

Network Rail Asset Management Policy Justification for Civil Engineering Policy

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Asset policy justification, Civils

1 General

The Network Rail asset management policy sets out our management policies for Civil engineering assets. This document records the information and assumptions that underpin those policy decisions, and provides quantitative evidence to support the principal cost drivers.

Issues addressed include:

- an assessment of the risk to business outputs as a result of asset degradation or failure.
- the options considered to mitigate this risk.
- the determination of the optimum balance between examination, maintenance and renewal.
- the rationale for the choice of the replacement asset
- an assessment of the long-term implications of this policy (in terms of impact on business outputs and cost).

The policy statements in this section apply to all civil engineering assets except where specific exceptions are identified.

The Strategic Route Sections used in local business planning that influences the implementation of the policy are consistent with other policies across Engineering and are a subdivision of the network into 308 sections, based upon traffic activity. This allows routes that are intensively used and support high speed traffic with associated high passenger revenue to receive proportionally more investment than route sections where utilisation is low.

The Policy is supported by the Civil Engineering suite of Group and Company Standards. These underpin all activity undertaken on the Civils Assets. A full list of the Company Standards is included in Annex A.

The competency and capability of staff employed to carry out management activity on the Civil Assets is assured through a consistently applied competency framework included in every job description. Each appointee is required to demonstrate

competence and sign off acceptance of the job description. Specific competencies required for each task are specified as part of each company standard.

Activity undertaken on each asset is informed by contemporary information and must accord with financial governance rules that assure value for money. Additionally any investment in excess of £50k requires national staged approval via investment panels. These standing forums consider business cases for each investment that describe priority scores, justification of the selected option and risk, financial and implementation proposals. Intended investment plans are defined in detail for 3 years and in outline for a further two years within our business plans. These investment plans cover approximately 75% of available funds, the balance being retained for a minor works programme and emerging need.

1.1 Brief description of the purpose of civil engineering assets

Civil engineering assets comprise:

- underbridges (under the railway)
- overbridges (over the railway)
- embankments
- rock and soil cuttings
- retaining walls
- culverts
- tunnels
- footbridges
- major structures (significant structures where normal policy might not be appropriate)
- coastal and estuarine defences

Civil engineering assets generally have long lives and slow initial deterioration rates. Most have been in existence since the time of constructing the original railway and are therefore between 100 and 150 years old.

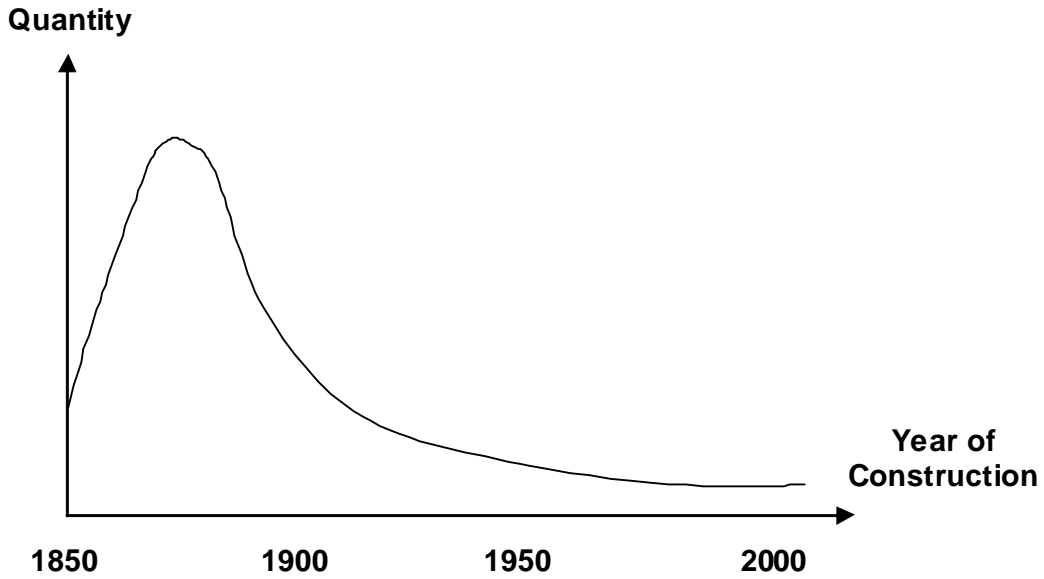


Figure 1, Approximate rates of construction for civil engineering assets

A number were improved around the beginning of the 20th century as a result of railway expansion, with the result that much of the asset base has remained unchanged for at least 90 years. During the last 90 years or so maintenance levels have been variable, with reliance often placed on the resilience of the assets to cope with deteriorating condition levels and changed loading and traffic levels.

As a result the ability of individual assets to meet business needs varies widely and careful evaluation of maintenance and renewal options is needed to ensure that each asset has an intervention plan which is consistent with the needs of the route.

1.2 Policy statements

| Figure 2 Structures Assets – General policy statements | |
|--|---|
| Number | Policy Statement |
| Civil-1 | Examination of civil engineering assets shall be carried out at regular intervals, selected to achieve the optimum balance between cost and risk, and the condition of each asset inspected shall be recorded |
| Civil-2 | Examination results shall be used to develop a bespoke plan for each |

| Figure 2 Structures Assets – General policy statements | |
|---|--|
| Number | Policy Statement |
| | asset, consistent with the policy selected for the asset, to remedy the defects found, if any, in order to maintain the asset's functionality |
| Civil-3 | Each civil engineering asset shall be identified as being managed under policy 1 or 2. |
| Civil-4 | <p>The selection and timing of the maintenance work to be carried out shall take into consideration:</p> <ul style="list-style-type: none"> • asset condition and strength required • short term and long term historical changes in the asset condition • the overall policy for the asset (policy 1 to 2) taking due account of the customer driven requirements of the route section on which the asset is located, including increases in traffic volume and loading. • the life cycle cost of each viable alternative (including cost of possessions and track outages) • statutory requirements, including the rights of users and heritage requirements • the timing of other asset interventions to reduce the impact on route availability |
| Civil-5 | Assets shall be replaced only when the risk to performance applicable to the asset requires it and it is cheaper, in whole life cost terms, than the maintenance needed to continue to meet the requirements of the route |
| Civil-6 | Where replacement of any asset is necessary this shall be selected on the basis of the least whole life cost solution that would meet the route's performance requirements. |
| Civil-7 | Replacement work shall take into account the same considerations as listed under Civil-4 |
| Civil-8 | Each bridge shall be allocated a Structures Condition Marking Index from 0 to 100 to reflect the condition found on detailed examination. . Bridge assets with critical hidden details shall have such revealed and verified periodically |
| Civil-9 | The Route Availability of each underbridge shall be maintained to be consistent with the requirements of the route on which the underbridge is located. Remeadiating any bridge that is below the requirements required |

| Figure 2 Structures Assets – General policy statements | |
|---|--|
| Number | Policy Statement |
| | will be prioritised in accordance with customer needs. |
| Civil-10 | Overbridges within the remit of Bridgeguard 3 shall be assessed to check their ability to carry 40 tonne vehicles and any necessary strengthening work to meet Network Rail's obligations implemented. . |

1.3 Degradation, failure modes and consequential risk

The principal purpose of civil engineering assets is to provide support. Their failure modes vary between the different types of asset, and are therefore described in the later detailed sections of this document.

Complete failure of civil engineering assets is rare and records show that most failures occur during construction. There are however emerging risks associated with the overall age and condition profile of the infrastructure and the modern traffic demands placed upon them. With some notable exceptions bridge structures have a considerable margin of safety and apparent deterioration may not be significant. However the relationship between condition and strength is not linear and ultimately strength can be jeopardised by small changes in condition, or hidden defects or changes that increase the direct traffic loading.

Earthworks fail in short lengths, with several occurrences a year across the network, usually as a result of exceptional weather or circumstances. However, all assets deteriorate, mainly according to the list below:

Key drivers for Civils asset deterioration

- rainfall
- groundwater
- surface water run-off
- chloride induced corrosion (road salts)
- geological conditions
- mining activity

- freeze thaw/ thermal cycle
- vegetation
- animal Infestation
- scour
- design/latent defects
- increased loading
- accidental impact
- wind

Defects develop which potentially lead to:

- loss of support to the track
- loss of support to adjoining land or roads or other features crossing over the railway
- material falling onto the railway
- flooding of the railway
- failure to meet legal obligations to others

It is sometimes possible to continue to operate rail services after some defects have occurred by:

- imposing weight restrictions on railway or road traffic
- imposing speed restrictions on railway traffic
- carrying out additional examinations

However, these options place limitations on the railway or road traffic or result in increased costs and as such these measures are used by exception only.

1.4 Managing degradation risk

We manage the risk of failure by applying to each asset one of three alternative policies, policy 1, 2 or 3:

Policy 1 *Return and maintain the asset to steady state by the use of maintenance activities that will retain performance levels and extend the remaining life of existing assets. This is the closest approach to a whole life cost optimum.*

Policy 2 *Allow assets to deteriorate until intervention is essential to maintain safety standards or raise performance levels to an acceptable level. At the time of intervention carry out works that represent best value for money and exceptionally where the demand of the route section in question warrants such consider further improved performance where exceptional value will be delivered, this will particularly apply to the heavy volume and heavy tonnage routes..*

Policy 3 Applies to Line Closure Only - *maintain at a level to comply with essential public health and safety obligations*

We apply these policies to achieve a balance between delivering current route capability and train performance, lowest whole life cost and maximise the delivery possible with the level of funding required. To aid decision making we use decision matrices to aid definition of when we will need to take action under Policy 2 and the limited number of circumstances where we can achieve additional value by applying a solution much closer to the whole life optimum.

Whilst the Policy statements above detail the overall generic policy approach in some cases an exceptional judgement will be required on individual assets that are so critical that they threaten a disproportionately negative effect on the performance of the route. We intend to develop a nationally held list of these structures which will be produced by March 2011. Any work to these assets will accord with our conventional rules surrounding financial governance of project investment & business planning.

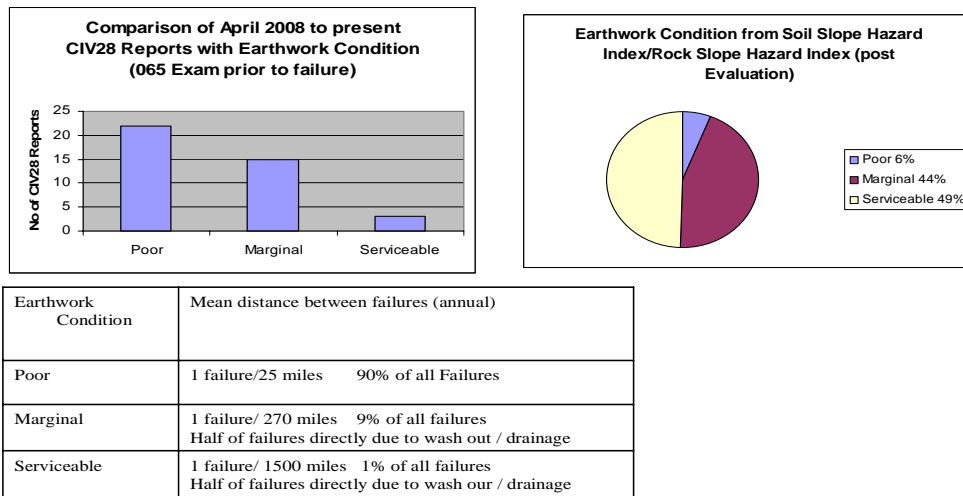
Bridges are largely well built robust structures that deteriorate slowly and have had regular maintenance interventions, albeit less than optimum. With the correct and timely maintenance regime these structures can be life extended for a very long time.

Some Earthworks in contrast with many bridges were constructed poorly because they pre-dated any scientific understanding of the behaviour of soils and there was an inability to transport sound bulk fill material any distance.

Because large lengths of earthworks have been in poor condition but are still serviceable, their failure depends not just on condition but on the risk that a particular set of circumstances will occur. We have reviewed evidence on past failures and can observe that the majority of failures are initiated by localised extreme weather. The headlines of this work are described in fig 3 below. With current weather patterns

exhibiting a greater frequency of extreme events these failure risks have increased and present risks not only to earthworks in poor condition but also in certain circumstances earthworks in rather better condition (that we classify as either marginal or serviceable) and we continue to work on the means to better manage such risks; our current work includes a national study to identify key sites where water is naturally concentrated and enters the railway from adjacent land, further remote monitoring techniques to help rapidly identify and control failures that do occur and research and development work in conjunction with the Railway Safety and Standards Board (RSSB) into the impact of and means to adapt to climate change.

Fig 3 Earthwork Failure by Condition



Modelling has shown that earlier expenditure on earthworks reduces the failure rate. Planned remediation of earthworks is less costly than dealing with failures reactively and incurs less disruption costs.

All assets are subject to examination regimes, which produce reports that are used to determine what maintenance and renewal work is needed. We aim to identify work at least two and preferably three years before it has to be carried out so that any repair schemes are developed and track possessions booked to allow us to procure the work as efficiently as possible. The aim is to optimise examination resources to minimise the risk of failures occurring. Our examination periods are developed from an assessment of condition, asset form and risk as specified in Network Rail company standards which

have developed from accepted national and international practice. We seek to continuously improve our approach to examination to draw learning from observed patterns of degradation and ensure periodicity of examination is soundly based.

Existing profile of condition of Network Rail Earthworks (data from December 2009)

| | Poor | Marginal | Serviceable | Not yet classified under current standard but previously Good |
|-------------------|------|----------|-------------|---|
| Length KM | 664 | 4,430 | 5,977 | 3,195 |
| % of Asset to 065 | 6% | 44% | 49% | N/A |

1.5 Examination

The examination regimes vary across the different assets types (so tunnels are inspected and examined in a different way to coastal and estuarine defences) to reflect the different failure mechanisms, these approaches are independent of variation in asset policy.

If necessary the frequency of the examination of an individual asset can be increased if circumstances warrant it. One example would be where the rate of development of a defect is such that failure of part of a structure is possible before the next examination would normally take place.

The maintenance response to the results of the examination process will vary according to the performance risk identified, the apparent best value investment and the availability of funds.

As the assets and their circumstances vary the maintenance proposed is tailored to provide the most cost-effective response under policy Civils-4.

1.6 Replacement

1.6.1 Replacement criteria

Replacement is considered as a last resort in most instances, with maintenance generally being the most cost-effective and sustainable approach, however as the population of assets gets progressively older it is envisaged that the volume reaching the end of their maintainable life will increase.

Replacement would be chosen for civil engineering assets only where it was cheaper, in whole life cost terms, than the maintenance needed to continue to meet the requirements of the route section.

All whole life evaluations, for civil engineering maintenance and renewal work, include consideration of both the cost of the work and the possessions required to enable its implementation. This ensures that work is carried out efficiently and encourages innovation in reducing possession times. Where the optimum solution is not transparent a computerised evaluation is carried out using STAMP (*Structures Asset Management Process*). Stamp is a decision support tool that can be used to compare alternative options and select the appropriate lowest whole life cost solution. It was developed by Mouchel Parkman for Network Rail and was validated by testing on a range of projects as part of its development. The unit cost rates used for a STAMP analysis are the appropriate SBMT (Structures benchmarking tool) rates contemporary with the date of the analysis.

STAMP is most effective for use on projects relating to larger, more complex structures. For simple structures the optimum structural solution can usually be designed directly from a library of standard repair solutions. It is proposed to produce generic STAMP analyses for a range of standard structure repair scenarios in order to provide engineers with a decision support reference and intend to continuously improve guidance in this area.

This process is reinforced by peer reviews as part of our financial governance of projects. These are to ensure robustness of priorities and consistency of design options selected.

1.6.2 Replacement type

Where replacement of any asset is necessary this would be selected on the basis of the least whole life cost solution that would meet the performance requirements of the route. Civil engineering replacements are largely bespoke to meet the circumstances of a particular location. However there are common features and an accepted best practice standard design suite has been developed. The actual best value solution meeting the needs of the location will normally be selected from these standard details.

A key factor in the need to review solutions on a case by case approach is that civil engineering assets provide the foundation to track and other railway equipment structures. In some cases a replacement option offering better support and dynamic response will significantly improve the long term reliability of these assets in service. The effect of interaction with other assets in this way has to be considered and best value solutions cannot be determined in isolation of other railway infrastructure. The same considerations are taken into account in carrying out maintenance work.

Replacement bridge decks are normally well proven types, designed and fabricated for the loading and dimensional requirements of the site. Any improved modification to their design is fed back for future use, resulting in a process of continuous improvement that has produced the modern robust and economic bridge decks currently specified.

1.7 Asset performance indication

The medium to long term asset performance can be established from the structures condition monitoring index (SCMI) and the earthworks condition rating. We started work capturing information on our tunnels using a Tunnels Condition marking index in late 2009. Our first full set of tunnel data will be available in the next 12 months. We will continue to develop further condition marking indexes for remaining asset groups. Civil engineering assets in general have slow deterioration profiles, so reliable short term performance indicators need careful definition. To date the key performance indicator has been related to service disruption e.g. the imposition of temporary speed restrictions (TSRs). For earthworks this still remains a valid measure and allows overall asset performance to be correlated with particular weather conditions in any one year.

For bridges, the incidents of TSRs have, through refurbishment work, been reduced to a very low level and whilst the severity index will now be additionally reported their

effectiveness as a measure of asset performance is limited. A measure of the precursors to TSR's utilising the number of additional examinations is a key performance indicator for Network Rail. This is an accurate measure of the volume of structures being examined because of suspected or known defects and will highlight the need to prioritise and address these before TSRs become necessary.

1.8 Constraints and deliverability check

The possible constraints on our asset management policies for civil engineering assets are:

- The availability of possessions and their duration, as these need to be agreed in consultation with our customers.
- Supply of materials and labour, particularly during the construction period for London 2012.

The work volumes that result from following the policies in this document are equivalent to the volumes delivered in the later years of CP3 and have been assessed as deliverable.

1.9 Planning assumptions

In contrast with some other assets, long term planning for civil engineering assets is not based on replacement after a given period of time since most structural assets remain in use from their original construction and can be maintained in a suitable condition for the medium term without wholesale replacement. The degree of work required may increase in the medium term as assets incur accelerated deterioration arising from the increased loading cycles associated with the past decades increases in traffic volume and loading. We have attempted to address this more precisely through a national top down asset investment model (CECASE). We acknowledge that this product requires more development before it can provide appropriate confidence levels. We therefore intend to carry out further work to improve evidence and foresight that an accurate model will provide.

Our forecasts for maintenance and replacement work to civil engineering assets are

based upon programme level modelling. This modelling is the subject of continuous improvement seeking to ensure validation and recalibration of condition, performance and rates of degradation using enhanced asset information and actual performance data. Where small asset groups exist, such as tunnels and major structures, future need is evaluated deterministically.

In all cases the forecasts are based on traffic levels allowed for over CP4 and make no allowance for traffic growth beyond this level.

Our forecasts for examination workload are based on the frequency of the examinations we currently carry out, which varies between the different types of asset.

1.10 Long term implications

The intention of the civil engineering policies is to maintain the average condition level of our assets across the network; this approach does not necessarily secure the desirable extension of asset life.

However, as a result of funding constraint described earlier the volume of work carried out will deliver this condition level but is unlikely to be at the optimum long term whole life cost, this introduces questions surrounding the sustainability of current management practices. Further modelling work is required to address sustainable investment and the extended asset life achieved.

1.11 Compliance with Network asset management policy

The policy for the management of civil engineering assets complies with Network Rail's asset management policy.

1.12 Critical assets

In line with Network Rail's asset management strategy, we are moving to a position where all key aspects of our structures management regimes are fact-based (i.e. based upon quantitative supporting evidence, where feasible, and subject to rigorous analysis). As this represents an extensive exercise we have prioritised our actions based upon

CP4 expenditure forecasts and the safety or performance impact of premature asset failure. For structures these “critical assets” cover underbridges (masonry, metal) and earthworks. We have a defined investment plan for 75% of funds available within CP4. We believe that this is the optimum level to define, allowing a suitable level of funds to service emerging workload and minor works over the course of CP4.

In addition for each of these assets we have identified the key interventions (in expenditure terms) that support the delivery of the management regimes for each of these assets. These are shown in the table below.

| Figure 4, Critical Assets within Civils (Structures) | | |
|---|-------------------|-----------------------------|
| Asset | Asset type | Activity |
| Underbridges | Masonry | Examination |
| | | Examination led maintenance |
| | Metal | Examination |
| | | Examination led maintenance |
| Earthworks | All | Examination |
| | | Examination led maintenance |

1.13 References

- **Rail Accident Investigation Branch, Network Rails Management of Existing Earthworks. Report 25/2008, Dec 2008**

2 Underbridges

2.1 Underbridges Asset policies

Our maintenance and renewal policies for underbridges are the same as our general structures policies

2.2 Brief description of the purpose of underbridges

The purpose of an underbridge is to carry rail traffic across a geographic feature or obstruction such as a road, river, valley, estuary, railway etc.

2.3 Asset types and population details

There are 23981 underbridges on the Network Rail system. As some bridges have more than one span, this equates to 42413 spans.

| Figure 5 population of underbridges | | |
|--|--------------------------|------------------------|
| Type | Number of Bridges | Number of Spans |
| Brick & Masonry | 11,221 | 24,758 |
| Stone | 359 | 806 |
| Concrete | 3,021 | 3,635 |
| Steel | 6,706 | 8,554 |
| Wrought Iron | 2,005 | 2,908 |
| Other (Timber, Cast Iron) | 669 | 1,752 |
| Total | 23,981 | 42,413 |

2.4 Degradation, failure modes, consequential risks

The principal measure of the fitness for purpose of an underbridge is its Route Availability (RA) rating. This is required to be maintained at or above published capability. Network Rail has a current programme in hand to ensure that all bridges achieve this requirement.

The table below summarises the degradation characteristics that apply to underbridges, their impact and predictability and possible mitigation measures.

| Figure 6, Business risk for Underbridges | | | | |
|--|---|--|----------------|---|
| Occurrence | Degradation and key driver | Impact | Predictability | Possible mitigation measures |
| Regular | Corrosion | Failure to support track with associated, speed restrictions, weight restrictions and train delays | Low | Standard visual / detailed examination cycle. |
| | Ground movement/shrinkage | | | |
| | Freeze thaw/ thermal Cycle | | | |
| Occasional | Groundwater | | | Minor maintenance items prioritised for extent/severity for minor works plan. |
| | Chloride induced corrosion (salt spray) | | | |
| | Surface water run-off | | | |
| | Mining or other subsidence | | | |
| | Vegetation | | | |
| | Scour | | | |
| | Design/latent defects | | | |
| Increased loading | Major maintenance proposals for inclusion in future business plans and scheme development work. | | | |
| Rare | | Animal Infestation | | |

These factors result in corrosion of metallic structures and components, perishing of mortar, loose brickwork, exfoliation of brickwork, masonry, concrete, and erosion of foundation conditions and longitudinal cracking between spandrel walls and arches. Each of these defects leads to a loss of strength or integrity which requires action for restoration or prevention of further loss. Some defects may combine to initiate an early failure mode; others may leave the structure vulnerable to the effects of an extreme weather or loading event which may precipitate failure.

2.5 Managing degradation risk

2.5.1 Examination and mitigation regime

The overall national rate of change of condition of bridges can be determined probabilistically through modelling of the national asset portfolio, however the actual occurrence of significant deterioration in individual bridges is much harder to predict. This issue is exacerbated where key structural elements are buried or where changed traffic loading is apparent. Hence in common with most other bridge owners we operate an examination regime with associated examination driven maintenance. The examination periods are calculated depending upon the degradation and performance risks as specified in Network Rail company standards and are designed as practices to prevent significant defects remaining undetected, prior to the occurrence of failure.

The current management regime comprises a detailed tactile examination carried out on each underbridge at intervals established by considering specific asset type, condition and performance drivers such as traffic volume and known material performance, with a detailed condition report prepared covering each element of the structure. Visual examination is carried out every twelve months to verify that there are no significant changes occurring. In addition the responsible engineer can specify a regime of additional examinations to monitor any defects pending corrective maintenance.

The parameters in the detailed condition report are combined to produce an overall condition index, on a scale of 0 to 100, using algorithms contained in the Structures Condition Marking Index (SCMI) tool. The SCMI score is weighted to take account of critical structural components. An example of the condition of a sample of 20624 bridges is shown in Figure 8 below. The sample includes both underbridges and overbridges and shows the relationship between SCMI score and the good, fair and poor categories used for bridge condition in the past. It is important to recognise that maintenance work may be driven by factors other than condition. These include for example overall structural capability, and repairs necessitated by road vehicle impact damage.

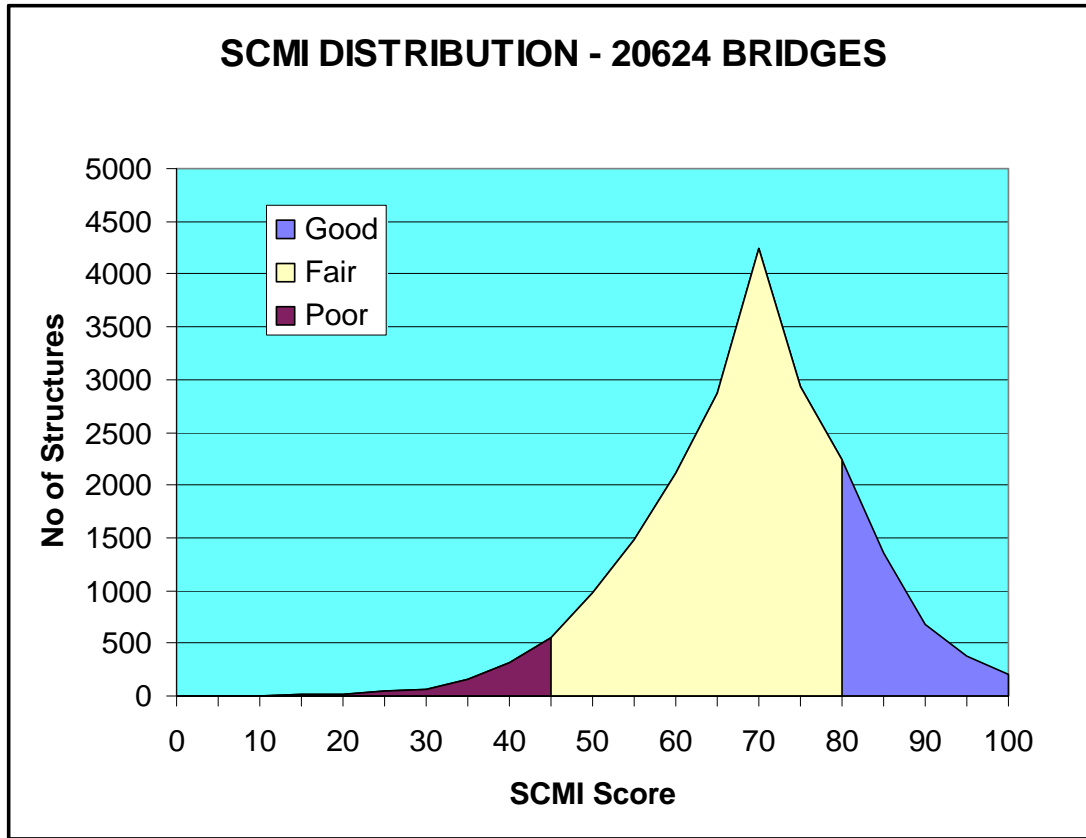


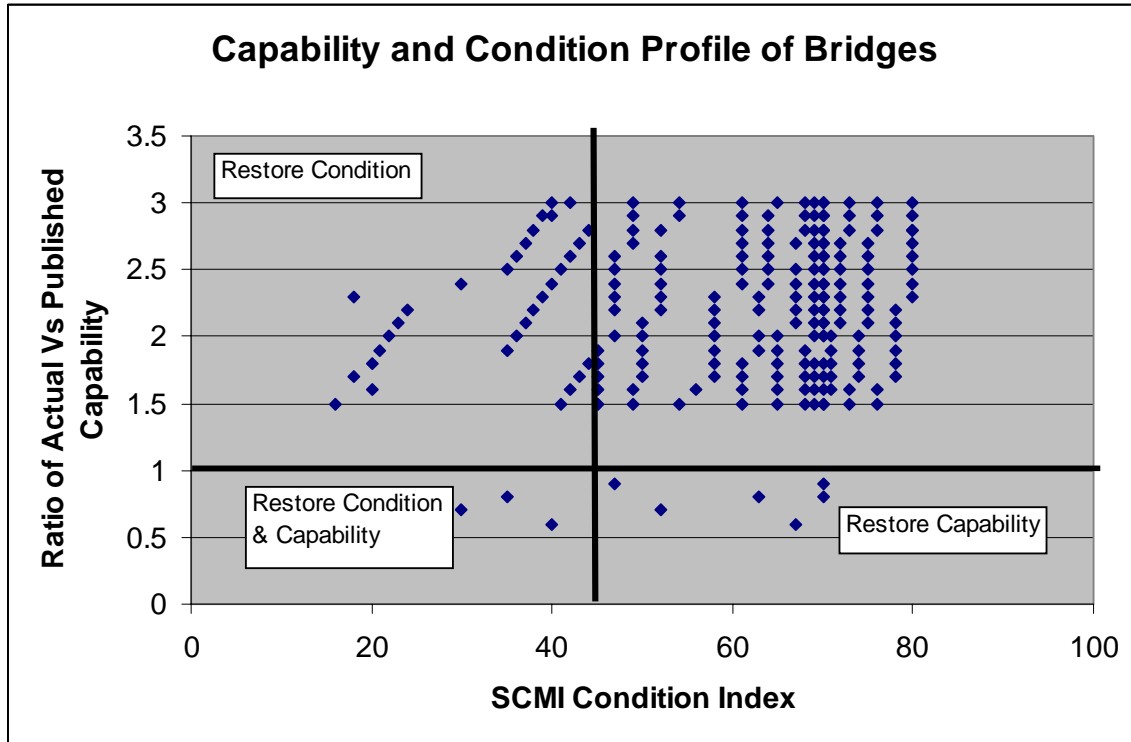
Figure 8, Indicative condition of civils assets

The relationship between capability and condition is not uniform. The dominant reason for this is that the requirements of lines when built were markedly different to the capability required today. In some circumstances this will mean a major redundancy exists with structures being capable of carrying much greater loads than they were constructed for, conversely many structures are now required to carry loads much closer to their original capability. An example plot of the relationship between condition (SCMI score) and the ratio of actual capability to the current required capability (the RA ratio) is shown on Figure 9 below.

Examinations are evaluated with respect to the relevant Civil Engineering policies for any corrective maintenance appropriate to that underbridge. This can be of a minor works nature or a proposal for a major maintenance item for inclusion in future business plans.

Fig 9 comparison of condition and bridge capability.

(NB This figure is purely for illustration of the principle and does not represent actual bridge data).



In order to ensure we make wise choices on where and how we carry out work we have developed risk scoring and priority scoring techniques.

The relative priority of an identified defect is developed from an initial evaluation of likelihood and impact (that is total risk) to achieve a minimum acceptable performance level. All risk above a threshold are dealt with at this point. Due to limits on funding we are not able to treat all identified defects so in order to make best use from the balance of funds that remain we evaluate residual risks further by considering in more detail whole life stewardship implications of the defect and factor in related impacts such as delay to passengers and freight and line availability. These aspects are used to compute a priority score and allow differentiation between structures and locations.

The examination regime detailed above is currently the subject of continuous improvement, with the object of refining further guidance on defining frequencies that optimise judgements on business risk in relation to structure type and deterioration characteristics.

It is known that the past convention of examining all structures at the same fixed intervals cannot equalise risk or be an efficient use resources. This is because different structure types have different levels of redundancy and rates of deterioration. They ideally therefore require differing examination input to assure the same continuing level of structural reliability.

Fixed examination intervals were previously used because we, along with most other bridge owners, have not had systems in place to enable the complexity of a risk based approach to be reliably carried out.

The advent and development of systems such as the Civils Asset Register & Reporting system (CARRS) has allowed targeted examinations to be scheduled and carried out for individual or specific categories of structures. This more equally proportions the risk and optimises the targeting of resources.

2.5.2 Examination led maintenance and key cost drivers

The site detailed examination condition report and condition index are reviewed to prepare and prioritise forward annual intervention plans and also schedule any immediate day to day maintenance requirements.

To develop national models of need an extensive study of maintenance intervention data was carried out to establish the key cost drivers for the models. 24 were identified with the rest accounting for less than 0.5% by element count and SCMI condition weighting.

The details are shown in figure 10 below.

| Figure 10 Examination Led Maintenance for Underbridges: Cost Drivers | | |
|---|--|----------------------------|
| Element Groups | Element | Percentage of Count |
| Masonry internal support | Piers/Trestles | 3.0% |
| | Padstone Cills | 1.4% |
| Masonry end support | Wing Wall | 12.7% |
| | Abutment | 8.1% |
| | Padstone Cills | 5.2% |
| Concrete end support | Wing Wall | 0.6% |
| | Abutment | 0.5% |
| Masonry deck | Face ring voussoirs | 7.3% |
| | Barrel arch | 4.2% |
| | Decking/Deck Plate/Deck Slab/Jack Arch | 0.9% |
| Walls | Parapets | 6.6% |
| | Parapets | 1.0% |
| | Spandrel Wall | 7.2% |
| Beams | Longitudinal main Beam Inner | 13.8% |
| | Longitudinal main Beam Exposed | 5.6% |
| | Parapets | 1.1% |
| Decking | Decking/Deck Plate/Deck Slab/Jack Arch | 1.6% |
| | Decking/Deck Plate/Deck Slab/Jack Arch | 5.3% |
| Ancillary components | Bearings | 2.3% |
| | Bracing | 1.6% |
| Beams | Transverse Beam/Girder inner | 1.5% |
| | Parapets | 1.2% |
| | Transverse Beam/Girder exposed | 1.0% |
| | Longitudinal Secondary Element exposed | 0.6% |

All other elements account for less than 0.5% of number (count) of elements and less than 0.5% of total SCMI weighting. These weighting criteria are subject to continuous improvement reflecting enhanced knowledge from our ongoing management activity. The next due data for reconsideration of these weightings is summer 2010 as part of our forward development of the CECASE model.

2.5.3 Fixed interval maintenance

There is currently no fixed interval maintenance applied to underbridges.

2.6 Replacement

Replacement criteria for underbridges are as described in 1.6.1 and 1.6.2

2.7 Asset performance indicators

The performance indicators are as described in section 1.7

2.8 Constraints and deliverability check

There are no particular constraints or deliverability issues for underbridges.

2.9 Planning assumptions

Our forecasts for underbridge maintenance and replacement are based on the output of our past national modelling (CECASE). This is a sophisticated programme simulation that utilises a dynamic Markov chain model to determine deterioration and maintenance intervention cycles for large populations of structures.

To work effectively CECASE requires a good knowledge of current asset condition and a large number of specific studies of assets to determine the deterioration and maintenance intervention probabilities. For CP4 extensive data were available on strength and condition.

Our forecasts for examination assume that underbridges are, in line with our current practice, examined every year and given a detailed examination as required under the risk based regime.. The means to optimise periodicities of examination is subject to continuous improvement.

2.10 Longer-term implications

The long term concerns for underbridges given current traffic levels relate to sub classes these include metal bridges and masonry structures subject to heavy axle weights. If these structures are simply subject to life extension in the long term there is likely to be an unsustainable volume of replacement work occurring in approximately 50 years that would prevent the reliable operation of large parts of the network. To prevent this we intend to investigate further the evidence for such a growth in replacement and the

means to control it through a proactive programme of major rehabilitation or early replacement.

The majority of masonry underbridges behaves differently and can continue to be maintained without any major penalties. The exception to this is if high axle load traffic growth occurs. Masonry arches are sensitive to the levels of deflection caused by loading and the difference between the levels of load that can be carried continuously and that which causes cumulative damage, resulting in rapid serviceability failure is small.

2.11 Compliance with Network Rail asset management policy

The policy for the management of underbridges complies with Network Rail's asset management policy.

2.12 References

- **The Civil Engineering Cost and Strategy Evaluation (CECASE) phase one and two:** Functional specification for the modelling process
- **Civil Engineering Standard NR/L3/CIV/006, section 1c guidance for risk based examination, including technical requirements for examinations guidance.**

3 Overbridges

3.1 Overbridges Asset policies

Our maintenance and renewals policies for overbridges are the same as our general structures policies.

3.2 Brief description of the purpose of overbridges

The purpose of an overbridge is to carry another service (roadway, footway, bridleway, public utility etc) over the railway. This asset group includes public highways as well as accommodation and occupation bridges.

All public road carrying bridges are being assessed as part of a nation-wide government funded project (Bridgeguard 3) to check their capacity to carry 40 tonne vehicles in compliance with EU Directive 96/53, which took effect from 1st January 1999.

3.3 Asset types and population details

There are approximately 11,146 overbridges which are owned and maintained by Network Rail. Some bridges have more than one span, giving a total of 16,016 spans.

| Figure 11, Populations for Overbridges | | | |
|---|--------------------------|------------------------|---------------------------|
| Type | Number of Bridges | Number of Spans | Average Age, years |
| Brick | 3,344 | 4,441 | 150 |
| Masonry | 39 | 416 | |
| Stone | 587 | 1,223 | |
| Concrete | 4,083 | 5,669 | 40 |
| Steel | 1,745 | 2,127 | 110 |
| Wrought Iron | 753 | 1,046 | |
| Other (Timber, Cast Iron, Fibre Reinforced Polymer) | 595 | 1,096 | |
| Total | 11,146 | 16,016 | |

| Figure 12, Number of overbridges (Bridgeguard 3) with Network Rail liability | |
|---|--------------------------|
| Criteria | Number of bridges |
| Assessed to date | 5,015 |
| Remaining number to be assessed | 425 |

3.4 Degradation, failure modes, consequential risks

The principal measure of the fitness for purpose of an overbridge is the avoidance of risk from unexpected failure of any element which would result in reduced operational performance while the defect is put right.

The table below summarises the degradation characteristics that apply to overbridges, their impact and predictability and possible mitigation measures

| Figure 13, Business risk for Overbridges | | | | |
|---|-----------------------------------|---------------|------------------------|-------------------------------------|
| Occurrence | Degradation and key driver | Impact | Predict ability | Possible mitigation measures |
| Regular | Chloride induced corrosion | | | |
| | Freeze thaw/thermal Cycle | | | |
| | Ground movement/shrinkage | | | |
| | Vegetation | | | |
| Occasional | Mining or other subsidence | | | |
| | Design/latent defects | | | |
| | Increased loading | | | |

| Figure 13, Business risk for Overbridges | | | | |
|--|----------------------------|--|-----------------|--|
| Occurrence | Degradation and key driver | Impact | Predict ability | Possible mitigation measures |
| Rare | Geological Conditions | <ul style="list-style-type: none"> • imposing other restrictions on road traffic (narrow lanes, banning types of traffic) • installing temporary supports (where the track layout permits) | | for extent/severity for minor works plan. Major maintenance proposals for inclusion in future business plans and scheme development work. |
| | Animal Infestation | | | |
| | Surface water run-off | | | |
| | Groundwater | | | |

Where highway bridges do not meet the obligations of Network Rail and/or the highway authority there is a risk of the structure failing either partially or fully through being overloaded. This is an unacceptable risk to the public using either the highway or the railway. Unlike underbridges it is not generally possible to restore structural safety factors for overbridges by imposing temporary speed restrictions.

3.5 Managing degradation risk

3.5.1 Examination and mitigation regime

The examination and mitigation regime for overbridges is the same as detailed for underbridges in section 2.5.1. with respect to civil engineering policies the examinations are evaluated for the effects of the sources of degradation as listed in Figure 13. It should be noted that chloride induced corrosion from road salts is more prevalent in overbridges as salt is directly applied to the road surface; whereas underbridges only suffer this indirectly from traffic spray. Chloride levels have been increasing in these structures since road salting commenced in the 1960's.

As with underbridges examination frequencies are also currently under review. An overall SCMI condition index is produced from each detailed examination.

Bridges that are within the Bridgeguard 3 remit are structurally assessed for ability to carry 40 tonne vehicles.

Bridges that fall short of this strength level are checked for meeting Network Rail's minimum liability for load capacity and where necessary Interim mitigation measures are provided to address any capacity deficiencies.

When strengthening or replacement is required the costs are apportioned between Network Rail and highway authority to an agreed formula in accordance with each party's respective liability for load capacity.

3.5.2 Examination led maintenance

The site detailed examination condition report and condition index are reviewed to prepare a bespoke annual intervention plan, taking consideration of the factors listed in section 2.5.

3.5.3 Fixed interval maintenance

There is currently no fixed interval maintenance applied to overbridges.

3.6 Replacement

The policy for the replacement criteria of overbridges is the same as our general civil engineering policies. As for other civil engineering assets, replacement is only considered where it is cheaper, in whole life cost terms, than the maintenance needed to continue to meet the requirements of the route section.

For Bridgeguard 3, bridge replacement is selected only when this has a lower whole life cost than strengthening or when the highway authority requires and is prepared to finance an enhanced structure dimension or load capacity.

3.7 Asset performance indicators

Performance indicators are largely as described for underbridges except that overbridges do not directly support track. The move to special examinations as a key performance indicator will provide more visibility of the performance of overbridges than was previously reported.

3.8 Constraints and deliverability check

There are no particular constraints or deliverability issues for overbridges.

3.9 Planning assumptions

Our forecasts for overbridge maintenance and replacement are based on the output of national modelling and include those bridges within the BG3 programme.

Our forecasts for examination assume that overbridges are, in line with our current practice.

Our forecasts for Bridgeguard 3 works are based on the current programme for the work with the number of bridges needing strengthening or replacement estimated from the number assessed based on past experience.

3.10 Longer-term implications

The long term implications for overbridges are the same as apply to underbridges. Sustainable investment should secure very long lifespans of these assets, however the level of sustainable activity does require further evaluation. Additionally should the demand for traffic loading change then this will have an impact on residual life and sufficiency beyond the levels achieved through the Bridgeguard 3 programme. Completion of the Bridgeguard 3 programme will result in public highway bridges all having the required capacity, with those which have been strengthened or replaced also achieving a “good” overall condition rating.

3.11 Compliance with Network Rail asset management policy

The policy for the management of overbridges complies with Network Rail's asset management policy.

3.12 References

No applicable references.

4 Earthworks

Earthworks is a generic group which includes embankments, rock and soil cuttings, retaining walls and culverts.

4.1 Earthworks Asset policies

Our maintenance policies for earthworks is the same as our general structures policies and are implemented in conjunction with Company Standards (see Annex A). The following Policy statements specifically relate to earthworks:-

| Policy Number | Figure 14, Examination and Maintenance Policy Statements for Earthworks |
|---------------|---|
| Civil-11 | Each embankment shall be allocated a condition on a poor /marginal/serviceable rating. |
| Civil-12 | Each cutting shall be allocated a condition on a poor /marginal/serviceable rating. |
| Civil-13 | Each retaining wall shall be allocated a condition on a good/fair/poor rating. |
| Civil-14 | Each culvert shall be allocated a condition on a good/fair/poor rating. |
| Civil-15 | Each culvert shall be maintained in a condition consistent with Route Availability and such that it's hydraulic capacity is adequate. |
| Civil-16 | Earthworks shall be repaired not replaced |

Our renewal policies for earthworks are the same as our general civil engineering policies.

4.2 Brief description of the purpose of earthworks

The purpose of

- an embankment is to provide a stable support to the track and associated lineside equipments to carry rail traffic across low lying ground, a flood plain or provide approach embankment to a bridge across an obstruction such as a road, river, valley, estuary, railway etc.

- a rock or soil cutting is to carry rail traffic through hilly topography at an acceptable level and track gradient.
- a retaining wall is to provide support to ground adjacent the railway to minimise land-take. Retaining walls can also provide support to the track.
- a culvert is to enable a watercourse to cross under the railway, normally through an embankment. Culverts are defined as structures spanning between 450mm and 1800mm, while larger spans are defined as bridges. Culverts acting as pedestrian subways and cattle creeps, even when they are within this definition, are treated as underbridges.

4.3 Asset types and population details

| Figure 15, Populations for Earthworks | | | |
|--|------------------------|--------------|---------------------------|
| Type | Number of Units | Units | Average Age, years |
| Embankments | 7861 | Route Km | 150 |
| Rock cuttings | 850 | Route Km | 150 |
| Soil cuttings | 5475 | Route Km | 150 |
| Retaining walls | 17,000 | Km | 150 |
| Culverts | 23,973 | Spans | 150 |

4.4 Degradation, failure modes, consequential risks

The principal measure of the fitness for purpose of an earthwork is the avoidance of risk from unexpected failure of any element which would result in reduced operational performance while the defect is put right.

The table below summarises the degradation characteristics that apply to earthworks, their impact and predictability and possible mitigation measures.

| Figure 16, Business risk for Earthworks (Embankments) | | | | |
|---|----------------------------|--|----------------|---|
| Occurrence | Degradation and key driver | Impact | Predictability | Possible mitigation measures |
| Regular | Rainfall | Embankment slips (either rotational or translational) are the most common mode of failure followed by damage to the toe of an embankment by river scour. | Medium | Regime of examinations leading to bespoke plans for examination lead maintenance. The results of examination can lead to additional examination instrumentation being installed, in turn leading to preventative maintenance. Replacement not an option |
| | Geological Conditions | | | |
| | Vegetation | | | |
| | Animal Infestation | | | |
| | Increased loading | | | |
| Occasional | Groundwater | Serviceability failure of embankments, which results in poor track geometry, also occurs due to flooding, desiccation of clay cored embankments in dry summers or due to animal burrowing. | | |
| | Surface water run-off | | | |
| | Mining Activity | | | |
| | Freeze Thaw Cycle | | | |
| | Design/latent defects | | | |
| | Scour | | | |
| | | Both slips and serviceability failures can lead to speeds restrictions and ultimately to an unacceptable risk of derailment | | |

| Figure 17, Business risk for Earthworks (rock cuttings) | | | | |
|---|----------------------------|---|----------------|---|
| Occurrence | Degradation and key driver | Impact | Predictability | Possible mitigation measures |
| Regular | Groundwater | Potential for derailment due to obstruction of track. | Medium | Regime of examinations leading to bespoke plans for examination lead maintenance. Replacement not an option |
| | Geological Conditions | | | |
| | Freeze Thaw Cycle | | | |
| Occasional | Rainfall | | | |
| | Surface water run-off | | | |
| | Mining Activity | | | |
| | Vegetation | | | |
| | Design/latent defects | | | |
| | Animal Infestation | | | |
| Rare | Scour | | | |

Rates of failure of rock cuttings depend on geology, slope angle, degree of frost action, vegetation and maintenance history.

| Figure 18, Business risk for Earthworks (soil cuttings) | | | | |
|---|----------------------------|---|----------------|---|
| Occurrence | Degradation and key driver | Impact | Predictability | Possible mitigation measures |
| Regular | Rainfall | Potential for derailment due to obstruction of track. | Medium | Regime of examinations leading to bespoke plans for examination lead maintenance. Replacement not an option |
| | Groundwater | | | |
| | Surface water run-off | | | |
| | Geological Conditions | | | |
| | Vegetation | | | |
| | Animal Infestation | | | |
| Occasional | Mining Activity | | | |
| | Freeze Thaw Cycle | | | |
| | Scour | | | |
| | Design/latent defects | | | |

Records show that rotational and translational cutting slips are the most common mode of failure followed by washout due to surface water run-off from adjacent land. However, soil cuttings also deteriorate due to weathering effects. Rates of failure of cuttings depend on geology, slope angle, maintenance history of drainage, vegetation, animal burrowing and extreme weather effects.

Where rock or soil cuttings are considered to be unstable it is possible to reduce risk levels by imposing speed restrictions on train services.

| Figure 19, Business risk for Earthworks (retaining walls) | | | | |
|---|----------------------------|---|----------------|---|
| Occurrence | Degradation and key driver | Impact | Predictability | Possible mitigation measures |
| Regular | Freeze Thaw Cycle | Potential for derailment due to obstruction of track. | Medium | Regime of examinations leading to bespoke plans for examination lead maintenance. Replacement not an option |
| | Vegetation | | | |
| Occasional | Rainfall | | | |
| | Groundwater | | | |
| | Surface water run-off | | | |
| Rare | Geological Conditions | | | |
| | Mining Activity | | | |
| | Animal Infestation | | | |
| | Scour | | | |
| | Design/latent defects | | | |
| | Increased loading | | | |

These factors result in perishing of mortar, loose brickwork, exfoliation of brickwork, masonry, concrete, and consequent increase of water ingress and accelerated deterioration.

| Figure 20 Business risk for Earthworks (culverts) | | | | |
|---|----------------------------|------------------------------------|----------------|------------------------------|
| Occurrence | Degradation and key driver | Impact | Predictability | Possible mitigation measures |
| Regular | Freeze Thaw Cycle | Flooding of track leading to train | Low | Regime of examinations |

| | | | | |
|------------|-----------------------|--|--|--|
| | Vegetation | | | |
| Occasional | Rainfall | | | |
| | Groundwater | | | |
| | Surface water run-off | | | |
| Rare | Geological Conditions | | | |
| | Mining Activity | | | |
| | Animal Infestation | | | |
| | Scour | | | |
| | Design/latent defects | | | |
| | Increased loading | | | |

Historically culverts have been managed on the basis of the risk to their load carrying capacity and the avoidance of structural failure. They are additionally susceptible to the risk of catastrophic damage by wash-out in extreme weather conditions, and sometimes increase the risk of embankment failure due to inadequate hydraulic performance. However, complete structural failure of culverts is a rare occurrence – it is more likely for a culvert to become blocked by silt or water-borne debris.

4.5 Managing degradation risk

4.5.1 Mitigation regime

The failure methods of earthworks can lead to either an almost immediate failure or some situation where failure is anticipated at some time in the future.

The mitigation regime for earthworks is therefore in two sections

- routine examination, with bespoke examination led maintenance appropriate to that type of earthwork, taking into account the relevant policy (1, or 2).
- supplementary examination, triggered by routine examination, typically using monitoring of instrumentation, which leads to preventative maintenance to prevent actual failure. Note that as this maintenance is initiated by examination,

it is regarded as examination led maintenance rather than fixed interval maintenance.

For embankments, rock cuttings and soil cuttings:

- the examinations consider the asset condition against serviceability criteria of the earthwork, the asset condition against ultimate failure of the earthwork and historical changes in the asset condition
- the examination reports classify the asset as being in poor, marginal or serviceable condition, from which assessment the period until the next examination is determined.
- replacement is not usually an option due to extreme operational impact.

For retaining walls and culverts (being brick built or similar) the examinations are based on a fixed period of one in 6 years, and is planned to move towards a risk based frequency applying the same criteria as assessing the periods of examination of bridges see section 2.5.1, annual visual examination are undertaken and will be retained.

Flooding causes risk of scour and piping failure (washout of embankment material from around the culvert), which may be catastrophic. Special examination measures are introduced where unexpected flooding introduces an additional risk. These may vary from occasional to full-time surveillance, extending to full underwater examination where it has been considered necessary to close the line due to uncertainty of the track support from either the structure or surrounding embankment.

4.5.2 Examination

Examination of earthworks is carried out at a condition based frequency of annual examination for poor condition earthworks, 5 yearly for marginal condition earthworks and 10 yearly for serviceable condition earthworks is in line with good industry practice as detailed in CIRIA Report C591 Infrastructure Cuttings – Condition Appraisal and Remedial Treatment and CIRIA Report C592 Infrastructure Embankments - Condition Appraisal and Remedial Treatment.

CECASE model predicts failure rate for application of different Policies.

| Figure 21, Examination options for Earthworks | |
|--|---|
| Type of Earthwork | Activity |
| Embankments | Visual examination based on embankment condition (including associated drainage condition), every year for poor condition embankments, every 5 years for marginal condition embankments and every 10 years for serviceable condition embankments. |
| Rock cuttings and soil cuttings | Visual examination based on cutting condition (and condition of associated drainage for soil cuttings), every year for poor condition cuttings, every 5 years for marginal condition cuttings and every 10 years for serviceable condition cuttings |
| Retaining walls and culverts | Annual visual examination |
| | Currently 6 yearly Moving to risk based periods for detailed examination |

These frequencies are also currently under review.

4.5.3 Examination led maintenance

The site detailed examination condition report and condition index are reviewed to prepare a bespoke annual intervention plan, taking consideration of the factors listed in section 4.4. This work is supported by a priority scoring methodology which is applied in a similar manner to that used for our structures as part of our business planning and financial governance processes (see section 1). Due to limits on funding we are not able to treat all identified defects so in order to make best use of funding we evaluate residual risks further by considering in more detail whole life stewardship implications of the defect and factor in related impacts such as delay to passengers and freight and line availability. These aspects are used to compute a priority score and allow differentiation between earthworks and locations.

| Figure 22 Examination led maintenance for Earthworks | |
|---|---|
| Type of Earthwork | Activity |
| Embankments | Typical repair solutions to an embankment slip are to regrade a soil cutting slope with a granular dressing and a gabion toe wall for shallow translational slips, sheet or bored piling retaining structures or soil nailing for rotational failures. |
| Rock cuttings | Typical repair solutions to a rock cutting where rock fall is a concern are to regularly scale the weathered rock material and where necessary to net the slope or install a rock-catch fence to prevent rock reaching the track. |
| Soil cuttings | Typical repair solutions to a soil cutting slip are to regrade the soil cutting slope using a granular dressing and a gabion toe wall for shallow translational slips and sheet or bored piling retaining structures or soil nailing for rotational failures. |
| Retaining walls and culverts | Typical repair to a culvert is repair of headwall, cleaning out and repointing of brickwork and repair to a retaining wall is repointing of brickwork. |

4.5.4 Fixed interval maintenance

There is currently no fixed interval maintenance applied to earthworks. It is however proposed to instigate cyclical drainage maintenance and scaling of rock slopes at fixed intervals in order to improve reliability.

4.6 Replacement

Replacement of earthworks is not usually a feasible option.

4.7 Asset performance indicators

The criteria by which we judge the success of these policies are

- That actual unit costs, supplied as feedback from site work, match up with those used in the calculation of whole life costs, and which the policies are based on
- That overall containment of any degradation of performance, or increase in

performance, as measured by train delay minutes, is achieved

- The measured Asset Stewardship Index is either held constant or improved.

4.8 Constraints and deliverability check

There are no particular constraints or deliverability issues for earthworks.

4.9 Planning assumptions

See Section 1.8 for earthwork forecast method for maintenance, repair and replacement using national modelling.

Our forecasts of examination workload are based on the following frequencies:

- poor condition cuttings examined once a year
- marginal condition cuttings examined every five years
- serviceable condition cuttings examined every ten years

Our forecasts for examination and examination lead maintenance assume that retaining walls are, in line with our current practice, examined every year and given a detailed examination every six years.

Our forecasts for examination and examination lead maintenance assume that culverts are, in line with our current practice, examined every year and given a detailed examination every six years.

4.10 Longer-term implications

There are no particular long term implications for earthworks.

4.11 Compliance with Network Rail asset management policy

The policy for the management of earthworks complies with Network Rail's asset management policy.

4.12 References

- **CIRIA Report C591 Infrastructure Cuttings** – Condition Appraisal and Remedial Treatment
- **CIRIA Report C592 Infrastructure Embankments** - Condition Appraisal and Remedial Treatment.
- **Functional Specification for CECASE Software**

5 Tunnels

5.1 Tunnels Asset policies

Our maintenance policies for tunnels are the same as our general structures policies with the addition of the following:

| Figure 23, Examination and Maintenance Policy Statements for Tunnels | |
|---|---|
| Policy Number | Policy Statement |
| Civil-17 | The condition of each tunnel shall be ranked using good/fair/poor ratings |
| Civil-18 | Tunnel maintenance work shall be specified on the assumption that replacement of a tunnel is not affordable and that each tunnel must remain in a fit for purpose condition for an indefinite period. |

Our renewal policies for tunnels are the same as our general civil engineering policies.

5.2 Brief description of the purpose of tunnels

The purpose of a tunnel is to allow the passage of services through or under a land feature such as high topographic relief, or a river, where the formation of alternative structures such as cuttings or bridges would have been undesirable on economic or technical grounds.

5.3 Asset types and population details

There are approximately 628 operational tunnels that are owned by Network Rail.

| Figure 24, Populations for Tunnels | | | |
|---|------------------------|---------------------|---------------------------|
| Type | Number of Units | Units | Average Age, years |
| Lined | 327 | Km aggregate length | 150 |
| Unlined | 8.4 | Km aggregate length | 150 |
| Open shafts | 453 | Quantity | 150 |

Unlined tunnels exist where local geology is both hard and stable. Longer term risks of movement and possible loss of blocks of rocks in unlined sections

demand that we treat unlined tunnels with specific care. We have a programme of geotechnical expert inspection of all unlined tunnels and have developed a means to risk score each location to ensure that risk mitigation through lining, rock bolting , scaling and shrouding are able to be applied where risks demand.

5.4 Degradation, failure modes, consequential risks

The table below summarises the degradation characteristics that apply to tunnels, their impact and predictability and possible mitigation measures.

| Figure 25, Business risk for Tunnels | | | | |
|---|-----------------------------------|---|-----------------------|---|
| Occurrence | Degradation and key driver | Impact | Predictability | Possible mitigation measures |
| Regular | Groundwater | The principal hazard to the operating railway is that of material failure leading to partial lining failure/collapse. | Low | Regime of examinations leading to bespoke plans for examination lead maintenance. Replacement not an option |
| | Geological Conditions | | | |
| | Freeze Thaw Cycle | | | |
| | Design/latent defects | | | |
| Occasional | Increased loading | | | |
| Rare | Mining Activity | | | |

The most common mode of failure in tunnels is progressively deteriorating lining materials as a result of freeze/thaw actions, high levels of water ingress, progressive increased loading from interaction with the surrounding geology and degradation of exposed rock faces in the unlined tunnels. Infilled construction shafts that are no longer visible, termed “hidden shafts” can cause instability to the tunnel and surface land above.

Unlike underbridges it is not generally possible to restore structural safety factors for tunnels by imposing temporary speed restrictions.

5.5 Managing degradation risk

5.5.1 Mitigation regime

The mitigation regime for tunnels comprises routine examination, with bespoke examination lead corrective maintenance appropriate to that asset. Replacement is not usually an economic option.

5.5.2 Examination

The aggressive geological settings of many tunnels results in faster deterioration than that seen in other structures. In addition any defects in the lining of tunnels are not easily visible other than during a well lit close examination; as a result the examinations are carried out more frequently. As tunnel linings are linear assets it is possible to adopt emerging technology such as vehicle mounted laser scanning technology to augment visual examination, delivering continuous improvement in the examination of tunnels.

| Figure 26 Examination options for Tunnels | |
|--|---|
| Type of Tunnel | Activity |
| Lined tunnels (non risk assessed) | Detailed examination every year |
| Lined tunnels (risk assessed, see note 1) | Detailed examination every two years |
| Tunnels subject to rapid change in condition or circumstances (see note 2) | Detailed examination according to the severity of the defects causing the change. |
| Shafts | Detailed examination every six years |

Notes

- 1 The risk assessment considers: the current tunnel condition and the predicted rate of deterioration of the tunnel, the frequency of reactive maintenance activities and the mode of rail operations within the tunnel.
- 2 At the moment there are 63 tunnels subjected to additional examinations pending remediation works

5.5.3 Examination led maintenance

The site detailed examination condition report and condition rating are combined to produce an overall condition index, on a scale of 0 to 100, using algorithms similar to the Structures Condition Marking Index (SCMI) tool. The Tunnel Condition Marking Tool (TCMI) score is weighted to take account of critical structural components. These results are reviewed to prepare an annual intervention plan, taking consideration of the factors listed in section 1.4.

| Figure 27 Examination led maintenance for Tunnels | |
|--|---|
| Asset | Activity |
| All tunnels and shafts | Bespoke annual intervention plan to keep each tunnel fit for purpose indefinitely |

5.5.4 Fixed interval maintenance

There is no appropriate fixed interval maintenance approach for tunnels.

5.6 Replacement

Total replacement of an entire tunnel is usually not cost effective.

5.7 Asset performance indicators

The criteria by which we judge the success of these policies are

- That actual unit costs, supplied as feedback from site work, match up with those used in the calculation of whole life costs, and which the policies are based on
- The measured Asset Stewardship Index is either held constant or improved.

5.8 Constraints and deliverability check

There are no particular constraints or deliverability issues for tunnels.

5.9 Planning assumptions

Our forecasts for tunnel maintenance are based on bottom-up intervention plans produced for our complete tunnel population.

5.10 Longer-term implications

Our approach during CP4 includes planned relining of tunnels where more frequent patch repair is proving prohibitively expensive, This activity requires greater disruptive access and therefore need to be carefully planned. Use of innovation to restrict disruptive possessions is an essential area of improvement to ensure that a predicted growth in the longer term need for tunnel relining can be delivered without undue impact on availability, this will ensure there are no long term implications for tunnels.

5.11 Compliance with Network Rail asset management policy

The policy for the management of tunnels complies with Network Rail's asset management policy.

5.12 References

No applicable references.

6 Footbridges

6.1 Footbridges Asset policies

Our maintenance policies for footbridges are the same as our general civil engineering policies with the following additions:

| Figure 28, Examination and Maintenance Policy Statements for Footbridges | |
|---|---|
| Policy Number | Policy Statement |
| Civil-19 | The condition of each footbridge shall be ranked using good/fair/poor ratings |

Our renewal policies for footbridges are the same as our general civil engineering policies.

6.2 Brief description of the purpose of footbridges

The purpose of a footbridge is to carry pedestrians over the railway. The structures in this group are mainly for public use and do not include footbridges at stations which may have restricted use (data provided below confirms footbridge numbers and those within TOC stations which is provided for comparative purposes only – Station footbridges are covered under the operational property Policy).

6.3 Asset types and population details

| Figure 29, Populations for Footbridges | | | |
|---|--------------------|------------------------|---------------------------|
| Description | Type | Number of Units | Average Age, years |
| <i>Footbridges</i> | <i>TOC Station</i> | <i>791</i> | <i>100</i> |
| Footbridges | All others | 2,089 | 100 |

6.4 Degradation, failure modes, consequential risks

The principal measure of the fitness for purpose of a footbridge is the avoidance of risk from unexpected failure of any element which would result in failure to meet our statutory obligations to users and potentially affect train services until the defect can be repaired.

With some exceptions foot bridges are light steel or concrete structures. Corrosion and timber decay are the main degradation drivers. Many foot bridges are salted in winter and this accelerates corrosion in both steel and concrete structures as a result of chloride penetration. In addition the atmosphere slowly neutralises the alkalinity of concrete causing the near surface reinforcement to corrode and split the thin concrete sections. Circa 1930's footbridges are especially vulnerable in this respect.

Many existing footbridges are timber decked with originally durable tropical hard wood. This material is now more difficult to source from sustainable supplies and inferior quality timber is less durable in use. FRP replacement decking is starting to be used as a durable replacement where appropriate but this material is still a costly alternative to timber.

The table below summarises the degradation characteristics that apply to footbridges, their impact and predictability and possible mitigation measures.

| Figure 30, Business risk for Footbridges | | | | |
|---|---|---|-----------------------|---|
| Occurrence | Degradation and key driver | Impact | Predictability | Possible mitigation measures |
| Regular | Chloride induced corrosion from salting | Both steel and concrete footbridges suffer from corrosion accelerated by the application of chlorides from winter salting. Thin concrete sections also suffer corrosion as a result of carbonation caused by atmospheric effects. Decay of timber decking is also an issue. Hard wood | Low | Regime of examinations leading to bespoke plans for examination lead maintenance. Replacement is an option when continued maintenance |
| | Timber decay | | | |
| Occasional | Surface water run-off | | | |
| | Freeze Thaw Cycle | | | |
| Rare | Vegetation | | | |
| | Groundwater | | | |

| Figure 30, Business risk for Footbridges | | | | |
|--|----------------------------|---|----------------|------------------------------|
| Occurrence | Degradation and key driver | Impact | Predictability | Possible mitigation measures |
| | Geological Conditions | is more durable and FRP replacement now being increasingly used | | becomes un-economic |
| | Mining Activity | | | |
| | Animal Infestation | | | |
| | Design/latent defects | | | |
| | Increased loading | | | |
| | | | | |

6.5 Managing degradation risk

6.5.1 Mitigation regime

The mitigation regime for footbridges comprises routine examination, with bespoke examination lead corrective maintenance appropriate to that asset. Replacement may be attractive when continued maintenance is shown to be uneconomic.

6.5.2 Examination

| Figure 31 Examination options for Footbridges | |
|---|--|
| Type of Footbridge | Activity |
| All | Annual visual examination |
| | Currently 6 yearly moving to risk based periods for detailed examination |

6.5.3 Examination led maintenance

The site detailed examination condition report and condition rating are reviewed to prepare a bespoke annual intervention plan, taking consideration of the factors listed in section 1.4.

| Figure 32 Examination led maintenance for Footbridges | |
|--|--|
| Asset | Activity |
| All | Bespoke annual intervention plan to keep each footbridge fit for purpose |

6.5.4 Fixed interval maintenance

There is currently no fixed interval maintenance applied to footbridges.

6.6 Replacement

6.6.1 Criteria

Footbridges are often light structures some of which can be complex and costly to repair in comparison with a new factory produced replacement. Unlike other types of structures replacement can be the economic option.

6.6.2 Replacement specification

There is no policy on replacement type though standard footbridge designs are in course of development.

6.7 Asset performance indicators

The criteria by which we judge the success of these policies are

- That actual unit costs, supplied as feedback from site work, match up with those used in the calculation of whole life costs, and which the policies are based on
- That the measured Asset Stewardship Index is either held constant or improved.

6.8 Constraints and deliverability check

There are no particular constraints or deliverability issues for footbridges.

6.9 Planning assumptions

Our forecasts for footbridge maintenance and renewal are based on the output of national modelling (CECASE).

Our forecasts for examination assume that footbridges are, in line with our current practice, given a visual examination annually and a detailed examination at six year intervals.

6.10 Longer-term implications

In the long term many footbridges will require replacement as they are very light structures that are often not economic to repair. Light concrete panel footbridges in particular have a finite life due to carbonation; beyond which the steel reinforcement cannot be prevented from corroding. Adequate repair of these structures is not possible and they will need replacing though in this case replacement will be the lowest whole life cost solution.

6.11 Compliance with Network Rail asset management policy

The policy for the management of footbridges complies with Network Rail's asset management policy.

6.12 References

No applicable references.

7 Major structures

7.1 Major Structures Asset policies

Our maintenance policies for major structures are the same as our general civil engineering policies with the following additions:

| Figure 33, Examination and Maintenance Policy Statements for Major Structures | |
|--|---|
| Policy Number | Policy Statement |
| Civil-20 | Each major structure shall be allocated a Condition Marking Index from 0 to 100 to reflect the condition found on detailed examination. |
| Civil-21 | A maintenance manual shall be produced for each major structure. |
| Civil-22 | As far as it is economic to do so major structures shall be maintained so that the need for complete replacement is avoided. |

Our renewal policies for major structures are the same as our general civil engineering policies.

7.2 Brief description of the purpose of Major Structures

The purpose of a major structure (which is typically an underbridge) is to carry rail traffic across a substantial geographic feature or obstruction such as a river, valley, estuary, etc. Major structures are defined as a special group identified by the extreme cost of replacement.

7.3 Asset types and population details

Although the definition is flexible, there are around 300 structures which could be considered as major structures, these are typically large and complex structures.

7.4 Degradation, failure modes, consequential risks

The principal measure of the fitness for purpose of a major structure is its Route Availability (RA) rating, for which it is desirable that every component of the structure has a rating equal to or in excess of the published RA rating for the route.

Major structures have the same degradation drivers as underbridges, as set out in section 2.4.

Complete structural failure of major structures is extremely rare. The only example of a failure in recent times is the River Ness viaduct which failed in February 1989 due to river scour. However major structures, like all underbridges, do deteriorate, and therefore develop defects. Not only is the cost of replacement extremely high if they do need replacement but, as major structures tend to be at strategic locations, the disruption caused by restrictions is also high.

7.5 Managing degradation risk

7.5.1 Mitigation regime

The mitigation regime for major structures comprises routine examination, with bespoke examination lead corrective maintenance appropriate to that asset. Replacement may be attractive when continued maintenance is shown to be uneconomic, although this is frequently constrained by heritage requirements.

7.5.2 Examination

Major structures are examined in the same way as underbridges.

| Figure 34 Examination options for Major Structures | |
|--|---------------------------------|
| Type of Major Structure | Activity |
| All | Annual visual examination |
| | Six yearly detailed examination |

7.5.3 Examination led maintenance

As for underbridges the examination reports are used to determine the immediate

maintenance requirement. The long-term maintenance requirements for major structures have been set out in the draft document called 'Major Structures Maintenance Strategy' produced in April 2006. The strategy sets out a development programme for twenty six major structures which includes the preparation of a bespoke maintenance plan for each structure. Each strategy will recognise the unique characteristics of the structure and demonstrate how whole-life benefits will be gained from its application.

The aim for major structures is, as far as it is economic to do so, to keep them in a suitable condition so that the need for complete replacement is avoided.

| Figure 35 Examination led maintenance for Major Structures | |
|---|--|
| Asset | Activity |
| All | Bespoke annual intervention plan to keep each footbridge fit for purpose |

7.5.4 Fixed interval maintenance

There is currently no fixed interval maintenance applied to major structures.

7.6 Replacement

7.6.1 Criteria

Replacement of major structures is not usually feasible or economic and maintaining rail traffic on most routes would require the construction of a new structure on a parallel alignment.

7.6.2 Replacement specification

If such a structure were ever replaced, excepting any heritage issues, a replacement specification would be for a modern economic design customised for the location.

7.7 Asset performance indicators

The criteria by which we judge the success of these policies are:

- That actual unit costs, supplied as feedback from site work, match up with those used in the calculation of whole life costs, and which the policies are based on
- That overall performance of the structure is maintained or improved in whole life cost terms.

- The measured Asset Stewardship Index is either held constant or improved.

7.8 Constraints and deliverability check

There are no particular constraints or deliverability issues for major structures.

7.9 Planning assumptions

Our forecasts are based on the draft document 'Major Structures Maintenance Strategy' produced in April 2006. This document sets out a long term view of the major maintenance needs which have been specifically evaluated for each structure.

7.10 Longer-term implications

There are no particular long term implications for major structures.

7.11 Compliance with Network Rail asset management policy

The policy for the management of major structures complies with Network Rail's asset management policy.

7.12 References

No applicable references.

8 Coastal and estuarine defences

8.1 Coastal and estuarine defences Asset policies

Our maintenance policies for coastal and estuarine defences are the same as our general civil engineering policies with the following additions:

Figure 36, Examination and Maintenance Policy Statements for Coastal and estuarine defences

| Policy Number | Policy Statement |
|----------------------|--|
| Civil-23 | The condition of each coastal and estuarine defence shall be ranked using good/fair/poor ratings |

Our renewal policies for coastal and estuarine defences are the same as our general civil engineering policies.

8.2 Brief description of the purpose of coastal and estuarine defences

The purpose of a coastal defence is to support and/or protect the railway from the effects of the sea (flooding, scour and erosion, overtopping waves etc). Estuarine defences perform a similar function in river estuaries.

8.3 Asset types and population details

There are approximately 300 coastal and estuarine defences on the Network Rail system, amounting to 240 kilometres of directly defended railway. Network Rail infrastructure also relies upon significant lengths of sea and coastal defences operated by local authorities, such as where the railway passes close to the shoreline.

| Figure 37, Populations for Coastal and estuarine defences | | | |
|--|-----------|------------------------|---------------------------|
| Description | Km | Number of Units | Average Age, years |
| Coastal and estuarine defence | 240 | 300 | 150 |

8.4 Degradation, failure modes, consequential risks

Coastal and estuarine defences suffer the most aggressive environment of all the civil engineering assets. They are often large structures and are a significant maintenance liability. The degradation and failure modes of coastal defences depend on the interaction between several factors, the first of which is the underlying geology of the coastline and its overall stability in the face of coastal erosion. The severity of the effect further depends on the direction of the prevailing weather and the wave height as a function of the overall exposure of the coast.

Within navigable estuaries or channels wash from passing vessels also causes scour to structures. In addition all marine environments are highly corrosive for any ferrous based structures or components.

| Figure 38, Business risk for Coastal and estuarine defences | | | | |
|--|-----------------------------------|--|-----------------------|--|
| Occurrence | Degradation and key driver | Impact | Predictability | Possible mitigation measures |
| Regular | Scour | Coastal erosion can be severe and is dependent on the geology of the coast and the exposure of the | Low | Regime of examinations leading to bespoke plans for examination lead |
| | Coastal erosion | | | |
| | Geological Conditions | | | |
| | Weather | | | |
| | Salt water corrosion | | | |

| Figure 38, Business risk for Coastal and estuarine defences | | | | |
|--|-----------------------------------|---------------|-----------------------|-------------------------------------|
| Occurrence | Degradation and key driver | Impact | Predictability | Possible mitigation measures |
| Occasional | Groundwater | | | |
| | Vegetation | | | |
| | Design/latent defects | | | |
| | Rainfall | | | |
| | Surface water run-off | | | |
| Rare | Mining Activity | | | |
| | Increased loading | | | |
| | Freeze Thaw Cycle | | | |
| | Animal Infestation | | | |

8.5 Managing degradation risk

8.5.1 Mitigation regime

The mitigation regime for coastal and estuarine defences comprises routine examination, with bespoke examination led corrective maintenance appropriate to that asset. Replacement may be viable when continued maintenance is shown to be uneconomic.

8.5.2 Examination

As a result of the risk of storm or flooding damage to many coastal and estuarine defences, examinations are carried out more frequently than for most other civil engineering assets with most defences being examined every year.

Where a defence is believed to be particularly at risk it is subjected to more frequent special examinations, and additional examination of defences may also take place when storms have occurred.

A report is produced after each examination and the defence assessed as being in good, fair or poor condition.

8.5.3 Examination led maintenance

| Figure 39 Examination led maintenance for Coastal and estuarine defences | |
|---|---|
| Asset | Activity |
| All | Bespoke annual intervention plan to keep each defence fit for purpose |

8.5.4 Fixed interval maintenance

There is currently no fixed interval maintenance applied to coastal and estuarine defences.

8.6 Replacement

8.6.1 Criteria and specification

As for other civil engineering assets, replacement is only considered as a last resort. However coastal erosion mechanisms are now much better understood and effective measures to mitigate the effects mean that the replacement alternative can sometimes be cheaper and more effective than the repair option. A suitable example is the use of rock armour optimised for size and shape so that it remains locked in position under storm conditions and effectively breaks up the waves dissipating their energy. Such a solution can be cheaper than repairing a concrete sea wall and significantly reduces the magnitude of the forces from wave action.

8.7 Asset performance indicators

The criteria by which we judge the success of these policies are

- That actual unit costs, supplied as feedback from site work, match up with those used in the calculation of whole life costs, and which the policies are based on.
- Intervals between maintenance interventions: poorly designed and constructed sea defences are short lived and maintenance frequency is a key indicator of performance.
- The measured Asset Stewardship Index is either held constant or improved.

8.8 Constraints and deliverability check

There are no particular constraints or deliverability issues for coastal and estuarine

8.9 Planning assumptions

Our forecasts for defence maintenance and renewal do not allow for any extra work in the medium term that may be needed as a result of the effects of climate change.

Our forecasts for examination assume that defences are, in line with our current practice, given a detailed examination every year.

8.10 Longer-term implications

While the intention of this policy is provide a constant asset condition in overall terms across the network, it does not allow for the effects of climate change. Climate change is predicted to bring increased storm severity and a significant sea level rise over the life of the defence. In the long term there is an increasing probability that existing individual assets become compromised both in terms of degradation rate and design adequacy.

8.11 Compliance with Network Rail asset management policy

The policy for the management of coastal and estuarine defences complies with Network Rail's asset management policy.

8.12 References

- **Coastal and Estuarine Defence Management Strategies, Good practice guide**, Mouchel Parkman report, client Network Rail.
- **Responding to Risks from Climate Change in the Coastal Zones, Good practice guide**, European Union LIFE Environment Programme, Centre for Coastal environment, Isle of Wight Council, Sept 2006.

ANNEX A - LIST OF CIVIL ENGINEERING STANDARDS**RT/CE/P/044 Managing Structures Works** Issue 1; Apr 04

The purpose of this Network Rail Standard is to define the requirements for works to new and existing structures on, over or under Network Rail's infrastructure such that there is no unacceptable risk to safety as a result of their Design or construction.

RT/CE/S/003 Technical Approval of Design, Construction and Maintenance of Civil Engineering Infrastructure Issue 2; Apr 04

Replaces Issue 1; Oct 01

This purpose of this Specification is to control the risk to Network Rail's infrastructure, to railway operations, to railway passengers, members of the public and the environment that may arise due to work activities associated with the Design and construction of Permanent Way and the Design, construction and maintenance of Structures, Buildings, and other Civil Engineering Infrastructure on, over, under or adjacent to Network Rail's infrastructure by defining procedures to be followed.

RT/CE/S/007 Design Loading for Accommodation and Occupation Overbridges Issue 1; Feb 95

This specification defines standard design loading for new or reconstructed accommodation and occupation Overbridges and gives criteria for when lesser design loadings may be permissible.

RT/CE/S/035 Assessment of Structures Issue 2; Feb 04

Replaces RT/CE/S/035 Iss 1; Jun 01; RT/CE/P/010 Iss 2; Dec 97

This document defines the Specification to be followed for the Assessment of Structures for which Network Rail has responsibility, either as owner of the Structure or as a result of a specific agreement.

RT/CE/S/044 Undertrack Crossings Issue 2; Aug 04

Replaces RT/CE/S/044 Iss 1; Apr 98

The purpose of this document is to define the requirements for the design and construction of undertrack crossings.

RT/CE/S/080 Management of Existing Bridges and Culverts Issue 1; Apr 04

Replaces RT/CE/P/023 Iss 3; Feb 99; RT/CE/S/222 Iss 1; Feb 99

The purpose of this Specification is to define the requirements for the management of existing Bridges and Culverts on, over or under Network Rail's infrastructure such that there is no unacceptable risk to safety as a result of their condition, use or location.

RT/CE/S/082 Management of Existing Retaining Walls Issue 1; Apr 04

Replaces RT/CE/P/023 Iss 3; Feb 99; RT/CE/S/222 Iss 1; Feb 99

The purpose of this Specification is to define the requirements for the management of existing Retaining Walls on Network Rail's infrastructure such that there is no unacceptable risk to safety as a result of their condition, use or location.

RT/CE/S/084 Management of Existing Tunnels Issue 1; Apr 04

Replaces RT/CE/P/023 Iss 3; Feb 99; RT/CE/S/222 Iss 1; Feb 99

The purpose of this Specification is to define the requirements for the management of existing tunnels within Network Rail's infrastructure such that there is no unacceptable risk to safety as a result of their condition, use or location.

RT/CE/S/087 Management of Existing Buildings and Station Structures

Issue 1; Apr 04

Replaces RT/CE/P/023 Iss 3; Feb 99; RT/CE/S/222 Iss 1; Feb 99

The purpose of this Specification is to define the requirements for the management of existing Buildings and station structures on, over or under Network Rail's infrastructure such that there is no unacceptable risk to safety as a result of their condition, use or location.

RT/CE/S/088 Examination of Buildings and Station Structures Issue 1; Apr 04

Replaces RT/CE/P/023 Iss 3; Feb 99; RT/CE/S/222 Iss 1; Feb 99

The purpose of this Specification is to define the requirements for the examination of Buildings and station structures on, over or under Network Rail's infrastructure, such that there is no unacceptable risk to safety as a result of their condition, and for recording and reporting the examination findings.

RT/CE/S/089 Management of Existing Coastal, Estuarine and River Defences Issue 1; Apr 04

Replaces RT/CE/P/023 Iss 3; Feb 99; RT/CE/S/222 Iss 1; Feb 99

The purpose of this Specification is to define the requirements for the management of existing Coastal, Estuarine and River Defences on Network Rail's infrastructure such that there is no unacceptable risk to safety as a result of their condition.

RT/CE/S/091 Management of Existing Ancillary Structures Issue 1; Apr 04

Replaces RT/CE/P/023 Iss 3; Feb 99; RT/CE/S/222 Iss 1; Feb 99

The purpose of this Specification is to define the requirements for the management of existing Ancillary Structures on, over or under Network Rail's infrastructure such that there is no unacceptable risk to safety as a result of their condition, use or location.

RT/CE/S/092 Examination of Ancillary Structures Issue 1; Apr 04

Replaces RT/CE/P/023 Iss 3; Feb 99; RT/CE/S/222 Iss 1; Feb 99

The purpose of this Specification is to define the requirements for the examination of ancillary structures on, over or under Network Rail's infrastructure, such that there is no unacceptable risk to safety as a result of their condition, and for recording and reporting the examination findings.

RT/CE/S/142 Management of Abnormal Road Loads Issue 1; Aug 04

The purpose of this Specification is to define the requirements for the management of the movement of Abnormal Road Loads over Bridges owned by Network Rail.

NR/L1/CIV/032 The Management of Structures Issue 2; Sep 09: Compliance
05/12/09

Replaces RT/CE/P/032 Iss 1; Apr 04

The purpose of this standard is to define the essential procedures that have to be followed so that no unacceptable risk to the safe use or performance of railway infrastructure will arise from the stability, load-bearing capacity, condition or use of existing structures.

NR/L2/CIV/086 Management of Existing Earthworks Issue 2; Jun 09
Compliance 05/09/09

Replaces RT/CE/S/086 Iss 1; Jun 05

The purpose of this standard is to define the requirements for managing existing Earthworks such that there is no unacceptable risk to safety or performance as a result of their stability, condition, use or location.

NR/L3/CIV/006 Handbook for the Examination of Structures Issue 2; Mar 10
Compliance 05/06/10

Replaces NR/L3/CIV/006 Iss 1; Sep 09

The purpose of this handbook is to define the requirements and provide recommendations for examination of Structures; recording and reporting the findings of an examination; identifying actions and remedial works that need to be undertaken so that there is no unacceptable risk to the safety or performance of a Structure as a result of its condition.

**NR/L3/CIV/037 Managing the Risk Arising from Mineral Extraction and
Landfill Operations** Issue 3; Dec 08

Replaces NR/SP/CIV/037 Iss 2; Apr 04 (RT/CE/P/037)

The purpose of this standard is to define the procedures and responsibilities for managing the risks that Mineral Extraction and Landfill operations pose to Network Rail's operations and infrastructure.

NR/L3/CIV/038 Managing the Potential Effects of Coal Mining Subsidence

Issue 1; Dec 08

Replaces NR/SP/CIV/037 Iss 2; Apr 04 (RT/CE/P/037)

The purpose of this standard is to define the procedure for managing the potential effects of subsidence arising from coal mining, so that in following this procedure (a) such effects will not produce an unacceptable risk to the integrity, safe use or performance of the rail infrastructure, and (b) the cost of Works to manage such effects or for requiring Reservation of Support are determined and, respectively, recovered or paid.

NR/L3/CIV/039 Specification for the Assessment and Certification of Protective Coatings and Sealants Issue 5; Mar 09

Replaces RT/CE/S/039 Iss 4; Feb 02

The purpose of this standard is to define the procedures and test methods that shall be followed when assessing and certifying coatings and sealants for use on Network Rail's infrastructure.

NR/L3/CIV/040 Specification for the use of Protective Coating Systems

Issue 1; Mar 09

New at Issue 71

The purpose of this standard is to define the requirements for the selection, application and reapplication of protective coating systems to Network Rail's infrastructure.

NR/L3/CIV/041 Waterproofing Systems for Underline Bridge Decks Issue 3;

Aug 08

Compliance 06/06/09

Replaces RT/CE/S/041 Iss 2; Aug 01

This specification provides the performance criteria for waterproofing systems proposed to be used on Network Rail's underline bridge decks and provides recommendations for tests to be carried out to prove compliance with the performance requirements.

NR/L3/CIV/065 Examination of Earthworks Issue 2; Dec 08

Compliance 01/04/09

Replaces NR/SP/CIV/065 Iss 1; Apr 05 (RT/CE/S/065)

The purpose of this Specification is to define the requirements for the examination of Earthworks that are on Network Rail's infrastructure, such that there is no unacceptable risk to safety as a result of their condition, and for recording and reporting the examination findings.

NR/L3/CIV/071 Geotechnical Design Issue 3; Mar 10

Compliance 01/04/10

Replaces RT/CE/S/071 Iss 2; Aug 04

This standard is applicable to all types of 'structure', which is defined in BS EN 1990: 2002 as an 'organised combination of connected parts, including fill placed during execution of the construction works, designed to carry loads and provide adequate rigidity'. Thus this standard is applicable to the geotechnical design of all types of building and civil engineering works - such as Earthworks; retaining walls; the foundations, piers, abutments and wing walls of bridges; and foundations to buildings. This standard does not apply to the design of Track support systems.

NR/L3/CIV/076 Management of the risk of Bridge Strikes from Road Vehicles and Waterborne Vessels Issue 3, Jun 08

Compliance 07/06/08

Replaces NR/SP/CIV/076 Iss 2; Apr 06

The purpose of NR/L3/CIV/076 is to specify the requirements for managing Underline and Overline Bridges on Network Rail's infrastructure such that (a) there is no unacceptable risk to safety as a result of Bridge Strikes, and (b) train delays resulting from Bridge Strikes are minimised, as far as is reasonably practicable, without compromising the safety of train operations.

NR/L3/CIV/140 Model Clauses for Civil Engineering Works Issue 8; Mar 10

Compliance 05/06/10

Replaces Iss 7; Dec 09

The purpose of the standard is to define the requirements for the production and use of Model Clauses for specifying Civil Engineering Works.

NR/L3/CIV/151 Technical Approval of Standard Designs and Details for Civil Engineering Works Issue 2; Sep 09

Compliance 05/12/09

Replaces NR/WI/CIV/151 Iss 1; Apr 06

The purpose of this standard is to issue Standard Details and Designs for Civil Engineering Works and supplementary information, to NR/SP/CIV/003, on the Technical Approval process for their use.

NR/L3/CIV/160 The Design of Car Parks for Railway Stations and Depots

Issue 1; Jun 09

Compliance 05/12/09

The purpose of the standard is to provide direction and guidance on the design of car parks for railway stations and depots.

NR/L3/CIV/162 Platform Extensions Issue 1; Mar 10

Compliance 07/06/10

This Standard provides requirements and guidance on works to extend existing platforms at stations; for example, those involved in the Longer Trains Programme.

NR/L3/CIV/176 Management of Reports on Bridge Strikes Issue 2; Jun 06

Replaces NR/WI/CIV/076 Iss 2; Jun 06

The purpose of NR/L3/CIV/176 is to define the processes and the responsibilities for reporting information on Bridge Strikes.

NR/L3/CIV/300 Managing Complaints About Pigeons Issue 1; Jun 07

Compliance 02/06/07

The purpose of this Work Instruction is to define:

1. The procedure for managing complaints and Legal Notices concerning the nuisance caused by pigeons.
2. The roles and responsibilities of Network Rail employees in managing such complaints and Notices.

The procedure is designed to deliver an amicable, timely and cost-effective solution that satisfies all legal obligations.

NR/L3/CIV/305 Application of the Structures Condition Marking Index to Masonry Bridges Issue 1; Oct 07

Compliance 06/10/07

The purpose of this standard is to improve the consistency of condition ratings

given to Masonry Bridges by defining a change to, and expanding upon, the information given in NR/GN/CIV/041: Structures Condition Marking Index handbook for Bridges.

NR/GN/CIV/001 Waterproofing Underline Bridge Decks Issue 3; Aug 08
Replaces RT/CE/C/001 Iss 2; Aug 01

The purpose of this standard is to supplement NR/GN/CIV/041: Waterproofing systems for Underline Bridge decks by providing information on; the types of Waterproofing Systems, and their components, the selection of a Waterproofing System for a particular bridge deck, the detailing of a Waterproofing System, the application of a Waterproofing System, and the performance criteria for a Waterproofing System.

NR/GN/CIV/002 The use of Protective Treatments and Sealants Issue 5; Mar 09

Replaces RT/CE/C/002 Iss 4; Feb 02

The purpose of this standard is to support NR/L3/CIV/040: Specification for the use of protective coating systems by providing guidance and information on the selection, application and reapplication of such systems to Network Rail infrastructure.

NR/GN/CIV/025 The Structural Assessment of Underbridges Issue 3: Jun 06

Replaces RT/CE/C/025 Iss 2; Feb 04

The purpose of this document is to provide recommendations for applicable standards and analytical methods that may be used to determine the load carrying capacity of existing Network Rail underbridges.

NR/GN/CIV/201 Managing bridge strike incidents - Good Practice Guide for Bridge Strike Nominees Issue 4; Jun 08

Replaces Issue 3; Apr 06

The purpose of NR/GN/CIV/201 is to provide guidance and additional information on the processes to be followed by Bridge Strike Nominees during examinations of Bridges following a reported bridge strike, and gives examples showing the damage limits to a bridge following a bridge strike up to which Bridge Strike Nominees are authorised to permit train movements.

NR/GN/CIV/202 Management of the Risk of Bridge Strikes Issue 2; Jun 08

Replaces Issue 1; Jun 06

The purpose of NR/GN/CIV/202 is to provide guidance and information to those within Network Rail, and its suppliers, contractors and consultants who have responsibilities for complying with the requirements of NR/L3/CIV/076: Management of the Risk of Bridge Strikes from road vehicles and waterborne vessels. This document is intended for use as an office reference rather than as a site guide.

NR/GN/CIV/203 Evaluation and Assessment of Earthworks Issue 1; Oct 07

The purpose of this document is to provide guidance on the Evaluation and Assessment of Earthworks. The objectives of these key activities of the asset management cycle are (a) to determine or confirm the stability of existing Earthworks, and (b) to assess the risk posed by the continued use of an Earthwork. The information from (a) and (b) may be used in the design of remedial works to the Earthwork.

NR/GN/CIV/801 The Application of the Observational Approach to the Design of Remedial Works to Earthworks Issue 3; Mar 09

Replaces NR/L3/CIV/801 Iss 2; Apr 07

The purpose of this Guidance Note is to supplement NR/SP/CIV/071: Design of earthworks, earthwork remediations and geotechnical aspects of foundations for structures by providing advice on the application of the Observational Approach (OA) to the design of remedial works to embankments and soil cuttings.

RT/CE/C/015 The Assessment of Underbridge Capacity Issue 1; Nov 95

Defines parameters and methods for the assessment of underbridges owned by

RT/CE/C/026 Examination of Tunnels Issue 1; Jan 96

This Code of Practice gives guidance on the techniques for examining tunnels, the frequency of the examination, the competency of the Examiners, and the recording and processing of the findings.

RT/CE/C/041 Structures Condition Marking Index Handbook for Bridges

Issue 3; Aug 04

Replaces RT/CE/C/041 Iss 2; Feb 01

This Code of Practice provides advice on the application of a quantitative condition marking system for underbridges, overbridges, intersection bridges, side bridges and viaducts.

RT/CE/C/045 Code of Practice for Terms and Definitions for use in Civil Engineering Standards Issue 1; Aug 04

This Code of Practice has been produced with the aim of ensuring that standard terms and definitions are used within all Network Rail Standards and Business Process Documents produced for and on behalf of the Head of Civil Engineering.

RT/CE/G/133 Information Required for an Approval in Principle Submission

Issue 1; Apr 05

This document supplements RT/CE/S/003: Technical approval of design, construction and maintenance of civil engineering infrastructure by providing guidance on the technical approval process, and on the information required for an Approval In Principle (AIP) submission.

NR/WI/CIV/028 Management of Reports of Safety-related Events on Earthworks and Structures

Issue 1; Dec 05

The purpose of this document is to define the processes for rating and reporting Safety-Related Events, herein, classified into Failures and Incidents, associated with an Earthwork or a Structure.

NR/WI/CIV/143 NTPO: Technical Approval Process for Civil Engineering Infrastructure Issue 1; Aug 05

This Work Instruction defines the procedures for gaining Technical Approval for works required for the FTN and the GSM-R