, construction materials, major dimensions, clearances, etc. This information is obtained from as-built drawings, design reports and confirmed and measured in the field. Where as-built drawings and design reports are not available, this information must be collected by way of measurements on site.

Inventory data remains mostly static, except when modifications or improvements are carried out on the structure or associated roads or services.

The collection and capturing of inventory data can be costly and only data required for decision-making should be collected. Certain inventory data items are considered essential and are indicated as required items in this document, while other inventory data items are considered as optional. The reporting needs of the Road Authority would inform which of the optional inventory data items need to be collected.

2.3 Inspection Data

Inspection data is collected during the visual inspection of structures. Each structure must be appraised at network level with respect to its condition of serviceability and safety. Inspections are carried out by completing standard inspection forms per structure type. These inspection forms list all the inspection items applicable to the particular structure type.

Inspection data is captured per date and the database must allow for storing multiple inspections.

An inspection data module has the following functionality:

- Input and viewing of inspection data;

- Input and viewing of inspection photos; and
- Viewing of inspection sheets.

2.4 Condition Analysis

The inspection data collected during the visual inspection of structures is used to calculate various indices for each structure.

The indices that can be calculated are:

- Average Condition Index;
- Priority Condition Index;
- Functional Index; and
- Combined Condition Index.

Average Condition Index

The Average Condition Index (ACI) is an indication of the overall condition of the structure and can be used to rank structures in terms of average condition and to allocate structures to condition categories. The change in the average condition indices over time provides an indication of the effectiveness of the Road Authority's maintenance programme.

Priority Condition Index

The Priority Condition Index (PCI) is used to place structures in order of priority for maintenance, rehabilitation and reconstruction activities. It is designed to identify structures with the greatest need for repair to be given the highest priority.

Functional Index

A Functional Index provides an indication of the level of service offered by a road structure. The aspects that are addressed in a Functional Index for road structures are capacity; riding quality; user risk; road safety; and availability.

Combined Condition Index

The Combined Condition Index is a weighted combination of the Structure Priority Condition Index and the Structure Functional Index.

The formulas to calculate these indices are not included in this manual, but can be found in the TMH 22 manual on road asset management.

2.5 Deterioration Analysis

Structures generally have a long lifespan and deteriorate slowly. There is also a variation in the materials used in the construction of structures. These factors make it difficult to develop accurate deterioration prediction models.

When defects are left to deteriorate, structures may collapse; therefore all critical defects need to be monitored and accounted for in the RSMS. With inspections carried out on five-yearly cycles, critical

defects would be identified and can be attended to in time to prevent further deterioration.

2.6 Repair Costs

During the inspection procedure repair activities are identified and the quantities for repair are estimated. This, together with the unit rate for the repair activity is used to calculate the cost of repair, from which the total required maintenance and repair costs can be calculated.

Repair activities are also given an urgency rating during the inspection procedure. This provides a way of applying time limits to the repair requirements.

This information can then be used by the Road Authority for global budgetary purposes after adjustment for P&G items; planning, design and overhead costs; and VAT as described in the TMH 22 manual on road asset management.

2.7 Validation

After data has been entered into the RSMS, it is essential that the data is validated to ensure the integrity thereof. This applies to both inventory and inspection data.

Verification is carried out firstly to confirm that all required data have been captured and secondly to confirm that all captured data is valid.

3 Inventory Information

3.1 Numbering of Structures

Each structure must have a unique number. The number should be displayed on the structure in a visible position. It is recommended that a Road Authority first identify all structures and allocate unique numbers to each structure and then physically attach the numbers to the structures prior to proceeding with the capture of inventory and inspection data.

3.2 Location Details

Adequate location details need to be captured to accurately identify the location of the structure. The location detail that is captured should also accommodate the Road Authority's reporting needs. If, for example, the Road Authority has to report on the condition of structure per maintenance region, or per ward, such location information must be captured. Some location items can be imported from other management systems by creating a link with such systems. For example, if a Road Authority has a Road Referencing System or Road Network Information system, information such as the maintenance region, political region, road name, etc. can be imported if the two systems are linked by road number and chainage.

Certain location details are Road Authority specific and should cater for the specific Road Authority's definitions and requirements.

Location details will differ in some ways for national, provincial and municipal road authorities. The GPS coordinates of a structure are common to all authorities. These coordinates should be captured at the beginning and the end of the structure, except for cantilevered gantries and light masts, where only one set of coordinates are captured. Coordinates must be captured as hh:mm:ss.s to a minimum of 5 m accuracy in the WGS84 format.

For national and provincial road authorities, the location details that could be captured are as follows:

- Route/Road Number;
- Section Number;
- Chainage km;
- Road Name/Description;
- Province;
- District;
- Municipality;
- Maintenance Region;
- Maintenance Depot;
- Elevation;
- Status (Indicates the current status of the structure, e.g. existing, demolished, planned, etc.);
- GPS Coordinates: Longitude (East) and Latitude (South); and
- Ownership (Indicates which authority is the owner of the structure).

For municipal authorities, the location details that could be captured are as follows:

- Road/Street Name;
- Route Number
- Town;
- Suburb;
- Ward;
- Maintenance Region;
- Maintenance Depot;
- Elevation;
- GPS Coordinates: Longitude (East) and Latitude (South);
- Status (Indicates the current status of the structure, e.g. existing, demolished, planned, etc.); and
- Ownership (Indicates which authority is the owner of the structure).

3.3 Structure Orientation

Structure orientation indicates whether the structure is orientated primarily north-south; east-west; northeast-southwest; or northwest-southeast, based on true north. The convention for indicating the orientation of the different road structures types is as follows:

- The orientation of bridges and major culverts are indicated according to the centre line of the feature over the structure (usually a road);
- The orientation of a retaining wall is indicated according to the centreline of the road along which the retaining wall is located;
- The orientation of a gantry is indicated perpendicular to the centreline of the road on which the gantry is located; and
- The orientation of a road tunnel is indicated according to the centreline of the road through the tunnel.

3.4 Inventory Items per Structure Type

For inventory and inspection purposes, each structure type is divided into a number of inventory items. The numbers of items per structure type are summarised in Table 2.

Table 2 Number of Inventory Items per Structure Type

Structure Type	Number of Items
Bridge (General)	21
Bridge (Arch)	21
Bridge (Cable)	21
Bridge (Cellular)	14
Culvert (Major)	14
Culvert (Lesser)	5
Retaining Wall	7
Gantry	8
Road Tunnel	8

3.4.1 Bridge (General; Arch; & Cable) Inventory Items

The 21 inventory items for Bridge (General; Arch; & Cable) are as follows:

General Items:

1. Approach embankments
2. Guardrails
3. Waterway
4. Approach embankment protection work
5. Abutment foundations
6. Abutments
7. Wing/retaining walls
8. Surfacing
9. Superstructure drainage
10. Kerbs/sidewalks
11. Parapets/handrails

Support Items:

12. Pier protection works
13. Pier foundations
14. Piers & columns
15. Bearings
16. Support drainage
17. Expansion joints

Span Items:

18. Longitudinal members in the deck
19. Transverse members in the deck
20. Deck slab

Miscellaneous Item:

21. Items not covered under Items 1 to 20

3.4.2 Bridge (Cellular) and Culvert (Major) Inventory items

The 14 inventory items for Bridge (Cellular) and Culvert (Major) are as follows:

General Items:

1. Apron slabs & cut off walls
2. Wing / return / head walls
3. Scour protection works (in river)
4. Embankments
5. Waterway
6. Road slabs
7. Roadway joints
8. Guardrails
9. Parapets/handrails

Cell Items:

10. Walls
11. Top slab

12. Invert slab
13. Cell displacement

Miscellaneous Item:

14. Items not covered under items 1 to 13

3.4.3 Culvert (Lesser) Inventory Items

The 4 inventory items for a Culvert (Lesser) are as follows:

1. Inlet Works
2. Outlet Works
3. Barrel(s)
4. Waterway

3.4.4 Retaining Wall Inventory Items

The 7 inventory items for a Retaining Wall are as follows:

General Items:

1. External Drainage
2. Slope Protection

Wall Items:

3. Walls
4. Joints
5. Internal Drainage
6. Foundations

Miscellaneous Item:

7. Items not covered under items 1 to 6

3.4.5 Gantry Inventory Items

The 8 inventory items for a Gantry are as follows:

General Items:

1. Guardrails

Gantry Items:

2. Foundations
3. HD Bolts and Base Plates
4. Vertical Members
5. Horizontal Members
6. Sign Face
7. Sign Fasteners

Miscellaneous Item:

8. Items not covered under items 1 to 7

3.4.6 Road Tunnel Inventory item

The 9 inventory items for a Road Tunnel are as follows:

Portal Items:

1. Portals
2. Slope Protection
3. Rock Fall Protection

General Items:

4. Drainage
5. Road Surface

Tunnel Bore Items

6. Lining
7. Joints

Miscellaneous Items:

8. Operational Services
9. Items not covered under items 1 to 8

3.5 Numbering of Sub-items

The numbering of sub-items can be Road Authority specific, but there are generally two conventions for the numbering of sub-items - one for national and provincial road authorities and one for municipal road authorities. National and provincial road authorities use road chainages to define their networks and usually number sub-items according to increased chainage, while for municipal road authorities usually number sub-items according to the structure orientation.

3.5.1 Bridges (General; Arch; and Cable)

Abutments, piers and spans are numbered numerically, for example: Abutment 1, Abutment 2; Pier 1, Pier 2, Pier 3; and Span 1, Span 2, Span 3.

For national and provincial road authorities, Abutment 1 would be the abutment at the bridge end with the lowest chainage value; Pier 1 would be the pier closest to Abutment 1; and Span 1 would be the span that starts at Abutment 1. Where the bridge crosses the national or provincial road authority's road, numbering would be done from left to right when looking in the direction of increased chainage on the national or provincial road. Abutment 1 would therefore be the abutment on the left hand side.

For municipal authorities, the convention for the numbering of abutments relative to the structure orientation is as follows:

Structure Orientation:	Abutment 1 is at the:
North-South	Northern end
East-West	Western end
Northeast-Southwest	North-eastern end
Northwest-Southeast	North-western end

Pier 1 would be the pier closest to Abutment 1; and Span 1 would be the span that starts at Abutment 1.

3.5.2 Bridges (Cellular); Culvert (Major) and Culvert (Lesser)

Embankments and cells are numbered numerically, for example: Embankment 1, Embankment 2; and Cell 1; Cell 2; Cell 3.

For national and provincial road authorities, embankments would be numbered from left to right when looking in the direction of increased chainage on the national or provincial road. Embankment 1 would therefore be the embankment on the left hand side. Cells are numbered in the direction of increasing chainage. Cell 1 would thus be the cell at the structure end with the lowest chainage value.

For municipal authorities, the convention for the numbering of embankments relative to the structure orientation is as follows:

Structure Orientation:	Embankment 1 is on the:
North-South	Western side
East-West	Northern side
Northeast-Southwest	North-western side
Northwest-Southeast	South-western side

For municipal authorities, the convention for the numbering of cells relative to the structure orientation is as follows:

Structure Orientation:	Cell 1 is at the:
North-South	Northern end
East-West	Western end
Northeast-Southwest	North-eastern end
Northwest-Southeast	North-western end

For cellular bridges and major culverts that are not buried structures (usually low-level river crossings), the convention for the numbering of the embankments changes, as in these cases the orientation of the embankments would be perpendicular to the orientation of the structure.

For national and provincial road authorities, Embankment 1 would then be the embankment at the structure end with the lowest chainage value.

For municipal authorities, the convention for the numbering of embankments relative to the structure orientation is then as follows:

Structure Orientation:	Embankment 1 is at the:
North-South	Northern end
East-West	Western end
Northeast-Southwest	North-eastern end
Northwest-Southeast	North-western end

3.5.3 Retaining Walls

Retaining walls inventory items do not have sub-items.

3.5.4 Gantries

Vertical members and spans are numbered numerically, for example: Vertical Member 1, Vertical Member 2; and Span 1, Span 2.

For national and provincial road authorities, vertical members and spans would be numbered from left to right when looking in the direction of increased chainage on the national or provincial road. Vertical Member 1 would thus be the vertical member on the left hand side and Span 1 would then be the horizontal member that starts at Vertical Member 1.

For municipal authorities, the convention for the numbering of the vertical members relative to the structure orientation is as follows:

Structure Orientation:	Vertical Member 1 is at the:
North-South	Northern end
East-West	Western end
Northeast-Southwest	North-eastern end
Northwest-Southeast	North-western end

Span 1 would then be the horizontal member that starts at Vertical Member 1.

3.5.5 Road Tunnels

Portals and Segments are numbered numerically, for example: Portal 1, Portal 2; and Segment 1; Segment 2; Segment 3.

For national and provincial road authorities, Portal 1 would be the portal at the tunnel end with the lowest chainage value; and Segment 1 would be the segment that starts at Portal 1.

For municipal authorities, the convention for the numbering of portals relative to the structure orientation is as follows:

Structure Orientation:	Portal 1 is at the:
North-South	Northern end
East-West	Western end
Northeast-Southwest	North-eastern end
Northwest-Southeast	North-western end

Segment 1 would be the segment that starts at Portal 1.

3.6 Inventory Data Required for Structures

In addition to the structure number and location details, certain other required inventory information must be recorded for structures. This information should preferably be recorded from “as-built” drawings and design and contract reports. Where no “as-built” drawings and reports of the structure are available, these required inventory data must be measured on site.

The required inventory information per structure type is the following:

Bridges (General, Arch, Cable)

- Bridge type;
- Number of spans;
- Number of piers;
- Number of abutments;
- Number of arches;
- Number of cable groups;
- Overall structure length;
- Overall structure width;
- Total deck area;
- Maximum pier height;
- Maximum abutment height;
- Minimum width of roadway between kerbs;
- Paved width of approach road;
- Minimum vertical clearances; and
- Angle of skew (see Figure 3).

Bridge (Cellular) and Culvert (Major)

- Number of cells;
- Overall structure length;
- Overall structure width;
- Maximum Cell Size: Width;
- Maximum Cell Size: Height;
- Total opening area;
- Average cell length;
- Maximum height of fill;
- Total plan area;
- Minimum width of roadway; and
- Paved width of approach road.

Retaining Walls

- Wall type;
- Length of wall;
- Maximum height of wall;
- Total area of wall in elevation.

Gantries

- Gantry type;
- Height of vertical members;
- Span of horizontal members; and
- Total length of vertical and horizontal members.

Road Tunnels

- Tunnel type;

- Length of tunnel;
- Width of tunnel;
- Height of tunnel; and
- Tunnel cross-sectional area.

Light Masts

- Group of masts or a single mast;
- Location of the first mast and the last mast in a linear group or of three masts on the outer extremities of a group such as light masts at an interchange;
- Number of masts in the group;
- Foundation type;
- Light mast type;
- Light mast material (e.g. galvanized steel); and
- Light mast height;

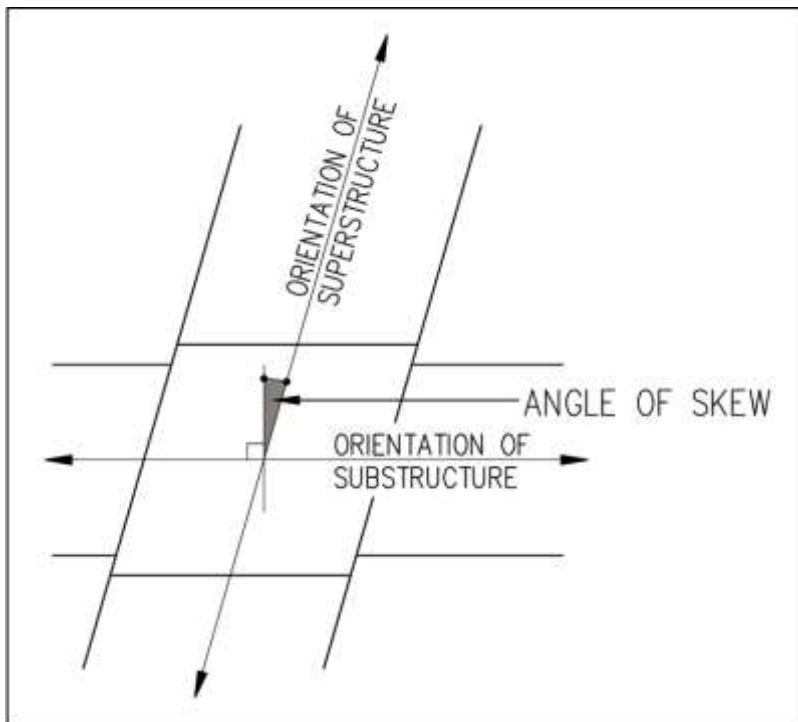


Figure 3 Angle of Skew

3.7 Additional Inventory Data for Structures

A more extensive range of inventory information that can be recorded is listed per structure type in Appendix A1. To collect and maintain data can be costly and the Road Authority must take care when deciding what additional information to collect. This should once again accommodate the Road Authority's reporting needs.

3.8 Recommended Inventory Photos

In order to ensure consistency of photos, a defined set of inventory photos is required. These photos must be uniquely numbered and it is recommended that all photos be geo-tagged.

Bridges (General; Arch; and Cable)

The following sixteen defined inventory photos for bridges should be captured:

- View 1: Bridge in elevation (must show total length of bridge, full pier heights and abutments. If necessary several photos can be taken and combined electronically).
- View 2: Bridge in elevation from opposite side.
- View 3: Bridge from upper approach (looking along centre line of road or as close as possible to centre line).
- View 4: Bridge from upper approach (opposite end).
- View 5: View taken from the top of the bridge of feature crossed (road, rail or upstream river view)
- View 6: View taken from the top of the bridge of feature crossed (road, rail or downstream river view).
- View 7: Deck edge to show profile of deck cantilever soffit.
- View 8: Opposite deck edge to show profile of deck cantilever soffit.
- View 9: Underside of deck (photo of each type if different deck types).
- View 10: Typical pier (photo of each type if different pier types).
- View 11: Typical abutment (photo of each type if different abutment types).
- View 12: Bridge number as seen from main route on which bridge is defined.
- View 13: Other bridge number adjacent to other road or rail.
- View 14: Typical parapet elevation.
- View 15: Typical roadway joint.
- View 16: Any other salient feature

Bridge (Cellular)

The following nine defined inventory photos for cellular bridges should be captured:

- View 1: Bridge inlet in elevation (show total number of cells);
- View 2: Bridge outlet in elevation (show total number of cells and apron slab);
- View 3: Bridge from upper approach (in direction of increasing chainage);
- View 4: Bridge from opposite end of approach (in direction of decreasing chainage).
- View 5: View taken from the top of fill of feature crossed (road or upstream river view);
- View 6: View taken from the top of fill of feature crossed (road or downstream river view);
- View 7: View of inside of bridge barrel showing roof walls & floor.
- View 8: Bridge number.
- View 9: Any other salient feature.

Culvert (Major)

The following nine defined inventory photos for Culvert (Major) should be captured:

- View 1: Culvert inlet in elevation (show total number of cells);
- View 2: Culvert outlet in elevation (show total number of cells and apron slab);
- View 3: Culvert from upper approach (in direction of increasing chainage);
- View 4: Culvert from opposite end of approach (in direction of decreasing chainage).
- View 5: View taken from the top of fill of feature crossed (road or upstream river view);
- View 6: View taken from the top of fill of feature crossed (road or downstream river view);
- View 7: View of inside of culvert barrel showing roof walls & floor.
- View 8: Culvert number.
- View 9: Any other salient feature.

Culvert (Lesser)

The following five defined inventory photos for lesser culverts should be captured:

- View 1: Culvert inlet in elevation.
- View 2: Culvert from upper approach.
- View 3: View taken from the top of fill of feature crossed.
- View 4: View of inside of culvert barrel showing roof walls & floor.
- View 5: Culvert number.

Retaining Walls

The following eight defined inventory photos for retaining wall should be captured:

- View 1: Wall in elevation start area.
- View 2: Wall in elevation mid area.
- View 3: Wall in elevation end area.
- View 4: Wall from on-coming approach.
- View 5: Wall from out-going approach.
- View 6: Embankment/terrain above the wall.
- View 7: Embankment/terrain below the wall.
- View 8: Structure number.

Gantries

The following eleven defined inventory photos for bridges should be captured:

- View 1: Gantry in elevation.
- View 2: Sign face front side.
- View 3: Sign face back side.
- View 4: Left Column.
- View 5: Right column.
- View 6: Beam.

View 7: Holding down bolts left column.

View 8: Holding down bolts right column.

View 9: Plinth and foundation left side.

View 10: Plinth and foundation right side.

View 11: Structure number.

Road Tunnels

The following eight defined inventory photos for tunnels should be captured:

View 1: Tunnel headwall elevation at start.

View 2: Tunnel headwall elevation at end.

View 3: Slope above tunnel at start.

View 4: Slope above tunnel at end.

View 5: View inside tunnel.

View 6: View of road surface with movement joint.

View 7: View of movement joint in wall.

View 8: Structure number.

Light mast

The following eight defined inventory photos for light masts should be captured. In the case of a group of masts a representative photo of one mast within the group of similar masts should be provided.

View 1: Light mast in elevation.

View 2: Holding down bolts.

View 3: Plinth and foundation.

View 4: Light fitting zoomed in.

View 5: Any special features relating to the light fitting access system.

View 6: Access hatch external covering.

View 7: Access hatch internal fittings.

View 8: Any other salient feature.

4 The DER Rating System

4.1 Description of the DER Rating System

The rating system used for the visual inspection of structures is referred to as the DER rating system. The essence of this system is to identify defects on a structure and to rate these defects. The inspector only has to focus on the defects on a structure and is not required to rate the condition of each inspection item or the structure as a whole.

DER refers to the degree (D); extent (E); and relevancy (R) of a defect as described below:

D	degree of defect:	How bad or severe is the defect.
E	extent of defect:	How widespread is the defect on the inspection item being inspected.
R	relevancy of defect:	The consequence of the defect with regards the structural or functional integrity of the inspection item or the safety of the user of the structure.

Degree

The DEGREE rating is a visual rating that defines the severity of the defect. It is not clouded by the need to consider the consequence of the defect with regards the inspection item and structure concerned. Rating the degree of the defect separately also allows for the monitoring of the deterioration of the defect over time.

Extent

The EXTENT of the defect goes hand in hand with the DEGREE, in that it expresses how extensive is the identified defect spread out on the element being inspected.

Relevancy

The RELEVANCY rating defines the relevancy of the defect with regards the safety of the user and the structural or functional integrity of the element and consequently of the structure being inspected. This rating requires the inspector to understand how the structure behaves, how the defect will interfere with the load path through the structure and how it will impact on the safety of pedestrians, motorists and truckers, and whoever else uses the structure. It is considered to be the most difficult to rate and for it to be of benefit it requires inspectors with the appropriate design and rehabilitation experience on the structure type being assessed.

By considering the three aspects of the defect separately, the inspector can concentrate on each aspect without confusing one with the other and consequently rate the defect with more accuracy. It simplifies the rating procedure and in the end provides a more realistic description of the true condition of the structure to the Road Authority.

4.2 DER Rating Values

D, E and R ratings are essentially a four point rating system, namely 1; 2; 3; or 4. For the degree rating, additional values can be allocated, namely 0; X; and U.

A degree rating of 0 is used to indicate that there are no visible defects on the inspection item.

A degree rating of X is used to indicate that the inspection item is not applicable to that structure. For example on a one span bridge, the inspection item “pier” is not applicable.

A Degree rating of U is used when it is not possible to inspect the inspection item, such as bearings that are inaccessible. This should not be used frequently. Foundations below ground level should generally not be marked as “unable to inspect”. The inspector should look at evidence or the lack of evidence of defects relating to the foundation and rate the foundation accordingly.

The allowable DER rating values are summarised in Table 3.

Table 3 Allowable DER Values

Rating	D (Degree)	E (Extent)	R (Relevancy)	
X	Not applicable			
U	Unable to inspect			
0	No visible defects			
1	Minor	Local	Minimum	No structural integrity or safety issues
2	Moderate	More than local	Moderate	Some possible structural integrity or safety issues
3	Warning	Less than general	Major	Structural integrity or safety compromised
4	Severe	General	Critical	Potentially a serious impact on structural integrity and/or user safety

For each inspection item, a D rating has to be allocated. If the D rating is 0; X; or U, then no E rating and R ratings are given. If the D rating is 1; 2; 3 or 4, an E rating and R Rating have to be given. These rating requirements are summarised in Table 4.

Table 4 DER-ratings Requirements

Degree	Extent	Relevancy	Interpretation
X	Leave blank	Leave blank	Item not applicable
U	Leave blank	Leave blank	Not able to inspect item
0	Leave blank	Leave blank	No defects visible on item
1, 2, 3 or 4	Must be entered	Must be entered	Visible defect(s) present on item

There is a restriction that the R-rating cannot be more than one point higher than the D-

rating. Certain D & R combinations are therefore not valid, as indicated in Table 5.

Table 5 Allowable Degree and Relevancy Combinations

D&R	R=1	R=2	R=3	R=4
D=1	1-1	1-2	Not valid	Not valid
D=2	2-1	2-2	2-3	Not valid
D=3	3-1	3-2	3-3	3-4
D=4	4-1	4-2	4-3	4-4



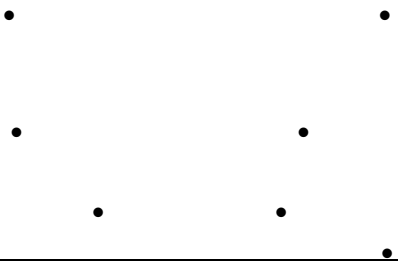

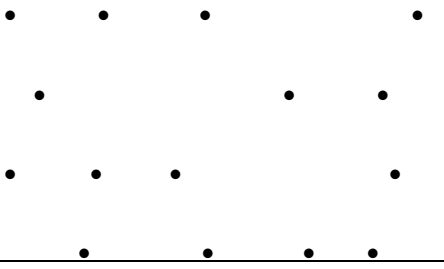
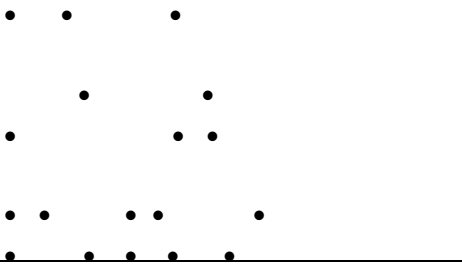
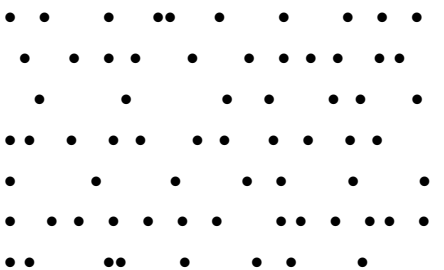
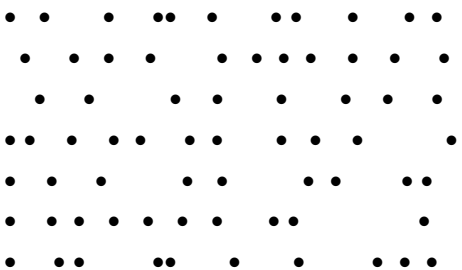
4.3 Procedure for Rating of Defects

Each inspection item (and sub-item) must be inspected. During the inspection, all defects on the item being inspected are identified. The inspector then has to decide which one of the identified defects is the worst defect. This would usually be the defect with the highest relevancy rating. The defect identified as the worst defect is then rated in terms of D, E and R. This becomes the rating for that inspection item or sub-item.

The rest of the identified defects on the inspection item or sub-item are recorded for maintenance/repair purposes, but are not rated in terms of D, E and R.

4.4 Illustration of Extent Rating

A diagrammatical illustration of Extent (E) is given in the table below:

E = 1		
Description	Local	
E = 2		
Description	More than local	
E = 3		
Description	Less than general	
E = 4		
Description	General	

5 Overview of Defects on Structures

5.1 Introduction

The identification of defects on structures forms the basis of the management system. Relevant defects that have consequences with regards the safety of users and the structural or functional integrity of the structure must be identified and rated.

The main types of defects are:

- Deficiencies;
 - Design deficiencies;
 - Construction deficiencies; and
 - Material performance related deficiencies.
- Damage; and
- Deterioration.

5.2 Types of Defects

5.2.1 Defects related to design deficiencies

Defects which are associated with deficiencies in:

- Design assumptions;
- Analysis;
- Design calculations;
- Detailing; and
- Geotechnical assumptions.

5.2.2 Defects related to construction deficiencies

Defects which are associated with construction deficiencies, such as:

- Incorrect placement of reinforcement;
- Lack of cover;
- Inadequate curing; and
- Poor workmanship and quality control.

A common defect associated with a construction deficiency is honeycombing. Honeycombed concrete occurs when there are water leakages from the formwork during the placing of concrete or from badly compacted concrete. Honeycombing becomes evident immediately after striking of formwork and should be repaired by the contractor at the time of construction. If left unrepaired, it could lead to corrosion of reinforcement or to the reduction in the load carrying capacity of the structural element concerned

5.2.3 Defects related to material performance deficiencies

These types of defect are normally noticed as abnormal deflections, cracking and other problems soon after or even during construction.

5.2.4 Defects related to damage

Damage is caused by a number of events, such as:

- Fire;
- Natural elements (earthquakes, floods, etc.);
- Foundation settlement;
- Impact;
- Scour;
- Constraint;
- Undermining and
- Overloading.

5.2.5 Defects related to deterioration

Deterioration of a structure can be caused by a number of factors, such as:

- Delamination;
- Spalling;
- Cracking;
- Carbonation;
- Chloride penetration;
- Efflorescence and discolouration;
- Alkali-aggregate reaction;
- Other chemical attack; and
- Corrosion and fatigue of structural steel.

Delamination and Spalling

Delamination occurs when a surface layer of concrete separates from the member mass. The primary cause is corrosion of the reinforcement. It can also be caused by fire. A spall is formed when delaminated material becomes dislodged.

Cracking

Reinforced concrete is designed with the knowledge that concrete will crack under tensile stresses. In many cases cracking does not present a problem and no treatment is required.

Cracks can form before hardening of concrete due to:

- Early frost damage;
- Plastic shrinkage;
- Plastic settlement; or
- Construction related movement.

Cracks can form after hardening of concrete due to:

- Drying shrinkage;
- Corrosion of reinforcement;
- Alkali-aggregate reaction;
- Freeze and thaw cycles;
- Thermal contraction;
- Structural reasons; and
- Creep

Table 6 Crack Width Ranges for Structural Concrete

Description of Crack	Width of Crack
Hairline	< 0.1 mm
Narrow	0.1 - 0.3 mm
Medium	0.3 - 0.7 mm
Wide	> 0.7 mm

Carbonation

Corrosion of reinforcement is inhibited in the presence of a strong alkaline environment by the formation of a film of iron oxide on the surface of the embedded reinforcement. Carbonation takes place when carbon dioxide in the air reacts with the calcium hydroxide in the concrete to neutralize the alkaline environment. The protective layer is thus neutralized by carbonation.

The rate of carbonation depends on the permeability of the concrete, relative humidity, concentration of carbon dioxide present and the seasonal drying and wetting cycles.

Chloride penetration

Chloride penetration is normally present in structures exposed to a marine environment or in structures subject to the use of de-icing salts to melt snow and ice on road surfaces (not common in southern Africa).

Chloride can also be present in concrete through the use of chloride contaminated sand (such as beach sand) to manufacture the concrete.

Efflorescence and discolouration

Efflorescence is evidenced by white deposits that sometimes leach out of concrete. It results from migration of salts in solution to the surface of the concrete where they crystallize. It can sometimes be visible as stalactites hanging from the deck soffit.

Efflorescence does not influence the durability of the concrete.

Alkali-aggregate reaction

Alkali-aggregate reaction occurs when water-soluble alkalis released from the hydrating cement react with the aggregate to form a gel. The gel swells when it absorbs water. The concrete cracks if the

swell pressure exceeds the tensile strength of the concrete.

Chemical attack

Acid rain is generally the most common cause of chemical attack in bridge structures in southern Africa. Acid rain is found in heavily air polluted zones where emissions of sulphur dioxide and nitrogen oxide react with water molecules in the atmosphere to produce acids. Accelerated deterioration will occur in concrete surfaces that are exposed to these acids.

Corrosion and fatigue of steel

When the corrosion protection system fails, steel corrodes with the resultant loss of structural strength. Cyclic loading may cause fatigue cracking which can result in sudden failure with little warning.

5.3 Common Bridge Defects

5.3.1 Rotation of Abutments, Wingwalls and Retaining Walls

Abutments, wingwalls and retaining walls founded on spread footings on compressible materials are likely to rotate because of the following reasons:

- Imbalance in forces acting behind and in front of the abutment or walls;
- The material behind the abutment or walls has a tendency to be compacted more than in front;
- If skidding, braking, temperature and earthquake forces are taken by the abutment, this will aggravate the forward rotation of the abutment; and
- Triangular stress distribution under the abutment footing. The higher pressure being in the front of the base.

For all of the above reasons it is important to look for tell-tale signs, which would indicate the forward rotation. These could be the following:

- Closing up of expansion joints at abutments;
- At abutments, the gap between the back wall and the deck has closed up;
- Excessive movement of abutment bearings towards the abutment back wall. This could be seen in mechanical as well as elastomeric bearings;
- Locking in of locating keys in skew decks;
- Secondary stresses resulting in unusual cracks in adjacent deck; and
- Large rotations of skew decks.

5.3.2 Longitudinal Members (Bridges)

- Spalled concrete in the vicinity of bearings could indicate high edge pressures;
- The outermost beams in overpasses of beam and slab construction are particularly vulnerable to damage from over height vehicles. The minimum clearance should be checked at these points;
- A map of cracking of the main members should be produced, so that the implications in terms of strength and durability can be carefully examined. Diagonal cracks close to

supports could indicate an incipient shear failure, whereas evenly spread vertical cracks at centre of span could indicate normal flexural cracks. All reinforced concrete members under tension action are likely to crack. The size and penetration of cracks need to be investigated to determine if the cracking is severe; and

- The effects of temperature differences should be considered at an early stage in investigations.

Prestressed concrete bridges should be given special attention and checked for the following additional defects:

- Longitudinal cracks in the flanges close to the supports may indicate insufficient transverse reinforcement, while transverse cracks in beams could indicate serious loss of prestress or the incorrect original positioning of the prestressing cables;
- Spalling or cracking of concrete may also occur near bearings or cable anchorages often due to inadequate design; and
- In box girders with access openings, the interior faces of flanges and webs need to be examined for signs of cracking.

5.3.3 Transverse Members (Bridges)

Defects in transverse members are similar to longitudinal members except that the relevancy of the defects is likely to be lower. This is because of transverse members being treated as secondary to the longitudinal members in the design of decks. Should a failure occur in transverse members, the loads would transfer to the longitudinal members and the deck would be saved.

Where the transverse members are being used as the main structural member, such as in the case of supports to bearings or end blocks to external prestress cables, they are to be treated similarly to the longitudinal members.

5.3.4 Decks and Slabs

The following types of defect occur typically on decks and slabs:

- Cracking - structural, restrained, shrinkage and temperature, material (bad mix or chemical attack) and workmanship (construction);
- Scaling - loss of mortar and aggregate on horizontal surfaces exposed to the weather and traffic and on other surfaces caused by frost or chloride damage;
- Spalling - loss of concrete between fracture surfaces;
- Corrosion of reinforcement - leads to discolouration of surfaces and in extreme cases to cracking and spalling
- Leakage - occurs at construction joints, where there is risk of cracking in thin component sections of the deck, e.g. at kerbs and in in-situ concrete topping over or between prestressed beams.
- Leaching - Seepage of water through cracks and voids in the hardened concrete may dissolve out calcium hydroxide and other constituent materials in the concrete. Most evident on the soffit of decks and take the form of staining, efflorescence or encrustation at cracks. It can present a corrosion threat to reinforcement, because of the gradual loss of alkalinity of the concrete.

- Porous or pervious concrete - Ingress of water leads to corrosion of reinforcement. More susceptible to chemical attack. Occurs where good compaction of concrete is difficult, as in densely reinforced slabs and in corners of formwork.
- Wear of deck surface - Where deck forms the running surface for traffic.
- Excessive deformation, deflection or vibration - Deck too slender and under-designed.
- Accidental damage - Most common is from damage to overpasses by over height vehicles.
- Chemical attack - Occurs in aggressive industrial environments or in coastal regions. Causes surface crumbling.

5.3.5 Foundations

Specialist work is required when the foundation material under a base is to be re-instated. Because of the restricted space, it is difficult to obtain proper compaction, so mass concrete or soilcrete is often used.

When considering the stability of the abutment, wall or pier it is important to establish whether the foundation is piled or on spread footings and what the founding material is. The structural integrity of a pile cap where the piles are founded on rock will be less affected with regards to undermining when compared to a spread footing founded on sand

Settlements in foundations can be checked by visual sighting along railings and walls, noting both the vertical and horizontal alignment.

Shallow pile caps have a tendency to develop vertical tension cracks between two adjacent piles. These cracks sometimes extend into the columns. Such cracks must be monitored as they can cause the collapse of the pier and the bridge if there is corrosion of the reinforcement.

5.3.6 Scour Damage

Scour damage will not affect structural integrity of structure in the following cases:

- Where spread footings are founded directly onto competent rock and the design allows for the flood forces to act on the full height of the pier and superstructure and overturning is resisted by the mass of the structure; and
- Foundations on piles where piles are founded on or in competent rock and the design has taken account of realistic scour depths under the action of corresponding hydrodynamic forces.

Structural integrity may be affected in the following cases:

- Spread footings founded on erodible material such as a boulder layer;
- Piled foundations which depend partly or fully on friction rather than fully end bearing; and
- Piled foundations which have been designed as end bearing piles founded on erodible material such as a boulder layer.

Other important aspects to be aware of when inspecting foundations in a river:

- The effect of scour will be greatest on pier foundations located on the outside of a bend;

- Should a second bend exist just upstream of the bend at the structures, but is in the opposite direction scouring will be further increased;
- A very sandy river bed will be more susceptible to scour;
- The location, lateral dimensions and depth of scour holes should be noted and, if possible, recorded photographically;
- Scouring is often aggravated by changes in the river's regime due to natural and man-made causes, such as earth slippage, property development and removal of sand from the river just upstream of the bridge;
- Wall type piers designed for a given direction of flow will become more susceptible to scour should the river change its flow path.

5.4 Ancillary Bridge Elements

Ancillary bridge elements include the following:

- Expansion joints;
- Bearings;
- Parapets and end blocks;
- Drainage;
- Embankment protection; and
- Surfacing

5.4.1 Typical expansion joint defects

- Inadequate allowance for movement;
- Poor detail at kerbs and sidewalks;
- Armoured edges of joints not continuous;
- Poor quality materials used in asphaltic plug type joints, resulting in segregation of aggregate and binder leaving permeable stone pockets;
- "Press fit" joints working out of joint over time;
- Epoxy nosing failure;
- Loosening or movement of the joint and its components;
- Irregularity of vertical profile. One part of the joint may become vertically displaced relative to the other;
- Leakage of water through joints;
- Cracking of surfacing at buried joints.

5.4.2 Typical bearing defects

- Corrosion;
- Delamination;
- Seizure;
- Deformation;
- Movement capacity exceeded;
- Incorrect orientation;
- Overloaded; and

- Plinth failure.

5.4.3 Typical parapet and end block defects

- Lack of concrete cover to reinforcement and general concrete defects;
- Collision / impact damage;
- Guardrail not attached to end block;
- Top rail missing;
- Expansion joint and inspection eye cover plates missing;
- Corrosion of steel items;
- Failed guardrail fixing to parapet ; and
- Inadequate handrail height.

5.4.4 Typical drainage defects

- Blocked drainage/weep holes;
- No drainage or weep holes provided;
- Scuppers not extended below soffit;
- Drainage outlets not extended through walls;
- No drainage provided to deck voids;
- Blowing of water on structure;
- Inadequate falls on surfacing and deck, preventing the drainage of water to drainage; and
- No drains in void formers. In voided decks drains should be provided to remove water from the lowest points of voids.

5.4.5 Typical embankment protection defects

- Embankment erosion;
- Inadequate side drain, gutter and down chutes;
- Damaged gabion boxes and mattresses;
- Settlement of protection works;
- Missing protection works; and
- Unwanted vegetation.

5.4.6 Typical Surfacing Defects

The defects most commonly experienced with surfacing on decks are:

- Cracking;
- Excessive deformation; and
- Loss of skid resistance.

5.5 Typical Defects on Steel Structures

- Corrosion;
- Cracking;
- Fracture;

- Excessive vibration and noise;
- Deformation and deflection;
- Buckling, kinking, warping and waviness;
- Loose bolts and rivets;
- Deterioration of the protective system;
- Excessive wear; and
- Accumulation of water in closed members.

5.6 Typical Defects on Cellular Bridges and Major Culverts

Typical defects on cellular bridges and major culverts over and above those listed in section 5.2 include:

- Rotation of headwalls and wingwalls;
- Cracking of concrete elements;
- Spalling of concrete elements;
- Corrosion of reinforcement;
- Undermining of apron slabs, invert slabs, and foundations;
- Scaling due to loss of mortar and aggregate on inverts slabs;
- Silting-up or blockages of cells;
- Rotation of cells; and
- Erosion of embankments.

5.7 Typical Retaining Wall Defects

Typical defects on retaining walls over and above those listed in section 5.2 include:

- Excessive movements;
- Piling defects;
- Post tensioned anchor defects;
- Block wall defects;
- Soil nail defects;
- Sprayed concrete defects;
- Defects in soil strengthening or stabilization;
- Defects in gabions meshes and boxes;
- Loss of gabion stones; and
- Defects in mechanically stabilized earth.

5.8 Typical Gantry Defects

Typical defects in gantries include:

- Corrosion of steel elements;
- Loose and missing nuts on anchor bolts;
- Snapped anchor bolt shafts;

- Corrosion of the welded site connection;
- Deterioration of paint system;
- Traffic impact or collision damage;
- Failed welds;
- Failed steel element;
- Damaged or deteriorated sign boards; and
- Foundation and plinth concrete cracks and spalls.

5.9 Typical Road Tunnel Defects

Typical defects in road tunnels over and above those listed in section 5.2 include:

- Excessive movements;
- Excessive water seepage;
- Damage to concrete including impact and rock-fall damage;
- Defects to road surface;
- Expansion joint defects;
- Lighting defects;
- Defects in steep cuttings;
- Electrical defects;
- Ventilation system defects; and
- Air quality.

The following items generally only apply to major tunnels (e.g. the Huguenot Tunnel) and can be grouped as “Operational Services”:

- Tunnel monitoring defects (CCTV, fire and smoke detectors, computers, etc.);
- Traffic control defects (variable speed signs, variable message signs, traffic lights, booms, electronic control, etc.);
- Communication system defects (Emergency lighting, PA system, etc.)
- Ventilation system defects (Vents, fans, electronic control etc.);
- Power supply defects (cabling, switchgear, UPS, generators etc.); and
- Water supply defects (Water treatment, storage tanks, pumps, water pipes, fire hydrants, electronic control, etc.).

5.10 Typical Light Mast Defects

Typical defects in light masts include:

- Inadequate foundation system (light mast leaning);
- Foundation and plinth concrete cracks and spalls;
- Loose and missing anchor bolts nuts;
- Snapped anchor bolt shafts;
- Failed welds due to, for example, fatigue;
- Failed steel sections due to, for example, inadequate thickness or strength;

- Deterioration of the corrosion protection system;
- Corrosion of steel elements;
- Traffic impact or collision damage;
- Defective light fittings and fixings;
- Defective light fitting access system;
- Defective electrics and cabling;
- Defective access hatch to electrical controls; and
- Inadequate cable theft preventative measures.

6 Inspection Items and Inspection Sheets

6.1 Introduction

For inspection purposes, a structure is divided into a number of inspection items. Inspection items are predefined structural elements and ancillary items that are typically assessed separately to determine their condition. The conditions of the items are consolidated to determine the condition of the structure. In some cases, items are made up of discrete yet similar parts (e.g. bridge piers). For the purpose of the condition assessment, these parts or “sub-items” are assessed individually. The condition of such an item is based on the condition of the sub-items. The number of inspection items is a function of the structure type, while the number of sub-items is generally a function of the size of the structure, such as the number of bridge spans or culvert cells.

6.2 Inspection Items per Structure Type

Defects are identified and rated at inspection item level and where applicable at sub-item level. The number of inspection items per structure type is summarised in Table 7.

Table 7 Number of Inspection Items per Structure Type

Structure Type	Number of Inspection Items
Bridge (General)	21
Bridge (Arch)	21
Bridge (Cable)	21
Bridge (Cellular)	14
Culvert (Major)	14
Culvert (Lesser)	5
Retaining Wall	7
Gantry	8
Road Tunnel	8

The actual inspection items per structure type are listed in Table 8 to Table 13 in the next section.

6.3 Inspection Sub-items per Structure Type

For inspection items that consist of sub-items, defects are rated at the sub-item level. For example, for a Bridge (General) type structure, one of the inspection items is “Abutment”. Most bridges have two abutments and each abutment is inspected separately. The inspection item “Abutment” would therefore have two sub-items, namely “Abutment 1” and “Abutment 2”.

The inspection items per structure type for Bridge (General), Bridge (Arch) and Bridge (Cable) with the number of sub-items per inspection item are summarised in Table 8 and for Bridge (Cellular) and Culvert (Major) in Table 9.

Table 8 Inspection Items and Sub-items for Bridge (General, Arch and Cable)

Inspection Item		Number of Sub-items		
		Bridge - General	Bridge – Arch	Bridge – Cable
	General Items:			
1	Approach embankments	No. of Abutments	No. of Abutments	No. of Abutments
2	Guardrails	Not applicable	Not applicable	Not applicable
3	Waterway	Not applicable	Not applicable	Not applicable
4	Approach embankment protection work	No. of Abutments	No. of Abutments	No. of Abutments
5	Abutment foundations	No. of Abutments	No. of Abutments	No. of Abutments
6	Abutments	No. of Abutments	No. of Abutments	No. of Abutments
7	Wing/retaining walls	No. of Abutments	No. of Abutments	No. of Abutments
8	Surfacing	Not applicable	Not applicable	Not applicable
9	Superstructure drainage	Not applicable	Not applicable	Not applicable
10	Kerbs/sidewalks	Not applicable	Not applicable	Not applicable
11	Parapets/handrails	Not applicable	Not applicable	Not applicable
	Support Items:			
12	Pier protection works	No. of Piers	No. of Piers plus No. of Springings	No. of Piers plus No. of Pylons
13	Pier foundations	No. of Piers	No. of Piers plus No. of Springings	No. of Piers plus No. of Pylons
14	Piers & columns	No. of Piers	No. of Piers plus No. of Springings	No. of Piers plus No. of Pylons
15	Bearings	No. of Piers plus No. of Abutments	No. of Piers plus No. of Abutments plus No. of Springings	No. of Piers plus No. of Abutments plus No. of Pylons
16	Support drainage	No. of Piers plus No. of Abutments	No. of Piers plus No. of Abutments plus No. of Springings	No. of Piers plus No. of Abutments plus No. of Pylons
17	Expansion joints	No. of Piers plus No. of Abutments	No. of Piers plus No. of Abutments plus No. of Springings	No. of Piers plus No. of Abutments plus No. of Pylons
	Span Items:			
18	Longitudinal members in the deck	No. of Spans	No. of Spans plus No. of Arches	No. of Spans plus No. of Cable Groups*
19	Transverse members in the deck	No. of Spans	No. of Spans plus No. of Arches	No. of Spans
20	Deck slab	No. of Spans	No. of Spans plus No. of Arches	No. of Spans
	Miscellaneous Item:			
21	Items not covered under Items 1 to 20	Not applicable	Not applicable	Not applicable

Inspection Item	Number of Sub-items		
	Bridge - General	Bridge – Arch	Bridge – Cable
*A Cable Group is defined as the cables supporting a span of a cable type bridge or the cables extended to an anchorage point or anchorage chamber behind a bridge abutment where no span is supported. Examples of Cable Groups are the main suspension cables and hangers supporting a span of a suspension bridge, the stay cables supporting a span of a cable stayed bridge or the hangers supporting a span of an arch bridge			

Table 9 Inspection Items and Sub-items for Bridge (Cellular) and Culvert (Major)

Inspection Item		Number of Sub-items
	General Items:	
1	Apron slabs & cut off walls	No. of embankments
2	Wing / return / head walls	No. of embankments
3	Scour protection works (in river)	No. of embankments
4	Embankments	No. of embankments
5	Waterway	Not applicable
6	Road slabs	Not applicable
7	Roadway joints	Not applicable
8	Guardrails	Not applicable
9	Parapets/handrails	Not applicable
	Cell Items:	
10	Walls	No. of Cells
11	Top slab	No. of Cells
12	Invert slab	No. of Cells
13	Cell displacement	No. of Cells
	Miscellaneous Item:	
14	Items not covered under items 1 to 13	Not applicable

The inspection items for structure type Culvert (Lesser) are summarised in Table 10.

Table 10 Inspection Items and Sub-items for Culvert (Lesser)

Inspection Item		Number of Sub-items
1	Inlet Works	Not applicable
2	Outlet Works	Not applicable
3	Barrel(s)	Not applicable
4	Waterway	Not applicable
5	Embankments	Not applicable

The inspection items for structure type Retaining Wall are summarised in Table 11.

Table 11 Inspection Items and Sub-items for Retaining Wall

Inspection Item		Number of Sub-items
	General Items:	
1	External Drainage	Not applicable
2	Slope Protection	Not applicable
	Wall Items	
3	Walls	Not applicable
4	Joints	Not applicable
5	Internal Drainage	Not applicable
6	Foundations	Not applicable
	Miscellaneous Item:	
7	Items not covered under items 1 to 6	Not applicable

The inspection items for structure type Gantry are summarised in Table 12.

Table 12 Inspection Items and Sub-items for Gantry

Inspection Item		Number of Sub-items
	General Items:	
1	Guardrails	Not applicable
	Gantry Items	
2	Foundations	No. of Vertical Members
3	HD Bolts and Base Plates	No. of Vertical Members
4	Vertical Members	No. of Vertical Members
5	Horizontal Members	No. of Horizontal Members
6	Sign Face	No. of Horizontal Members
7	Sign Fasteners	No. of Horizontal Members
	Miscellaneous Item:	
8	Items not covered under items 1 to 7	Not applicable

The inspection items for structure type Road Tunnel are summarised in Table 13.

Table 13 Inspection Items and Sub-items for Road Tunnel

Inspection Item		Number of Sub-items
	Portal Items	
1	Portals	No. of Portals
2	Slope Protection	No. of Portals
3	Rock Fall Protection	No. of Portals
	General Items	
4	Drainage	Not applicable
5	Road Surface	Not applicable
	Tunnel Bore Items	
6	Lining	No. of Panels
7	Joints	No. of Panels

Inspection Item		Number of Sub-items
	Miscellaneous Item:	
8	Operational Services (see 5.9)	No. of operational services
9	Items not covered under items 1 to 8	Not applicable

6.4 Inspection Forms

Inspection data is collected during the visual inspection of structures. Inspections are carried out by completing standard inspection forms per structure type. These inspection forms list all the inspection items and sub-items applicable to the particular structure type.

Examples of inspection forms for the following structure types are presented in Appendix A3:

- Bridge (General);
- Bridge (Arch);
- Bridge (Cable);
- Bridge (Cellular);
- Culvert (Major);
- Retaining Wall;
- Gantry; and
- Road Tunnel.

Appendix A3 also includes inspection forms for routine inspections, normally carried out by routine road maintenance staff, of the following structure or inspection types:

- Culvert (Lesser);
- Waterway Inspection; and
- Light Mast.

The inspection forms included in Appendix A3 can be downloaded from the SANRAL website in MS Excel and pdf format.

6.5 Structure Orientation Sketches

A structure orientation sketch should be provided with each inspection to indicate the orientation of the structure and the numbering of the sub-items. This sketch can be drawn in the space provided on the inspection form or as a separate scanned sketch if the space provided on the inspection form is not adequate. The scanned structure orientation sketch should be saved as an inspection photo. Examples of structure orientation sketches are presented in Figure 4.

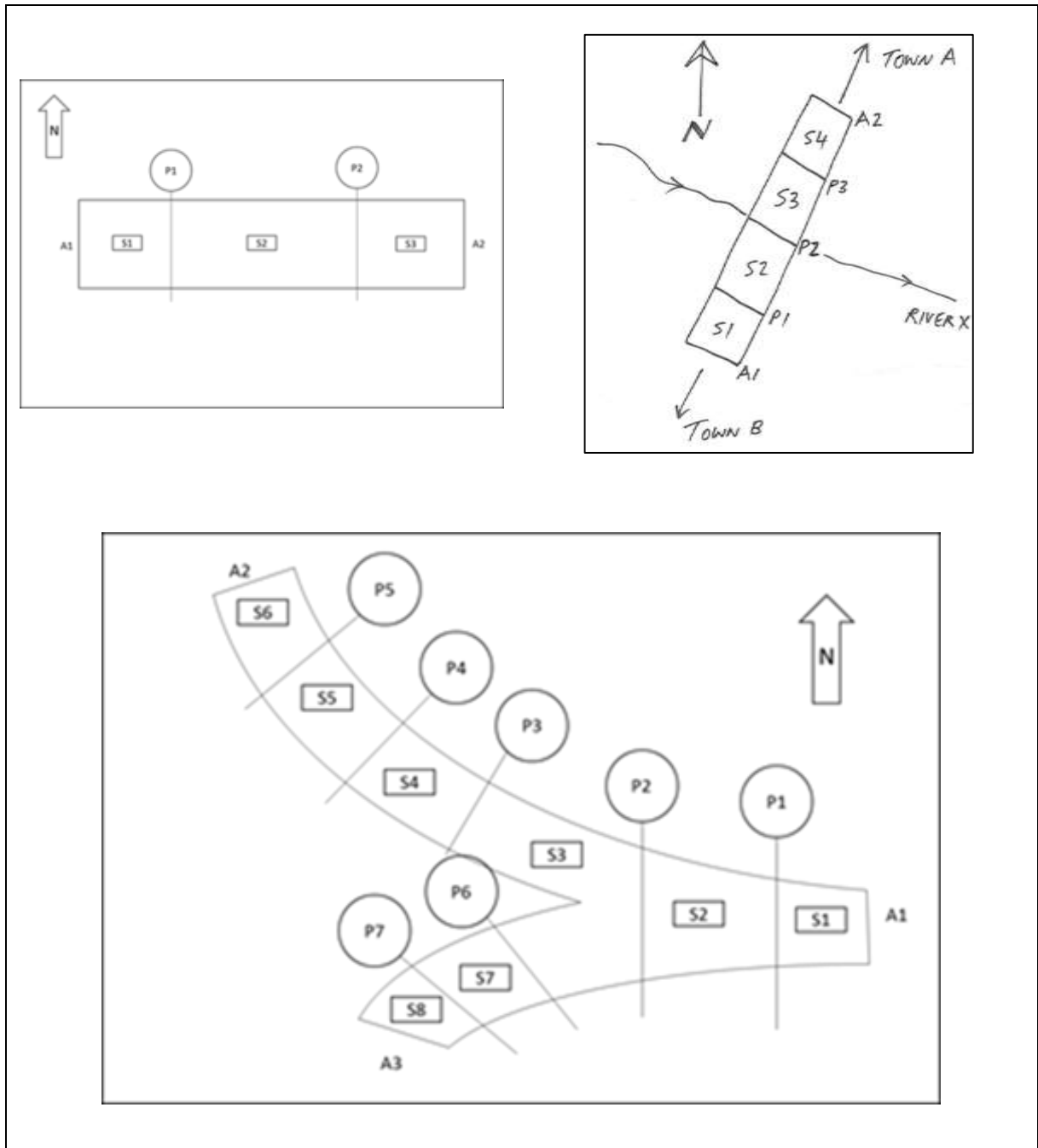


Figure 4 Examples of Structure Orientation Sketches

7 Inspection Procedure and Quality Assurance

7.1 Types of Inspections

7.1.1 Principal Inspections

A Principal Inspection is a comprehensive visual inspection of the whole structure and forms the basis of the road structure management system. It has to be carried out by suitably qualified personnel experienced in structural design and maintenance. Principal Inspections should be carried out every 5 years.

7.1.2 Partial Inspections

During a Partial Inspection, only certain inspection items are inspected. One reason is that on some structures certain inspection items can only be inspected with the use of specialised access equipment, such as the Under Bridge Inspection Unit.

Partial Inspections are usually combined with inspection data for the remaining inspection items from the most recent Principal Inspection to calculate the various condition indices for the structure.

7.1.3 Completion Inspections

Completion Inspections are carried out after the completion of maintenance or rehabilitation on a structure, either by the client or by the consultant that was responsible for the maintenance/rehabilitation project. The purpose of this inspection is to assign new ratings to those inspection items that have been repaired or rehabilitated. Depending on the extent of the maintenance work, Completion Inspections can take the form of a Principal Inspection or a Partial Inspection. Completion Inspections are also carried out after the completion of a new structure and in this case will be carried out as a Principal Inspection.

7.2 Inspections to be Carried Out by Routine Road Maintenance Staff

7.2.1 Culvert (Lesser) Inspections

Inspections of lesser culvert should be carried out at least once a year and can be carried out by routine road maintenance staff after attending a training course. These inspections must be carried out using the Culvert (Lesser) inspection form, included in Appendix A3. The required remedial activities must be recorded using the remedial activity list for Culvert (Lesser) included in Appendix A4.

7.2.2 Waterway Inspections

Waterway inspections refer to inspections to be carried out on all structures crossing a waterway. These inspections should be carried out at least once a year or after any significant storm event. Such inspections can be carried out by routine road maintenance staff after attending a training course. These inspections must be carried out using the Waterway inspection form, included in Appendix A3. The required remedial activities must be recorded using the applicable remedial activities from the remedial activity lists for bridges and culverts included in Appendix A4.

7.2.3 Light Mast Inspections

Inspections of light mast should be carried out at least once a year and can be carried out by routine road maintenance staff after attending a training course. These inspections must be carried out using the Light Mast inspection form, included in Appendix A3. The required remedial activities must be recorded using the remedial activity list for light masts included in Appendix A4. A suitably defined mast number as well as GPS co-ordinates should be used to identify a single mast with a unique defect.

7.3 Qualifications and Experience of Inspectors

The minimum experience and qualification requirements for inspectors for the various structure types are specified in this section. Valid experience means personal design experience and does not include signing off designs done by others.

7.3.1 Bridge Inspector

The requirements to inspect a structure classified as a bridge is a professional engineer with a minimum of 5 years bridge and culvert design experience obtained during the previous 20 years or a Professional Technologist with a minimum of 10 years bridge and culvert design experience obtained during the previous 20 years.

7.3.2 Senior Bridge Inspector

A Senior Bridge Inspector is a professional engineer with a minimum of 15 years full time bridge design experience accumulated over the previous 25 years. Ideally such a candidate will be in a senior position and view bridges as their full time occupation. It is of utmost importance that the applicant has personal design experience in continuous prestressed concrete bridges as well extensive other experience.

7.3.3 Road Tunnel Inspector

The requirements to inspect a road tunnel are the same as those for a Bridge Inspector.

7.3.4 Major Culvert Inspector

The requirements to inspect a major culvert are a qualified technician, technologist or engineer with a minimum of 5 years bridge and culvert design experience obtained during the previous 12 years. Other structural design experience will also be considered.

7.3.5 Lesser Culvert Inspector

The requirement to inspect a lesser culvert is a suitable technical person trained in the use of the rating system and inspection form.

7.3.6 Retaining Wall Inspector

The requirements to inspect a retaining wall are a qualified technician, technologist or engineer with a minimum of 5 years structural design experience obtained during the previous 12 years.

7.3.7 Gantry Inspector

The requirements to inspect a gantry are a qualified technician, technologist or engineer with a minimum of 5 years structural design experience obtained during the previous 12 years.

7.3.8 Light Mast Inspector

The requirement to inspect a light mast is a suitable technical person trained in the use of the rating system and inspection form.

7.3.9 Waterway Inspector

The requirement to carry out a waterway inspection is a suitable technical person trained in the use of the rating system and inspection form.

7.4 Accreditation of Inspectors

Structure inspectors will be accredited through the COTO Structures Committee. Only inspectors whose accreditation is valid and up to date will be allowed to carry out visual assessments of road structures.

The accreditation will be per structure class and inspectors will be accredited in the following classes:

- Senior Bridge Inspector (including Road Tunnels);
- Bridge Inspector (including Road Tunnels);
- Major Culvert Inspector;
- Retaining Wall Inspector; and
- Gantry Inspector.

Inspectors with the minimum required qualifications and experience can only be accredited after undergoing the training as described in Section 7.5.

Accreditation will be valid for a five year period, following which the inspector must receive refresher training to be re-accredited.

7.5 Training and Calibration of Inspectors

Inspectors must undergo training before being accredited. The training must be presented by accredited trainers. A list of accredited trainers is obtainable from the SANRAL website. Candidates must have a thorough understanding of this manual before they start the training.

The training and calibration programme for first time candidates must include the following:

- An overview of the objectives of the visual assessment of structures together with a brief description of the data processing procedures and applications of the final results;
- An in-depth explanation of the DER methodology of assessment, including descriptions of various types of distress and ratings for each type;
- An in-depth explanation of the lay-out of the inspection sheets for the different structure types and how these have to be completed;
- Detail of the procedure to be followed during inspections, including the required equipment and safety requirements;
- A written test with a required pass mark of 70% to confirm the candidate's knowledge of this manual in general and the application of the DER rating system in particular. Only candidates who pass this test would be allowed to take part in the practical training;
- Practical training consisting of both combined inspections and practical testing;
- Combined inspections should be carried out on a structure showing different types and degrees of distress. The method of rating should be discussed and the ratings compared at the end of the inspection; and
- Following the combined inspection, the candidates must independently assess one structure. The results of this assessment must be within the required criteria.

The refresher training for re-accreditation must include the following:

- An overview of the objectives of the visual assessment of structures together with a brief description of the data processing procedures and applications of the final results;
- An overview of the DER methodology of assessment, including descriptions of various types of distress and ratings for each type;
- An overview of the lay-out of the inspection sheets for the different structure types and how these have to be completed; and
- A written test with a required pass mark of 70% to confirm the candidate's knowledge of this manual in general and the application of the DER rating system in particular.

7.6 Procedure for Visual Inspections

Prior to commencing with a round of inspections, the Road Authority should arrange an orientation meeting with all the inspectors. During this orientation meeting, the specific requirements of the Road Authority must be communicated to the inspectors. This should include a list of inventory data items that have to be captured or confirmed during the inspection. An important issue to be clarified during the orientation meeting is how to deal with structural elements not complying with current specifications or requirements. For example, the parapets and handrails on older bridges might not comply with current specifications and the Road Authority must give guidance on whether this should be rated as a defect in itself or whether the inspector should only rate defects present on the current parapet or handrail.

The next step is for inspectors to study any available drawings and inventory data of the structure prior to carrying out the visual inspection. This will assist the inspector in understanding how the structure behaves as a result of temperature variation, settlement, rotation, live and dead loads etc. and facilitate the identification of the causes of various defects.

When arriving on site, a walkthrough of the structure should be done to obtain a general appreciation

of the condition of the structure. During the walkthrough some of the required inventory photos (see Section 3.8) could also be taken.

The inspection forms (see Section 6.4) are specific to the structure type and cover all items applicable to the type of structure. The inspector selects an item with which to start the inspection and then proceeds through the structure in a systematic manner. Using a bridge as an example, the inspector may start with one of the approaches of the bridge, followed by the sub-structure, bearings and deck soffit, then the opposite approach and finally the top of the bridge deck, including parapets, guardrail, surfacing and deck joints, ensuring that no items or sub-items are overlooked.

When evaluating an inspection item, the inspector must identify all visible defects on the item. The inspector must decide which of these defects is the most severe for the item under consideration and must then allocate a Degree (D), Extent (E) and Relevancy (R) rating to the most severe defect. The most severe defect would usually be the one with the highest Relevancy rating.

If a defect is critical to the structural integrity such that collapse is imminent or where public safety risk is considered high, such a defect should be recorded as Make Safe (MS) and should receive immediate attention. The inspector should immediately alert the authorities to implement appropriate safety measures to ensure the safety of the user. The “Make Safe” box on the inspection form must be ticked and proof of the communication should be kept, clearly indicating the Road Authority and person(s) contacted.

Once the inspector has rated the most severe defect for the item, the remedial work sheet can be completed. Each defect type applicable to the inspection item, including the most severe defect, must be allocated at least one remedial activity item from the applicable remedial activity list with the estimated quantity and an urgency rating.

The next step is to photograph all the defect types applicable to the inspection item. One photo may be sufficient to record a type of defect, but in many cases a close-up photo of the defect and one taken a few metres away showing its location in relation to the item or structure would be necessary. The photographic record sheet must be completed to record each photo. This contains a brief description of the defect and the direction in which the photo was taken. Each photo should be uniquely numbered and it is recommended that all photos be geo-tagged.

The inspector then moves to the next inspection item and repeats the process. Before leaving the site, the inspector must ensure that the inspection sheet has been completed in full i.e. there should be ratings for each item on the inspection form and remedial activities for all defects. If an element has no defects; is not applicable; or is unable to be inspected, the appropriate value of D = 0; X; or U must be recorded under the degree rating for such an element. The D-rating must not be left blank.

If cracks exist, it is sometimes beneficial to draw a freehand sketch of the crack pattern. This can provide useful information in determining probable causes. Such a sketch can be scanned or photographed and captured as a defect photo.

Inspections must be carried out during daylight, as it is easy to overlook defects, especially cracks, when the light starts to fade. Culverts must be lit up when inspecting inside the barrels.

Equipment and material that are required for inspections include the following:

- Clipboard, pencil and eraser
- Notebook
- As-built drawings (if available)
- Torch
- Binoculars
- Digital camera (GPS enabled)
- Handheld GPS device (minimum of 5 m accuracy; WGS84 format)
- Access equipment, e.g. 6 m ladder
- Gumboots (for culvert inspections)
- Laser distance meter
- Crack width gauge
- Tape measure and
- Measuring wheel
- High-visibility vest
- Non-skid shoes/boots
- Amber flashing light

7.7 Requirements for Additional Inspections

Allowance has been made at the bottom of the inspection forms for identifying further inspections that may be required. The intention is that where there is clearly a problem with the structure that cannot be sufficiently identified with a visual inspection, the need and requirements for an additional inspection can be described.

Typically this would be used in the following situations:

- Where a bridge is in a poor condition and the inspector can only get access to some of the spans due to, for example, deep water, the inspector can request that a further inspection be done using the Under-bridge Inspection Unit (UBIU) or a boat. Where the bridge is in good condition and there is no indication, using binoculars, that the spans that cannot be inspected are in a poor condition, it is not necessary to have further inspections;
- Where there are signs that a structure may collapse and a more detailed assessment of the remaining strength is required, this can be indicated here. For example, if a culvert has a severe crack in the soffit, this could be due to insufficient reinforcement in the top slab on the one hand, or damage during construction on the other. The former is more critical than the latter and can be identified by exposing and measuring the reinforcement across the crack; and
- Where a problem on a structure falls outside the expertise of the inspector, further inspections can be requested. An example would be a significant geotechnical failure to a retaining wall or a tunnel.

7.8 Quality Assurance

The Quality Assurance for visual assessments includes Quality Control and Quality Acceptance components.

Quality Control is an internal responsibility of the agent carrying out the assessment. These agents can be the authorities own teams carrying out an in-house assessment or external service providers appointed for the assessment. Visual assessments carried out by individuals without up to date accreditation must be rejected. The accredited inspector is responsible for the quality control of the data submitted to the Road Authority.

Quality acceptance is an external responsibility and must be undertaken by an organisation independent of the assessment agent. Quality acceptance comprises the assessment of a representative sample of at least 5% of all structures assessed. These results must be compared with the assessment results for accuracy.

The checking procedure must include checking of the calculated indices and the degree, extent and relevancy rating for individual defects. To ensure efficiency and minimise the losses that may be incurred, the quality assurance checks must be completed within 2 weeks of completion of the assessments in an area.

7.9 Occupational Health and Safety Requirements

Inspectors must at all times comply with all the relevant Occupational Health and Safety legislation. The safety of the inspector and the traveling public must always be priority and inspectors should take note of the following safety aspects:

- Always wear a safety vest and light coloured clothing;
- Non-skid shoes are essential;
- Always keep office staff informed of which structures will be inspected on a daily basis in case of an emergency;
- Carry out inspections during daylight;
- Ensure culverts are lit up when inspecting inside the barrels;
- Always take an assistant with when doing inspections;
- Take care when inspecting culverts in areas prone to flash floods;
- No rope access may be used during inspections, unless the inspector has specifically been trained for this; and
- Ladders must be used in the correct and safe manner.

When entering an enclosed space, special care is required. This especially applies to service culverts and box-girder bridges which are not well-ventilated. There may be harmful gasses being released from the service or insufficient oxygen present as concrete gives off carbon dioxide due to the on-going chemical reaction and concrete can also absorb oxygen. Before the inspection, the structure must be opened up and allowed to ventilate. Furthermore, the inspector must have an assistant on the outside and keep in constant communication with him during the inspection. If the communication breaks down, the assistant must take immediate action to get the inspector out of structure.

7.10 Inspection Photos

Inspection photographs are taken to indicate the location and details of defects. Inspection photos

have no set form and are based on the discretion of the inspector. At least one photo of each type of defect on an inspection item is required. In many cases more than one photo of a defect would be required to illustrate the defect adequately in terms of location and detail of the defect itself. A close-up view of the defect and a view of the defect in relation to the overall structure or inspection item are required in most cases.

It is important to record adequate information per inspection photo during the inspection to be able to link the correct photo(s) to the correct defect on the correct structure. The camera photo numbers are the only link between the structure, the defects and the inspection photos and it is recommended that the camera photo number and relevant photo details are entered on a photo record sheet as the photos are taken. Cameras that have “GPS tagging” functionality will assist with linking photos to the correct structure, but cannot assist in linking the photo to the correct defect.

Each inspection photo must have a description attached to it in which the defect and the position of the defect are described, e.g. “0.2 mm bending crack in deck slab of Span 2”.

When taking photographs of cracks, it is useful to outline the cracks with chalk or to include an object in the photo to provide scale, such as a ruler or crack width gauge.

8 Repair Cost Calculations

8.1 Introduction

All defects identified during the inspection process have to be recorded for maintenance or repair purposes. The following information has to be recorded per defect type per inspection item:

- Item Number;
- Position of Defect;
- Activity;
- Quantity;
- Urgency; and
- MS (Make Safe) (if applicable)

8.1.1 Item Number

Item number refers to the inspection item where the defect occurs. For example, if a crack occurs on a pier, the item number for the remedial activity to repair the crack would be “Item 14: Piers and Columns”.

8.1.2 Position of Defect

Position of defect describes where on the inspection item the defect occurs and is indicated by way of a code. For example, if a crack occurs on pier 2 of a five span bridge, the item number would be “Item 14: Piers and Columns”, while the position of the defect (the crack in this case) would be indicated as “P2” (for Pier 2). If similar cracks occur on all piers, the position of the defect would be indicated as “AP” (for all piers).

8.1.3 Activity

Activity refers to the remedial activity required to repair the defect. For a crack, for example, the remedial activity would be “Seal Crack”. Each remedial activity has an associated unit of measurement and unit rate. For example, for the activity “Seal Crack”, the unit of measurement is m (metre) and the unit rate R 590/m (2016 value).

8.1.4 Quantity

Quantity is the estimated quantity to repair the defect. Inspections are done at a network level and these quantities are estimated as accurately as possible and in most cases not measured. The estimated quantity multiplied by the unit rate provides the estimated cost to repair the defect.

8.1.5 Urgency

Urgency refers to when the defect should be repaired. The Urgency is indicated by way of the Urgency Rating, which is a numerical rating as described in Section 8.2. The urgency rating is used to allocate the cost to repair a defect to a specific budget period. The urgency rating must relate to the relevancy rating. For example, a defect with a high relevancy rating would also have a high urgency to be repaired.

8.1.6 Make Safe

If a defect is critical to the structural integrity such that collapse is imminent or where public safety risk is considered high, such a defect should be recorded as Make Safe (MS) and should receive immediate attention. The inspector should immediately alert the authorities to implement appropriate safety measures to ensure the safety of the user. Proof of the communication should be kept clearly indicating the Road Authority and person(s) contacted.

The “Make Safe” box on the inspection form must be ticked.

8.2 Urgency Ratings

The available Urgency (U) ratings are presented in Table 14.

Table 14 Available Urgency (U) Ratings

U-Rating	Description	Remarks
1	Routine	Use for remedial activities that have been identified as routine activities by the Road Authority.
2	Within 10 years	With a five year inspection cycle, these are defects that only need to be repaired after the next round of principle inspections.
3	Within 5 years	These are defects that should be repaired before the next round of principle inspections.
4	As soon as possible	These are defects that should be repaired as soon as possible. In practical terms, it could take up to two years from the time that a defect is identified during an inspection until a contractor is on-site to carry out the repair. Defects where public safety risk is considered high and that have to receive immediate attention will get an urgency rating of 4, but has to be marked as a “Make Safe” item and treated accordingly.
R	Record only	This urgency rating is used for defects for which no remedial work is envisaged. Such defects would have a D-rating of 1 or 2 and an R-rating of 1.
0	Monitor only	This urgency rating is used for defects for which remedial work is not envisaged for the foreseeable future. A monitoring frequency must be indicated (e.g. 12, 24, 36 months). This urgency rating should not be used frequently, as it is not always practical for a Road Authority to monitor defects on structures, especially where the structures are dispersed over a wide area, as is the case for national and provincial roads authorities.

8.3 Remedial Activities

Remedial Activity lists are available for each structure type. These activity lists are included in this document in Appendix A4.

8.4 Position Codes

In order to indicate the position of a defect and therefore also the position of the remedial activity, use should be made of standardised position codes. Examples of position codes for the various structure types are presented in Table 15 to Table 20. If a similar defect occurs on both abutments, for example spalling, the position code of the remedial activity “Repair Spall” would be indicated as “BA” for “Both Abutments”. The quantity of the remedial activity would then be the total volume of spalling to be repaired on both abutments.

Table 15 Position Codes for Remedial Activities on Bridges (General; Arch; and Cable)

Code	Description	Examples
A	Abutment	Abutment 1: A1; Abutment 2: A2; Both Abutments: BA
Ar	Arch	Arch 1: Ar1; Arch 1 to Arch 3: Ar1-Ar3; Arch 1 and Arch 3: Ar1,Ar3
E	Embankment	Embankment 1: E1; Both Embankments: BE
G	General	
P	Pier	Pier 1: P1; Piers 1 to 3: P1-P3; Piers 1, 3 and 4: P1,P3,P4; All Piers: AP
S	Span	Span 1: S1; Spans 1 to 3: S1-S3; Spans 1, 3 and 4: S1,S3,S4; All Spans: AS
Sp	Springing	Springing 1: Sp1; Springing 1 to Springing 3: Sp1-Sp3; Springing 1 and Springing 3: Sp1,Sp3
Py	Pylon	Pylon 1: Py1; Pylon 2 to 4: Py2-Py4; Pylon 1 and 3: Py1,Py3
CG	Cable Group	Cable Group 1: CG1; Cable Group 1 and 3: CG1,CG4

Table 16 Position Codes for Remedial Activities on Bridges (Cellular) and Culverts (Major)

Code	Description	Examples
C	Cell	Cell 1: C1; Cell 1 to Cell 3: C1-C3; Cell 2 and Cell 4: C2,C4; All cells: AC
E	Embankment	Embankment 1: E1; Both embankments: BE
G	General	
Ap	Approach	Approach 1: Ap1; Approach 2: Ap2; Both approaches: BAp

Table 17 Position Codes for Remedial Activities on Culverts (Lesser)

Code	Description	Examples
C	Cell	Cell 1: C1; Cell 1 to Cell 3: C1-C3; Cell 2 and Cell 4: C2,C4; All cells: AC
E	Embankment	Embankment 1: E1; Both embankments: BE
G	General	

Table 18 Position Codes for Remedial Activities on Retaining Walls

Code	Description	Examples
W	Wall	Wall 1: W1

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Code	Description	Examples
E	Embankment	Embankment 1: E1
G	General	
Ap	Approach	Approach 1: Ap1
W	Wall	Wall 1: W1
E	Embankment	Embankment 1: E1

Table 19 Position Codes for Remedial Activities on Gantries

Code	Description	Examples
Vm	Vertical Member	Vertical Member 1: Vm1, Vertical Members 1 and 2: Vm1-Vm2
S	Span	Span 1: S1; Spans 1 to 3: S1-S3; Spans 1 and 3: S1,S4; All Spans: AS
G	General	

Table 20 Position Codes for Remedial Activities on Road Tunnels

Code	Description	Examples
Po	Portals	Portal 1: Po1; Portal 2: Po2; Both portals: BPo
Pa	Panels	Panel 1: Pa1, Panel 2 to 4: Pa2-Pa4; All panels: Apa
G	General	

Table 21 Position Codes for Remedial Activities on Light Masts

Code	Description	Examples
Mo	Mast	Mast 1: M1; Mast 2: M2
MG	Mast Group	Mast Group 1: MG1
G	General	

Appendices

Appendix A1. Inventory Information per Structure Type

Table A1. 1 Common Inventory Items (R = Required and O = Optional)

Item	Bridge (General/Arch/Cable)	Bridge (Cellular)	Culvert (Major)	Culvert (Lesser)	Retaining Wall	Gantry	Tunnel
Location Details							
Route/Road Number	R	R	R	R	R	R	R
Section Number	R	R	R	R	R	R	R
Chainage km	R	R	R	R	R	R	R
Road Name/Description	R	R	R	R	R	R	R
Class Of Road	R	R	R	R	R	R	R
District/Province/Municipality	O	O	O	O	O	O	O
Region/Suburb	O	O	O	O	O	O	O
Other Authority	O	O	O		O	O	O
Primary Feature Over	O	O	O	O			
Primary Feature Over Name	O	O	O	O			
Primary Feature Over Road Number	O	O	O	O			
Primary Feature Over Road km	O						
Secondary Feature Over	O	O	O				
Secondary Feature Over Name	O	O	O				
Primary Feature Under	O	O	O	O			
Primary Feature Under Name	O	O	O				
Primary Feature Under Road Number	O						
Primary Feature Under Road km	O						
Secondary Feature Under	O	O	O				
Secondary Feature Under Name	O	O	O				
Other/Old Bridge Number	O	O					
Elevation	O	O	O	O			O
Structure Orientation	R	R	R	O	R	R	R
Direction of River Flow	O	O	O	O			
Approach Embankment Orientation	R						
Embankment Orientation		R	R				
Survey System	R	R	R	R	R	R	R
GPS Coordinates: Longitude	R	R	R	R	R	R	R
GPS Coordinates: Latitude	R	R	R	R	R	R	R
Status	R	R	R	R	R	R	R
Ownership	R	R	R	R	R	R	R
Contract details							
Design Engineers	O	O	O		O	O	O

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Item	Bridge (General/Arch/Cable)	Bridge (Cellular)	Culvert (Major)	Culvert (Lesser)	Retaining Wall	Gantry	Tunnel
Contractor	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Contract No.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Contract/Construction Cost	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Year Completed	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Completion Period	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Escalated Cost	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Total Cost	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Design Characteristics							
Design Live Loading	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Percentage Increase Due to Overloading	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Design Codes	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Temperature Range	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Temperature Gradient	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Wind Loads	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Frequency.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Warrant History.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Hydraulic Data							
Class Of Road	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Catchment Area (The Catchment Area Of The River Up To The Point Where The Structure Crosses The River)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Flood Calculation Method	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Twenty Year Return Period Flood (Q20)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Design Return Period (T)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Design Peak Discharge (QT)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Peak Discharge (Q2T)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Regional Maximum Flood (QRMF)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Average Slope (S)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Natural Design Flood Level (NDFL)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Natural Design Flow Depth (NDFD)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Natural Design Flow Velocity (Vn)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Backwater (Δh)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Design High Flood Level (DHFL) For QT	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Design High Flood Level (DHFL) For Q2T:	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

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Item	Bridge (General/Arch/Cable)	Bridge (Cellular)	Culvert (Major)	Culvert (Lesser)	Retaining Wall	Gantry	Tunnel
Design Flow Velocity (Vn2)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>				
Required Freeboard	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>				
Level Of Shoulder Break Point (SBP)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>				
Drainage							
Support Drainage	<input type="radio"/>						
Superstructure Drainage	<input type="radio"/>						
Road Surface Drainage	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>				<input type="radio"/>
Cell Drainage		<input type="radio"/>	<input type="radio"/>				
Wing/Return Wall Drainage	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>				
Seepage Drains	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>				
Minimum Horizontal Clearances							
The Minimum Horizontal Clearance	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>				
The Date	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>				
The Position	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>				
Minimum Vertical Clearances							
The Minimum Vertical Clearance	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>			<input type="radio"/>	<input type="radio"/>
The Date Recorded	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>			<input type="radio"/>	<input type="radio"/>
The Position Where Recorded	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>			<input type="radio"/>	<input type="radio"/>
Services in/on/under Structure							
Service Type	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>		<input type="radio"/>		<input type="radio"/>
Service Description	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>		<input type="radio"/>		<input type="radio"/>
Service Location	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>		<input type="radio"/>		<input type="radio"/>
Service Responsible Authority	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>		<input type="radio"/>		<input type="radio"/>
Road Configuration, Traffic Volumes and Surfacing							
Class of Road	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>		<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Number of Carriageways	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>		<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Number of Lanes/Dimensions	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>		<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Number of Shoulders/Dimensions	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>		<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Number of Sidewalks/Dimensions	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>		<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Annual Average Daily Traffic	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>		<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Year ADT Recorded	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>		<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

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Item	Bridge (General/Arch/Cable)	Bridge (Cellular)	Culvert (Major)	Culvert (Lesser)	Retaining Wall	Gantry	Tunnel
Percentage Heavy Vehicles	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Detour Length	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Minimum Class of Detour	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Surfacing on Deck	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Surfacing on Approaches.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Archive Details							
Project Number	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Correspondence File Reference Number	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Strip Map Number	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Drawing Number	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Drawing Title	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Drawing Location	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Drawing Type	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Microfilm Number	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Microfilm Title	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Microfilm Location	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Maintenance Agreements and Responsibilities							
Responsibilities	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Share of Costs	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Agreement Number	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Agreement Location	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Maintenance History							
Details	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Designer	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Contractor	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Year Completed	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Cost	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Widening, Strengthening and Retrofitting							
Details	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Designer	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Contractor	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Year Completed	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

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Item	Tunnel	
	Gantry	
Retaining Wall		
	Culvert (Lesser)	
Culvert (Major)		O
Bridge (Cellular)		O
Bridge (General/Arch/Cable)		O
Cost		

Table A1.2 Inventory Items Specific to Bridge (General/Arch/Cable)

Item	Required or Optional		
	Bridge (General)	Bridge (Arch)	Bridge (Cable)
General Features			
Bridge Type	R	R	R
Number of Spans	R	R	R
Number of Piers	R	R	R
Number of Abutments	R	R	R
Number of Arches		R	
Number of Cable Groups			R
Facility Carried	O	O	O
Bridge Description	O	O	O
Deck Construction Method	O	O	O
Parapet/Handrail Type	O	O	O
Approach Slabs	O	O	O
Abutment Galleries	O	O	O
fcu Slabs	O	O	O
fcu Beams	O	O	O
fcu Piers	O	O	O
fcu Abutments	O	O	O
fcu Arches		O	
Dimensions, Geometry and Road Clearances			
Overall Structure Length	R	R	R
Overall Structure Width	R	R	R
Total Deck Area (normally L x W)	R	R	R
Angle of Skew	R	R	R
Single/Dual Carriageway Over	O	O	O
Direction of Traffic	O	O	O
Minimum Width of Roadway between Kerbs	R	R	R
Width of Approach Road	R	R	R
Vertical Alignment	O	O	O
Horizontal Alignment	O	O	O
Camber/Crossfall	O	O	O
Structural Features			
Deck			
Deck Position	R	R	R
Deck Type	O	O	O
Deck Material	O	O	O
Deck Depth (Average)	O	O	O
Deck Depth (Maximum)	O	O	O

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Item	Required or Optional		
	Bridge (General)	Bridge (Arch)	Bridge (Cable)
Deck Depth (Minimum)	O	O	O
Span Length	O	O	O
Deck Soffit Profile	O	O	O
Arches			
Arch Position		R	
Arch Type		O	
Arch Material		O	
Arch Span		R	
Arch Rise		O	
Arch Thickness at Crown		O	
Arch Thickness at Springing		O	
Bearings			
Bearing Position	R	R	R
Bearing Type	O	O	O
Bearings Fixity	O	O	O
Expansion Joints			
Expansion Joint Position	R	R	R
Expansion Joint Type	O	O	O
Expansion Joint Direction of Movement	O	O	O
Piers			
Pier Position	R	R	R
Pier Type	O	O	O
Pier Material	O	O	O
Pier Foundation Type	O	O	O
Pier Founding Material	O	O	O
Pier Maximum Height	R	R	R
Pier Foundation Maximum Depth	O	O	O
Abutments			
Abutment Position	R	R	R
Abutment Type	O	O	O
Abutment Material	O	O	O
Abutment Foundation Type	O	O	O
Abutment Founding Material	O	O	O
Abutment Maximum Height	R	R	R
Abutment Foundation Maximum Depth	O	O	O
Springings			
Springing Position		R	
Springing Material		O	
Springing Foundation Type		O	
Springing Founding Material		O	

Item	Required or Optional		
	Bridge (General)	Bridge (Arch)	Bridge (Cable)
Cable Groups			
Cable Group Position e.g. span no. and/or abutment no. (backstay)			R
Cable Group Type e.g. suspension, stay, hanger			O
Cable Group Material			O
Cable Group Size			O
Wing/Retaining Walls			
Wing/Retaining Wall Position	R	R	R
Wing/Retaining Wall Type	O	O	O
Wing/Retaining Wall Material	O	O	O
Wing/Retaining Wall Foundation Type	O	O	O
Wing/Retaining Wall Founding Material	O	O	O
Wing/Retaining Wall Maximum Height	O	O	O
Wing/Retaining Wall Foundation Maximum Depth	O	O	O
Embankment Protection			
Embankment Position	R	R	R
Embankment Protection Type	O	O	O
Embankment Protection Material	O	O	O
Embankment Protection Thickness	O	O	O
Embankment Protection Slope	O	O	O
Factors Influencing Field Inspection			
Access Factors: Piers	O	O	O
Access to Bearings	O	O	O
Access to Inside of Box Girder	O	O	O
Access to Deck Soffit	O	O	O
Access to Abutment Galleries	O	O	O
Traffic Volume	O	O	O
Availability of Drawings	O	O	O
General Information	O	O	O

Table A1.3 Inventory Items Specific to Bridge (Cellular) and Culvert (Major)

Item	Required or Optional
General Features	
Number of Cells	R
Cell Type	O
Purpose of Bridge	O
Parapet/Handrail Type	O
Inlet/Outlet Walls Type	O
Causeway	O
Buried Structure	O
Bridge Road Slabs	O
Approach Road Slabs	O
Floor Slope	O
fcu Cells – Precast	O
fcu Cells – In-situ	O
fcu Apron Slabs & Cut-off Walls	O
fcu Wing/Retaining Walls	O
fcu Road Slabs	O
Dimensions, Geometry and Road Clearances	
Overall Structure Length	R
Overall Structure Width	R
Total Plan Area	R
Average Cell Length	R
Total Opening Area	R
Maximum Cell Size: Width	R
Maximum Cell Size: Height	R
Maximum Fill Height	R
Minimum Clear Width	O
Angle of Skew	O
Single/Dual Carriageway Over	O
Direction of Traffic	O
Minimum Width of Roadway	R
Width of Approach Road	R
Vertical Alignment	O
Horizontal Alignment	O
Camber/Crossfall	O
Minimum Depth of Fill Over	O
Slope of Invert Slab	O
Structural Features	
Cells	

Item	Required or Optional
Cell Position	R
Cell Material: Walls	O
Cell Material: Top Slab	O
Cell Foundation Type	O
Cell Founding Material	O
Cell Internal Width	O
Cell Internal Height	O
Invert Slabs	
Invert Slab Position	R
Invert Slabs Type	O
Invert Slabs Material	O
Invert Slabs Thickness	O
Apron Slabs	
Apron Slab Position	R
Apron Slab Material	O
Apron Slab Thickness	O
Cut-off Walls	
Cut-off Wall Position	R
Cut-off Wall Material	O
Cut-off Wall Width	O
Cut-off Wall Depth	O
Dissipators	
Dissipators Position	R
Dissipator Type	O
Dissipator Material	O
Wing/Retaining Walls	
Wing/Retaining Wall Position	R
Wing/Retaining Wall Type	O
Wing/Retaining Wall Material	O
Wing/Retaining Wall Foundation Type	O
Wing/Retaining Wall Founding Material	O
Wing/Retaining Wall Maximum Height	O
Wing/Retaining Wall Foundation Maximum Depth	O
Embankment Protection	
Embankment Position	R
Embankment Protection Type	O
Embankment Protection Material	O
Embankment Protection Thickness	O
Embankment Protection Slope	O
Factors Influencing Field Inspection	

Item	Required or Optional
Access to Bridge/Culvert	O
Effective Cell Opening	O
Traffic Volume	O
Availability of Drawings	O
General Information	O

Table A1. 4 Inventory Items Specific to Culvert (Lesser)

Item	Required or Optional
General Features	
Number of Cells	R
Culvert Type	O
Inlet/Outlet Walls Type	O
Floor Slope	O
Dimensions, Geometry and Road Clearances	
Overall Structure Length	O
Overall Structure Width	O
Overall Cell Length	O
Maximum Cell Size: Width	R
Maximum Cell Size: Height	R
Maximum Fill Height	O
Minimum Depth of Fill Over	O
Slope of Invert Slab	O
Structural Features	
Cells	
Cell Position	R
Cell Material: Walls	O
Cell Material: Top Slab	O
Cell Material: invert Slab	O
Cell Internal Width	R
Cell Internal Height	R
Apron Slabs	
Apron Slab Position	R
Apron Slab Material	O
Apron Slab Thickness	O
Cut-off Walls	
Cut-off Wall Position	R
Cut-off Wall Material	O
Cut-off Wall Width	O

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Item	Required or Optional
Cut-off Wall Depth	O
Dissipators	
Dissipators Position	R
Dissipator Type	O
Dissipator Material	O
Wing/Retaining Walls	
Wing/Retaining Wall Position	R
Wing/Retaining Wall Type	O
Wing/Retaining Wall Material	O
Wing/Retaining Wall Foundation Type	O
Wing/Retaining Wall Founding Material	O
Wing/Retaining Wall Maximum Height	O
Wing/Retaining Wall Foundation Maximum Depth	O
Embankment Protection	
Embankment Position	R
Embankment Protection Material	O
Embankment Protection Thickness	O
Embankment Protection Slope	O
Factors Influencing Field Inspection	
Traffic Volume	O
General Information	O

Table A1. 5 Inventory Items Specific to Retaining Walls

Item	Required or Optional
General Features	
Wall Type	R
Description (in terms of its function)	O
Construction method	O
Slope Angle	O
Retained Material	O
fcu Foundations	O
fcu Walls	O
fcu Sprayed Concrete	O
fcu Precast Members	O
Dimensions, Geometry and Road Clearances	
Overall Length of Wall	R
Maximum Wall Height	R
Total Area of Wall in Elevation	R
Minimum Horizontal Clearance from Roadway Yellow Line	O
Structural Features	
Wall	
Wall material	O
Joints	
Wall Joints Type	O
External Drains	
External Drain Type	O
Internal Drainage	
Wall Drainage System Type	O
Wall Drainage System Size	O
Seepage Drain Type	O
Seepage Drain Size	O
Slope Protection	
Slope Protection Type	O
Slope Protection Material	O
Slope Protection Thickness	O
Embankment Protection Slope	O
Foundations	
Foundation type	O
Founding material	O
Wall foundation maximum depth	O
Factors Influencing Field Inspection	

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Item	Required or Optional
Access factors: Bottom of wall	O
Access factors: Top of wall	O
Traffic Volume	O
Availability of Drawings	O
General Information	O

Table A1. 6 Inventory Items Specific to Gantries

Item	Required or Optional
General Features	
Gantry Type	R
Gantry Material	O
fcu Foundations	O
fcu Plinths	O
fst Structural steel	O
fst Anchor Bolts	O
Dimensions, Geometry and Road Clearances	
Total Length of Horizontal and Vertical Members	R
Left plinth projection	O
Within median barrier structure	O
Right plinth projection	O
Sign face length	O
Sign face height	O
Structural Features	
Foundations	
Foundation Position	R
Foundation Type	O
Founding Material	O
Gantry Foundation Maximum/Minimum Depth	O
Vertical Members	
Vertical Member Position	R
Vertical Member Type	O
Vertical Member Material	O
Vertical Member Height	R
Vertical Member Size	O
Type of Corrosion Protection	O
Horizontal Member	
Horizontal Member Position	R
Horizontal Member Type	O
Horizontal Member Material	O
Span of Horizontal Member	R
Horizontal Member Size	O
Type of Corrosion Protection	O
Sign Face	
Position of Sign	R
Type of Sign Face	O

Item	Required or Optional
Type of Corrosion Protection	O
Sign Fasteners	
Position of Sign	R
Type of Sign Fasteners	O
Type of Corrosion Protection	O
HD Bolts and Base Plates	
Position of HD Bolts and Base	R
Size of HD Bolts	O
Size of Base Plate	O
Type of Corrosion Protection	O
Factors Influencing Field Inspection	
Access factors: Gantry	O
Traffic Volume	O
Availability of Drawings	O
General Information	O

Table A1.7 Inventory Items Specific to Road Tunnels

Item	Required or Optional
General Features	
Tunnel Type	R
Description in terms of its Function	O
Material Bored Through	O
fcu Tunnel lining.	O
Dimensions, Geometry and Road Clearances	
Length of Tunnel	R
Width of Tunnel	R
Height of Tunnel	R
Tunnel Cross-sectional Area	R
Structural Features	
Lining	
Lining Position	R
Bore Lining Material	O
Joints	
Joint Position	R
Expansion Joints to Road Surface and Walls	O
Drainage	
Tunnel Wall Drainage System Type	O
Slope Protection	
Slope Position	R
Slope Protection Type	O
Slope Protection Material	O
Slope Protection Thickness	O
Slope Angle	O
Portals	
Portal Position	R
Portal Type	O
Factors Influencing Field Inspection	
Access factors: Tunnel bore	O
Access factors: Portals	O
Traffic Volume	O
Availability of Drawings	O
General Information	O

Table A1. 8 Inventory Items Specific to Light Masts

Item	Required or Optional
General Features	
Group of masts or single mast	R
Light mast or mast group location	R
Number of masts in the group	R
Foundations	
Foundation Type	R
Founding Material	O
Light Mast Foundation Maximum/Minimum Depth	O
Plinth projection	O
Within median barrier structure (Y/N)	O
f_{cu} Foundations	O
f_{cu} Plinths	O
HD Bolts and Base Plates	
Gusset plate description	O
Size of HD bolts	O
Size of base plate	O
f_{st} Anchor Bolts	O
Masts	
Light Mast Type	R
Light Mast Material	R
Light Mast Height	R
Mast Size e.g. diameter	O
f_{st} Structural steel	O
Type of Corrosion Protection	O
Light fittings and fixings	
Type of light fitting	O
Type of light fixing	O
Number of lights, bulbs or fittings	O
Access hatch to electrical controls	
Does a hatch exist Y/N	O
Hatch type and size	O
Light fitting access system	
Type of light fitting access system	O
Cable theft preventative measures	
Are cable theft preventative measures in place Y/N	O
Factors Influencing Field Inspection	
Access factors	O
Traffic Volume	O
Availability of Drawings	O
General Information	O

Appendix A2. Examples of Relevancy and Urgency Ratings

Introduction

Relevancy (R) – Considers the consequence of the defect with regards the structural/functional integrity of the inspection item or the safety of the user of the structure

The possible values for R are given in the table below:

R - Relevancy

Minimum	Moderate	Major	Critical
1	2	3	4

Urgency (U) - Considers possible future events which could adversely affect defects and provides a way of applying direct time limits on the requirement to do the repairs

The possible values for U are given in the table below:

U – Urgency

Record purposes only R	Monitor only 0	Routine 1	< 10 yrs 2	< 5 yrs 3	ASAP 4
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Concrete Items (Structural)

These defects are applicable to the following inspection items:

- Bridge (General/Arch/Cable) Item 6 Abutments
- Bridge (General/Arch/Cable) Item 7 Wing/Retaining Walls
- Bridge (General/Arch/Cable) Item 14 Piers and Columns
- Bridge (General/Arch/Cable) Item 18 Longitudinal Members in Deck
- Bridge (General/Arch/Cable) Item 19 Transverse Members in Deck
- Bridge (General/Arch/Cable) Item 20 Deck Slab
- Bridge (Cellular) Item 1 Apron Slabs and Cut-off Walls
- Bridge (Cellular) Item 2 Wing/Return/Head Walls
- Bridge (Cellular) Item 6 Road Slabs
- Bridge (Cellular) Item 10 Walls
- Bridge (Cellular) Item 11 Top Slab
- Bridge (Cellular) Item 12 Invert Slab
- Culvert (Major) Item 1 Apron Slabs and Cut-off Walls
- Culvert (Major) Item 2 Wing/Return/Head Walls
- Culvert (Major) Item 6 Road Slabs
- Culvert (Major) Item 10 Walls
- Culvert (Major) Item 11 Top Slab
- Culvert (Major) Item 12 Invert Slab
- Retaining Wall Item 3 Walls
- Road Tunnel Item 1 Portals

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• Road Tunnel

Item 6 Lining

Activity Description	Range of "R"	Remarks	U	R
Repair spalled concrete	1 to 4	Spalling is local and will not affect the structural integrity (SI) of the element	3	1
		Spalling is severe and the SI of the element will be affected	4	4
Seal, repair cracks > 0.3	1 to 4	Cracks are < 0.3 mm and there are no signs of leaching or leakage	-	-
		Cracks show signs of leaching or leakage, are local and will not affect the SI of the element	2	1
		Cracks show signs of leaching or leakage, are local and will not affect the SI of the element but there are signs of corrosion of reinforcement	3	2
		Cracks are global and show signs of corrosion of reinforcement but will not affect the SI of the element	4	3
		Cracks are local or global and will affect the SI of the element, i.e. where there is a possibility of collapse or where there are clear signs of badly corroded reinforcement	4	4
Repair honeycombed concrete	1 to 4	Honeycombing is superficial. Cover to the reinforcement is reduced but there are no signs of corrosion.	1	1
		Reinforcement is exposed but there are no signs of corrosion. The SI of the element will not be affected.	3	2
		Reinforcement is exposed and there are clear signs of corrosion. The SI of the element will be affected	4	4
Remove & reconstruct backwall at abutment	2 & 3	The severity of the rotation and movements of the abutment would determine whether it would be necessary to relieve stresses by removing and reconstructing the backwall	2	2
			3	3
Apply protective coating	1	After repairs to extend the life of the element	1	1
		Cover to reinforcement is substandard over extensive areas. To improve the durability of the element a protective coating is applied	1	1
		Concrete found to be very porous. A protective coating is used to protect the reinforcement from chloride attack and/or carbonation	2	1
Apply surface sealer/ paint	1 & 2	To lengthen the life of a structure and will usually be applied after extensive repair to a structure.	2	2
		If concrete is found to be very porous and where there is a need to protect the reinforcement against future corrosion.	2	2

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Activity Description	Range of "R"	Remarks	U	R
		Where concrete is found to be under-strength and there is a need to increase its durability	1	1
Repair wear in riding surface if deck is unsurfaced	1 to 3	Rutting due to vehicular traffic: < 10 mm and local or global	R	1
		Rutting due to vehicular traffic: > 10 mm and local	2	2
		Rutting due to vehicular traffic: > 10 mm and global	3	3
Waterproof top surface	2 & 3	Evidence of reflection cracking or deformation of the surfacing material which could indicate slip between the asphalt layer and a waterproofing material if present	2	2
		Clear evidence of chemical attack to concrete i.e. where ingress of water will cause rapid deterioration of the concrete such as in AAR	3	2
		Evidence of leaching and leaking causing corrosion to reinforcement	4	3

Concrete Items (Non-structural)

These defects are applicable to the following inspection items:

- Bridge (General/Arch/Cable) Item 10 Kerbs/Sidewalks
- Bridge (General/Arch/Cable) Item 11 Parapets and Handrails
- Bridge (Cellular) Item 9 Parapets and Handrails
- Culver (Major) Item 9 Parapets and Handrails

Activity Description	Range of "R"	Remarks	U	R
Repair spalled concrete	1 & 3	Spalling is local and will not affect the integrity of the element	1	1
		Spalling is severe and the integrity of the element will be affected (kerbs)	3	2
		Spalling is severe and the integrity of the element will be affected (parapets and handrails)	3	3
Seal, repair cracks > 0.3 mm	1 to 3	Cracks are < 0.3 mm	-	-
		Cracks are > 0.3 mm, are local and will not affect the integrity of the element	1	1
		Cracks are > 0.3 mm, are local and will not affect the integrity of the element, but there are signs of corrosion of reinforcement	2	2
		Cracks are global and show signs of corrosion of reinforcement but will not affect the integrity of the element	3	2

Activity Description	Range of "R"	Remarks	U	R
		Cracks are local or global, there are clear signs of badly corroded reinforcement and the integrity of the element will be affected	3	3
Repair honeycombed concrete	1 to 3	Honeycombing is superficial. Cover to the reinforcement is reduced but there are no signs of corrosion.	1	1
		Reinforcement is exposed but there are no signs of corrosion. The integrity of the element will not be affected.	2	1
		Reinforcement is exposed and there are clear signs of corrosion. The integrity of the element will be affected (kerbs)	3	2
		Reinforcement is exposed and there are clear signs of corrosion. The integrity of the element will be affected (parapets and handrails)	3	3

Foundations

These defects are applicable to the following inspection items:

- Bridge (General/Arch/Cable) Item 5 Abutment Foundations
- Bridge (General/Arch/Cable) Item 13 Pier Foundations
- Retaining Wall Item 6 Foundations
- Gantry Item 2 Foundations
- Light Mast Item 1 Foundations and Plinths

Activity Description	Range of "R"	Remarks	U	R
Backfill/ underpin foundations undermined by erosion or scour	2 to 4	The stability of the foundation is not endangered and the SI of the supported element is not affected	3	2
		The stability of the foundation may be endangered and the SI of the supported element will become affected should there be a further significant increase in scour	4	3
		The stability of the foundation is endangered and the SI of the supported element is affected and there is danger of collapse	4	4
Repair spalled concrete	1 & 3	Spalling is local and will not affect the SI of the foundation	1	1
		Spalling is severe and the SI of the foundation will be affected	3	3
Seal, repair cracks > 0.3 mm	1 to 3	Cracks are < 0.3 mm	-	-
		Cracks are > 0.3 mm, are local and will not affect the SI of the foundation	1	1

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Activity Description	Range of "R"	Remarks	U	R
		Cracks are > 0.3 mm, are local and will not affect the SI of the foundation, but there are signs of corrosion of reinforcement	2	2
		Cracks are global and show signs of corrosion of reinforcement but will not affect the SI of the foundation.	3	2
		Cracks are local or global, there are clear signs of badly corroded reinforcement and the SI of the foundation will be affected	3	3
Repair honeycombed concrete	1 to 3	Honeycombing is superficial. Cover to the reinforcement is reduced but there are no signs of corrosion.	1	1
		Reinforcement is exposed but there are no signs of corrosion. The SI of the foundation will not be affected.	2	1
		Reinforcement is exposed and there are clear signs of corrosion. The SI of the foundation will be affected.	3	3

Embankments

These defects are applicable to the following inspection items:

- Bridge (General/Arch/Cable) Item 1 Approach Embankment
- Bridge(Cellular) Item 4 Embankments
- Culvert (Major) Item 4 Embankments

Activity Description	Range of "R"	Remarks	U	R
Down chutes - replace	3	If not replaced could lead to severe erosion of embankment	4	3
Down chutes - clean	1 & 2	Blocked up due to accumulation of silt or debris	1	1
		Inadequate to cater for water flow	3	2
Inlets/outlets - renew	3	If not replaced could lead to severe erosion of embankment	4	3
Inlets/outlets - clean	1 & 2	Blocked up due to accumulation of silt or debris	1	1
		Inadequate to cater for water flow	3	2
Erosion and scour damage - backfill	1 to 4	Erosion and scour are unlikely to affect stability of embankment	1	1
		Erosion and scour are highly likely to cause collapse in embankments but will not affect safety of traffic	3	2
		Erosion and scour are highly likely to cause collapse which will endanger the traffic on the embankment	4	4
Settlement - rectify	1 & 3	Minor settlement of road	1	1

Activity Description	Range of "R"	Remarks	U	R
		Settlement of road may cause discomfort to user	3	2
		Settlement of road may cause accidents	4	3

Slope Protection

These defects are applicable to the following inspection items:

- Bridge (General/Arch/Cable) Item 4 Approach Embankment Protection Works
- Retaining Wall Item 2 Slope Protection
- Road Tunnel Item 2 Slope Protection
- Road Tunnel Item 3 Rock Fall Protection

Activity Description	Range of "R"	Remarks	U	R
Renew/repair protection works (gabion boxes, stone pitching etc.)	1 to 3	Minor damage to protection works caused by settlement of embankment, vegetation, vandalism etc.	1	1
		Portions of the protection works have been damaged, displaced or removed locally by floodwaters	4	2
		Large portions have been damaged, displaced or removed by floodwaters	4	3

Bearings

These defects are applicable to the following inspection item:

- Bridge (General/Arch/Cable) Item 15 Bearings

Activity Description	Range of "R"	Remarks	U	R
Clean bearings	1	Dirt and debris may impair movement	1	1
Corrosion protection of bearing	1 & 2	Touching up of paint-work needed	1	1
		Corrosion causing excessive frictional forces between substructure and superstructure	3	2
Reset bearings	1 to 3	Minor adjustment needed in bearing alignment	2	1
		Key ways and thrust plates are not properly engaged and are binding causing large forces to be transmitted to substructure	3	2
		Bearing at limit of movement capacity and further movement expected	4	3
Replace elastomeric bearing	2	Tearing, cracking or splitting of exposed edges	2	2
		Excessive bulging and distortion indicating under-design	2	2

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Activity Description	Range of "R"	Remarks	U	R
Replace mechanical bearing	3	Very badly corroded bearing where the movement and support capabilities have been impaired	3	3
		Distortions in top or bottom adapter plates causing restrictions in the movement capabilities of bearing	3	3
Reinstate horizontal force capacity of bearing	1 to 3	Anchor bolts badly corroded	2	1
		Relative movement between the bearing seating and the supporting structure	3	3
		Shear keys have either failed or caused spalling of concrete to reduce their capacity to provide restraint to the structure	3	3
Tighten anchor bolts	1	Anchor bolts loose	1	1
Repair bearing plinths	2 to 4	Spalling of edges where bearings have been placed too close to edges	2	2
		Vertical crack caused by the bursting forces as a result of excessive bearing loads or inadequate strength (under designed)	4	4
		Corrosion of reinforcement caused by lack of cover	3	2
		Spalling of concrete in vicinity of holding down bolts, caused by excessive horizontal forces or corrosion of bolts	3	3

Expansion Joints

These defects are applicable to the following inspection item:

- Bridge (General/Arch/Cable) Item 17 Expansion Joints

Activity Description	Range of "R"	Remarks	U	R
Repair or replace concrete or synthetic nosing	1-4	Some slight spalling and cracking of the joint but no signs of it posing a danger to traffic	2	1
		Some spalling and cracking of the joint but does not pose a danger to traffic	3	2
		Parts of the nosing are coming loose but in small pieces. Claws and steel or aluminium components are no longer firmly fixed	4	3
		Parts of the nosing is coming loose in large pieces, claws and steel or aluminium components are loose, etc. any of which can pose a danger to traffic	4	4

Activity Description	Range of "R"	Remarks	U	R
Refit or replace elastomer element or replace sealant	1 to 4	Signs of some minor leaking but no consequential damage to bearings, concrete, steel, etc. below	R	1
		Signs of more extensive leaking but no damage to bearings, concrete, steel, etc. below	3	2
		Extensive signs of leaking with damage to bearings, concrete, steel, etc. below	3	4
		Extensive leaking has caused significant damage such as bearings seizing, extensive concrete spalling, prestressing anchors corroding, etc.	4	4
Repair or replace asphaltic plug joint	1 to 4	Some deterioration such as some small cracks, slight rutting etc.	R	1
		More extensive deterioration such as some cracks, rutting etc.	3	2
		Large cracks, deep rutting, some loss of joint causing holes	3	3
		Deep rutting and large holes presenting a danger to traffic	4	4
Joint cover plates (replace and refit)	1 to 4	Slight deterioration to cover plates	R	1
		More deterioration to cover plates, loose bolts, plates missing over small gaps less than 40 mm etc.	3	2
		Bolts missing, plates missing over gaps less than 150 mm, etc.	3	3
		Plates standing out at a dangerous angle, missing plates over large gaps, etc. any of which present a danger to traffic or pedestrians	4	4
Clean joint of all loose material and debris	1 & 2	Routine maintenance activity. R rating would be determined by the extent to which the loose material and debris is preventing the expansion joint from fulfilling its function	1	1 2

Structural Steel Members

These defects are applicable to the following inspection items:

- Bridge (General/Arch/Cable) Item 18 Longitudinal Members in Deck
- Bridge (General/Arch/Cable) Item 19 Transverse Members in Deck
- Bridge (General/Arch/Cable) Item 20 Deck Superstructure
- Gantry Item 4 Vertical Members
- Gantry Item 5 Horizontal Members
- Light Mast Item 3 Mast

Activity Description	Range of "R"	Remarks	U	R
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Activity Description	Range of "R"	Remarks	U	R
Gouging out of weld & re-welding Re-torque bolts Monitoring of cracks 20% paint system 100% paint system Sand blast to white metal Replace bolts Remove all rivets & replace with bolts Strengthen structural member	1 to 4	The value of "R" chosen shall depend on whether a delay in carrying out a repair will or will not lead to a possible safety hazard to the motorist. A steel structure requires a detailed inspection. It is important that the inspector has a thorough understanding of the structural significance of the defects. It would be impossible to deal in this section with all the possible consequences of defects because of the many different types of steel structures. Although, it must be mentioned that chain reactions of failures can result from what may appear to be a very insignificant defect. One must be aware of such possibilities.		
Replace structural member				

HD Bolts and Base Plates

These defects are applicable to the following inspection items:

- Gantry Item 3 HD Bolts and Base Plates
- Light Mast Item 2 HD Bolts and Base Plates

Activity Description	Range of "R"	Remarks	U	R
Corrosion protection	1 to 4	Minor corrosion of base plate	2	1
		Minor corrosion of HD bolts	1	1
		Moderate corrosion of base plate	3	3
		Moderate corrosion of HD bolts	3	2
		Severe corrosion of base plate	4	4
Replace bolts, washers, etc.	1 to 4	The relevancy and urgency will depend on the number of HD bolts of the base plate that are missing or sheared off		
Replace base plate	4	The base plate is corroded or damaged to such an extent that it cannot fulfil its function.	4	4
Strengthen baseplate	2 & 3	The base plate needs to be strengthened to ensure that it can fulfil its function. The relevancy and urgency will be determined by the extent of strengthening required		

Drainage

Road Structure Management Part A: Appendix A2

These defects are applicable to the following inspection items:

- Bridge (General/Arch/Cable) Item 9 Superstructure Drainage
- Bridge (General/Arch/Cable) Item 16 Support Drainage
- Retaining Wall Item 1 External Drainage
- Retaining Wall Item 5 Internal Drainage
- Road Tunnel Item 4 Drainage

Activity Description	Range of "R"	Remarks	U	R
Clear blocked drainage outlets	1 to 3	Drainage defects do not represent a safety hazard to the motorist and would not cause damage to the structure	1	1
		Drainage defects could cause damage to components of the structure	2	2
		Drainage defects represents a safety hazard to motorist	3	3
Repair damaged pipes	1 to 3	Drainage defects do not represent a safety hazard to the motorist and would not cause damage to the structure	1	1
		Drainage defects could cause damage to components of the structure	2	2
		Drainage defects represents a safety hazard to motorist	3	3
Repair and clean drainage holes	1 to 4	Drainage holes are blocked or inadequate (no evidence of water at holes). Water build up behind wall is not possible	1	1
		Drainage holes are blocked and water build up behind wall could render abutment unsafe with respect to stability against overturning and sliding.	3	3

Guardrails

These defects are applicable to the following inspection items:

- Bridge (General/Arch/Cable) Item 2 Guardrails
- Bridge (General/Arch/Cable) Item 12 Pier Protection Works
- Bridge(Cellular) Item 8 Guardrails
- Culvert (Major) Item 8 Guardrails
- Gantry Item 1 Guardrails

Activity Description	Range of "R"	Remarks	U	R
Align rails & tighten bolts	1	Some bolts attaching the guardrails to the posts or bolts joining guardrail lengths are loose and need to be tightened.	3	1

Road Structure Management Part A: Appendix A2

Activity Description	Range of "R"	Remarks	U	R
		Slight misalignment due to vehicular impact and guardrail needs to be re-aligned	2	1
Replace rails	2 to 4	Rail badly dented and/or bent	3	2
		Rail severed from post and therefore no longer performing its function, but not protruding into the oncoming traffic.	4	3
		Rail severed from post and therefore no longer performing its function and protruding into the oncoming traffic	4	4
Attach rail to end block	2 & 3	No danger of oncoming traffic to collide with the end block	2	2
		Danger of oncoming traffic to collide with the end block	3	3
Provide wood spacer blocks	2	Wood spacers are either damaged or missing	3	2
Reseal wood spacer blocks	1	Protective maintenance needed on wood spacer blocks	1	1
Replace broken posts	2 & 3	One post is broken at a location	3	2
		Two adjacent posts are broken at a location	4	2
		Three or more posts are broken at a location	4	3
Replace missing bolts	2	Some of the bolts are missing or damaged and need to be replaced	3	2

Surfacing

These defects are applicable to the following inspection items:

- Bridge (General/Arch/Cable) Item 8 Surfacing
- Road Tunnel Item 5 Road Surface

Activity Description	Range of "R"	Remarks	U	R
Resurface or patch surfacing on deck	1 to 3	The defects in the surfacing are not likely to cause an accident on the bridge/culvert	1	1
		The defects in the surfacing could cause an accident on the bridge/culvert	3	3

Waterway

These defects are applicable to the following inspection items:

- Bridge (General/Arch/Cable) Item 3 Waterway
- Bridge(Cellular) Item 5 Waterway

Road Structure Management Part A: Appendix A2

- Culvert (Major) Item 5 Waterway
- Culvert (Lesser) Item 4 Waterway

Activity Description	Range of "R"	Remarks	U	R
Clear waterway	1 to 4	Flood debris needs to be cleared from piers for fear of floods imposing excessive flood forces.	1	1
		Waterway is overgrown with vegetation	2	2
		Waterway has been reduced due to debris accumulation or build-up of sediment but overtopping will not occur	3	3
		Waterway has been severely reduced due to debris accumulation or built up of sediment which may cause overtopping of the structure.	4	4
Repair scour damage	2 to 4	Erosion and scour is unlikely to affect stability of an adjacent pier or abutment foundation.	3	2
		Erosion and scour is highly likely to cause collapse of an adjacent pier or abutment foundation.	4	4

Scour Protection

These defects are applicable to the following inspection items:

- Bridge (General/Arch/Cable) Item 12 Pier Protection Works
- Bridge (Cellular) Item 3 Scour Protection (in river)
- Culvert (Major) Item 3 Scour Protection (in river)

Activity Description	Range of "R"	Remarks	U	R
Renew/repair protection works (gabion boxes; stone pitching; etc.)	1 to 3	Minor damage to protection works caused by settlement, vegetation, vandalism etc...	1	1
		Portions of the protection works have been damaged, displaced or removed locally by floodwater	4	2
		Large portions of the protection works have been damaged, displaced or removed by floodwater	4	3

Miscellaneous Items

These defects are applicable to the following inspection items:

- Bridge (General/Arch/Cable) Item 21 Miscellaneous Items
- Bridge (Cellular) Item 14 Miscellaneous Items
- Culvert (Major) Item 14 Miscellaneous Items
- Retaining Wall Item 7 Miscellaneous Items
- Gantry Item 8 Miscellaneous Items

Road Structure Management Part A: Appendix A2

- Road Tunnel Item 9 Miscellaneous Items
- Light Mast Item 8 Miscellaneous Items

Activity Description	Range of "R"	Remarks	U	R
Cover slabs, manhole covers, lids, etc.	1 to 4	Smaller covers missing or broken, not creating a hazard	1	1
		Larger covers missing or broken, not creating a hazard	1	2
		Covers missing, creating a hazard for vehicles or pedestrians but not in direct path of vehicles or pedestrians	3	3
		Large covers missing, creating an immediate hazard for vehicles or pedestrians	4	4
Access chamber doors, gallery doors, access holes to deck soffit - missing or damaged:	1 to 4	Posing no danger, no access to an habitable area	1	1
		Potentially dangerous or posing a risk to the structure	3	3
		Dangerous, or people living inside structure and lighting fires, damaging the structure, etc.	4	4
People living in structure:	1 to 4	Small group of people with no erected structures	3	1
		Larger group of people with structures but not posing any risk	3	2
		Habitation causing obstructions or, fire or safety risk	4	3
		Dense habitation creating a high fire or safety risk	4	4
Missing vertical clearance signs:	1 to 4	No signs with vertical clearance less than 5.0 m	1	1
		No signs with vertical clearance less than 4.9 m	1	2
		No signs with vertical clearance less than 4.8 m	3	3
		No signs with vertical clearance less than 4.8 m with beam-and-slab deck	3	4
Road signs – missing or damaged:	1 to 4	River name, information signs	1	1
		Warning signs, hazard signs but not posing a safety risk	1	3
		Warning signs, hazard signs posing a safety risk	4	4
Services and street lighting:	1 to 4	Services not attached properly, missing cover plates but not posing a risk	3	1
		Missing cover plates exposing wiring, damaged lighting posing some difficulty to pedestrians, etc.	3	2

Road Structure Management Part A: Appendix A2

Activity Description	Range of "R"	Remarks	U	R
		Exposed live wires, leaking sewerage, etc.	4	4
Fencing – missing or damaged:	1 to 4	Small holes, posing no danger	1	1
		Posing a significant danger such as livestock getting onto the road or pedestrians crossing an extremely busy road	4	4
Structure number plate:	2	Damaged structure number plate	1	2
		Missing structure number plate	1	2
Animal infestation including bats, bees, wasps, snakes, etc.	1 to 3	Slight infestation, not posing a risk to people or the structure	3	1
		Dangerous infestation or causing damage to the structure such as guano causing corrosion	3	3

Appendix A3. Inspection Forms per Structure Type

Road Structure Management Part A: Appendix A3

Inspection Form B1: Bridge (General)

ROAD AUTHORITY		STRUCTURE TYPE		BRIDGE NUMBER				LOCATION SKETCH																				
		BRIDGE - GENERAL																										
				BRIDGE NAME																								
INSPECTION INFORMATION																												
Inspection Type		Inspector Name				Firm		Date (dd/mm/yyyy)																				
GPS COORDINATES - START																												
Latitude (South)						Longitude (East)																						
DD		MM		SS.s		DD		MM		SS.s																		
GPS COORDINATES - END																												
Latitude (South)						Longitude (East)																						
DD		MM		SS.s		DD		MM		SS.s																		
VERTICAL CLEARANCES (road-over-road bridges only)																												
Position/Span No																												
Min height (m)																												
LOCATION DETAIL																												
Road No.		Road km		Road Name		Feature Crossed		Feature Name/Road No.		Region/Depot																		
STRUCTURE INFORMATION																												
No. of Spans		Structure Orientation				Overall Length		Overall Width		Year Constructed		Bridge Type																
INSPECTION RATINGS																												
INSPECTION ITEM	1. APPROACH EMBANKMENT			2. GUARDRAIL			3. WATERWAY			4. APPROACH EMB. PROT. WORKS			5. ABUTMENT FOUNDATIONS			6. ABUTMENTS			7. WING / RETAINING WALLS			8. SURFACING			9. SUPER-STRUCT. DRAINAGE			
POSITION	D	E	R	D	E	R	D	E	R	D	E	R	D	E	R	D	E	R	D	E	R	D	E	R	D	E	R	
Abut																												
Abut																												
INSPECTION ITEM	10. KERBS / SIDEWALKS			11. PARAPET / HANDRAIL			21. MISC. ITEMS																					
	D	E	R	D	E	R	D	E	R																			
INSPECTION ITEM	12. PIER PROTECTION WORKS			13. PIER FOUNDATIONS			14. PIERS & COLUMNS			15. BEARINGS			16. SUPPORT DRAINAGE			17. EXPANSION JOINTS			INSPECTION ITEM	18. LONGITUDINAL MEMBER			19. TRANSVERSAL MEMBERS			20. DECK SLAB		
POSITION	D	E	R	D	E	R	D	E	R	D	E	R	D	E	R	D	E	R	POSITION	D	E	R	D	E	R	D	E	R
Abut																			Span									
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Road Structure Management Part A: Appendix A3

Inspection Form B2: Bridge (Arch)

ROAD AUTHORITY		STRUCTURE TYPE						BRIDGE NUMBER						LOCATION SKETCH																
		<div>BRIDGE - ARCH</div>																												
																								BRIDGE NAME						
INSPECTION INFORMATION																														
Inspection Type		Inspector Name				Firm		Date (dd/mm/yyyy)																						
GPS COORDINATES - START																														
Latitude (South)						Longitude (East)																								
DD		MM		SS.s		DD		MM		SS.s																				
GPS COORDINATES - END																														
Latitude (South)						Longitude (East)																								
DD		MM		SS.s		DD		MM		SS.s																				
VERTICAL CLEARANCES (road-over-road bridges only)																														
Position/Span No																														
Min height (m)																														
LOCATION DETAIL																														
Road No.		Road km		Road Name				Feature Crossed				Feature Name/Road No.				Region/Depot														
STRUCTURE INFORMATION																														
No. of Spans		No of Arches		Structure Orientation				Overall Length				Overall Width				Year Constructed		Bridge Type												
INSPECTION RATINGS																														
INSPECTION ITEM		1. APPROACH EMBANKMENT			2. GUARDRAIL			3. WATERWAY			4. APPROACH EMB. PROT WORKS			5. ABUTMENT FOUNDATIONS			6. ABUTMENTS			7. WING / RETAINING WALLS			8. SURFACING			9. SUPER-STRUCTURE DRAINAGE				
POSITION		D	E	R	D	E	R	D	E	R	D	E	R	D	E	R	D	E	R	D	E	R	D	E	R	D	E	R		
Abut																														
Abut																														
INSPECTION ITEM		10. KERBS / SIDEWALKS			11. PARAPET / HANDRAIL			21. MISC. ITEMS																						
		D	E	R	D	E	R	D	E	R																				
INSPECTION ITEM		12. PIER/SPRINGING PROTECTION WORKS			13. PIER/SPRINGING FOUNDATIONS			14. PIERS & COLUMNS / SPRINGINGS			15. BEARINGS			16. SUPPORT DRAINAGE			17. EXPANSION JOINTS			INSPECTION ITEM		18. LONGITUDINAL MEMBER			19. TRANSVERSAL MEMBERS			20. DECK SLAB		
POSITION		D	E	R	D	E	R	D	E	R	D	E	R	D	E	R	POSITION		D	E	R	D	E	R	D	E	R			
Abut																		Span												
Abut																		Span												
Pier																		Span												
Pier																		Span												
Pier																		Span												
Pier																		Span												
Springing																		Arch												
Springing																		Arch												
ITEM	POSITION	ACTIVITY CODE or DESCRIPTION									QTY	Unit	U	Make safe	REMARKS						Rpt. Photo	Mon freq								
Inspector's assessment and further comments:																														

Road Structure Management Part A: Appendix A3

Inspection Form B3: Bridge (Cable)

[illegible]

Road Structure Management Part A: Appendix A3

Inspection Form B4: Bridge (Cellular)[illegible]

Road Structure Management Part A: Appendix A3

Inspection Form C1: Culvert (Major)

ROAD AUTHORITY							STRUCTURE TYPE						CULVERT NUMBER								LOCATION SKETCH								
							CULVERT - MAJOR																						
													CULVERT NAME																
INSPECTION INFORMATION																													
Inspection Type				Inspector Name					Firm				Date (dd/mm/yyyy)																
GPS COORDINATES - START																													
Latitude (South)								Longitude (East)																					
DD		MM		SS.s				DD		MM		SS.s																	
GPS COORDINATES - END																													
Latitude (South)								Longitude (East)																					
DD		MM		SS.s				DD		MM		SS.s																	
LOCATION DETAIL																													
Road No.				Road km				Road Name				Feature Crossed				Feature Name				Region/Depot									
STRUCTURE INFORMATION																													
No. of Cells			Cell Orientation					Overall Length				Overall Width				Year Constructed				Culvert Type									
INSPECTION RATINGS																													
INSPECTION ITEM		1. APRON SLABS & CUT OFF WALLS				2. WING / RET / HEAD WALLS				3. SCOUR PROT. WORKS (IN RIVER)				4. EMBANKMENTS															
POSITION		D	E	R	D	E	R	D	E	R	D	E	R	D	E	R													
Emb																													
Emb																													
INSPECTION ITEM		5. WATERWAY				6. ROAD SLABS				7. ROADWAY JOINTS				8. GUARDRAILS				9. PARAPETS / HANDRAILS				14. MISC-ELLANEOUS ITEMS							
		D	E	R	D	E	R	D	E	R	D	E	R	D	E	R	D	E	R	D	E	R							
INSPECTION ITEM		10. WALLS				11. TOP SLAB				12. INVERT SLAB/ FOUNDATIONS				13. CELL DISPLACE-MENT															
POSITION		D	E	R	D	E	R	D	E	R	D	E	R	D	E	R													
Cell																													
Cell																													
Cell																													
Cell																													
Cell																													
Cell																													
Cell																													
Cell																													
ITEM	POSITION	ACTIVITY CODE or DESCRIPTION								QTY	Unit	U	Make safe	REMARKS						Rpt. Photo	Mon freq								
Inspector's assessment of structure condition and further comments:																													
Further inspection needed ? Y/N																			Requirements for further inspection:										
D - DEGREE							E - EXTENT				R - RELEVANCY				U - URGENCY														
Not Applicable	Unable to inspect	None	Minor	Moderate	Warning	Severe	Local	More than local	Less than general	General	Min	Moderate	Major	Critical	Record only	Monitor only	Routine	< 10 yrs	< 5 yrs	ASAP									
X	U	0	1	2	3	4	1	2	3	4	1	2	3	4	R	0	1	2	3	4									

Road Structure Management Part A: Appendix A3

Inspection Form C2: Culvert (Lesser)

[illegible]

Road Structure Management Part A: Appendix A3

Inspection Form R1: Retaining Wall

[illegible]

Road Structure Management Part A: Appendix A3

Inspection Form G1: Gantry

[illegible]

Road Structure Management Part A: Appendix A3

Inspection Form T1: Road Tunnel

[illegible]

Road Structure Management Part A: Appendix A3

Inspection Form L1: Light Mast

[illegible]

Inspection Form W1: Waterway Inspection

ROAD AUTHORITY		STRUCTURE TYPE		STRUCTURE NUMBER		No. of OPENINGS		LOCATION SKETCH											
INSPECTION INFORMATION																			
Inspection Type		Inspector Name		Firm		Date (dd/mm/yyyy)													
Waterway Inspection																			
GPS COORDINATES - START																			
Longitude (East)					Latitude (South)														
DD		MM		SS.s		DD										MM		SS.s	
GPS COORDINATES - END																			
Longitude (East)					Latitude (South)														
DD		MM		SS.s		DD		MM		SS.s									
LOCATION DETAIL																			
Road No.		Road km		Road Name		Feature Crossed		Feature Name		Region/Depot									
INSPECTION RATINGS																			
Inspection Item		Waterway Upstream					Waterway Downstream					Number of Openings with a							
		D rating					D rating					D rating of							
Defect		0	1	2	3	4	0	1	2	3	4	0	1	2	3	4			
Siltation																			
Scouring																			
Debris																			
Vegetation																			
Erosion																			
Environmental issues																			
ACTIONS REQUIRED																			
Position		Description of required action																	
Photos																			
Structure in Elevation		Photo Number																	
Upstream view of feature crossed		Photo Number																	
Photos of serious defects																			
Position		Description										Photo Number							
Inspector's comments:																			
DESCRIPTION OF D - DEGREE RATING																			
None		Minor		Moderate		Warning		Severe											
0		1		2		3		4											

Appendix A4. Remedial Activities per Structure Type

Remedial Activities for Bridges (General, Arch, Cable)

Act. ID	Activity Description	Unit	Unit Cost (2013 Rand Value)	Routine Maintenance
01. APPROACH EMBANKMENT				
116	Repair concrete sidedrain/gutter/downchute	m	500	Yes
155	Earth backfill	m3	200	Yes
156	Gabion (mattresses and boxes)	m3	1 000	Yes
157	Mass concrete backfill	m3	1 800	
158	Rock backfill	m3	600	
201	Clean downchutes/sidedrains	m	50	Yes
357	Replace kerbs or berms	m	200	Yes
358	Replace cover slabs and lids	No	500	Yes
359	Replace sidedrain/gutter/downchutes	m	500	Yes
362	Replace inlet/outlet structures	No	3 000	Yes
363	Install kerbs or berms	m	200	Yes
402	Clear bush	m2	40	Yes
404	Remove trees (girth < 500 mm)	No	200	Yes
405	Remove trees (girth > 500 mm)	No	500	Yes
504	Repair settlement (asphalt fill)	m3	3 500	Yes
953	Ad-hoc item (describe under Remarks)	No	1 000	
02. GUARDRAIL				
451	Attach guardrail to endblock	No	300	Yes
452	Cut bolts for pedestrian safety	No	50	Yes
455	New guardrail (single and double)	m	300	Yes
463	Repair guardrail (realign, bolt replacement, etc.)	m	100	Yes
466	Replace bolts and washers	No	20	Yes
467	Replace posts (steel or timber)	No	200	Yes
468	Replace reflectors	No	50	Yes
469	Reverse laps in guardrails	No	100	Yes
953	Ad-hoc item (describe under Remarks)	No	1 000	
03. WATERWAY				
151	Backfill scour damage (earth)	m3	200	Yes
152	Backfill scour damage (mass concrete)	m3	1 800	
153	Backfill scour damage (rock)	m3	600	
156	Gabion (mattresses and boxes)	m3	1 000	Yes
207	Clear debris	m3	100	Yes
209	Clear siltation	m3	100	Yes
404	Remove trees (girth < 500 mm)	No	200	Yes
405	Remove trees (girth > 500 mm)	No	500	Yes
953	Ad-hoc item (describe under Remarks)	No	1 000	

Road Structure Management Part A: Appendix A4

Act. ID	Activity Description	Unit	Unit Cost (2013 Rand Value)	Routine Maintenance
04. APPROACH EMBANKMENT PROTECTION WORKS				
155	Earth backfill	m3	200	Yes
156	Gabion (mattresses and boxes)	m3	1 000	Yes
157	Mass concrete backfill	m3	1 800	
158	Rock backfill	m3	600	
159	Stone pitching	m2	300	Yes
160	Interlocking blocks	m2	300	Yes
401	Apply weed killer/ant poison and remove growth	m2	30	Yes
403	Grassing	m2	30	Yes
953	Ad-hoc item (describe under Remarks)	No	1 000	
05. ABUTMENT FOUNDATIONS				
101	Apply protective coating	m2	200	
102	Apply silanes	m2	150	
106	Construct earth berms for access	m3	400	
108	Cut back reinforcement (tie rods) and make good	No	50	
118	Repair spall (including honeycombing)	L	100	
120	Seal cracks	m	200	
155	Earth backfill	m3	200	Yes
156	Gabion (mattresses and boxes)	m3	1 000	Yes
157	Mass concrete backfill	m3	1 800	
158	Rock backfill	m3	600	
161	Underpinning (describe under Remarks)	No	10 000	
953	Ad-hoc item (describe under Remarks)	No	1 000	
06. ABUTMENTS				
101	Apply protective coating	m2	200	
102	Apply silanes	m2	150	
103	Clean concrete surface	m2	50	
104	Concrete (reinforced)	m3	4 000	
105	Concrete (mass)	m3	4 000	
108	Cut back reinforcement (tie rods) and make good	No	50	
114	Reconstruct backwall (re-instate gap)	m3	10 000	
115	Repair ground/rock anchor heads	No	6 000	
118	Repair spall (including honeycombing)	L	100	
120	Seal cracks	m	200	
122	Stabilise wall with ground/rock anchors	m2	1 000	
154	Construct masonry wall	m2	1 000	
202	Clean drainage	m	50	Yes
207	Clear debris	m3	100	Yes
309	Reinstate expansion gap	m	5 000	
311	Remove/repair cladding/bearing protection plates	m	100	Yes
314	Replace joint sealant	m	100	Yes

Road Structure Management Part A: Appendix A4

Act. ID	Activity Description	Unit	Unit Cost (2013 Rand Value)	Routine Maintenance
355	Repair weep holes	No	150	
618	Service and repair gallery doors/manholes	No	1 500	Yes
653	Access-using scaffold (> 10 m)	No	1 000	
654	Access-using scaffold (< 10 m)	No	500	
702	Traffic accommodation-Low (< 10 000 vpd)	LS	90 000	
703	Traffic accommodation-Medium (10 000 - 40 000 vpd)	LS	110 000	
704	Traffic accommodation-High (> 40 000 vpd)	LS	140 000	
953	Ad-hoc item (describe under Remarks)	No	1 000	
07. WING/RETAINING WALLS				
101	Apply protective coating	m2	200	
102	Apply silanes	m2	150	
103	Clean concrete surface	m2	50	
104	Concrete (reinforced)	m3	4 000	
105	Concrete (mass)	m3	4 000	
108	Cut back reinforcement (tie rods) and make good	No	50	
118	Repair spall (including honeycombing)	L	100	
120	Seal cracks	m	200	
122	Stabilise wall with ground/rock anchors	m2	1 000	
155	Earth backfill	m3	200	Yes
156	Gabion (mattresses and boxes)	m3	1 000	Yes
157	Mass concrete backfill	m3	1 800	
158	Rock backfill	m3	600	
161	Underpinning (describe under Remarks)	No	10 000	
207	Clear debris	m3	100	Yes
309	Reinstate expansion gap	m	5 000	
314	Replace joint sealant	m	100	Yes
355	Repair weep holes	No	150	
607	Monitor (movements, rotations, etc.) (5 year period)	No	10 000	
653	Access-using scaffold (> 10 m)	No	1 000	
654	Access-using scaffold (< 10 m)	No	500	
702	Traffic accommodation-Low (< 10 000 vpd)	LS	90 000	
703	Traffic accommodation-Medium (10 000 - 40 000 vpd)	LS	110 000	
704	Traffic accommodation-High (> 40 000 vpd)	LS	140 000	
953	Ad-hoc item (describe under Remarks)	No	1 000	
08. SURFACING				
117	Repair concrete topping	m3	2 500	
207	Clear debris	m3	100	Yes
209	Clear siltation	m3	100	Yes
501	Crack seal (asphalt)	m	20	Yes
502	Resurface or patch	m2	300	Yes
505	Shape surfacing at scuppers	No	300	Yes

Road Structure Management Part A: Appendix A4

Act. ID	Activity Description	Unit	Unit Cost (2013 Rand Value)	Routine Maintenance
702	Traffic accommodation-Low (< 10 000 vpd)	LS	90 000	
703	Traffic accommodation-Medium (10 000 - 40 000 vpd)	LS	110 000	
704	Traffic accommodation-High (> 40 000 vpd)	LS	140 000	
953	Ad-hoc item (describe under Remarks)	No	1 000	
	09. SUPERSTRUCTURE DRAINAGE			
206	Clear channel	m	50	Yes
208	Clear scuppers	No	50	
351	Construct new scuppers	No	500	
353	Extend scupper below deck soffit	No	300	
354	Repair scuppers	No	200	
361	Replace grid inlet	No	400	
365	Seal leaking pipes	No	250	
653	Access-using scaffold (> 10 m)	No	1 000	
654	Access-using scaffold (< 10 m)	No	500	
702	Traffic accommodation-Low (< 10 000 vpd)	LS	90 000	
703	Traffic accommodation-Medium (10 000 - 40 000 vpd)	LS	110 000	
704	Traffic accommodation-High (> 40 000 vpd)	LS	140 000	
953	Ad-hoc item (describe under Remarks)	No	1 000	
	10. KERBS AND SIDEWALKS			
101	Apply protective coating	m2	200	
102	Apply silanes	m2	150	
118	Repair spall (including honeycombing)	L	100	
120	Seal cracks	m	200	
207	Clear debris	m3	100	Yes
314	Replace joint sealant	m	100	Yes
357	Replace kerbs or berms	m	200	Yes
363	Install kerbs or berms	m	200	Yes
366	Install/replace concrete channel	m	150	
568	Replace service duct cover	No	200	
609	Provide sidewalk	m2	500	Yes
614	Repair sidewalk surface (blocks, screed etc.)	m2	300	Yes
702	Traffic accommodation-Low (< 10 000 vpd)	LS	90 000	
703	Traffic accommodation-Medium (10 000 - 40 000 vpd)	LS	110 000	
704	Traffic accommodation-High (> 40 000 vpd)	LS	140 000	
953	Ad-hoc item (describe under Remarks)	No	1 000	
	11. PARAPET			
101	Apply protective coating	m2	200	
102	Apply silanes	m2	150	
103	Clean concrete surface	m2	50	
104	Concrete (reinforced)	m3	4 000	

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Act. ID	Activity Description	Unit	Unit Cost (2013 Rand Value)	Routine Maintenance
113	Concrete (precast)	m3	6 000	
118	Repair spall (including honeycombing)	L	100	
120	Seal cracks	m	200	
309	Reinstate expansion gap	m	5 000	
314	Replace joint sealant	m	100	Yes
453	Install full height pedestrian balustrade	m	2 000	
454	New endblocks	No	8 000	
456	New pedestrian parapet	m	3 300	
457	New traffic barrier (Concrete F-Shape/NJ)	m	5 000	
458	New/repair steel railing	m	1 200	
459	Paint steel rails	m2	300	
462	Realign handrails	m	100	
464	Repair/replace guardrail fixings	No	200	Yes
465	Repair/replace handrail posts	No	750	
568	Replace service duct cover	No	200	
651	Access-using hanging basket for outer surface	No	5 000	
702	Traffic accommodation-Low (< 10 000 vpd)	LS	90 000	
703	Traffic accommodation-Medium (10 000 - 40 000 vpd)	LS	110 000	
704	Traffic accommodation-High (> 40 000 vpd)	LS	140 000	
953	Ad-hoc item (describe under Remarks)	No	1 000	
	12. PIER PROTECTION WORKS			
156	Gabion (mattresses and boxes)	m3	1 000	Yes
157	Mass concrete backfill	m3	1 800	
158	Rock backfill	m3	600	
460	Provide guardrail protection	m	300	Yes
461	Provide F-shape NJ barrier protection	m	5 000	
702	Traffic accommodation-Low (< 10 000 vpd)	LS	90 000	
703	Traffic accommodation-Medium (10 000 - 40 000 vpd)	LS	110 000	
704	Traffic accommodation-High (> 40 000 vpd)	LS	140 000	
953	Ad-hoc item (describe under Remarks)	No	1 000	
	13. PIER FOUNDATIONS			
101	Apply protective coating	m2	200	
102	Apply silanes	m2	150	
104	Concrete (reinforced)	m3	4 000	
105	Concrete (mass)	m3	4 000	
106	Construct earth berms for access	m3	400	
118	Repair spall (including honeycombing)	L	100	
120	Seal cracks	m	200	
155	Earth backfill	m3	200	Yes
156	Gabion (mattresses and boxes)	m3	1 000	Yes
157	Mass concrete backfill	m3	1 800	

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Act. ID	Activity Description	Unit	Unit Cost (2013 Rand Value)	Routine Maintenance
158	Rock backfill	m3	600	
161	Underpinning (describe under Remarks)	No	10 000	
702	Traffic accommodation-Low (< 10 000 vpd)	LS	90 000	
703	Traffic accommodation-Medium (10 000 - 40 000 vpd)	LS	110 000	
704	Traffic accommodation-High (> 40 000 vpd)	LS	140 000	
953	Ad-hoc item (describe under Remarks)	No	1 000	
	14. PIERS AND COLUMNS			
101	Apply protective coating	m2	200	
102	Apply silanes	m2	150	
103	Clean concrete surface	m2	50	
104	Concrete (reinforced)	m3	4 000	
108	Cut back reinforcement (tie rods) and make good	No	50	
118	Repair spall (including honeycombing)	L	100	
120	Seal cracks	m	200	
207	Clear debris	m3	100	Yes
310	Remove cladding - bearing plates	m	30	Yes
653	Access-using scaffold (> 10 m)	No	1 000	
654	Access-using scaffold (< 10 m)	No	500	
702	Traffic accommodation-Low (< 10 000 vpd)	LS	90 000	
703	Traffic accommodation-Medium (10 000 - 40 000 vpd)	LS	110 000	
704	Traffic accommodation-High (> 40 000 vpd)	LS	140 000	
953	Ad-hoc item (describe under Remarks)	No	1 000	
	15. BEARINGS			
251	Jacking - complicated (provide jack support work)	No	20 000	
252	Jacking - simple (flat jacks)	No	10 000	
253	Refurbish (corrosion protection, anchor bolts, etc.)	No	3 000	
254	Repair bearing plinth	No	500	
255	Replace - elastomeric	No	2 000	
256	Replace - mechanical	No	30 000	
257	Re-seat	No	1 000	
258	Service bearing (clear obstructions, etc.)	No	500	Yes
653	Access-using scaffold (> 10 m)	No	1 000	
654	Access-using scaffold (< 10 m)	No	500	
702	Traffic accommodation-Low (< 10 000 vpd)	LS	90 000	
703	Traffic accommodation-Medium (10 000 - 40 000 vpd)	LS	110 000	
704	Traffic accommodation-High (> 40 000 vpd)	LS	140 000	
953	Ad-hoc item (describe under Remarks)	No	1 000	
	16. SUPPORT DRAINAGE			
205	Clear blocked drainage	No	50	Yes
360	Replace drainage	m	100	

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Act. ID	Activity Description	Unit	Unit Cost (2013 Rand Value)	Routine Maintenance
953	Ad-hoc item (describe under Remarks)	No	1 000	
	17. EXPANSION JOINTS			
203	Clean joint of loose material	m	50	
301	Install silicon/bituminous seal	m	200	
302	Joint cover plates (replace and refit)	No	1 400	
304	New 40mm claw	m	4 000	
305	New 80mm claw	m	6 000	
306	New asphalt plug joint	m	3 000	
307	New multi element joint	m	30 000	
308	Refurbish (paint, etc.) metal claw/rail	m	100	
312	Repair concrete at joint up-turns	L	200	
313	Repair concrete nosing	m	2 000	
315	Replace glands of claw joint	m	800	
316	Replace pressfit seal with silicone	m	500	
317	Service multi-element joint	m	2 000	
602	Bolts to cover plates	No	100	Yes
702	Traffic accommodation-Low (< 10 000 vpd)	LS	90 000	
703	Traffic accommodation-Medium (10 000 - 40 000 vpd)	LS	110 000	
704	Traffic accommodation-High (> 40 000 vpd)	LS	140 000	
953	Ad-hoc item (describe under Remarks)	No	1 000	
	18. LONGITUDINAL MEMBERS			
101	Apply protective coating	m2	200	
102	Apply silanes	m2	150	
103	Clean concrete surface	m2	50	
104	Concrete (reinforced)	m3	4 000	
108	Cut back reinforcement (tie rods) and make good	No	50	
110	Jacking - complicated (provide jack support work)	No	6 000	
111	Jacking - simple (flat jacks)	No	3 000	
118	Repair spall (including honeycombing)	L	100	
120	Seal cracks	m	200	
123	Strengthening (using plates, carbon fibre, etc.)	m2	10 000	
352	Drill drainage holes	No	50	
520	Cable anchorage refurbishment for cables up to 100 mm diameter	No	10 000	
521	Cable anchorage refurbishment for cables 100 mm to 200 mm diameter	No	12 000	
522	Cable anchorage refurbishment for cables greater than 200 mm diameter	No	20 000	
523	Cable replacement up to 100 mm diameter	m	5 000	
524	Cable replacement 100 mm to 200 mm diameter	m	10 000	
525	Cable replacement greater than 200 mm diameter	m	15 000	

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Act. ID	Activity Description	Unit	Unit Cost (2013 Rand Value)	Routine Maintenance
526	Access to pylon head for repair (crane or other means)	Sum	50 000	
527	Install anti-vandalism tubes to cables	No	25 000	
528	Additional (corrosion) protection for cables (painting, wrapping or sheathing a cable)	m	10 000	
553	Corrosion protection to steel cables	m	300	
576	Structural steel - re-torque bolts	No	50	Yes
653	Access-using scaffold (> 10 m)	No	1 000	
654	Access-using scaffold (< 10 m)	No	500	
702	Traffic accommodation-Low (< 10 000 vpd)	LS	90 000	
703	Traffic accommodation-Medium (10 000 - 40 000 vpd)	LS	110 000	
704	Traffic accommodation-High (> 40 000 vpd)	LS	140 000	
953	Ad-hoc item (describe under Remarks)	No	1 000	
19. TRANSVERSE MEMBERS				
101	Apply protective coating	m2	200	
102	Apply silanes	m2	150	
103	Clean concrete surface	m2	50	
104	Concrete (reinforced)	m3	4 000	
108	Cut back reinforcement (tie rods) and make good	No	50	
110	Jacking - complicated (provide jack support work)	No	6 000	
111	Jacking - simple (flat jacks)	No	3 000	
118	Repair spall (including honeycombing)	L	100	
120	Seal cracks	m	200	
123	Strengthening (using plates, carbon fibre, etc.)	m2	10 000	
352	Drill drainage holes	No	50	
553	Corrosion protection to steel cables	m	300	
653	Access-using scaffold (> 10 m)	No	1 000	
654	Access-using scaffold (< 10 m)	No	500	
702	Traffic accommodation-Low (< 10 000 vpd)	LS	90 000	
703	Traffic accommodation-Medium (10 000 - 40 000 vpd)	LS	110 000	
704	Traffic accommodation-High (> 40 000 vpd)	LS	140 000	
953	Ad-hoc item (describe under Remarks)	No	1 000	
20. DECKS AND SLABS				
101	Apply protective coating	m2	200	
102	Apply silanes	m2	150	
103	Clean concrete surface	m2	50	
104	Concrete (reinforced)	m3	4 000	
108	Cut back reinforcement (tie rods) and make good	No	50	
110	Jacking - complicated (provide jack support work)	No	6 000	
111	Jacking - simple (flat jacks)	No	3 000	
118	Repair spall (including honeycombing)	L	100	
120	Seal cracks	m	200	

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Act. ID	Activity Description	Unit	Unit Cost (2013 Rand Value)	Routine Maintenance
123	Strengthening (using plates, carbon fibre, etc.)	m2	10 000	
125	Waterproofing of top surface	m2	1 000	
207	Clear debris	m3	100	Yes
352	Drill drainage holes	No	50	
551	Paint steelwork	m2	300	
553	Corrosion protection to steel cables	m	300	
556	Structural steel - remove all rivets and replace with bolts	No	300	
557	Structural steel - remove all rivets and replace	No	300	
558	Structural steel - replace bolts, washers etc.	No	50	Yes
559	Replace structural steel member	t	30 000	
577	Structural steel - sand blast to white metal	m2	200	
578	Strengthen structural steel member	t	30 000	
653	Access-using scaffold (> 10 m)	No	1 000	
654	Access-using scaffold (< 10 m)	No	500	
702	Traffic accommodation-Low (< 10 000 vpd)	LS	90 000	
703	Traffic accommodation-Medium (10 000 - 40 000 vpd)	LS	110 000	
704	Traffic accommodation-High (> 40 000 vpd)	LS	140 000	
953	Ad-hoc item (describe under Remarks)	No	1 000	
	21. MISCELLANEOUS ITEMS			
119	Repair support plinths	L	50	
554	Corrosion protection to masts	m2	1 000	
570	Replace cover plates on street lights	No	300	
601	Bolts (miscellaneous)	No	50	Yes
604	Install vertical clearance sign	No	1 000	Yes
606	Install fencing	m	600	Yes
610	Rebuild/repair access chamber	No	6 000	Yes
612	Remove people using structure as habitat	LS	30 000	Yes
613	Repair service hangers (lighting etc.)	No	4 000	
615	Repair sign gantries	No	30 000	
616	Repair signpost connections	No	300	Yes
617	Replace road signs	m2	1 600	Yes
619	Service structure lights	No	150	Yes
620	Install structure number plate	No	1 000	
953	Ad-hoc item (describe under Remarks)	No	1 000	

Remedial Activities for Bridge (Cellular) and Culvert (Major)

Act. ID	Activity Description	Unit	Unit Cost (2013 Rand Value)	Routine Maintenance
01. APRON SLABS AND CUT-OFF WALLS				
101	Apply protective coating	m2	200	
102	Apply silanes	m2	150	
104	Concrete (reinforced)	m3	4 000	
105	Concrete (mass)	m3	4 000	
108	Cut back reinforcement (tie rods) and make good	No	50	
118	Repair spall (including honeycombing)	L	100	
120	Seal cracks	m	200	
155	Earth backfill	m3	200	Yes
156	Gabion (mattresses and boxes)	m3	1 000	Yes
157	Mass concrete backfill	m3	1 800	
158	Rock backfill	m3	600	
207	Clear debris	m3	100	Yes
953	Ad-hoc item (describe under Remarks)	No	1 000	
02. WING / RETURN / HEAD WALLS				
101	Apply protective coating	m2	200	
102	Apply silanes	m2	150	
103	Clean concrete surface	m2	50	
104	Concrete (reinforced)	m3	4 000	
105	Concrete (mass)	m3	4 000	
108	Cut back reinforcement (tie rods) and make good	No	50	
118	Repair spall (including honeycombing)	L	100	
120	Seal cracks	m	200	
122	Stabilise wall with ground/rock anchors	m2	1 000	
155	Earth backfill	m3	200	Yes
156	Gabion (mattresses and boxes)	m3	1 000	Yes
157	Mass concrete backfill	m3	1 800	
158	Rock backfill	m3	600	
161	Underpinning (describe under Remarks)	No	10 000	
207	Clear debris	m3	100	Yes
303	Monitor (movements, rotations, etc.) (5 year period)	No	10 000	
355	Repair weep holes	No	150	
953	Ad-hoc item (describe under Remarks)	No	1 000	
03. SCOUR PROTECTION WORKS				
104	Concrete (reinforced)	m3	4 000	
105	Concrete (mass)	m3	4 000	
156	Gabion (mattresses and boxes)	m3	1 000	Yes
157	Mass concrete backfill	m3	1 800	
158	Rock backfill	m3	600	

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Act. ID	Activity Description	Unit	Unit Cost (2013 Rand Value)	Routine Maintenance
953	Ad-hoc item (describe under Remarks)	No	1 000	
	04. EMBANKMENTS			
116	Repair concrete sidedrain/gutter/downchute	m	500	Yes
155	Earth backfill	m3	200	Yes
156	Gabion (mattresses and boxes)	m3	1 000	Yes
157	Mass concrete backfill	m3	1 800	
158	Rock backfill	m3	600	
159	Stone pitching	m2	300	Yes
160	Interlocking blocks	m2	300	Yes
201	Clean downchutes/sidedrains	m	50	Yes
357	Replace kerbs or berms	m	200	Yes
358	Replace cover slabs and lids	No	500	Yes
359	Replace sidedrain/gutter/downchutes	m	500	Yes
362	Replace inlet/outlet structures	No	3 000	Yes
363	Install kerbs or berms	m	200	Yes
401	Apply weed killer/ant poison and remove growth	m2	30	Yes
402	Clear bush	m2	40	Yes
403	Grassing	m2	30	Yes
404	Remove trees (girth < 500 mm)	No	200	Yes
405	Remove trees (girth > 500 mm)	No	500	Yes
504	Repair settlement (asphalt fill)	m3	3 500	Yes
953	Ad-hoc item (describe under Remarks)	No	1 000	
	05. WATERWAY			
151	Backfill scour damage (earth)	m3	200	Yes
152	Backfill scour damage (mass concrete)	m3	1 800	
153	Backfill scour damage (rock)	m3	600	
156	Gabion (mattresses and boxes)	m3	1 000	Yes
207	Clear debris	m3	100	Yes
209	Clear siltation	m3	100	Yes
404	Remove trees (girth < 500 mm)	No	200	Yes
405	Remove trees (girth > 500 mm)	No	500	Yes
953	Ad-hoc item (describe under Remarks)	No	1 000	
	06. ROAD SLABS			
101	Apply protective coating	m2	200	
102	Apply silanes	m2	150	
104	Concrete (reinforced)	m3	4 000	
105	Concrete (mass)	m3	4 000	
117	Repair concrete topping	m3	2 500	
118	Repair spall (including honeycombing)	L	100	
120	Seal cracks	m	200	
155	Earth backfill	m3	200	Yes

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Act. ID	Activity Description	Unit	Unit Cost (2013 Rand Value)	Routine Maintenance
157	Mass concrete backfill	m3	1 800	
158	Rock backfill	m3	600	
207	Clear debris	m3	100	Yes
501	Crack seal (asphalt)	m	20	Yes
503	Resurface or patch asphalt	m2	300	Yes
702	Traffic accommodation-Low (< 10 000 vpd)	LS	90 000	
703	Traffic accommodation-Medium (10 000 - 40 000 vpd)	LS	110 000	
704	Traffic accommodation-High (> 40 000 vpd)	LS	140 000	
953	Ad-hoc item (describe under Remarks)	No	1 000	
07. ROAD WAY JOINTS				
203	Clean joint of loose material	m	50	
207	Clear debris	m3	100	Yes
301	Install silicon/bituminous seal	m	200	
302	Joint cover plates (replace and refit)	No	1 400	
303	Monitor (movements, rotations, etc.) (5 year period)	No	10 000	
306	New asphaltic plug joint	m	3 000	
312	Repair concrete at joint up-turns	L	200	
316	Replace pressfit seal with silicone	m	500	
602	Bolts to cover plates	No	100	Yes
702	Traffic accommodation-Low (< 10 000 vpd)	LS	90 000	
703	Traffic accommodation-Medium (10 000 - 40 000 vpd)	LS	110 000	
704	Traffic accommodation-High (> 40 000 vpd)	LS	140 000	
953	Ad-hoc item (describe under Remarks)	No	1 000	
08. GUARDRAILS				
451	Attach guardrail to endblock	No	300	Yes
452	Cut bolts for pedestrian safety	No	50	Yes
455	New guardrail (single and double)	m	300	Yes
463	Repair guardrail (realign, bolt replacement, etc.)	m	100	Yes
466	Replace bolts and washers	No	20	Yes
467	Replace posts (steel or timber)	No	200	Yes
468	Replace reflectors	No	50	Yes
469	Reverse laps in guardrails	No	100	Yes
953	Ad-hoc item (describe under Remarks)	No	1 000	
09. PARAPETS/HANDRAILS				
101	Apply protective coating	m2	200	
102	Apply silanes	m2	150	
103	Clean concrete surface	m2	50	
104	Concrete (reinforced)	m3	4 000	

Road Structure Management Part A: Appendix A4

Act. ID	Activity Description	Unit	Unit Cost (2013 Rand Value)	Routine Maintenance
112	New endblocks	No	8 000	
113	Concrete (precast)	m3	6 000	
118	Repair spall (including honeycombing)	L	100	
120	Seal cracks	m	200	
314	Replace joint sealant	m	100	Yes
453	Install full height pedestrian balustrade	m	2 000	
456	New pedestrian parapet	m	3 300	
457	New traffic barrier (Concrete F-Shape/NJ)	m	5 000	
458	New/repair steel railing	m	1 200	
459	Paint steel rails	m2	300	
462	Realign handrails	m	100	
464	Repair/replace guardrail fixings	No	200	Yes
465	Repair/replace handrail posts	No	750	
466	Replace bolts and washers	No	20	Yes
568	Replace service duct cover	No	200	
651	Access-using hanging basket for outer surface	No	5 000	
702	Traffic accommodation-Low (< 10 000 vpd)	LS	90 000	
703	Traffic accommodation-Medium (10 000 - 40 000 vpd)	LS	110 000	
704	Traffic accommodation-High (> 40 000 vpd)	LS	140 000	
953	Ad-hoc item (describe under Remarks)	No	1 000	
	10. WALLS			
101	Apply protective coating	m2	200	
102	Apply silanes	m2	150	
103	Clean concrete surface	m2	50	
104	Concrete (reinforced)	m3	4 000	
105	Concrete (mass)	m3	4 000	
108	Cut back reinforcement (tie rods) and make good	No	50	
118	Repair spall (including honeycombing)	L	100	
120	Seal cracks	m	200	
122	Stabilise wall with ground/rock anchors	m2	1 000	
314	Replace joint sealant	m	100	Yes
355	Repair weep holes	No	150	
654	Access-using scaffold (< 10 m)	No	500	
953	Ad-hoc item (describe under Remarks)	No	1 000	
	11. TOP SLAB			
101	Apply protective coating	m2	200	
102	Apply silanes	m2	150	
103	Clean concrete surface	m2	50	
104	Concrete (reinforced)	m3	4 000	
108	Cut back reinforcement (tie rods) and make good	No	50	
118	Repair spall (including honeycombing)	L	100	

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Act. ID	Activity Description	Unit	Unit Cost (2013 Rand Value)	Routine Maintenance
120	Seal cracks	m	200	
123	Strengthening (using plates, carbon fibre, etc.)	m2	10 000	
352	Drill drainage holes	No	50	
654	Access-using scaffold (< 10 m)	No	500	
953	Ad-hoc item (describe under Remarks)	No	1 000	
	12. INVERT SLAB			
101	Apply protective coating	m2	200	
102	Apply silanes	m2	150	
104	Concrete (reinforced)	m3	4 000	
105	Concrete (mass)	m3	4 000	
117	Repair concrete topping	m3	2 500	
118	Repair spall (including honeycombing)	L	100	
120	Seal cracks	m	200	
155	Earth backfill	m3	200	Yes
157	Mass concrete backfill	m3	1 800	
158	Rock backfill	m3	600	
207	Clear debris	m3	100	Yes
953	Ad-hoc item (describe under Remarks)	No	1 000	
	13 CELL DEFORMATION			
104	Concrete (reinforced)	m3	4 000	
105	Concrete (mass)	m3	4 000	
109	Demolish and reconstruct	m3	4 400	
654	Access-using scaffold (< 10 m)	No	500	
953	Ad-hoc item (describe under Remarks)	No	1 000	
	14. MISCELLANEOUS ITEMS			
570	Replace cover plates on street lights	No	300	
601	Bolts (miscellaneous)	No	50	Yes
604	Install clearance sign	No	1 000	Yes
605	Install culvert markers (danger plates)	No	200	Yes
606	Install fencing	m	600	Yes
612	Remove people using structure as habitat	LS	30 000	Yes
617	Replace road signs	m2	1 600	Yes
619	Service structure lights	No	150	Yes
620	Install structure number plate	No	1 000	
621	Construct pedestal for culvert number	No	1 000	
953	Ad-hoc item (describe under Remarks)	No	1 000	

Remedial Activities for Culverts (Lesser)

Act. ID	Activity Description	Unit	Unit Cost (2013 Rand Value)	Routine Maintenance
01. INLET WORKS				
101	Apply protective coating	m2	200	
102	Apply silanes	m2	150	
103	Clean concrete surface	m2	50	
104	Concrete (reinforced)	m3	4 000	
108	Cut back reinforcement (tie rods) and make good	No	50	
118	Repair spall (including honeycombing)	L	100	
120	Seal cracks	m	200	
155	Earth backfill	m3	200	Yes
156	Gabion (mattresses and boxes)	m3	1 000	Yes
157	Mass concrete backfill	m3	1 800	
158	Rock backfill	m3	600	
160	Interlocking blocks	m2	300	Yes
207	Clear debris	m3	100	Yes
355	Repair weep holes	No	150	
702	Traffic accommodation-Low (< 10 000 vpd)	LS	90 000	
703	Traffic accommodation-Medium (10 000 - 40 000 vpd)	LS	110 000	
704	Traffic accommodation-High (> 40 000 vpd)	LS	140 000	
953	Ad-hoc item (describe under Remarks)	No	1 000	
02. OUTLET WORKS				
101	Apply protective coating	m2	200	
102	Apply silanes	m2	150	
103	Clean concrete surface	m2	50	
104	Concrete (reinforced)	m3	4 000	
108	Cut back reinforcement (tie rods) and make good	No	50	
118	Repair spall (including honeycombing)	L	100	
120	Seal cracks	m	200	
155	Earth backfill	m3	200	Yes
156	Gabion (mattresses and boxes)	m3	1 000	Yes
157	Mass concrete backfill	m3	1 800	
158	Rock backfill	m3	600	
160	Interlocking blocks	m2	300	Yes
207	Clear debris	m3	100	Yes
355	Repair weep holes	No	150	
702	Traffic accommodation-Low (< 10 000 vpd)	LS	90 000	
703	Traffic accommodation-Medium (10 000 - 40 000 vpd)	LS	110 000	
704	Traffic accommodation-High (> 40 000 vpd)	LS	140 000	
953	Ad-hoc item (describe under Remarks)	No	1 000	

Road Structure Management Part A: Appendix A4

Act. ID	Activity Description	Unit	Unit Cost (2013 Rand Value)	Routine Maintenance
03. BARREL/S				
101	Apply protective coating	m2	200	
102	Apply silanes	m2	150	
103	Clean concrete surface	m2	50	
104	Concrete (reinforced)	m3	4 000	
105	Concrete (mass)	m3	4 000	
108	Cut back reinforcement (tie rods) and make good	No	50	
109	Demolish and reconstruct	m3	4 400	
117	Repair concrete topping	m3	2 500	
118	Repair spall (including honeycombing)	L	100	
120	Seal cracks	m	200	
124	Strengthening of slab	m2	20 000	
155	Earth backfill	m3	200	Yes
157	Mass concrete backfill	m3	1 800	
158	Rock backfill	m3	600	
202	Clean drainage	m	50	Yes
207	Clear debris	m3	100	Yes
314	Replace joint sealant	m	100	Yes
352	Drill drainage holes	No	50	
355	Repair weep holes	No	150	
702	Traffic accommodation-Low (< 10 000 vpd)	LS	90 000	
703	Traffic accommodation-Medium (10 000 - 40 000 vpd)	LS	110 000	
704	Traffic accommodation-High (> 40 000 vpd)	LS	140 000	
953	Ad-hoc item (describe under Remarks)	No	1 000	
04. WATERWAY				
151	Backfill scour damage (earth)	m3	200	Yes
152	Backfill scour damage (mass concrete)	m3	1 800	
153	Backfill scour damage (rock)	m3	600	
156	Gabion (mattresses and boxes)	m3	1 000	Yes
207	Clear debris	m3	100	Yes
209	Clear siltation	m3	100	Yes
404	Remove trees (girth < 500 mm)	No	200	Yes
405	Remove trees (girth > 500 mm)	No	500	Yes
953	Ad-hoc item (describe under Remarks)	No	1 000	

Remedial Activities for Retaining Walls

Act. ID	Activity Description	Unit	Unit Cost (2013 Rand Value)	Routine Maintenance
01. EXTERNAL DRAINAGE				
116	Repair concrete sidedrain/gutter/downchute	m	500	Yes
156	Gabion (mattresses and boxes)	m3	1 000	Yes
201	Clean downchutes/sidedrains	m	50	Yes
206	Clear channel	m	50	Yes
357	Replace kerbs or berms	m	200	Yes
359	Replace sidedrain/gutter/downchutes	m	500	Yes
360	Replace drainage	m	100	
361	Replace grid inlet	No	400	
363	Install kerbs or berms	m	200	Yes
366	Install/replace concrete channel	m	150	
653	Access-using scaffold (> 10 m)	No	1 000	
654	Access-using scaffold (< 10 m)	No	500	
702	Traffic accommodation-Low (< 10 000 vpd)	LS	90 000	
703	Traffic accommodation-Medium (10 000 - 40 000 vpd)	LS	110 000	
704	Traffic accommodation-High (> 40 000 vpd)	LS	140 000	
953	Ad-hoc item (describe under Remarks)	No	1 000	
02. SLOPE PROTECTION				
151	Backfill scour damage (earth)	m3	200	Yes
152	Backfill scour damage (mass concrete)	m3	1 800	
153	Backfill scour damage (rock)	m3	600	
155	Earth backfill	m3	200	Yes
156	Gabion (mattresses and boxes)	m3	1 000	Yes
158	Rock backfill	m3	600	
159	Stone pitching	m2	300	Yes
160	Interlocking blocks	m2	300	Yes
401	Apply weed killer/ant poison and remove growth	m2	30	Yes
402	Clear bush	m2	40	Yes
403	Grassing	m2	30	Yes
404	Remove trees (girth < 500 mm)	No	200	Yes
405	Remove trees (girth > 500 mm)	No	500	Yes
453	Install full height pedestrian balustrade	m	2 000	
653	Access-using scaffold (> 10 m)	No	1 000	
654	Access-using scaffold (< 10 m)	No	500	
702	Traffic accommodation-Low (< 10 000 vpd)	LS	90 000	
703	Traffic accommodation-Medium (10 000 - 40 000 vpd)	LS	110 000	
704	Traffic accommodation-High (> 40 000 vpd)	LS	140 000	
953	Ad-hoc item (describe under Remarks)	No	1 000	

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Act. ID	Activity Description	Unit	Unit Cost (2013 Rand Value)	Routine Maintenance
03. WALLS				
101	Apply protective coating	m2	200	
102	Apply silanes	m2	150	
103	Clean concrete surface	m2	50	
104	Concrete (reinforced)	m3	4 000	
105	Concrete (mass)	m3	4 000	
108	Cut back reinforcement (tie rods) and make good	No	50	
113	Concrete (precast)	m3	6 000	
115	Repair anchor heads	No	6 000	
118	Repair spall (including honeycombing)	L	100	
120	Seal cracks	m	200	
122	Stabilise wall with ground/rock anchors	m2	1 000	
123	Strengthening (using plates, carbon fibre, etc.)	m2	10 000	
653	Access-using scaffold (> 10 m)	No	1 000	
654	Access-using scaffold (< 10 m)	No	500	
702	Traffic accommodation-Low (< 10 000 vpd)	LS	90 000	
703	Traffic accommodation-Medium (10 000 - 40 000 vpd)	LS	110 000	
704	Traffic accommodation-High (> 40 000 vpd)	LS	140 000	
953	Ad-hoc item (describe under Remarks)	No	1 000	
04. JOINTS				
203	Clean joint of loose material	m	50	
301	Install silicon/bituminous seal	m	200	
302	Joint cover plates (replace and refit)	No	1 400	
309	Reinstate expansion gap	m	5 000	
314	Replace joint sealant	m	100	Yes
653	Access-using scaffold (> 10 m)	No	1 000	
654	Access-using scaffold (< 10 m)	No	500	
702	Traffic accommodation-Low (< 10 000 vpd)	LS	90 000	
703	Traffic accommodation-Medium (10 000 - 40 000 vpd)	LS	110 000	
704	Traffic accommodation-High (> 40 000 vpd)	LS	140 000	
953	Ad-hoc item (describe under Remarks)	No	1 000	
05. INTERNAL DRAINAGE				
205	Clear blocked drainage	No	50	Yes
207	Clear debris	m3	100	Yes
209	Clear siltation	m3	100	Yes
352	Drill drainage holes	No	50	
355	Repair weep holes	No	150	
360	Replace drainage	m	100	
365	Seal leaking pipes	No	250	
653	Access-using scaffold (> 10 m)	No	1 000	

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Act. ID	Activity Description	Unit	Unit Cost (2013 Rand Value)	Routine Maintenance
654	Access-using scaffold (< 10 m)	No	500	
702	Traffic accommodation-Low (< 10 000 vpd)	LS	90 000	
703	Traffic accommodation-Medium (10 000 - 40 000 vpd)	LS	110 000	
704	Traffic accommodation-High (> 40 000 vpd)	LS	140 000	
953	Ad-hoc item (describe under Remarks)	No	1 000	
06. FOUNDATIONS				
105	Concrete (mass)	m3	4 000	
157	Mass concrete backfill	m3	1 800	
158	Rock backfill	m3	600	
161	Underpinning (describe under Remarks)	No	10 000	
607	Monitor (movements, rotations, etc.) (5 year period)	No	10 000	
702	Traffic accommodation-Low (< 10 000 vpd)	LS	90 000	
703	Traffic accommodation-Medium (10 000 - 40 000 vpd)	LS	110 000	
704	Traffic accommodation-High (> 40 000 vpd)	LS	140 000	
953	Ad-hoc item (describe under Remarks)	No	1 000	
07. MISCELLANEOUS ITEMS				
156	Gabion (mattresses and boxes)	m3	1 000	Yes
456	New pedestrian parapet	m	3 300	
457	New traffic barrier (Concrete F-Shape/NJ)	m	5 000	
458	New/repair steel railing	m	1 200	
459	Paint steel rails	m2	300	
551	Paint steelwork	m2	300	
568	Replace service duct cover	No	200	
601	Bolts (miscellaneous)	No	50	Yes
602	Bolts to cover plates	No	100	Yes
606	Install fencing	m	600	Yes
609	Provide sidewalk	m2	500	Yes
620	Install structure number plate	No	1 000	
953	Ad-hoc item (describe under Remarks)	No	1 000	

Remedial Activities for Gantries

Act. ID	Activity Description	Unit	Unit Cost (2013 Rand Value)	Routine Maintenance
01. GUARDRAILS				
455	New guardrail (single and double)	m	300	Yes
460	Provide guardrail protection	m	300	Yes
462	Realign handrails	m	100	
463	Repair guardrail (realign, bolt replacement, etc.)	m	100	Yes
464	Repair/replace guardrail fixings	No	200	Yes
466	Replace bolts and washers	No	20	Yes
467	Replace posts (steel or timber)	No	200	Yes
468	Replace reflectors	No	50	Yes
469	Reverse laps in guardrails	No	100	Yes
551	Paint steelwork	m2	300	
702	Traffic accommodation-Low (< 10 000 vpd)	LS	90 000	
703	Traffic accommodation-Medium (10 000 - 40 000 vpd)	LS	110 000	
704	Traffic accommodation-High (> 40 000 vpd)	LS	140 000	
953	Ad-hoc item (describe under Remarks)	No	1 000	
02. FOUNDATIONS				
101	Apply protective coating	m2	200	
102	Apply silanes	m2	150	
103	Clean concrete surface	m2	50	
104	Concrete (reinforced)	m3	4 000	
105	Concrete (mass)	m3	4 000	
108	Cut back reinforcement (tie rods) and make good	No	50	
118	Repair spall (including honeycombing)	L	100	
120	Seal cracks	m	200	
151	Backfill scour damage (earth)	m3	200	Yes
155	Earth backfill	m3	200	Yes
157	Mass concrete backfill	m3	1 800	
158	Rock backfill	m3	600	
159	Stone pitching	m2	300	Yes
160	Interlocking blocks	m2	300	Yes
607	Monitor (movements, rotations, etc.) (5 year period)	No	10 000	
620	Install structure number plate	No	1 000	
702	Traffic accommodation-Low (< 10 000 vpd)	LS	90 000	
703	Traffic accommodation-Medium (10 000 - 40 000 vpd)	LS	110 000	
704	Traffic accommodation-High (> 40 000 vpd)	LS	140 000	
953	Ad-hoc item (describe under Remarks)	No	1 000	
03. HD BOLTS AND BASE PLATES				

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Act. ID	Activity Description	Unit	Unit Cost (2013 Rand Value)	Routine Maintenance
549	Corrosion protection repair. Full removal of existing paint & rust	m2	400	
550	Corrosion protection repair. Prepare existing painted surfaces	m2	300	
551	Paint steelwork	m2	300	
555	Replace structural steel members	t	30 000	
558	Structural steel - replace bolts, washers etc.	No	50	Yes
591	Strengthen structural steel member	t	30 000	
601	Bolts (miscellaneous)	No	50	Yes
702	Traffic accommodation-Low (< 10 000 vpd)	LS	90 000	
703	Traffic accommodation-Medium (10 000 - 40 000 vpd)	LS	110 000	
704	Traffic accommodation-High (> 40 000 vpd)	LS	140 000	
953	Ad-hoc item (describe under Remarks)	No	1 000	
04. VERTICAL MEMBERS				
549	Corrosion protection repair. Full removal of existing paint & rust	m2	400	
550	Corrosion protection repair. Prepare existing painted surfaces	m2	300	
551	Paint steelwork	m2	300	
555	Replace structural steel members	t	30 000	
558	Structural steel - replace bolts, washers etc.	No	50	Yes
591	Strengthen structural steel member	t	30 000	
601	Bolts (miscellaneous)	No	50	Yes
604	Install clearance sign	No	1 000	Yes
654	Access-using scaffold (< 10 m)	No	500	
702	Traffic accommodation-Low (< 10 000 vpd)	LS	90 000	
703	Traffic accommodation-Medium (10 000 - 40 000 vpd)	LS	110 000	
704	Traffic accommodation-High (> 40 000 vpd)	LS	140 000	
953	Ad-hoc item (describe under Remarks)	No	1 000	
05. HORIZONTAL MEMBERS				
549	Corrosion protection repair. Full removal of existing paint & rust	m2	400	
550	Corrosion protection repair. Prepare existing painted surfaces	m2	300	
551	Paint steelwork	m2	300	
555	Replace structural steel members	t	30 000	
558	Structural steel - replace bolts, washers etc.	No	50	Yes
591	Strengthen structural steel member	t	30 000	
601	Bolts (miscellaneous)	No	50	Yes
604	Install clearance sign	No	1 000	Yes

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Act. ID	Activity Description	Unit	Unit Cost (2013 Rand Value)	Routine Maintenance
654	Access-using scaffold (< 10 m)	No	500	
702	Traffic accommodation-Low (< 10 000 vpd)	LS	90 000	
703	Traffic accommodation-Medium (10 000 - 40 000 vpd)	LS	110 000	
704	Traffic accommodation-High (> 40 000 vpd)	LS	140 000	
953	Ad-hoc item (describe under Remarks)	No	1 000	
	06. SIGN FACE			
404	Remove trees (girth < 500 mm)	No	200	Yes
405	Remove trees (girth > 500 mm)	No	500	Yes
549	Corrosion protection repair. Full removal of existing paint & rust	m2	400	
550	Corrosion protection repair. Prepare existing painted surfaces	m2	300	
551	Paint steelwork	m2	300	
555	Replace structural steel members	t	30 000	
558	Structural steel - replace bolts, washers etc.	No	50	Yes
591	Strengthen structural steel member	t	30 000	
601	Bolts (miscellaneous)	No	50	Yes
617	Replace road signs	m2	1 600	Yes
621	Repair road signs whilst fixed to gantry	m2	1 600	Yes
622	Repair road signs by removing, transport to workshop, repairing and re-erecting	m2	4 000	Yes
623	Repair sign face lettering	No	100	
654	Access-using scaffold (< 10 m)	No	500	
702	Traffic accommodation-Low (< 10 000 vpd)	LS	90 000	
703	Traffic accommodation-Medium (10 000 - 40 000 vpd)	LS	110 000	
704	Traffic accommodation-High (> 40 000 vpd)	LS	140 000	
953	Ad-hoc item (describe under Remarks)	No	1 000	
	07. SIGN FASTENERS			
549	Corrosion protection repair. Full removal of existing paint & rust	m2	400	
550	Corrosion protection repair. Prepare existing painted surfaces	m2	300	
551	Paint steelwork	m2	300	
555	Replace structural steel members	t	30 000	
558	Structural steel - replace bolts, washers etc.	No	50	Yes
591	Strengthen structural steel member	t	30 000	
601	Bolts (miscellaneous)	No	50	Yes
654	Access-using scaffold (< 10 m)	No	500	
702	Traffic accommodation-Low (< 10 000 vpd)	LS	90 000	
703	Traffic accommodation-Medium (10 000 - 40 000 vpd)	LS	110 000	

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Act. ID	Activity Description	Unit	Unit Cost (2013 Rand Value)	Routine Maintenance
	vpd)			
704	Traffic accommodation-High (> 40 000 vpd)	LS	140 000	
953	Ad-hoc item (describe under Remarks)	No	1 000	
	08. MISCELLANEOUS ITEMS			
457	New traffic barrier (Concrete F-Shape/NJ)	m	5 000	
461	Provide F-shape NJ barrier protection	m	5 000	
615	Repair sign gantries	No	30 000	
953	Ad-hoc item (describe under Remarks)	No	1 000	

Remedial Activities for Road Tunnels

Act. ID	Activity Description	Unit	Unit Cost (2013 Rand Value)	Routine Maintenance
01. PORTALS				
101	Apply protective coating	m2	200	
102	Apply silanes	m2	150	
103	Clean concrete surface	m2	50	Yes
104	Concrete (reinforced)	m3	4 000	
105	Concrete (mass)	m3	4 000	
108	Cut back reinforcement (tie rods) and make good	No	50	
113	Concrete (precast)	m3	6 000	
118	Repair spall (including honeycombing)	L	100	
120	Seal cracks	m	200	
653	Access-using scaffold (> 10 m)	No	1 000	
654	Access-using scaffold (< 10 m)	No	500	
702	Traffic accommodation-Low (< 10 000 vpd)	LS	90 000	
703	Traffic accommodation-Medium (10 000 - 40 000 vpd)	LS	110 000	
704	Traffic accommodation-High (> 40 000 vpd)	LS	140 000	
953	Ad-hoc item (describe under Remarks)	No	1 000	
02. SLOPE PROTECTION				
113	Concrete (precast)	m3	6 000	
114	Reconstruct backwall (re-instate gap)	m3	10 000	
115	Repair anchor heads	No	6 000	
116	Repair concrete sidedrain/gutter/downchute	m	500	Yes
118	Repair spall (including honeycombing)	L	100	
120	Seal cracks	m	200	
122	Stabilise wall with ground/rock anchors	m2	1 000	
155	Earth backfill	m3	200	Yes
156	Gabion (mattresses and boxes)	m3	1 000	Yes
157	Mass concrete backfill	m3	1 800	
158	Rock backfill	m3	600	
159	Stone pitching	m2	300	Yes
401	Apply weed killer/ant poison and remove growth	m2	30	Yes
403	Grassing	m2	30	Yes
653	Access-using scaffold (> 10 m)	No	1 000	
654	Access-using scaffold (< 10 m)	No	500	
702	Traffic accommodation-Low (< 10 000 vpd)	LS	90 000	
703	Traffic accommodation-Medium (10 000 - 40 000 vpd)	LS	110 000	
704	Traffic accommodation-High (> 40 000 vpd)	LS	140 000	
953	Ad-hoc item (describe under Remarks)	No	1 000	

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Act. ID	Activity Description	Unit	Unit Cost (2013 Rand Value)	Routine Maintenance
	03. ROCK FALL PROTECTION			
104	Concrete (reinforced)	m3	4 000	
105	Concrete (mass)	m3	4 000	
113	Concrete (precast)	m3	6 000	
115	Repair anchor heads	No	6 000	
118	Repair spall (including honeycombing)	L	100	
120	Seal cracks	m	200	
154	Construct masonry wall	m2	1 000	
156	Gabion (mattresses and boxes)	m3	1 000	Yes
606	Install fencing	m	600	Yes
653	Access-using scaffold (> 10 m)	No	1 000	
654	Access-using scaffold (< 10 m)	No	500	
702	Traffic accommodation-Low (< 10 000 vpd)	LS	90 000	
703	Traffic accommodation-Medium (10 000 - 40 000 vpd)	LS	110 000	
704	Traffic accommodation-High (> 40 000 vpd)	LS	140 000	
953	Ad-hoc item (describe under Remarks)	No	1 000	
	04. DRAINAGE			
202	Clean drainage	m	50	Yes
205	Clear blocked drainage	No	50	Yes
206	Clear channel	m	50	Yes
352	Drill drainage holes	No	50	
360	Replace drainage	m	100	
365	Seal leaking pipes	No	250	
653	Access-using scaffold (> 10 m)	No	1 000	
654	Access-using scaffold (< 10 m)	No	500	
702	Traffic accommodation-Low (< 10 000 vpd)	LS	90 000	
703	Traffic accommodation-Medium (10 000 - 40 000 vpd)	LS	110 000	
704	Traffic accommodation-High (> 40 000 vpd)	LS	140 000	
953	Ad-hoc item (describe under Remarks)	No	1 000	
	05. ROAD SURFACE			
501	Crack seal (asphalt)	m	20	Yes
502	Resurface or patch	m2	300	Yes
504	Repair settlement (asphalt fill)	m3	3 500	Yes
702	Traffic accommodation-Low (< 10 000 vpd)	LS	90 000	
703	Traffic accommodation-Medium (10 000 - 40 000 vpd)	LS	110 000	
704	Traffic accommodation-High (> 40 000 vpd)	LS	140 000	
953	Ad-hoc item (describe under Remarks)	No	1 000	

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Act. ID	Activity Description	Unit	Unit Cost (2013 Rand Value)	Routine Maintenance
06. LINING				
101	Apply protective coating	m2	200	
102	Apply silanes	m2	150	
103	Clean concrete surface	m2	50	Yes
104	Concrete (reinforced)	m3	4 000	
105	Concrete (mass)	m3	4 000	
108	Cut back reinforcement (tie rods) and make good	No	50	
113	Concrete (precast)	m3	6 000	
118	Repair spall (including honeycombing)	L	100	
120	Seal cracks	m	200	
653	Access-using scaffold (> 10 m)	No	1 000	
654	Access-using scaffold (< 10 m)	No	500	
702	Traffic accommodation-Low (< 10 000 vpd)	LS	90 000	
703	Traffic accommodation-Medium (10 000 - 40 000 vpd)	LS	110 000	
704	Traffic accommodation-High (> 40 000 vpd)	LS	140 000	
953	Ad-hoc item (describe under Remarks)	No	1 000	
07. JOINTS				
203	Clean joint of loose material	m	50	
301	Install silicon/bituminous seal	m	200	
309	Reinstate expansion gap	m	5 000	
653	Access-using scaffold (> 10 m)	No	1 000	
654	Access-using scaffold (< 10 m)	No	500	
702	Traffic accommodation-Low (< 10 000 vpd)	LS	90 000	
703	Traffic accommodation-Medium (10 000 - 40 000 vpd)	LS	110 000	
704	Traffic accommodation-High (> 40 000 vpd)	LS	140 000	
953	Ad-hoc item (describe under Remarks)	No	1 000	
08. OPERATIONAL SERVICES				
653	Access-using scaffold (> 10 m)	No	1 000	
654	Access-using scaffold (< 10 m)	No	500	
702	Traffic accommodation-Low (< 10 000 vpd)	LS	90 000	
703	Traffic accommodation-Medium (10 000 - 40 000 vpd)	LS	110 000	
704	Traffic accommodation-High (> 40 000 vpd)	LS	140 000	
953	Ad-hoc item (describe under Remarks)	No	1 000	
09. MISCELLANEOUS ITEMS				
604	Install clearance sign	No	1 000	Yes
609	Provide sidewalk	m2	500	Yes
616	Repair signpost connections	No	300	Yes

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Act. ID	Activity Description	Unit	Unit Cost (2013 Rand Value)	Routine Maintenance
617	Replace road signs	m2	1 600	Yes
619	Service structure lights	No	150	Yes
620	Install structure number plate	No	1 000	
953	Ad-hoc item (describe under Remarks)	No	1 000	

Remedial Activities for Light Mast Group

Act. ID	Activity Description	Unit	Unit Cost (2013 Rand Value)	Routine Maintenance
01. FOUNDATIONS AND PLINTHS				
118	Repair spall (including honeycombing)	L	100	
120	Seal cracks	m	200	
155	Earth backfill	m3	200	Yes
157	Mass concrete backfill	m3	1 800	
953	Ad-hoc item (describe under Remarks)	No	1 000	
02. HD BOLTS AND BASE PLATES				
549	Corrosion protection repair. Full removal of existing paint & rust	m2	400	
550	Corrosion protection repair. Prepare existing painted surfaces	m2	300	
551	Paint steelwork	m2	300	
555	Replace structural steel members	t	30 000	
558	Structural steel - replace bolts, washers etc.	No	50	Yes
591	Strengthen structural steel member	t	30 000	
601	Bolts (miscellaneous)	No	50	Yes
953	Ad-hoc item (describe under Remarks)	No	1 000	
03. VERTICAL MEMBERS				
549	Corrosion protection repair. Full removal of existing paint & rust	m2	400	
550	Corrosion protection repair. Prepare existing painted surfaces	m2	300	
551	Paint steelwork	m2	300	
555	Replace structural steel members	t	30 000	
558	Structural steel - replace bolts, washers etc.	No	50	Yes
591	Strengthen structural steel member	t	30 000	
601	Bolts (miscellaneous)	No	50	Yes
953	Ad-hoc item (describe under Remarks)	No	1 000	
04. LIGHT FITTINGS AND FIXINGS				
801	Repair light fittings and fixings	No	2 000	
802	Replace light fittings and fixings	No	4 000	
803	Replace lights or bulbs	No	1 000	Yes
953	Ad-hoc item (describe under Remarks)	No	1 000	
05. ACCESS HATCH TO ELECTRICAL CONTROLS				
821	Repair access hatch to electrical controls	No	2 000	
822	Replace access hatch to electrical controls	No	4 000	
823	Repair access hatch locking device	No	1 000	
824	Repair electrical controls	No	2 000	

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Act. ID	Activity Description	Unit	Unit Cost (2013 Rand Value)	Routine Maintenance
825	Replace electrical controls	No	4 000	
953	Ad-hoc item (describe under Remarks)	No	1 000	
	06. LIGHT FITTING ACCESS SYSTEM			
830	Repair light fittings access system	No	3 000	
831	Replace light fittings access system	No	6 000	
832	Ad-hoc item (describe under Remarks)	No	1 000	
	07. CABLE THEFT PREVENTATIVE MEASURES			
840	Introduce cable theft preventative measures	No	3 000	
841	Repair cable theft preventative measures	No	1 500	Yes
842	Ad-hoc item (describe under Remarks)	No	1 000	
	08. MISCELLANEOUS ITEMS			
953	Ad-hoc item (describe under Remarks)	No	1 000	