Highways Infrastructure Life Cycle Planning

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Contents

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1. Introduction

The aim of good asset management is to minimise costs, optimise investment decisions and deliver effective maintenance solutions by delivering a robust, sustainable, and long-term approach to improve the asset's performance, improve safety and reduce the risk to stakeholders (both operators and users), whist supporting carbon reduction and climate change as set out in the 'Highway Infrastructure Asset Management Strategy'.

Consequently, it is essential that asset management is supported by an effective approach to managing the whole of the assets life cycle and ensuring that the most effective maintenance is prioritised in the annual service plan. This requires an understanding of the highways infrastructure assets, making use of all appropriate data sources and providing an efficient and effective maintenance plan to deliver desired levels of service and a sustainable highway network.

Life Cycle Planning provides.

- an understanding of the maintenance need and cycle of the asset to maintain its performance over the whole of its life
- the input for condition modelling to create a forecast of the future works and budget implications required to maintain levels of service appropriate to the network hierarchy

Underpinned by quality inventory and condition data, life cycle planning assists in providing an indicative long term forward plan of works likely to be required over the next 5, 10, 20 years, including a forecast of future budget needs.

Furthermore, through a process of condition projection modelling, the future condition of the highway infrastructure network asset can be assessed against various investment scenarios to secure the most appropriate and effective maintenance plan and to ascertain associated funding needs over the period of the Asset Management / Annual Service Plan (typically 5 years).

This document sets out the London Borough of Newham's direction to implementing a Life Cycle Planning approach to inform and facilitate priority maintenance works and asset replacement works required to support a well performing highway infrastructure network of assets.

A well-conceived 'Life Cycle Planning' Strategy will help address some common challenges faced by local authorities such as:

- Understanding the holistic maintenance need of the highway infrastructure network, to ensure safety, availability, accessibility and the long-term sustainability of the highway infrastructure network as well as the opportunities to improve recycling, carbon reduction
- Managing the highway maintenance budget across all highway infrastructure assets
- Managing stakeholder expectations across the highway network
- Providing a transparent approach to the prioritisation and selection of highway infrastructure maintenance and replacement schemes
- Providing a long-term understanding of future works and associated budget requirements across the highway network
- Understanding the long-term outcomes of the maintenance decisions made each year
- Monitoring the effectiveness of the Council's highways asset management approach to the management and maintenance of the highway infrastructure network

The Highways infrastructure Code of Practice provides the following recommendations for Life Cycle Planning in support of highways investment planning and works prioritisation:

RECOMMENDATION 13 – WHOLE LIFE / DESIGNING FOR MAINTENANCE
'Authorities should take whole life costs into consideration when assessing options for maintenance, new and improved highway schemes. The future maintenance costs of such new infrastructure are therefore a prime consideration.'

RECOMMENDATION 29 – LIFECYCLE PLANS
'Lifecycle planning principles should be used to review the level of funding, support investment decisions and substantiate the need for appropriate and sustainable long-term investment.' (HIAMG Recommendation 6)

RECOMMENDATION 30 – CROSS ASSET PRIORITIES
'In developing priorities and programmes, consideration should be given to prioritising across asset groups as well as within them.'

RECOMMENDATION 31 – WORKS PROGRAMMING

'A prioritised forward works programme for a rolling period of three to five years should be developed and updated regularly.' (Highways Maintenance Efficiency Programme UKRLG, Highway Infrastructure Asset Management Guidance (HIAMG) Recommendation 7)

RECOMMENDATION 32 – CARBON

'The impact of highway infrastructure maintenance activities in terms of whole life carbon costs should be taken into account when determining appropriate interventions, materials and treatments.'

It is against this background that a 'Life Cycle Planning' Strategy is required.

2. Scope

The 'Highways Infrastructure Life Cycle Planning (LCP) strategy sets out the approach to delivering an asset management methodology to the maintenance and replacement of highway infrastructure asset, in line with the 'Highway Infrastructure Asset Management Strategy'.

The aim of this LCP strategy is to:

- Provide a consistent, transparent and data led approach to the planned maintenance of the highway infrastructure asset, that considers the whole life evaluation of the asset
- Develop an optimised approach to maintenance treatments considering cost, performance, use, in addition to carbon, recycling, and the long-term sustainability of the asset
- Develop a long-term forward plan and understanding of the recommended work and associated budget implications to meet the levels of service agreed with stakeholders
- Facilitate the prioritisation of work within and across all asset groups to ensure that all maintenance and replacement works undertaken on the highway infrastructure network assets provides the most effective solution when considering risk and aligns to the goals and objectives of the Council in providing safe, serviceable, sustainable, available and accessible network of highway infrastructure assets

A derivative of life cycle planning is a 'Life Cycle Planning and Works Prioritisation Framework' which serves to link Life Cycle Plans with Highways Investment Planning and the Annual Service Plan and to make these available on a scale of granularity suitable for an effective understanding of investment strategies in the maintenance of the highway infrastructure network at all levels.

2.1. Life Cycle Planning and Works Prioritisation Framework

Life Cycle Plans (LCP) are aligned with condition projection modelling and with the Councils' budgets and resources to support Highways Investment Planning and the provision of an effective Annual Service Plan, this process is shown in Figure 1 below.

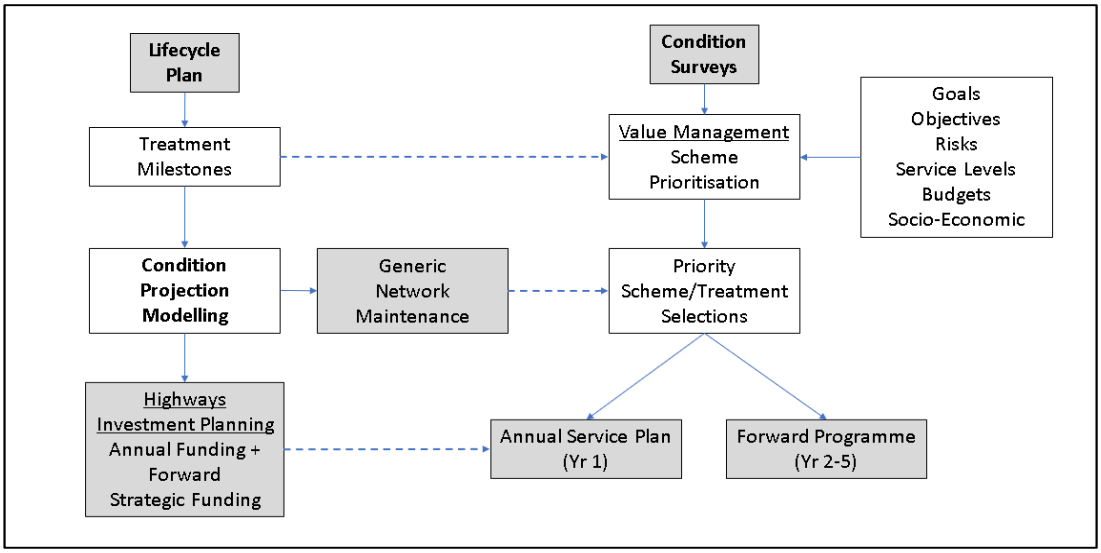


Figure 1 – Life Cycle Planning & Works Prioritisation Framework

The 'Life Cycle Plan' models the future asset maintenance interventions and treatment milestones required in order to optimise the longevity of the asset in the most cost-efficient manner and to achieve optimal asset performance. The maintenance life cycle is then applied to the process of asset condition projection modelling and tested against various funding and resource scenarios to develop a future understanding of the condition outcomes and to determine the most effective investment planning profile.

The treatment milestones derived from LCP may be set alongside the condition survey value management scheme prioritisation model as an additional marker for scheme priority consideration. This may bring additional maintenance sites into the priority scheme list or upon analysis it may result in the deferral of a lifecycle treatment in order to 'sweat' the asset to extend its current life condition before the next milestone treatment is applied.

3. Life Cycle Plans

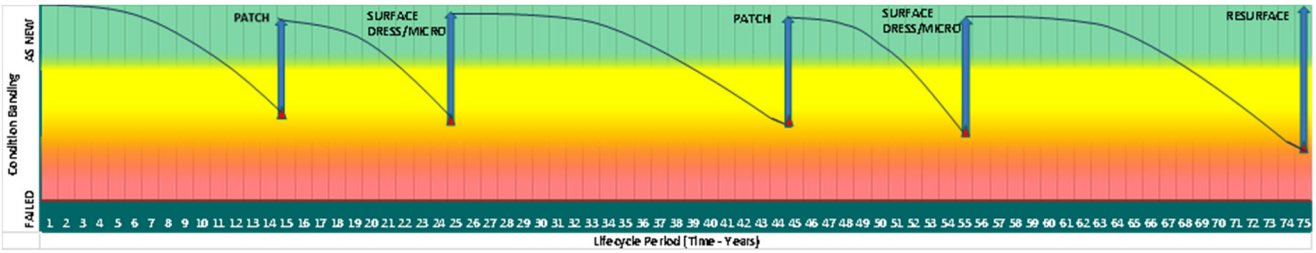
3.1. Life Cycle Model

An asset's life cycle covers the time during which an organisation spends money on it, from the initial installation up to the end of its useful life or its decommissioning.

Life cycle Planning is the continuous process of managing an asset throughout its service life and it provides for the long-term strategic planning of maintenance treatments and replacements to extend and optimise the serviceable life of the asset.

Life cycle planning illustrates the process of modelling the anticipated service life of an asset reflective of its nature, composition, the environment it resides within and its usage. The model allows for timely and periodic maintenance treatment interventions to be undertaken throughout the asset's serviceable life, thereby extending the useful life of the asset until it needs to be replaced. When applied to the network, this process can then be used to identify potential maintenance treatment milestones, planned investment needs and service priorities.

A typical carriageway life cycle plan is illustrated below, which shows how a road may be maintained through a series on routine and planned maintenance treatment interventions over time to provide what is effectively an infinite life of the asset. Appendix 1 illustrates this further with milestone treatments.



Life cycle planning is not directly a works programming tool. However, it can be used in conjunction with condition survey analysis, condition projection modelling and value management modelling to review annual maintenance works programmes and to calculate the overall planned maintenance investment needs of the network over time, say for 20-30 years, under varying budget and resource scenarios.

This model can then form the basis of and justification to support the need to retain the level of asset maintenance funding to achieve steady state condition of the asset and for seeking increased funding to improve asset performance and condition over time and to support the desired levels of service.

Life Cycle Planning

- advises on what should be done to achieve and maintain a steady condition state of performance (i.e., a network in a stable condition)
- recommends the minimum maintenance and replacement that should be undertaken to maintain the asset at the required service level
- indicates the annual budget required to sustain the agreed levels of service

An asset's life cycle begins with its new installation, it then proceeds to a prolonged cycle of routine and planned maintenance and upkeep leading finally to its renewal or replacement when the asset is at a substantial risk of gross failure and/or further maintenance is not applicable or cost effective, alternatively in some instances it can end with its removal or decommissioning from service.

Typically, the 'end-of-life' phase includes the ultimate disposal of the asset, however this does not generally apply to most highway infrastructure assets or to assets of infinite life unless they are abandoned and require removal. As a consequence, the potential to decommission and remove assets should always be considered and reviewed at each of its maintenance treatment milestones, which if applicable will reduce or remove entirely the ongoing carbon footprint of the infrastructure asset.

Highway Infrastructure assets fall into two distinct lifecycle types 'Finite' and 'Infinite'.

Finite assets are those with limited options for extending their life and that once they have been fully used they require replacement.

- Finite assets include:
    - Road markings and signs
    - Streetlights
    - Traffic Signals
    - Street Furniture

Infinite assets are those which can be maintained 'ad infinitum', essentially forevermore, provided the appropriate lifecycle plans and associated maintenance regimes are followed.

- Infinite asset include:
  - Carriageways, Footways & Cycleways
  - Structures – Bridges, subways, retaining walls.
  - Drainage

3.2. Life Cycle Management

The components for the management of an asset's life cycle can be divided into four distinct areas:

- Governance
- Design
- Operations
- Treatments

3.2.1. Governance

Encompasses all the decision making and project management for the asset and extends over the whole life of the asset, ensuring the asset is effective in meeting stakeholder and service level needs and understanding the associated benefits and costs. Good governance allows the Council to maximise the value of their asset and is in many ways the most important aspect of Life Cycle Management.

3.2.2. Design

Prior to commissioning the creation and installation of any highway asset, the Highway Authority will consider the effective long-term maintenance, replacement and disposal cost of the asset at the end of its life. 'Design' provides the key stage in ensuring assets are compatible with the Highway Authority's aims in creating a safe available, serviceable, accessible and sustainable highway network that will not be an undue burden on those responsible for its ongoing maintenance. Newham has adopted a policy of the sustainable design of all highway assets to maximise the life of the asset whilst minimising the number of maintenance interventions (e.g., the conversion to LED lighting)

3.2.3. Operations

The Highway Authority will effectively plan, fund and facilitate the maintenance treatments and replacements of highways assets in a strategic way to maximise the service life of all assets within the constraints of annual budgets, affordability and engineering resource allocations based on the best supporting information available. This will be through the adoption of a coordinated approach to service delivery with other in-house service departments, with external infrastructure organisations, e.g., utility services, and with other external stakeholders such as transport organisations, TfL, DfT, Network Rail, etc.

3.2.4. Treatments

To enable life cycle plans to have credence and to be useful in the modelling process, the Highway Authority has an array of standard treatments that it uses to maintain its assets effectively. These treatments have been developed reflective of the maintenance hierarchy to ensure treatments are appropriate to the use of the asset, its importance, risks, and to ensure it is fit for purpose. There are often numerous maintenance solutions available for consideration to address a particular maintenance problem, each treatment option has an associated cost and service life that contribute to the final treatment selection decision.

3.2.5. Treatment Options

In determining the optimum lifecycle and associated budget needs, there is a requirement to analyse different maintenance scenarios to establish which is the preferred option for treatments. A 'scenario' is where a cycle of treatment options is considered over the defined life for the asset. The basket of treatments and appropriate maintenance scenarios are determined by the Highway Authority engineers, which are then used in the modelling process to determine which treatments and maintenance scenarios offer the most effective and optimal lifecycle maintenance solution appropriate to the hierarchy under consideration.

The following management and operational considerations are applied in the execution of this treatment selection process:

- Cost
- Performance
- Longevity
- Carbon footprint
- Budgets

- Service life
- Carbon consumption
- Sustainability of solution
- Performance
- Level of Service (varies with hierarchy).
- Reduced interventions and less disruption
- Less traffic management and less delays
- Minimising diversions

3.2.6. Treatment Costs

In calculating and comparing the cost of maintenance lifecycle options there is a need to understand the cost of a treatment in the future against carrying out the treatment now. To compare like with like, the Highway Authority may evaluate life cycle scenarios over say a 30-year period and use the 'Net Present Value' (NPV) of the treatments in the lifecycle, assessing the optimal treatment for every asset / hierarchy.

- NPV is the primary criterion for deciding the best course of action to be applied and can be justified. The cheaper the NPV the better 'Value for Money' the lifecycle option is
- NPV calculations will be based on a discount rate of 'x' % (Current Interest Rate) and an inflation rate of 'y' %. (Current Inflation Rate). This will be reviewed for future modelling with information from the Council's accountants

NB – the 'Discount Rate' in an NPV calculation is a percentage value based upon a rate of return expected from investing the money elsewhere.

3.2.7. Treatment Service Life

'Service Life' describes the life expectancy of the asset from its initial construction or treatment to the next treatment or replacement intervention, based on best practice, local and historic knowledge and it may vary according to traffic or environmental conditions.

The Highway Authority should keep good records of the past performance of their assets, their treatment and replacement timelines, and these are a good reference to the understanding of treatment performance and longevity, and the realistic determination of service lives applied to LCP.

In terms of highways, surface course replacement is one of the key drivers in this process. Typically, if a surface is very durable then the correct time to replace the surface would be when the skid

resistance has greatly diminished (i.e., polishing), depending on the traffic loading this can be upwardly of 15 years. However, in a heavily trafficked urban environment this time can be significantly reduced and hence will need treatment more frequently.

To reflect this possible variation in life span of different hierarchies, the LCP treatment option model may be adapted to apply a range of treatment life spans for each hierarchy. An appropriate point within this window of serviceable treatment life may then be applied to the model calculations reflective of maintenance hierarchy.

A practical by-product of lifecycle planning modelling is its use in the 'Condition Projection 'modelling process.

3.2.8. Condition Projection Modelling

Condition Projection Modelling uses the lifecycle planning model to provide an estimate or forecast of future asset condition from a study of past and current deterioration trends, based on the following:

- Condition
- Location / Environment
- Use

Through applying the LCP maintenance solutions aligned to variable budget scenarios the most effective maintenance plan may be determined to provide a steady state condition or one that gives rise to improving asset condition performance.

'Condition Projection' is complementary to lifecycle planning in that it takes into consideration the current condition of each asset, applies a funding scenario and a treatment correction to those assets where the most benefit can be gained, and it projects the future condition outcome. This process enables investment scenarios and outcomes to be considered in the light of the Council's current goals and objectives as well as the budget limitations they may have.

3.2.9. Highway Investment Planning Scenarios

Life Cycle Planning and Condition Projection modelling both serve to explore and consolidate the financial and resource investment requirements needed to promote asset stability and improvement.

From a works maintenance management perspective there are two fundamental directions that may be followed:

- Do Nothing
- Do Something

If a 'Do Nothing' scenario is adopted, the asset will gradually lose its integrity and start to decay, this strategy is acceptable providing the asset remains in a serviceable condition for a finite period of its life, and up to the point of condition transition as given by life cycle planning.

Once past the 'Do Nothing' stage the 'do something' option indicates that a treatment should be applied in order to retain the steady state condition or to secure asset condition improvement. The two treatment components of a 'do something' scenario are:

- Preventative
- Restorative

On the highway, a preventative treatment may take the form of road patching and surface dressing to protect and enhance the surface integrity of the asset, whilst a restorative treatment could be in the form of a structural resurfacing process which restores the life of the asset close to its 'as new' condition.

Whatever maintenance scenario is selected there is a cost in terms of changing condition and financial investment that needs to be apportioned to all parts of the network based on maintenance hierarchy. In addition, to meet the required performance outcomes, the Council's approach to carbon saving, levels of service, and the reduction in maintenance interventions should also be considered.

3.2.10. Forward Plans

The outcome from life cycle planning and condition projection when linked with condition survey data analysis is the development of current and future works programmes. A works programme for the current/next year is based on the maintenance priority needs through condition surveys and it

can be further checked against the maintenance milestones denoted through LCP with a high level of confidence of selecting the most appropriate schemes and treatments at the right time. Forward maintenance plans for future years can also be generated via the same process however as the years progress these tend to reduce in confidence and be more indicative in nature and they can be superseded by changing network condition at that time, in particular reflective of annual winter degradation performance or emergency events, e.g., flooding, excessive heat, etc.

Forward plans can be effectively used to understand the investment planning requirements of assets individual and asset groups, and they assist in understanding future budget planning and resource implications. The Highway Authority will promote the development of long-term forward plans based on the outcomes of lifecycle planning, condition projection and investment scenarios to provide an understanding of the likely work and budgetary requirements of each asset or asset group over the next 5 years.

Forward plans provide an indication of the works and costs required to maintain the asset, returning it from its current depleted condition to a costed and validated lifecycle plan. This allows the Highway Authority to plan its future maintenance strategies based on budget, hierarchy and risk and to make well-informed decisions for the most effective maintenance and replacement of its assets.

Using forward plans as a basis for the development of an annual programme of maintenance and replacement works, often referred to as the 'Annual Service Plan', allows the Highway Authority to plan ahead and implement a maintenance strategy that works best for stakeholders by ensuring adequate cash flow and cost-efficient practices, and by minimising the number of future uncertainties.

4. Summary

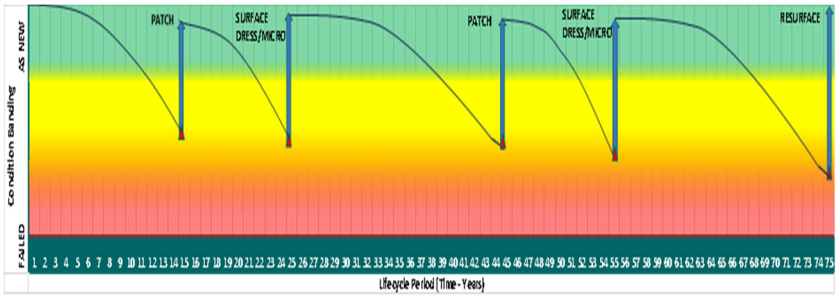
The processes outlined in the Life Cycle Planning strategy are applicable to all highway infrastructure assets and service delivery operations. The wide range of defined service levels, performance measures and performance targets identified by the Highway Authority are recognised as necessary to meet the corporate business needs, aims, goals and objectives of the Council at the strategic level and also the more specific detailed delivery aspects of the service at the tactical and operational levels of service reflective of considerations of risk and benefits.

The effective implementation of the LCP strategy will provide a sound approach to the provision of an 'Annual Service Plan' and a 'Forward Works Programme', providing the maximum cost benefit to the highway infrastructure network. In essence this will support good asset management protocols and will align with the requirements of the 'Highway Infrastructure Asset Management Policy and Strategy' and with the 'Scheme Prioritisation Strategy'.

Appendices

Appendix 1: Life Cycle Plan (Example: Treatment Milestones)

Network Length	300,288 km				
Network Area	1,592,586 sq m				
Lifecycle Plan	Treatment Plan	Unit Rate (£/sq m)	Treatment Life (Yrs)	∑ Service Life (Yrs)	
New/As New	Implementation Year (New Surface)	£35.00	15	15	
Treatment 1	Patch @ 10% Network Area	£18.00	10	25	
Treatment 2	Surface Dress / Micro Surface	£12.00	20	45	
Treatment 3	Patch @ 10% Network Area	£18.00	10	55	
Treatment 4	Surface Dress / Micro Surface	£12.00	20	75	
	Lifecycle Plan Duration		**75**		



On Average		Annual Treatment Length (km)	Annual Treatment Area (sq m)	Annual Spend (£)
1/75th of the network should be resurfaced 'As New' every year		4,004	21,234	£743,190
1/75th of the network should be treated with Treatment 1 every year		4,004	2,123	£38,214
1/75th of the network should be treated with Treatment 2 every year		4,004	21,234	£254,808
1/75th of the network should be treated with Treatment 3 every year		4,004	2,123	£38,214
1/75th of the network should be treated with Treatment 4 every year		4,004	21,234	£254,808
Total Annual Budget Required =				**£1,329,234**