Appendix C – Highway Structures Lifecycle Plan

Introduction

1. The background to lifecycle plans, and the format of each, are described in Section 5 of the TAMP. This lifecycle plan covers the asset group of highway structures owned and maintained by the County Council.

2. The key document covering this area of the TAMP is *Management of Highway Structures: A Code of Practice* (The Code of Practice), published in 2005, with *Complementary Guidance* issued from May 2009, which has been adopted by the County Council.

3. This asset group comprises the following structure types:-

    - Highway bridges;
    - Retaining walls;
    - Gantries;
    - Bridges on public rights of way.

4. A highway bridge is defined as a structure with a span of 1.5m or more, spanning and providing passage over an obstacle. Smaller structures are deemed to be highway drainage structures and will be included in a future version of the TAMP.

5. A retaining wall is defined as a wall associated with the highway where the dominant function is to act as a retaining structure.

6. A gantry is defined as a support structure spanning the highway, the primary function of which is to support traffics signs and signalling equipment.

7. A significant number of structures on the highway network are the responsibility of other owners and are not included in this plan. The other owners with significant numbers of structures are:-

    - Highways Agency;
    - Network Rail;
    - BRB (Residuary) Ltd;
    - British Waterways;
    - Various District Councils;
    - Shackerstone Railway Society;
    - Sustrans.

8. Bridge surfacing is not generally included in this plan, the exception being proprietary footbridge surfacing.

Levels of Service

9. The desirable levels of service for this asset group are set out in the table below. Judgements on the four attributes of safety, availability, serviceability and condition are made based on the criteria described in Section 2, though information on customer views is, for this version of the TAMP, based largely on informal feedback.

Attribute	***Desired standard***	***Performance measure***
Safety	Provide adequate containment for vehicles, pedestrians and livestock	None
Availability	Provide adequate load-carrying capacity (which may include weight limits in lieu of strengthening at appropriate locations), width and headroom	None
Serviceability	Maintain appropriate appearance, including removal of:- • offensive graffiti • debris in watercourse beneath bridges	None
Condition	At a level consistent with achieving minimum whole-life cost	For highway bridges, Bridge Condition Index (BCI_{CRIT}) monitored on an annual basis.

10. These levels of service fully meet all aspirations whilst minimising whole-life cost. The lifecycle plan, in later sections, shows how different levels of available funding will influence the extent to which the desirable levels of service can be achieved

11. Failure to respond adequately to any of these four levels of service will produce risk to the Authority. The table below, which details the main risks, underlines the importance of responding properly to each:-

Risk type	***Description example***
Physical	Accidents caused by asset defects
Business	Legal proceedings for failure in duty of care
Financial	Reduction in asset value and increase in eventual maintenance costs arising from lack of timely repairs
Corporate image	Poor condition reflects on the overall image of the Authority
Environmental	Increased risk of flooding if watercourses beneath structures are not properly maintained
Network	Increased disruption to highway users caused by emergency unplanned maintenance arising from sub-optimal maintenance

Asset Base and Characteristics

12. The highway bridge stock comprises several different sub-groups and the following table gives a breakdown by road classification and material types:-

Bridge Type	***Road Classification***				***Total***
	PRN	***A***	***B***	***Other***	
Masonry	17	21	23	243	304
Concrete	69	32	24	220	345
Metal	16	2	0	27	45
Total	**102**	**55**	**47**	**490**	**694**

13. The retaining wall stock comprises several different sub-groups. The inventory is incomplete, in terms of overall number, sub-group type and ownership, but the following table gives the information held to date, by road classification:-

Wall Type	***Road Classification***			***Total***
	PRN	***A***	***Other***	
All (LCC confirmed)	19	2	79	100
All (Potential LCC)	66	11	567	644
Total	**85**	**13**	**646**	**744**

14. The gantry stock comprises two sub-groups. The following table gives the information held to date, by road classification:-.

Gantry Type	***Road Classification***			***Total***
	PRN	***A***	***Other***	
Frame gantries	7	0	2	9
Cantilever arm	25	20	10	55
Total	**32**	**20**	**12**	**64**

15. The inventory for bridges on public rights of way is substantially incomplete. This information will be available for future editions of the TAMP.

Asset Condition and Assessment

16. To assess the extent to which the desirable levels of service are met requires measurements covering the four dimensions of safety, availability, serviceability and condition. There are as yet no measures for safety and serviceability and these will be considered in future versions of the TAMP.

Condition

17. Highway bridges are subject to periodic inspection to determine their condition and to record defects. The County Council has adopted a risk-based regime that generally accords with that set out in the Code of Practice and is as follows:-

Type	***Frequency***	***Assets Inspected***
General Inspections	Every 2 years	All highway bridges
Principal Inspections	Every 6 years	Highway bridges on A or B roads or lorry routes
	Every 10 years	All other highway bridges
Diving Inspections	Ad hoc	Highway bridges which have substructures in deep, often fast-flowing, watercourses
Special Inspections	Ad hoc	All highway structures as necessary

18. A Bridge Condition Index (BCI) is determined for each individual bridge, based on its condition at the time of the inspection. The BCI system is a nationally developed method, endorsed by ADEPT (formerly the County Surveyors' Society [CSS]), with two BCI values calculated for each bridge:-

    - BCI_{CRIT} – the value when only the critical load-carrying elements are considered;
    - BCI_{AV} – the value when every element of the bridge is considered.

19. As a guide, the BCI values represent the following:-

    - 100 – 95 Very Good condition;
    - 94 – 85 Good condition;
    - 84 – 65 Fair condition;
    - 64 – 40 Poor condition;
    - 39 – 0 Very Poor condition.

20. The average BCI_{CRIT} values for the highway bridge stock, by road classification and material types is as follows:-

Bridge Type	***Average BCI_{CRIT} values***		
	PRN	***A***	***Other***
Masonry	79	74	75
Concrete	93	79	84
Metal	88	79	77

21. An average value for the whole bridge stock, known as the Bridge Stock Condition Index ($BSCI_{AV}$), is also calculated based on the individual BCI_{AV} values, and is weighted by area.

22. Bridge condition deteriorates at different rates according to the construction type, exposure conditions, traffic flows and maintenance regime adopted. It is a complex interaction of variables which makes forecasting trends very difficult.

23. Condition values monitored over time indicate that the bridge stock is being maintained in a steady state condition (see table below):-

Date	***No of Spans***	***BCI_{AV}***	***BCI_{CRIT}***	***$BSCI_{AV}$***	***$BSCI_{CRIT}$***	***% below BCI_{CRIT} 75***
2007/08	1241	90	83	92	87	12.5
2008/09	1253	90	83	92	87	11.0
2009/10	1258	89	83	90	84	10.2
2010/11	1270	89	81	89	83	10.2
2011/12	1275	88	81	90	83	10.3

24. Where other owners have structures within the highway, they are responsible for ensuring the safety, integrity and adequacy of those structures for use by the public. Where the highway authority cannot be reasonably confident that an adequate inspection regime is in place, such as those of Network Rail and British Waterways, they are expected to carry out 'duty of care' inspections on these structures. Current and historic funding levels have not permitted these inspections to be carried out. The owners falling into this category are summarised in the following table:-

Highway Bridge Owner	***No***
Landowners and others (various)	136
District Councils (various)	22
Lafarge	10
Shackerstone Railway Society	10
Total	**178**

25. There is currently no formal inspection regime for the other structures in this asset group. However, ad-hoc inspections are carried out when concerns are received from interested parties.

Availability

26. In addition to condition inspections, a programme of strength assessments has been completed to determine whether highway bridges achieved the required live load capacity of 40/44T. Where highway bridges failed to provide this capacity, strengthening work was usually carried out, although some structures on non-critical routes were subject to permanent restriction limit in lieu of strengthening. The following table shows the number of structures that either do not meet the desired live load capacity or require further attention:-

Group of Highway Bridges	***No***
Highway bridges subject to a permanent weight restriction in-lieu of strengthening	8
Highway bridges which still require attention i.e. further assessment, strengthening or other load-limiting measures	2
Total	**10**

27. The Code of Practice recommends that a review of existing strength assessments should be carried out at the following intervals:-

    - a minimum of 12 years, to coincide with principal inspections;
    - whenever there is a significant change in the bridge condition.

28. A review of existing strength assessments has commenced, as have some re-assessments, starting with those with the smallest margin of safety, but available funding has restricted the progress to date.

29. Highway structures are required to have a minimum clearance of 5.03m (16'6"). Where this cannot be achieved, signed height restrictions are required. There are no highway structures with height restrictions.

Asset Valuation

30. The background to Asset Valuation is described in Section 4 and Appendix E. The interim value of the highway bridge stock, based on the Gross Replacement Cost (GRC), is estimated to be approximately £419M.

31. This valuation has been developed from unit rates contained in *Accounting for Highways Infrastructure Assets in the Local Authority Sector on a Depreciated Replacement Costs Basis: Interim Accounting Arrangements for the Period up to 2012-13* which is based on the decisions made by the CIPFA Project Implementation Steering Group (PISG).

32. No work has been carried out on the Depreciated Replacement Cost (DRC) pending the delivery of a suitable process under the asset support contract, which is being funded by DfT.

Future Changes in Demand

33. Imminent changes to national bridge guidance will recommend that all highway bridges that were previously outside the scope of the Bridgeguard programme, i.e. those constructed after 1975, should be assessed to determine their current load carrying capacity.

34. Some bridge owners, such as Network Rail, BRB (Residuary) and British Waterways, are only statutorily required to maintain their structures to be able to carry 24 imperial tons, as set out in Section 117 of the Transport Act 1968 supplemented by the Railway Bridges (Load Bearing Standards) Regulations (England and Wales) Order 1972 (SI 1705/1972). Many of their structures have higher load carrying capacities, but as their bridge stock gets older and its condition deteriorates, the County Council's desire to retain 40/44T availability over these highway bridges will require increased investment, as the bridge owner is protected from liability provided the bridge is capable of providing 24 imperial tons.

35. All highway bridges will need to meet increased demands caused by increasing traffic levels. In addition, the potential increase in housing and employment developments proposed for the County will produce more highway bridges which, in the longer term, will become the maintenance responsibility of the County Council.

36. The expected increased prevalence of flooding, caused by climate change, will put added demand on highway bridges over watercourses. Some of these highway bridges may require re-building.

Treatment Options and Costs

37. Treatment options and costs may be summarised as follows:-

Regular:
- routine/cyclic maintenance – includes vegetation removal, re-pointing brickwork and re-painting metalwork;
- management of sub-standard structures – includes implementation of weight restrictions in lieu of strengthening and condition monitoring, where appropriate.

Programmed:
- preventative maintenance – includes concrete repairs and painting metalwork;
- component renewal/upgrading – includes waterproofing membranes, parapets, carriageway joints and bearings;
- replacement – includes deck replacement and replacing brick arches with precast concrete box culverts.

Reactive:
- emergency work and non-programmed essential maintenance;
- graffiti removal.

38. The table below shows intervention data for different bridge types, with typical intervention periods and costs, based on the County's highway bridge stock and the Department for Transport's Structures Asset Management Planning Toolkit:-

Structure	***Work***	***Interval***	***Cost (£)***
Masonry arch *(span range 1.5m – 12.0m, average span – 4.6m, average area – 131m^2)*			
	Brickwork repairs	40 years	15,000
	Complete replacement **(with modern equivalent @ £6,042/m2)**	120 years	791,000
Concrete bridge *(span range 1.5m – 33.5m, average span – 5.0m, average area – 103m^2)*			
	Drainage/bearing shelf cleaning	5 years	500
	Parapet painting	15 years	7,500
	Deck re-waterproofing	20 years	25,000

	Expansion joint renewal	20 years	15,000
	Concrete repairs (@ £1,192/m2)	30 years	
	Bearing renewal	30 years	60,000
	Complete replacement (with modern equivalent @ £6,042/m2)	120 years	622,000
Steel bridge *(span range 3.0m – 39.0m, average span – 8.6m, average area – 265m^2)*			
	Drainage/bearing shelf cleaning	5 years	500
	Structural metalwork painting	12 years	10,000
	Parapet painting	15 years	7,500
	Deck re-waterproofing	20 years	30,000
	Expansion joint renewal	20 years	15,000
	Bearing renewal	30 years	60,000
	Complete replacement (with modern equivalent @ £6,042/m2)	120 years	1,600,000

39. It should be noted that not all highway bridges will require each of the treatments shown.

40. The intervention data for other structures in this asset group will be added in future editions of the TAMP.

Management Strategy for Minimising Whole-Life Costs

41. When considering whole life costs, account needs to be taken of the direct and indirect costs associated with the asset group, including works, design and supervision, inspection and assessment. With highway bridges, which have a long life but are very expensive to replace at the end of that life, it is essential to plan preventative maintenance works in a timely manner, since delays will increase the whole-life cost of the structure.

42. The work programme is determined using the data in the bridge management system, and priority is given to the following:-

    - structures with low BCI_{CRIT} values, i.e. those with structural defects which have a direct impact on their load-carrying capacity;
    - structures with safety-related defects;
    - structures with defects which, if not remedied, are likely to lead to more serious problems, for example failed waterproofing systems which will permit salt laden water ingress into decks, leading to corrosion of steel reinforcement and potential alkali silica reaction.

43. The available funding is allocated to each of the above work-types on an annual basis to suit the importance or criticality of the works identified. This strategy is intended to deliver the identified levels of service.

44. Precedence is given to highway bridges on higher group roads and on roads carrying higher volumes of traffic.

45. Currently, maintenance works are identified in an annual programme, with major schemes planned up to two years ahead. However, to assist with scheme delivery and overall financial planning, a two-year work programme is being developed, which will be subject to amendment in the event that a more critical scheme arises.

Options and Targets within the Management Strategy

46. The causal link between capital spend and resulting condition is complicated and not necessarily fully explained by the headline figures; this is another area for further investigation in future editions of the TAMP.

LTP proposals

47. The third Local Transport Plan gave indicative allocations for the period commencing in 2011/12 and set out following performance indicator:-

PI 30	% of bridge spans with a BCI_{CRIT} value below 75

48. The LTP capital programme and proposed trajectory for the BCI_{CRIT} target are shown below:-

	11/12	***12/13***	***13/14***	***14/15***
LTP3 Investment (£000's)	1,475	1,530	1,580	1,590
% of bridge spans with a BCI_{CRIT} value below 75	10	10	10	10

49. Targeted investment in bridge maintenance over recent years has resulted in the BCI_{CRIT} measure being reduced to close to the target value. There is, therefore, a reasonable level of confidence that, with a similar level of funding, the target of 10% could be achieved and maintained during this LTP period.

50. However, if the same level of investment is made in the maintenance of the existing bridge stock, there will be insufficient funds available to carry out the full programme of strength re-assessments, the 'duty of care' inspections and the component-based calculation of Depreciated Replacement Cost.

Alternative options

51. Any reduction in the level of funding will have a detrimental effect not only on the condition of the bridge stock, but also on the County Council's ability to inspect and assess the stock in accordance with the Code of Practice.

52. Our appraisal, based on evidence currently available, is that minimum whole life cost is obtained if individual highway bridges have a BCI_{CRIT} value of 75 or above, i.e. in the 'fair condition' range. Reduced performance, that is lower BCI_{CRIT} values, will therefore lead to increased costs in the longer term. To achieve a level of condition which reflects minimum whole-life cost we believe we need to move, in the longer term, to a point where no more than 5% of all bridge spans fall below this criterion. To achieve this would require some increased investment.

Lifecycle Action Plan

53. Most of the actions to deliver this lifecycle plan are, for this TAMP, contained within the wider summary of development contained in Section 9. A separate action plan is therefore not included here, though it will be in future editions of the TAMP.

Risks

54. The risks involved in implementing the lifecycle plan have been assessed against the Authority's standard grid of likelihood versus impact table below, with an outline of the mitigation to be planned. The 'red' risks are listed in Section 7 of the main TAMP document.

Impact of effects		Very Unlikely (4)	Not Very Likely (3)	Quite Likely (2)	Very Likely (1)
Severe	A				
Significant	B				1,2
Moderate	C				3
Minor	D			5	4

Likelihood of causes

Risk	***Level***	***Mitigation (for red risks)***	***Responsible***
1. Insufficient funding to meet and maintain targets	1B	Review allocation between different asset groups to minimise overall deterioration	Oversight Board
2. Insufficient funding to permit 'duty-of-care' inspections	1B	Review allocation between different asset groups to enable inspections to be carried out	Oversight Board
3. Insufficient staff resources for analytical work, particularly given structural change in the department	1C	Ensure prioritised within group local action plan	Group Manager (Engineering Design)
4. Insufficient staff resources and skills for customer attitude work	1D	Link with other customer attitude surveying and use external agency	Group Manager (Engineering Design)
5. Insufficient progress nationally and in the region to support changes in practice	2D	Work through Midlands Service Improvement Group to try to ensure key issues are tackled	Group Manager (Engineering Design)