Managing a cost-effective rolling programme using a pavement management system to deliver a safe road system in Carmarthenshire, Wales

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ABSTRACT

Carmarthenshire County Council has undertaken reviews of network condition and identified a maintenance backlog for a number of years. This is reported to council members and forms part of the process of planning future service delivery and standards. It provides an overview of road condition in the county in terms of national indicators and the underlying condition data. Condition is also expressed in financial terms by the use of the CIPFA approved accountancy reporting standards, and Welsh Government 'backlog' calculation methodology. The most recent update was undertaken in 2012. One of the key objectives of the process is to identify maintenance schemes, including safety schemes, from all available condition surveys and inspections, and develop ranking criteria for scheme prioritisation.

This paper outlines how the Carmarthenshire Road Condition report was developed, the survey regime currently in place in Carmarthenshire, and the changes to this regime implemented since 2005 with the reasons for these changes. It describes the road condition parameters recorded during surveys, and discusses how the various parameters can be used in highway asset management, including those associated with highway safety. The report explains how road condition data is managed using the Pavement Management System and developments to the system that have been implemented in Carmarthenshire.

Carmarthenshire has been using the WDM® Scheme Manager application for over three years, and is utilised to generate and prioritise maintenance schemes by analysing condition data. A standard methodology that can be applied every year to undertake this task has been developed and documented. This can be used to develop levels of service against which all scheme proposals can be assessed. The methodology ensures that road safety related parameters such as skid resistance and surface texture depth are given adequate weighting when prioritising schemes.

A list of potential schemes has been identified, in addition to the detailed programme that has already been identified and validated by Carmarthenshire engineering staff. Provisional costs have been determined for the additional schemes. These provide an indication of the value of work that is required to treat all lengths of roads in the county that have been identified as defective. It is anticipated that the additional schemes will be subject to a process of value management to improve the forecasting of costs.

The paper will discuss how surface treatment schemes are identified using both skid resistance data, and using the findings and recommendations from a separate skid resistance investigations. It will detail how these considerations are set alongside other condition data to develop a single scheme list for use, and the benefits that have been achieved through this approach.

1. INTRODUCTION

Carmarthenshire County Council is a large unitary Authority in South West Wales, with a road network of 3373km of predominantly rural roads. Like many similar authorities it is faced with numerous demands on a limited highway maintenance budget. The council has identified that it needs a clear strategy of using road condition surveys to inform and develop a programme that balanced structural, functional and safety considerations. It has also identified that through setting out a clear strategy it can help in informing members and the public of its programme of works.

In 2002 and 2005, W.D.M. Limited provided a report setting out the maintenance procedures used in Carmarthenshire to monitor road condition and to develop and prioritise maintenance proposals. The report was then updated in 2012 setting out changes in survey methods, condition of the network and procedures used in Carmarthenshire to manage the highway network. The specific objectives are to:

- Describe the road condition assessment regime in place in Carmarthenshire

- Report on condition from the most recent surveys

- Identify maintenance schemes from the available condition data

- Assist in the development of ranking criteria to prioritise schemes

- Report the Gross Replacement Cost and Depreciated Replacement Cost

- Make recommendations on improvements to how Carmarthenshire manage the road network

Since 2005 Carmarthenshire have moved from a part machine/ visual to a full machine based survey regime, and currently hold SCANNER, SCRIM and Deflectograph data on the network. This has enabled a good understanding of network condition, but also presents challenges in determining investment priorities. To address these concerns an integrated programme of works was required. Carmarthenshire has been using the WDM® Scheme Manager application for over three years now to manage its skid resistance investigations, and has now been enhanced to generate and prioritise maintenance schemes by analysing all available condition data. A standard methodology that can be applied every year to undertake this task has been developed and documented.

A list of potential schemes has been identified. Provisional costs have been identified for the schemes giving an appreciation of the programme of works required to maintain a level of service to road users. These provide an indication of the value of work that is required to treat all lengths of roads in the county that have been identified as defective. It is anticipated that the schemes will be subject to a process of value management to improve the forecasting of costs.

2. ROAD CONDITION

The Carmarthenshire network comprises of around 3,373km of carriageway and 937km of footway. The breakdown of carriageway by class and environment is shown in table 1.

Table 1 – Road Length by Classification and Environment

Class	Rural (km)	Urban (km)	Total (km)
A class	150.98	98.63	249.61
B class	226.56	104.82	331.38
C class	1158.68	110.58	1269.26
Unclassified	1131.59	391.20	1522.79
Total	**2667.81**	**705.23**	**3373.04**

2.1 CONDITION OF THE CARMARTHENSHIRE NETWORK

Condition data held in the Carmarthenshire PMS are processed to assess the condition of the network as reported on 31 March 2012. The National Indicators calculated will be those reported to the Welsh Government for 2011/12.

The Class I, II, and III networks are surveyed with SCANNER in accordance with the Welsh Government requirements for reporting as set out below:

A class Roads   100% of the network to be surveyed in one direction or 50% in both directions

B class Roads   100% of the network to be surveyed in one direction or 50% in both directions

C class Roads   50% of the network to be surveyed in one direction or 25% in both directions

In addition, the unclassified roads are surveyed on a sample basis using the MRM or SCANNER. The MRM uses the same laser technology as SCANNER and measures rutting, longitudinal profile, and texture in the same manner, but does not include crack recognition. In 2011/12, 290km of unclassified roads were surveyed in Carmarthenshire.

SCRIM surveys are undertaken on A and B class networks on an annual basis.

Whilst a regular programme of Deflectograph surveys is no longer followed in Carmarthenshire, 235km of survey has been carried out since 2007.

2.2 NATIONAL INDICATORS

The SCANNER data has been processed using the relevant UKPMS rules and parameters to calculate the National Indicators.

Table 2 – National Indicators for 2011/12

Class	% Red Above 100	% Amber 100-40	% Green Below 40
A class	6.1	30.0	63.9
B class	6.5	30.4	63.1
C class	21.1	36.2	42.7
Unclassifed	9.8	16.0	74.3

Note: The unclassified indicator is based on survey of 38% of the network

2.3 SCRIM DEFICIENCY

The SCRIM survey data has been processed and the SCRIM condition is shown in table 3.

Table 3 – SCRIM Condition Data

Condition Indicator	Deficiency in relation to IL	A class	B class
Very Poor	0.05 or more below IL	4.2%	2.7%
Poor	Between 0 and 0.05 below IL	8.9%	5.8%
Fair	0.01 to 0.05 above IL	11.9%	9.8%
Good	>0.05 above IL	75.0%	81.7%
Total		100.0%	100.0%

2.4   DEFLECTOGRAPH DATA

The Deflectograph data collected since 2007 (235 lane km) has been processed to calculate Deflectograph Residual Lives, using the traffic data and construction records held in the PMS. The residual life distribution is shown in table 4.

Table 4 – Deflectograph Residual Life Profile

Residual life	Percentage of Survey Length (235 lane km)
< 0 years	37.9%
0 - 4 years	14.4%
5 - 9 years	11.0%
10 - 14 years	7.7%
15 - 19 years	6.4%
>20 years	22.6%

3. WELSH BACKLOG & DEPRECIATION CALCULATIONS

The Network Backlog calculation carried out on behalf of the Welsh Government is different in principle to the CIPFA Depreciated Replacement Cost calculations[1]. The following two sections describe the characteristics of the two backlog calculation methods.

3.1   BACKLOG CALCULATIONS UNDERTAKEN BY WELSH GOVERNMENT

This calculation requires the network SCANNER data to be processed using the National Indicator specifications for Class 1, 2, and 3 networks, and the unclassified network weighting set specifically established for Welsh local authority networks.

This backlog calculation is dependent upon the amount of survey data available, and it does not scale to the total length of the network (i.e. backlog is only to treat sections that have been surveyed).

For each 10m subsection where an RCI score has been determined in the appropriate survey period for the class, a backlog figure is calculated. Then, all the subsection backlog figures are summated to determine the total backlog of the network.

The calculation used an average lane width based on road class, and a unit cost that depended upon the RCI value for the section.

The latest backlog figure issued by WAG was in 2011/12; and the reported backlog for Carmarthenshire was £25.07m.

3.2   HAMFIG/CIPFA Depreciation Calculations

In 2010, UKPMS published Technical Note 46[2], which details the methodology to determine network depreciation using the Carriageway Condition Index (CCI). The procedures set out in Technical Note 46 can be used to produce various reports for financial information to support asset management as requested by the Highway Asset Management Financial Information Group (HAMFIG).

In this process, a CCI score is determined for each 10m subsection based on survey data. The CCI uses the same parameters as used in the National Indicator calculations; but uses a different calculation. The CCI does not apply thresholds, and texture depth is not as influential in deriving the CCI as the RCI.

The CCI is then converted to an accumulated depreciation using deterioration parameters T_{INI} (the time to when deterioration commences) and T_{TUL} (the time to when the pavement is unserviceable and needs replacement respectively).

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[1] Code of Practice on Transport infrastructure Assets. CIPFA.2010

[2] **Technical Note 46.** Financial Information to support Asset Management Guidance notes for UKPMS Developers for 2012/13 Carriageways. UKPMS 2013

Subsequently, the Network Accumulated Depreciation Percentage for the network group is determined as the length weighted average of all the subsection Accumulated Depreciation Percentages. Using this methodology the Depreciated Replacement Cost for Carmarthenshire is shown in table 5.

Table 5 Road Asset Valuation Summary

Asset Type	Gross Replacement Cost	Depreciated Replacement Cost	Annualised Depreciation Charge
Carriageway	£2,486,631,270	£2,167,797,993	£22,215,161
Footway	£62,852,627	£50,033,061	£1,341,085
Structures	£363,798,429	£330,853,223	£1,234,500
Street Lighting	£29,918,231	£14,060,256	£978,765
Street Furniture	£0	£0	£0
Traffic Management Systems	£1,100,000	£577,500	£55,000
Land			
Total	**£2,944,300,557**	**£2,563,322,033**	**£25,824,511**

It can be seen that the carriageway Depreciation is £380.98m using the HAMFIG methodology. When compared to the Welsh Government figures this creates confusion due to the huge difference in value, derived from using the same data. The perception is that the DRC calculation includes depreciation on lengths that would never be prioritised for treatment, whilst the Wales Government figure is low when set against a likely set of schemes. When communicating with members and the public this creates uncertainly and undermines confidence in the use of condition data. It was therefore decided to develop a Carmarthenshire maintenance shortfall based on a realistic assessment of a programme of works that could be justified by road condition.

4.0 WDM SCHEME MANAGER

Scheme Manager is an application in the WDM PMS. It is designed to process condition data with the objective of identifying schemes. A set of rules specifically defined for Carmarthenshire, determined through careful examination of the condition of the Carmarthenshire network was developed and applied.

4.1 SCHEME GENERATION

Schemes can be generated using any condition data, or other spatial data held in the PMS database. The schemes are identified using a threshold value, scheme length and join distance. Schemes have been identified using SCANNER data and SCRIM data.

4.2 SCHEME RANKING

A ranking methodology that utilises SCANNER parameter data (actual parameter/defect values) and SCRIM deficiency has been developed for Carmarthenshire, which uses an engineered approach to scheme prioritisation by considering weighted importance defect values and defect severity. The parameters, derived from SCANNER and SCRIM surveys shown in table 6 are used. The Overall Ranking Score gives 80:20 weighting ratio for SCANNER and SCRIM data respectively.

The table shows the maximum scores for individual parameters which has been determined in consideration of the importance and reliability of the data, and the significance of each parameter on triggering maintenance. The criteria attempt to give a weighting to replicate the conventional site assessment. Each 10m sub section of data within any given scheme is scored, and a scheme score is calculated from all the valid 10 sub sections.

Table 6 – Ranking Parameters and Scores

Condition Parameter	Maximum Score for Parameter
Rut Depth	223
3m Profile Variance	178
10m profile Variance	133
WC Cracking	133
Texture Depth	133
SCRIM Deficiency	200
Overall Ranking Score	**1000**

For each condition parameter a scoring matrix has been adopted based on the distribution of the parameter values. Table 7 shows those adopted for 3m profile.

Table 7 – 3m profile scoring in scheme manager

3m Profile Variance				Score
Class I	Class II	Class III	Unclassified	
>=8.5	>=11.0	>=19.5	>=33	**178**
7.4	9.6	17.3	29	**148**
6.3	8.2	15.1	25	**119**
5.2	6.8	12.9	21	**89**
4.1	5.4	10.7	17	**59**
3.0	4.0	8.5	13	**30**

This indicates that 3m profile is considered more important on the A class roads, i.e. a different level of service is applied in determining scheme rankings.

5.0   SCHEME IDENTIFICATION

Four separate scheme sets were generated for the four road classes using the scheme generation criteria established. A total of 2774 schemes with an overall length of 1531.897km were identified; however a number of these were triggered by short sections of defective carriageway, amongst lengths in generally good condition.

To report an 'equivalent' scheme based backlog any schemes which scored over a minimum threshold ranking are reported. With typical rates applied for surface dressing and resurfacing a scheme based backlog is reported in table 8.

Table 1 – Summary of Schemes Selected

Class	Number of Schemes	Total Length of Schemes	Average Scheme Length	Total Cost of Schemes
Class I	227	84.299km	371m	£7.05M
Class II	338	129.038km	382m	£9.94M
Class III	980	354.274km	362m	£14.70M
Rural Unclassified	715	818.504km	1145m	£18.32M
Urban Unclassified	212	62.607km	295m	£4.82M
Totals	**2472**	**1446.722km**	**586m**	**£54.83M**

The schemes are stored in the Scheme Manager application and available for review, interrogation within the Carmarthenshire live PMS.

£54.83m is considered to be a more realistic assessment of backlog, and has a programme of works identified that can be developed into schemes fairly easily. It also combines the use of SCRIM and SCANNER data; therefore representing a more realistic assessment of maintenance need. It is acknowledged that this is a desktop-based process and it is important to undertake a field validation (or at least a desktop validation) of sites before including in the rolling maintenance programme.

6.0 SKIDDING RESISTANCE INVESTIGATIONS

Carmarthenshire run a parallel process to identify sites requiring investigation under their SCRIM policy. This uses the seasonally corrected SCRIM data and 4 years accident records to identify sites for investigation. The sites are generated using Scheme Manager and provided to a consultant appointed to undertake the investigations on an annual programme.

The purpose of the investigation is to determine whether form of treatment will be justified using the following principles:

- Based on an accident analysis, the number of accidents observed is higher than average for the type of site being considered;
- Based on an accident analysis, the site has a higher than average proportion of accidents in wet conditions or involving skidding for the type of site being considered with the skid resistance at its current value or if it were to fall further before the next measurement. In this case, preventive treatment is justified to pre-empt a potential increase in accident risk.

If none of the above are true then there is no justification to increase the skid resistance.

6.1 ADDRESSING SAFETY

It can be seen that within the overall scheme development and assessment Carmarthenshire have 2 complementary approaches. The first involves the priortisation of sites using SCRIM data for investigation. The recommendations from investigations are either implemented, or used as part of the overall scheme development. This approach typically addresses the 'risk' sites identified through the surveys.

The second process is to use SCRIM data as a general input into ranking schemes identified through other condition data. This provide a proactive approach to improving the skid resistance on the network in a targeted manner.

6.0 CONCLUSION

Similar to many authorities Carmarthenshire collect condition data for Indicator and financial reporting purposes. However they have also realised the value of the data in developing a comprehensive programme of works and have used WDM Scheme Manager to assist with this process. The result is that the council have a clear maintenance investment programme identified that can be continually refreshed as new data becomes available.

The programme is also use to identify a maintenance backlog that is considered a realistic assessment of network condition and maintenance needs, but is backed up by a series of identified schemes. This assists in planning and programming Carmarthenshire's own works, but also in coordination with other works promoters such as utility companies. Resident and road users in Carmarthenshire benefit for a better maintained and planned network.