Department for Transport

# Appraisal and Modelling Strategy
## Appraisal Periods Consultation

**Moving Britain Ahead**

**December 2020**

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# Foreword

The government has ambitious plans for transforming the nation's infrastructure over the coming decades, with a number of major transport projects already underway or in the development pipeline. These have the potential to deliver benefits for decades, if not hundreds of years to come. It is therefore essential that we are able to understand and represent long-term potential benefits within transport scheme business cases, in order to inform robust, evidence-based decision making.

One key analytical assumption is the length of the appraisal period used to assess project benefits, typically 60 years at present. Many projects have the potential to deliver benefits well beyond this time horizon, but these benefits are not currently included in scheme appraisals. Indeed, many historical investments in transport have had a lasting legacy far beyond 60 years. Set against this, there is inevitably greater uncertainty associated with benefits in the longer term. This is driven by uncertainty around future demand, the condition of the transport system and ‘unknown unknowns’ such as fundamental technological change or climate risks.

We are now launching a consultation on the recommended appraisal period for transport appraisal, in order to gather evidence on the issue, seek the views of our stakeholders and ultimately and help us reach a decision on changes to TAG.

Amanda Rowlatt, Chief Analyst

December 2020

# Executive summary

## Introduction

The Transport Analysis Guidance (TAG) Route Map, published in July 2020, set out the Department's plans to consult on setting the appropriate appraisal period within TAG. Given the ambition of Government to invest heavily in a number of major transport projects over the coming years and decades, it is crucial to have the right investment appraisal framework in place to help inform value for money decision making.

In particular, recognising the potential for transformative investment to deliver on key strategic goals such as inter-regional connectivity and levelling up over the longer term, we are revisiting our approach to ensure long-run impacts are appropriately recognised in appraisal.

## Capturing long-term benefits

Major transport projects can often involve creating assets with a design life much longer than the 60-year period typically used in scheme appraisal. The standard design life for major civil engineering projects is often up to 100 years or greater, for example tunnels typically have a 100-year design life. More generally, much of the railway network is inherited from the Victorian era and many key road links were originally established far longer than 60 years ago. For example, the East Coast Main Line was originally built in the 1840s and the M1 opened in 1959. The majority of the West Coast Main Line runs on land that was purchased for and earthworks that were dug for the London & Birmingham Railway and the Grand Junction Railway, both of which opened around 1840. All of these assets remain operational and arguably have remaining value for many more years to come, albeit while incurring substantial maintenance, renewal and enhancement costs which should also be considered.

Transport investments, providing the network is appropriately maintained and renewed over time, can often deliver benefits effectively indefinitely. Viewed from today’s standpoint, it is clear that the outturn benefits of many past infrastructure projects have been realised far in excess of what a 60-year appraisal would demonstrate. Furthermore, transport investments have the potential to open up new corridors which are sustained over time, even beyond the useful life of the initial investment, thereby having lasting impact on economic geography.

However, there is a risk that some investments become obsolete (or far diminished in importance) far earlier than the end of their design life, for example the inland waterway network or some tram networks of the early 20$^{th}$ century. This obsolescence could occur for environmental, technological, behavioural, economic, social or political reasons, and essentially reflects the risk that project benefits could fall dramatically towards zero due to exogenous factors that are impossible to predict in advance forecast.

Furthermore, in order to carry on delivering benefits over the very long-term, infrastructure will need to undergo extensive maintenance and renewal, the costs of which need to be accounted for in any assessment of long-term or residual asset value.

Major investments also have the potential to, alongside other factors, facilitate significant changes in economic geography. Where they occur, these effects could be very long lasting, far beyond the usual 60-year horizon. Currently, methods to model and forecast these are less well developed than other parts of TAG, with the resulting estimates generally subject to greater uncertainty than conventional appraisal outputs. However, we recognise that these effects can be key components of certain business cases so, in principle, may warrant consideration over a longer timeframe than 60 years from scheme opening.

## Identifying the way forward

Overall, a balanced appraisal framework should be able to consider the possibility that project benefits could last into the very long term, while also acknowledging the risk of obsolescence or catastrophic failure and the increased uncertainty associated with any modelling and appraisal outputs when using a longer appraisal period.

There are a range of potential approaches to capturing the long-run benefits of transport schemes, which broadly speaking fall into three groups. Firstly, the appraisal period can be extended, with various options around how benefits and costs are estimated and profiled over the additional years. Secondly, a range of approaches can be used to estimate the commercial value of operating an infrastructure asset beyond the standard 60-year appraisal period. Finally, the scrap value of assets, and any recoverable land value, after 60 years can be considered. Overall, we think only the first of these (in some form) offers a viable basis for appraisal, given that the other approaches systematically fail to capture the full social value of investment. Therefore, this consultation focuses mainly on the appraisal period.

It is important to recognise that any arguments for a longer appraisal period may also apply to other forms of transport investment too, for example local transport or cycling and walking schemes, so we cannot consider the impact on major schemes in isolation.

As noted above, uncertainty about the future increases very significantly over time, so we need to explicitly address uncertainty as an integral part of any change to the length of the appraisal period. This is considered in this consultation and will be covered in more depth in the forthcoming Uncertainty Toolkit which was discussed in the Route Map.

## Seeking your views

As well as inviting written responses on the questions contained in this document, we plan to pro-actively engage with our stakeholders during the consultation through an online workshop as part of the TAG digital events set out in the Route Map. Please register your interest by emailing tasm@dft.gov.uk.

The consultation will run for six weeks. Once the consultation is closed, we will analyse your responses to help inform our next steps. A consultation response document will then be issued in due course, setting out how we plan to address the appraisal periods question in TAG.

# How to respond

The consultation period began on [date] and will run until [date]. Please ensure that your response reaches us before the closing date. If you would like further copies of this consultation document, it can be found at https://www.gov.uk/dft#consultations or you can contact [contact details] if you need alternative formats (Braille, audio CD, etc.).

Please send consultation responses to:

Email address: tasm@dft.gov.uk.

When responding, please state whether you are responding as an individual or representing the views of an organisation. If responding on behalf of a larger organisation, please make it clear who the organisation represents and, where applicable, how the views of members were assembled.

There will be two consultation events on Friday 18th December 2020 and Friday 8th January 2021, both from 10:00-12:00. If you would be interested in attending these events, please email tasm@dft.gov.uk, with the subject and date as follows 'Appraisal Periods Consultation: workshop attendance dd/mm/yyyy' giving at least 3 working days' notice.

Due to remote working for the foreseeable future, we cannot accept hard copies of responses but please let us know if you are unable to respond by using the survey or by email.

## Freedom of Information

Information provided in response to this consultation, including personal information, may be subject to publication or disclosure in accordance with the Freedom of Information Act 2000 (FOIA) or the Environmental Information Regulations 2004.

If you want information that you provide to be treated as confidential, please be aware that, under the FOIA, there is a statutory Code of Practice with which public authorities must comply and which deals, amongst other things, with obligations of confidence.

In view of this it would be helpful if you could explain to us why you regard the information you have provided as confidential. If we receive a request for disclosure of the information, we will take full account of your explanation, but we cannot give an assurance that confidentiality can be maintained in all circumstances. An automatic confidentiality disclaimer generated by your IT system will not, of itself, be regarded as binding on the Department.

The Department will process your personal data in accordance with the Data Protection Act (DPA) and in the majority of circumstances this will mean that your personal data will not be disclosed to third parties.

## Data Protection

The Department for Transport (DfT) is carrying out this consultation to gather evidence on the length of the appraisal period for transport projects. This consultation and the processing of personal data that it entails is necessary for the exercise of our functions as a government department. If your answers contain any information that allows you to be identified, DfT will, under data protection law, be the Controller for this information.

As part of this consultation we're asking for your name and email address. This is in case we need to ask you follow-up questions about any of your responses. You do not have to give us this personal information. If you do provide it, we will use it only for the purpose of asking follow-up questions.

# Background

## Current approach

Current TAG advice is to use a 60-year appraisal period from scheme opening for assets with an indefinite lifespan, and that appropriate maintenance and renewal costs to ensure they remain operational are counted in the appraisal. A shorter period may be used for assets with a shorter lifespan – only in such cases should a residual value, in general, be included according to current guidance. However, where a scheme involves large capital expenditure towards the end of the 60-year appraisal, residual value may be considered on a case-by-case basis subject to contacting the DfT for advice. The primary motivation for capping appraisals at 60 years regardless of asset life is to provide a consistent basis for comparisons between options and schemes.

The HMT Green Book, which provides the overall guidance for appraisal in Government, sets a default maximum appraisal period of 60 years for infrastructure. However, the Green Book also recognises a longer appraisal period than 60 years may be needed where an intervention is likely to have significant social costs or benefits beyond that point. In such cases, agreement should be sought from the approving authority. The Green Book also recommends that an asset's residual value or liability at the end of the appraisal period should be included to reflect its opportunity cost.

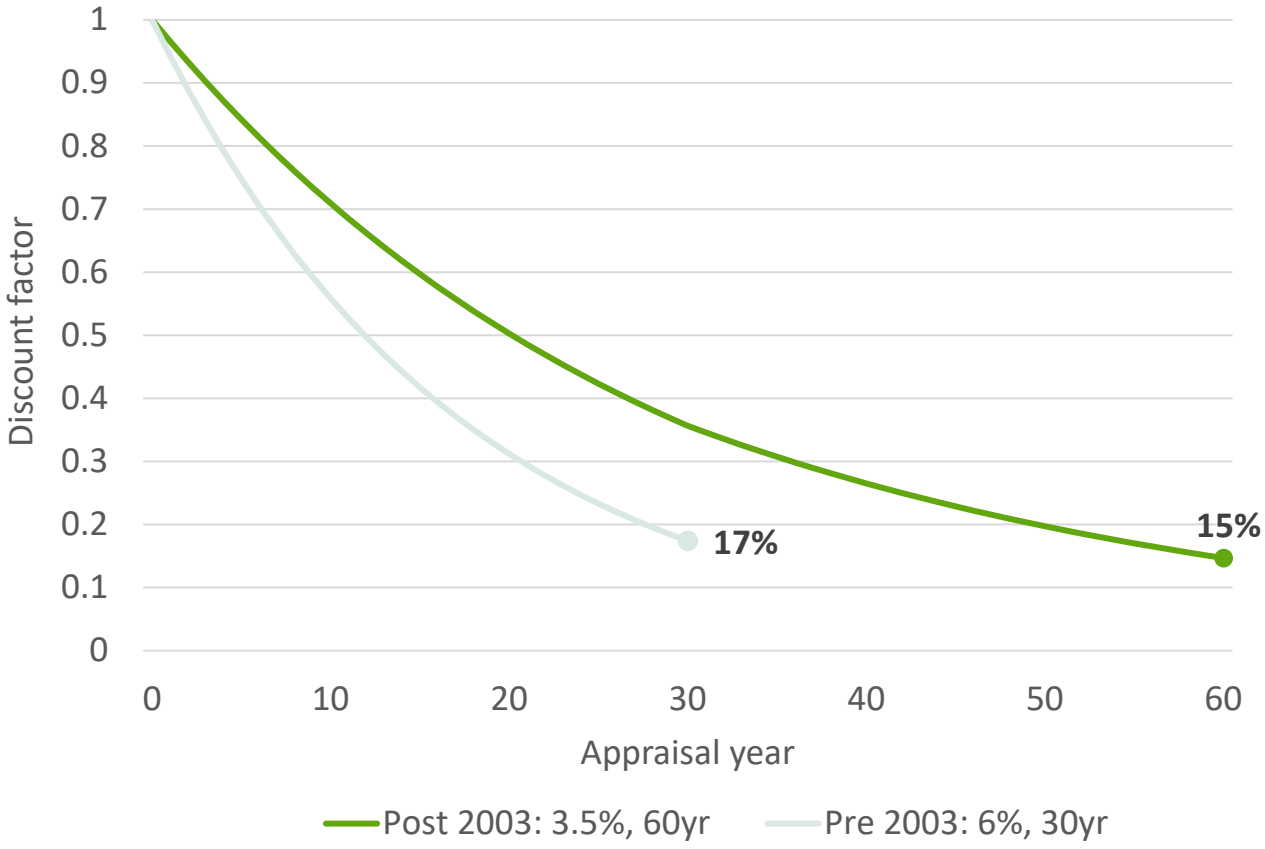
In practice, our current approach to scheme appraisal is to estimate benefits using detailed modelling results up to a final model year typically no more than 20 years from now, and generally before 2051 (as this is the final year the Department's travel demand projections, as provided in the TEMPro software, are available for). Beyond this, we usually consider some form of extrapolation of benefits up to 60 years, implicitly assuming that there are zero benefits thereafter. The basic challenge facing us, therefore, is whether we should make some allowance for potentially longer-term benefits within our appraisal and value for money assessment framework.

There is a categorical difference between benefits appraised over the period of detailed modelling (i.e. approximately the first 20 years) and the remainder of the appraisal. While the former are generally supported by detailed network and demand modelling, with quantified uncertainty ranges, anything beyond this is inevitably extrapolation based with a greater role for judgement in determining the post-final modelled year profile of benefits. Therefore, these longer-term benefits will always, in principle, be subject to a higher degree of uncertainty; however that is not to say they should not be considered within the value for money assessment.

## Historical context

Prior to 2003 a shorter appraisal period of 30 years and a 6% discount rate was used. Shortly after the publication of the 2003 Green Book, the DfT moved to a 60-year appraisal and a new, lower discount rate of 3.5%. This placed significantly more emphasis on long-term benefits than before. As figure 1 shows below, together these changes meant that the discount factor achieved by the end of the appraisal period remained fairly constant between approaches. Overall, all else equal, the present value of benefits of a project with a lifespan of at least 60 years is substantially higher under the current approach than the pre-2003 method.

**Figure 1: discount factor profiles for pre- and post-2003 regimes**




## Recent work

In 2016 DfT published a report by ARUP and Leeds Institute of Transport Studies (ITS) entitled 'Research Into The Appraisal Of Long Term Benefits Of Transport Schemes'. This was focused on issues surrounding the demand cap in appraisal (typically 20 years from the appraisal year for rail, and 15 years from scheme opening for road). Although it did not discuss the appraisal period at length, some important conclusions from that research were that:

- forecast uncertainty increases significantly over the appraisal period, due to uncertainty in both the drivers of demand and modelling/appraisal parameters;

- if capacity constraints eventually bite, benefits growth can be significantly curtailed towards zero;
- there are significant practical challenges in extending final modelled years far into the future, including the fact that models may not converge and the difficulties in specifying a plausible do-minimum scenario; and
- a hard demand cap fixed at a point in time, while being easy to understand and helping to mitigate uncertainty in demand forecasts, may unfairly disadvantage schemes which open later and offer substantial capacity improvements.

A key outcome of this programme of work was to update TAG, permitting population-based benefits extrapolation post-final modelled year subject to the analyst presenting a reasonable case that capacity constraints do not curtail this. Please see TAG Units A1.1 section 2.4.6 and A5.3 section 2.3 for further details.

The long-term benefits research highlighted a number of complexities associated with the appraisal of transport schemes over the long-term including the treatment of uncertainty. As set out in the Route Map, we have separately been progressing work to drive the more consistent treatment of uncertainty in appraisal, through developing an uncertainty toolkit and piloting national demand uncertainty scenarios.

## Making the case for change

Having set out the current position in guidance, and recent work in this area, we believe there is a case, in principle, for reflecting longer-term benefits in transport appraisal. Broadly, this claim has three justifications which are explored in more detail throughout this document:

- Many schemes and assets we construct have a longer design life than 60 years – for instance tunnelling work or new rail lines can often have design lives of 100 years or more. Therefore, we might expect them to remain operational and deliver benefits over a longer period than the standard 60-year appraisal.
- For many assets, including shorter lived ones, maintenance and renewal expenditure can often ensure they remain operational for a much longer time period than their initial design life, continuing to deliver benefits. Providing the network is appropriately maintained and renewed over time, these benefits can in principle be realised indefinitely.
- Transport investments have the potential to establish new corridors, which can be sustained even beyond the lifespan of the assets. While this is not a straightforward benefit in cost-benefit analysis terms – as it relates to future investments which may or may not be brought forward to make use of those corridors – this is effectively a form of option value potentially unlocked by transport schemes.

## Scope of the consultation

Given the ongoing work by Transport Appraisal and Strategic Modelling (TASM) to develop an Uncertainty Toolkit, this consultation does not seek views on how we handle uncertainty in modelling, appraisal and decision making in general. However,

we recognise that judgments over the length of the appraisal period are ultimately a balancing act between forecast uncertainty and a desire to capture the full benefits of investment as far as is reasonable. Therefore, we welcome perspectives on how this trade-off should be best handled.

In the following sections we set out some of the key practical, technical and theoretical issues surrounding the appraisal periods debate. We are also seeking views on the guiding principles we should use to inform our decision over subsequent updates to TAG. We propose a set of criteria we will use to support this decision. We invite respondents to submit any evidence they feel is relevant to the consultation questions.

**Overall Approach**

1 Do you think there is a case for including long-term benefits, beyond the existing 60-year appraisal period? What do you think are the main challenges associated with this?

# Alternative approaches for reflecting long-term value

## Longer appraisal period

If we are able to establish the case for reflecting the very long-term (i.e. post 60 years from opening) value of transport projects in appraisal, then there are a range of potential approaches we might consider. These are outlined below.

One approach is to simply extend the appraisal period, which is the focus of this consultation. This has the advantage that, in principle, a full accounting of social costs and benefits is made, in line with Green Book principles. However, this is reliant on being able to make transport model forecasts, or reasonable extrapolations of benefits, beyond the typical forecast horizon of 15-20 years from now. Furthermore, the longer the appraisal period, the greater uncertainty there is around appraisal results which will need to be explored and presented as part of the appraisal process.

Conceptually, this is the most appealing approach from a purely welfare-based cost-benefit analysis standpoint. None of the other options discussed below are likely to be able to quantify the full social value of investment beyond the standard 60-year appraisal period.

## Market based valuations

There is also a family of approaches which consider the market value of the asset to an operator, based on some form of discounted cash flow analysis. For example, the value of concession to operate the asset could be calculated, or we could estimate the value of the infrastructure manager. The former approach would capture the cost of running the service plus an allowance for normal profit, while the latter would seek to estimate what the market would pay to assume ownership of the asset.

Both approaches would only reflect the financial value of the asset, and not the full social value. For example, in the case of a railway service, this would broadly reflect the market's present value of the future revenue stream, minus the costs of running the service. This is likely to understate the full social value of providing those services, as it would not include the consumer surplus benefits to users, nor reflect the cost of any subsidies or government spending underpinning the operation of the asset (e.g. the full cost of maintaining the network). Another significant difficulty is that for non-public transport schemes there is generally no toll, fare or any other form of user charge to base the discounted cash flow analysis on. It may be possible to estimate the value based on the charges a private operator could hypothetically levy, but this would still not account for the full social value of the asset. Furthermore, it would arguably be internally inconsistent to value the asset in this way when it is highly unlikely that such charges would actually be applied, given that those charges would affect the use of, and social value derived from, the asset.

Another approach would be to base any residual value on the remaining book value of the asset after 60 years. For example, a straight-line depreciation profile might be applied for the design life of the asset, so there would be a portion of value remaining on the balance sheet at year 60. As with the above approaches using cash flow analysis, this approach is unlikely to reflect the full social value of the asset. It is simply based on the cost of the asset (accounting for depreciation and renewals up to year 60) and not the benefits of operating it. Moreover, it implies that when the book value of the asset is zero, it has no value, which is clearly not necessarily the case from a social welfare perspective.

## Scrap value

The final alternative approach noted here is to use a scrap value of the asset at 60 years, reflecting the value of selling the assets (but not the ability to operate a service using them) to the market, including any land parcels. This again fails to reflect the social value of operating the asset.

This approach is still useful for capturing the residual value of an asset with a necessarily limited lifespan, and still warrants inclusion in appraisal in such cases as set out in TAG Unit A1.1. In this sense, the use of scrap values and a longer appraisal period are not necessarily mutually exclusive.

## Summary

Of these approaches, we believe an extended appraisal period is the only plausible approach from a cost-benefit analysis perspective. All of the other options systematically fail to capture the broader social value of operating transport services beyond the current 60-year appraisal period. As per current TAG, a scrap value approach is appropriate for assets of finite life of under 60 years.

Therefore, while we welcome views on alternative approaches, for appraising the value of schemes beyond 60 years it is unlikely we will adopt an approach that is not based in some form on consideration of the full flow of social costs and benefits that may accrue after 60 years. The other approaches discussed may usefully provide a lower bound estimate of the social value of an infrastructure asset beyond this point but should not be considered a substitute for broader consideration of social costs and benefits.

**Market-based residual value approaches**

2 In light of our assessment of alternative approaches, are there other methods we may not have considered? In particular, should we be focusing on the wide range of possible social, economic and environmental impacts over the longer term, which are unlikely to be fully captured in a market-based valuation?

# Modelling and appraisal challenges

## Introduction

In this section we set out the key analytical challenges associated with a longer appraisal period and raise several questions where we seek stakeholder feedback.

## Impact of a longer appraisal period

In order to give a sense of the materiality of a potentially longer appraisal period, focusing solely on the benefits side for exposition, we have undertaken illustrative analysis of a hypothetical scheme. Details are available at annex C.

It is important to note that the analysis in this section does not consider maintenance, renewal and operation costs. These are much more scheme specific and harder to generalise for illustrative purposes than appraisal benefit streams. These costs are likely to be substantial, and would need to be robustly estimated, alongside any appropriate allowances for optimism bias and real cost inflation, for the whole period for which any benefits are claimed. However, our expectation is that the net impact would be positive in terms of benefit to cost ratios.

Three key insights from this analysis are:

- There is a strong interaction between the length of the appraisal period needed to capture the large majority of benefits, and the approach taken to growing appraisal values over the very long-term (discussed later in this document). Where growth in appraisal values is held flat, a much longer appraisal period may appear warranted. However, caution is needed here, given that the present value tends to infinity as the appraisal period gets longer, casting severe doubt on the plausibility of these results and, by extension, the approach of a constant rate of growth in appraisal values combined with a declining discount rate. This also applies for bolder extrapolation assumptions, for example where extrapolation of benefits is based on a 1% per annum population growth rate the perpetual value is infinity due to the declining discount rate eventually falling below 1%.
- For modest population growth-based extrapolation parameters (in the range of 0.15-0.3% per annum, once we ensure the growth in appraisal values declines in line with the discount rate, the results are similar for appraisal periods up to 100 years. Decisions around population extrapolation become more material with longer appraisal periods. Much more ambitious forms of extrapolation, for example using model trends, could also have a material effect over shorter appraisal periods, as indicated by the results under 1% per annum extrapolation of demand growth.

- Population extrapolation plays a slightly more important role for later scheme opening years. However, for very long appraisals, 200 years or longer, the impact of the opening year in the overall analysis becomes negligible.

We note that because rail schemes tend to generate revenue which is offset against costs in the benefit to cost ratio (BCR) calculation, they have the potential to be more sensitive to the appraisal period than other projects. Note, this applies even where the change in overall social benefits is the same and is purely a result of the way we treat revenue in the BCR. This will be especially pronounced where they are operationally positive, meaning that at the margin (i.e. once up-front capital costs are incurred) they take more in revenue than the costs of running the service. A simple worked example is shown at figure 2 below.

**Figure 2: Illustrative example of the impact on BCRs of the interaction between fare revenues and the appraisal period**

| | Rail | | Road | |
|---|---|---|---|---|
| | **60 yrs** | **100 yrs** | **60 yrs** | **100 yrs** |
| **Benefit** | 80 | 110 | 100 | 137.5 |
| **Cost** | 40 | 45 | 40 | 45 |
| **Revenue** | 20 | 27.5 | 0 | 0 |
| **BCR** | 4 | 6.3 | 2.5 | 3.1 |
| **NPV** | 60 | 92.5 | 60 | 92.5 |

*This table shows that extending for the appraisal period for a rail scheme is likely to have a greater proportional BCR impact than for a road scheme, even though the net present value (NPV) is the same*.

## Supply side uncertainty and the do-minimum

Current guidance is, in general, to only include supply side changes (other than the one being appraised) in the do-minimum where they are 'near certain' or 'more than likely', as set out in TAG Unit M4 section 7.4 and Appendix A. However, there is a proviso in TAG Unit M4 to include further schemes in the do-minimum (p.16):

> *7.4.4. The Without-Scheme Forecast should be updated from the Reference Forecast by incorporating all the core transport supply assumptions identified in the uncertainty log. In some cases it may be clear that further improvements to the transport system, that had not been identified in the published plans, are likely to be required to accommodate future demand. Such improvements should be included, provided they do not involve large expenditures (up to say 20% of the proposed scheme cost) as this could distort the appraisal severely. Where greater expenditure would be required, the impact should be established by use of a sensitivity test. Any such changes should be reported.*

As we consider a potentially longer appraisal period, this issue becomes more acute. It is hard to conceive a plausible state of the world in 30 or 60 years hence, let alone 100 or more, where no further non-committed projects are brought forward to meet growing demand. It might seem appealing, therefore, to assume a minimum level of service, or even a more ambitious baseline scenario, for modelling further and further

out. However, this runs somewhat contrary to the logic of cost-benefit analysis, where the goal is to assess the incremental value of a decision being taken today, all else equal. Taking forward a project to deliver large amounts of capacity sufficient for decades to come will almost certainly ameliorate the need for the other assumed 'de minimis' solutions such that they may not in fact occur. If this is the case, then by including them in the do-minimum there is a risk of understating project benefits and, therefore, misallocating public resources.

In addition to these conceptual concerns around the do-minimum, there are severe practical difficulties in achieving convergence in further out modelled years, particularly in assignment models. This inhibits the ability to estimate do-minimum travel costs and, therefore, to do appraisal. Arguably, this brings into question the validity of extrapolating benefits growth beyond the final modelled year, as there is no robust way of validating the approach.

One of the recommendations from the ARUP/ITS Long Term Benefits research was to consider extrapolating demand from the final modelled year until a capacity cap is reached and holding benefits flat thereafter, although little specific detail was offered on how to extrapolate in practice. More work would be needed to operationalise this approach, likely by defining appropriate measures of capacity which can be used in practice. Furthermore, this approach is highly likely to require multiple additional model runs, adding a significant resource burden on scheme promoters.

Current TAG Unit A1.1 offers general guidance on extrapolation, noting that it is important to consider the potential for the magnitude of scheme impacts to go up or down after the final modelled year.

Note, these issues are in principle the same whether benefits are extrapolated using a model trend, as the Long Term Benefits report suggested, or population-based extrapolation. However, given the present low OBR population projections, under population-based extrapolation it is less likely capacity limits will be breached than if more ambitious model-based extrapolations are used. If capacity is fully used up, however, following the argument set out in the Long Term Benefits report, direct user benefits will in principle fall to zero. However, there may still additional wider benefits to the economy and society from providing additional capacity compared to the without-scheme scenario, which may warrant consideration even when capacity limits are reached in the with-scheme scenario.

## Demand side uncertainty, technology and behaviour change

As the appraisal period gets longer, the resulting benefit estimates inevitably becomes more uncertain. Key drivers of this uncertainty include:

- Uncertainty in exogenous input assumptions such as gross domestic product, fuel costs, population and employment.
- Uncertainty in modelling parameters which are used to convert these exogenous drivers into impacts on travel demand, such as demand elasticities and mode choice parameters.
- Uncertainty in appraisal values, such as forecast values of time, health impacts and agglomeration elasticities.

In addition, there is systemic uncertainty around the future value of investment, related to the possibility of assets becoming obsolete or catastrophically failing – or indeed having much higher additional value than expected – due to external factors.

The external factors may include new forms of technology (e.g. autonomous vehicles) which radically shift the composition or level of travel demand, behavioural change such as increased home-working or changes to driving licence holding, or the risk of climate change or natural disasters rendering an asset unusable.

There is also a small risk of national catastrophe which fundamentally changes the social structure permanently such that benefits are effectively zero. The current HMT discount rate in includes a 1% per annum catastrophic risk factor which arguably captures these systemic risks within project appraisal. This corresponds to an implied probability of 'survival' beyond 60 years of about 55% (the survival probability after 60 years is given by $e^{-60(0.01)}$ = 0.55), assuming a continuous annual rate of failure of 1%. Taken at face value, this might suggest the risk of extreme catastrophic failure is sufficiently well accounted for within appraisal.

However, some of the potential behavioural and technological changes that might impact society over the coming decades warrant consideration within value for money assessment, but do not neatly correspond to 'catastrophic risk'. As set out in the Route Map, TASM is planning to release an 'Uncertainty Toolkit' which is intended to support scheme promoters in reflecting such uncertainties within business cases. This will also consider how to appropriately represent uncertainty with a longer appraisal period, should one be adopted. If this were the case, it would likely be necessary to place even greater emphasis on technology and behaviour driven forms on uncertainty in the value for money assessment, for example through greater use of scenarios.

**Treatment of uncertainty**

3 What do you consider to be the key sources of uncertainty associated with appraising benefits over a longer timeframe?

4 To what extent do you believe that limiting the appraisal period to a set timeframe is an appropriate way of handling uncertainty? Are there other approaches which might better balance uncertainty with the potential longer-term benefits of investment?

## Asset life and maintenance

Certain infrastructure assets will be built for a shorter design life than 60 years, whereas others have expected lifespans in excess of 100 years. Figure 3 below demonstrates the typical assumed asset lives for various categories of scheme typically considered within the Department's investment portfolio.

**Figure 3: typical asset design lives (sourced from DfT business case analysis assumptions)**

| Asset | Typical design life (years) |
|---|---|
| Rolling stock | 30-35 |
| Signalling | 30-40 |
| Tunnels | 100 |
| Buildings | 60 |
| Railway track | Up to 50 |
| Road surface | Up to 15 |

*This table typical asset lives used in business case appraisals. As can be see, for some assets such as tunnels the design life is significantly longer than the current maximum appraisal period in TAG of 60 years.*

One possible approach would be to limit the appraisal period to the asset life in question, therefore allowing it to vary by scheme. However, it is important to note that many forms of infrastructure improvement, for example new road or rail links, can potentially have an indefinite lifespan providing they are adequately maintained and renewed where necessary. If a longer appraisal period is used, arguably such projects should be permitted to claim benefits for the full extended period even if the original design life for the underlying assets is shorter than that, provided the relevant maintenance and renewals measures are fully costed in the appraisal.

Note that this means in cases where shorter appraisal periods than 60 years are typically used at present, for example cycling or behaviour change schemes, there may be a case for considering longer-term value despite a relatively short (or non-existent, in the case of pure behaviour change) asset life.

As with benefits, there is also greater uncertainty associated with maintenance and renewal costs in the longer term. Current guidance focuses much less on these, even within the current 60-year appraisal period. This is partly pragmatic, as for most projects the up-front capital costs are likely to represent a majority of project costs. However, we recognise this can vary by scheme, and that there is significant uncertainty in projected maintenance costs into the very long term.

It is also important to consider the decision context. If comparing options for solving a local transport problem on a fairly minor scale, such as a roundabout or junction improvement, it is unlikely to make a material difference if a longer appraisal period is considered because it is likely to have a similar proportional impact on the value for money of each option. However, when comparing across major projects or whole programmes of spending, a longer appraisal period could be much more influential on the ultimate decision given some projects might have greater long-term potential than others. In these cases, it would arguably be misleading to tie appraisal periods to initial asset lives, providing projects can clearly demonstrate and accurately cost continued delivery of benefits beyond their initial design life.

**Differential impacts by project**

5 To what extent do you think that current practice in relation to appraisal periods materially biases against particular schemes or options? What do you consider the source of this bias to be?

## Inter-generational effects

Current Green Book guidance states the following:

> *A6.20 Where the possible effects of an intervention being examined as part of an appraisal are long term and involve very substantial or irreversible wealth transfers between generations further sensitivity analysis is appropriate. This could include irreversible changes to the natural environment. This involves applying both the standard Green Book discount rate and a reduced discount rate (excluding pure social time preference, δ) to costs and benefits.*

Arguably, some major transport projects fall into this bracket. They often involve large, up-front investment costs to create assets which will have the potential to deliver significant benefits for generations to come. Therefore, one potential option for better representing longer-term value is to remove the pure time reference rate from the discount rate, reducing the initial rate from 3.5% to 3% (the discount rate then declines over time), and present this as a sensitivity test.

In principle, this option could be combined with a longer appraisal period or treated as a standalone option. Figure 4 below shows the potential impact on appraisal results for a range of appraisal periods. This has the potential to materially increase benefits.

**Figure 4: Illustrative example of the impact on benefits of using a zero rate of pure time preference in the discount rate**

| | Scheme opening year 2040 | | | Scheme opening year 2020 | | |
|---|---|---|---|---|---|---|
| **Appraisal Period** | **Regular DR** | **No PTP** | **% increase** | **Regular DR** | **No PTP** | **% increase** |
| 60 | 49 | 57 | 16% | 43 | 48 | 13% |
| 100 | 57 | 69 | 21% | 54 | 64 | 19% |
| 200 | 63 | 81 | 27% | 63 | 79 | 26% |
| 250 | 64 | 83 | 28% | 64 | 82 | 28% |
| Perpetual | 66 | 86 | 31% | 66 | 86 | 31% |

*Uses demand growth of 1% p.a. up to 2040, 0.15% p.a. population extrapolation thereafter and GDP pc growth of 1.5% p.a. declining with the discount rate*

*This table shows that using a zero rate of pure time preference (PTP), compared to the regular HMT discount rate (DR) significantly increases benefits over any appraisal period, and the size of this increase is much bigger with a longer appraisal.*

*For shorter appraisal periods the increase in benefits is slightly larger with a later scheme opening year.*

**Inter-generational effects**

6 Do you think there is a case for reflecting potential inter-generational effects in appraisal?

## Growth in the value of impacts over the very long term

If we adopt a longer appraisal period, assumptions about how we uplift and discount appraisal benefits in the long term become more material for the calculation of the present value of benefits. Beyond the final modelled year, discounted benefits are driven by the combined impact of growth in appraisal values (e.g. values of travel time savings) and the discount rate (which gradually declines over time from an initial rate of 3.5%, in line with HMT Green Book guidance). Current guidance treats the growth in appraisal values and the declining discount rate independently. If the appraisal period is extended, we plan to review this approach given the potential sensitivity of benefit calculations to these assumptions over the very long run.

The Green Book social time preference rate is based on the Ramsey Equation which is given as follows:

$$r = \rho + \mu g = 1.5\% + 1 * 2\% = 3.5\%$$

Where:

- $r$ is the discount rate
- $\rho$ is the utility discount rate, composed of the rate of pure time preference ($\delta$) plus an allowance for catastrophic risk ($L$). Currently set at 1.5%.
- $g$ is the expected growth rate of future real per capita consumption (in practice, we currently take this to be real GDP per capita).
- $\mu$ is the (negative of) the elasticity of the marginal utility of consumption with respect to consumption (this measures how quickly the marginal value of a £ diminishes as people get richer). Currently set at 1, which means if income doubles the marginal utility of income halves.

This rate, which starts at 3.5% as shown above, then declines to 3% after 30 years and 2.5% after 75 years, with further declines thereafter in principle. The profile of decline in the discount rate is based on the idea that the future discount rate is uncertain, in which case it is possible to show mathematically that, over time, the discount rate should decline. See Oxera (2002) 'A social time preference rate for use in long-term discounting' (appendix 2) for a derivation of this. The Green Book is not currently specific on which component(s) from the Ramsey Equation are attributed as driving this uncertainty in the discount rate.

If that uncertainty is entirely characterised as being driven by uncertain future economic growth prospects (the term *g* in the Ramsey Equation), then the economic growth rate used for uprating appraisal values should in theory decline in line with the discount rate. At the other extreme, if we characterise the uncertainty as driven solely

by the non-growth terms in the Ramsey Equation, the economic growth rate used for uprating values should be flat, as per current guidance. The reality could also lie between these two extremes, in which case the growth rate for uprating would fall over time, but it would decline more slowly than the discount rate.

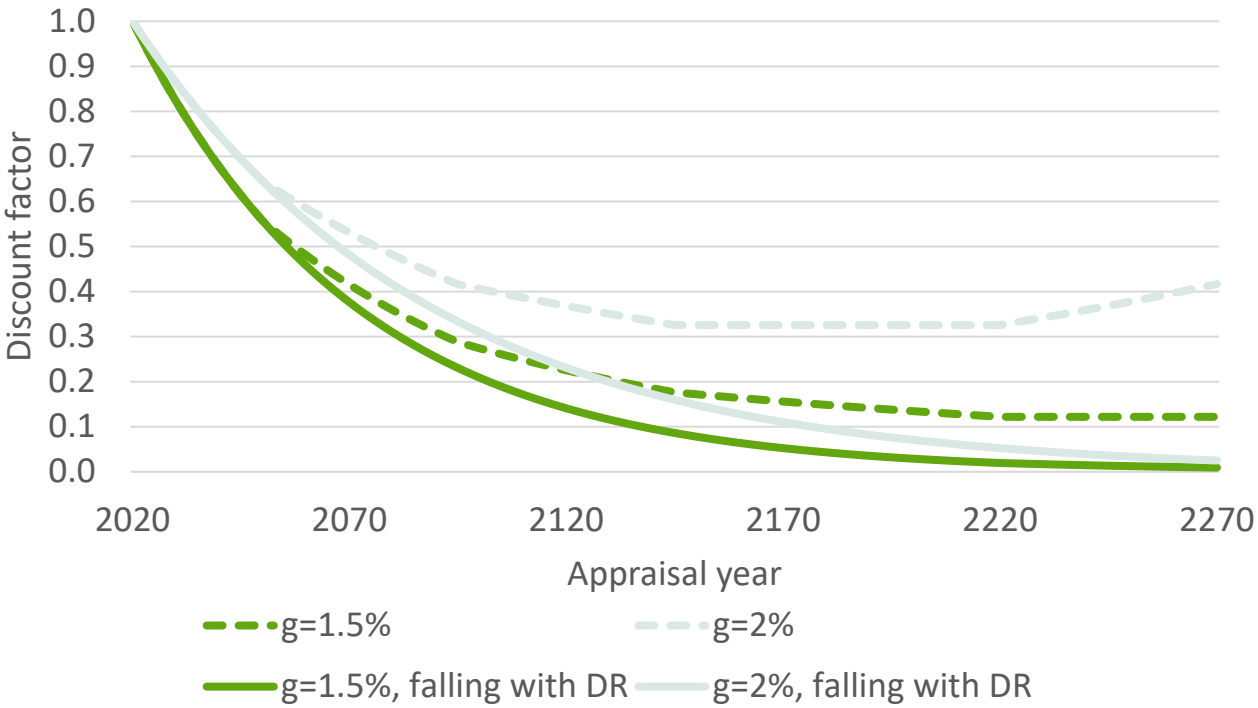
We might prefer the former interpretation – the uncertainty in the discount rate as being primarily driven by uncertain future economic growth – which is in line with much of the literature on social discounting (for an overview of the rationale for declining discount rates see Arrow et al. (2014) 'Should Governments Use a Declining Discount Rate in Project Analysis'). In this case, the *net* discount rate (the different between the growth rate of appraisal values and the social time preference rate) should only decline if the income elasticity of appraisal values is different to the elasticity of marginal utility of income parameter in the discount rate (otherwise it will be constant over time).

The basic intuition for this is that, when we consider the uncertainty in economic growth as affecting both the discount rate and the appraisal values growth rate simultaneously, the possible range of 'net' discount rates is compressed, potentially very dramatically compared to the 'gross' discount rates. The extent of this compression depends on the elasticity of marginal utility parameter in the discount rate. This is because if economic growth, and therefore the discount rate (following the Ramsey equation), is high, so should be the rate of growth in appraisal values, offsetting the higher discount rate in the computation of the net discount rate. The opposite occurs when growth is low: a lower discount rate goes hand in hand with a lower appraisal values growth rate.

If we use a fixed growth rate for uprating appraisal values in the very long-term, as per current practice, it is possible for the growth rate used to uplift values to exceed the discount rate, so that the 'net' discount rate (the difference between the growth in appraisal values and the discount rate) becomes negative. In this case, the present value for a perpetual appraisal period will be undefined (tend to infinity), as figure 5 below indicates. Even where the net discount rate does not turn negative, the approach taken to profiling benefits growth still has a material bearing on appraisal results over the very long-term.

Figure 5 below shows net discount factor profiles with the two-different assumed annual GDP per capita growth rates ($g$), 1.5% and 2%, to be illustrative of the pre- and post- March 2020 OBR long-run forecasts respectively (refer to the Route Map pp.12-15 for further details). The dotted lines show the profile of the discount factor where growth in appraisal values has been held constant at the respective level, whereas the corresponding coloured solid lines show the discount factors where the growth in appraisal values is stepped down proportionally in line with the discount rate. This represents the two limiting cases outlined above.

**Figure 5: net discount factor profiles according to whether the growth in appraisal is constant or declines with the Discount Rate, shown for values of g = 1.5% and 2%**




With a shorter appraisal period of 60 years, the issue of the relationship between the appraisal values growth rate and the declining discount rate is less material, however it grows in significance as the appraisal period is progressively extended. See figure 6 below. This figure assumes one unit of benefit (e.g. time saved) accruing each year for a hypothetical scheme opening in 2030. The effect is larger for later opening years.

The issues discussed in this section apply similarly to all appraisal values uplifted in line with income growth over time, for example our health, noise and air quality values.

**Figure 6: Difference in present value under different approaches to appraisal values growth (indexed to current approach = 100)**

| *Appraisal period (years)* | *Growth rate of appraisal values decline with discount rate* | *Growth rate of appraisal values invariant to discount rate* | *% diff between approaches* |
|---|---|---|---|
| 60 | 97 | 100 | 4% |
| 100 | 114 | 125 | 10% |
| 150 | 124 | 147 | 19% |
| 200 | 127 | 163 | 28% |
| 250 | 129 | 179 | 39% |

*This table shows that the approach to uprating appraisal values over time is much more important the longer the appraisal period is..*

**Appraisal accounting**

7 Do you have any further thoughts on the interaction between the discount rate and the approach to uplifting appraisal values which we should consider in the event that appraisal periods are extended?

## Profiling other appraisal impacts

It is important to note that the discussion in this section applies not only to values of time or other benefits whose unit values grow over time in line with income. As well as transport user benefits and costs, if a longer appraisal period is adopted in principle all other appraisal impacts will need to be appropriately profiled over the longer-term too.

This includes, for example, air quality, noise and carbon impacts which would need to be extrapolated in a manner consistent with the approach for user benefits. For instance, if the magnitude of impacts, related to the level of demand, for a road scheme is flat-lined after a certain point, then all noise, air quality and carbon impacts should be consistent with those flat-lined traffic flows. This would include flat lining the car fleet assumptions from 2050, the latest year for which they are currently provide in TAG.

Wider economic impacts, as currently calculated by WITA software, are currently extrapolated in line with value of time growth beyond the final modelled year (apart from output change in imperfectly competitive markets which is simply 10% of business user benefits). This could also be applied over any longer appraisal period, should it be adopted.

There are however significant challenges associated with valuing ‘level 3’ impacts associated with land-use change in appraisal. Currently, a range of supplementary economic modelling techniques may be used to estimate these impacts for inclusion in value for money assessment, but these are difficult to validate and their outputs are generally subject to a high degree of uncertainty.

Nonetheless, these impacts have the potential to be extremely important over a longer appraisal period. We welcome views on the practical considerations associated with estimating benefits using supplementary economic models over a longer period of time.

**Profiling other appraisal impacts over the long-term**

8 Are there any further considerations we have omitted with regards to profiling relevant cost or benefit streams over a longer appraisal period, including environmental, social and wider economy impacts?

## Other appraisal period related issues

There are two other specific challenges which often arise with regards to determining the appropriate appraisal period. These concern (i) handling the appraisal of multiple sub-components of an overall programme or package, or a scheme which opens in phases; and (ii) how to appraise the benefits and costs of delaying or bringing forward a scheme opening date.

In case (i), the principal challenge is that the opening date of each scheme or phase will be different, suggesting a range of possible approaches for setting the length of the appraisal. Broadly speaking these could be as follows (using the current standard 60-year appraisal period as a reference point):

- Appraising all schemes/phases until 60 years after the first opening year, so that later phases get fewer years' worth of appraisal benefits and costs.
- Appraising all schemes/phases until 60 years after the last opening year, so that earlier phases get more years' worth of appraisal benefits and costs.
- Having three overlapping, incremental appraisals such that the benefits of each scheme/phase are captured for 60 years (as illustrated at figure 7 below). Note, this means that each further phase/scheme has to be appraised against a do-minimum which includes the prior phases.

**Figure 7: Possible approach to setting the appraisal periods for a scheme opening in phases**

| **Appraisal of:** | 2020 | 2030 | 2040 | 2050 | 2060 | 2070 | 2080 | 2090 | 2100 |
|---|---|---|---|---|---|---|---|---|---|
| Scheme A | Opens | *N/A* | *N/A* | *N/A* | *N/A* | *N/A* | End | *N/A* | *N/A* |
| Scheme B **given** scheme A | *N/A* | Opens | *N/A* | *N/A* | *N/A* | *N/A* | *N/A* | End | *N/A* |
| Scheme C **given** schemes A and B | *N/A* | *N/A* | Opens | *N/A* | *N/A* | *N/A* | *N/A* | *N/A* | End |

*This table illustrates a potential approach to setting the appraisal periods for each phase of scheme or programme with multiple opening dates for different components. The idea is that each section gets from the same length appraisal period.*

In the past, a range of approaches have been used on different business cases. Given the potential for this to be material in value for money assessments, there is a case of codifying a preferred approach within TAG, in order to provide a consistent basis for comparison across projects and scheme options. Arguably, the third approach listed above (overlapping incremental appraisals) is most in-line with the

principles behind current TAG – namely, consistency across appraisals. We welcome views on the appropriate approach to take in our guidance.

Case (ii) discussed above, the appraisal of bringing forward or delaying scheme opening, also poses a unique challenge. Again, various approaches have been taken in business case analysis historically and we see value in codifying a preferred approach.

One approach which has been used in the past is to shift the entire window of the appraisal forwards or backwards in time. This effectively means benefits and costs are subject to one more (or less) year worth of discounting. Shifting the entire appraisal window in this way may not accurately portray the underlying effect on social welfare of the decision to delay/accelerate a scheme. Impacts are merely displaced in time, whereas in reality delaying a project (for example) is likely to lead to fewer years of benefits being delivered.

The primary rationale for fixing the appraisal period – which motivates the idea of shifting the entire appraisal window in time – is for comparability across schemes. However, when making a standalone decision on delaying/accelerating a project, this is arguably not relevant.

Another approach which might mitigate these concerns would be to fix the end year of the appraisal – say 60 years from the initially planned opening date, then value the costs and benefits of simply moving the starting appraisal year forwards or backwards. This will in general lead to vfm being much more sensitive to decisions to delay/accelerate projects, as might be expected. Furthermore, providing schemes that are a net benefit to society, and for any fixed profile of costs, this approach would always tend to favour bringing forward an opening date to earn more years' worth of benefits.

We welcome views on the appropriate approach to setting appraisal periods for these types of decisions.

**Other appraisal period issues**

9 How should we determine the appropriate appraisal period for a programme or package of schemes, with potentially different opening dates? Should this differ from the approach taken for a standalone project?

# Supporting decision making

## Differential impacts on value for money

Lengthening the appraisal period is likely to improve the value for money (vfm) assessment of most transport projects. When considering the best option for a particular scheme or how to allocate funds within the transport budget, it is the impact on the relative vfm of different projects that matters. The change to the absolute values of BCRs will also be important for certain decision contexts, such as allocating funding across different sectors of the economy or ensuring a positive return on taxpayers' funding is achieved.

Using a longer appraisal period, all else equal, is likely to favour schemes which generate revenue accruing to the broad transport budget and those with comparatively low incremental costs of operation, maintenance and renewal over the extended period. It is likely to worsen the relative position of schemes which focus on short lived assets or have time-limited appraisals for policy reasons, for example a commitment to formal review after so many years.

In this light, it is important to recognise that not only 'transformational' projects which deliver very large accessibility improvements, and potentially significant changes to economic geography, stand to gain from a longer appraisal period. While such projects likely stand to make more aggregate gain from a longer appraisal, this partially reflects their size. In terms of vfm assessment, however, impacts on benefits per pound spent are of interest. Smaller projects could also be maintained over the longer term and deliver significant additional benefit relative to costs, thereby seeing an improvement in vfm that could be just as large as for a 'transformational' project.

In essence, the key decision here is what weight to place on benefits beyond the initial 60-year appraisal, which are currently zero-weighted. For a wide variety of projects, given the difficulties associated with extending the period of detailed modelling much beyond 2050, over the very long-term appraisal benefits are inevitably extrapolation based. Therefore, there is a degree of judgement associated with the period which is set. As such, if a longer appraisal period is adopted, there is a strong case to ensure consistency in the maximum allowable appraisal period across projects, so as not to provide spurious vfm comparisons.

## Representing uncertainty

As discussed above, there is significant additional uncertainty in appraisal results when a longer appraisal period is used. Furthermore, practical constraints on modelling often mean it is not feasible to even carry out a detailed appraisal for further out modelled years, regardless of how uncertain the results would be. It is important these uncertainties are transparently presented to decision makers.

The Department's overall approach to dealing with uncertainty in appraisal is outside the scope of this consultation and is being considered separately as part of the work to develop an 'Uncertainty Toolkit'. However, we recognise the close trade-off between the length of the appraisal period (and therefore the size of benefits) and the uncertainty in appraisal results. Therefore, as we consider updating TAG in this area, we will jointly consider what immediate implications this might have for the representation of uncertainty in vfm assessment.

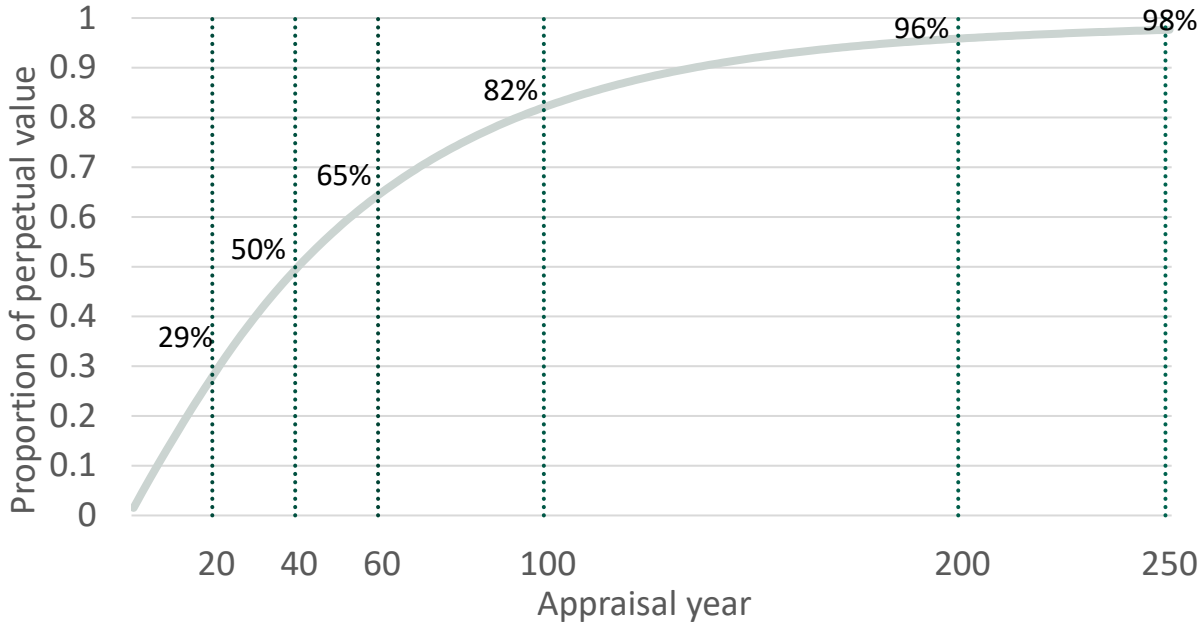
The appropriate approach to representing uncertainty will to some extent depend on how a potentially longer appraisal period is implemented. In any case, in order to provide greater transparency around the time profile of benefits, should a longer appraisal period be used, a simple breakdown of benefits by time period could be reported to decision makers, for example the proportion of benefits accruing in years 0-20, 20-40, 40-60 and 60+.

Another option could be to present switching value analysis around the length of the appraisal period, which could identify how many years of operation are needed for a scheme to reach a given vfm band. There is also a question of where in the vfm assessment longer-term benefits should sit – the initial BCR, adjusted BCR, or 'indicatively monetised' category.

For example, an illustration such as figure 8 below could be presented to decision makers, which shows the percentage of perpetual benefits achieved at the 20, 40, 60, 100, 200 and 250-year points. Nearer term benefits could be included in the initial BCR, whereas benefits further out could be reflected in the adjusted BCR and indicatively monetised categories respectively to reflect the greater uncertainty associated with those estimates. Note, a full appraisal would also need to consider the growth in scheme costs over time.

Figure 8 uses demand growth of 1% up to 2040, 0.15 % p.a. population extrapolation thereafter and GDP per capita growth of 1.5% p.a. declining with the discount rate. It is necessary to step the GDP per capita growth rate down in line with the discount rate to ensure a finite perpetual value, for the purposes of this chart.

**Figure 8: possible visual presentation of benefits associated with a longer appraisal period**




## Strategic case or non-monetised impacts

There is potentially scope for the consideration of longer-term impacts to be primarily considered in the strategic case, instead of being directly factored into the vfm assessment. This would help circumvent some of the significant modelling challenges associated with a longer appraisal period. Furthermore, it avoids the need for extrapolating modelling results over a longer timeframe which generates significant uncertainty in appraisal results.

Another option might be to create a category of non-monetised benefit for ‘residual value’, which seeks to capture the remaining benefits beyond the initial 60-year appraisal period. A robust scoring system would likely need to be developed under this option, for example using a 7-point qualitative scale as with other non-monetised impacts in TAG. Potentially, we could develop a set of criteria to help analysts determine whether this residual value is likely to be, for example, ‘large beneficial’ or only ‘slight beneficial’. These criteria might include factors such as spare capacity, level of service, asset life, scope for materially changing economic geography, and feasibility/likelihood of longer-term maintenance and renewal of the asset.

There is also potentially scope to better reflect the option value associated with different scales of investment in the business case. For example, investing in shorter lived assets confers the option to abandon earlier if good value is not achieved, whereas investing in a longer-lived asset may help to minimise whole-life costs compared to a cycle of more frequent renewals.

**Supporting decision making**

10 How can we best ensure that decision makers understand the potential value of longer-term assets and the risks, uncertainties and limitations of the analysis in relation to long-term benefits.

# Potential Ways Forward

In this section we present our proposed criteria for determining our preferred approach to reflecting very long-term value in appraisal. As noted above, we believe a balanced appraisal framework should be able to consider the possibility that project benefits could last into the very long term, while also representing the additional risk and uncertainty around longer term benefits.

We propose the following set of criteria for helping us judge between different options for capturing longer-term benefits in appraisal:

- **Accuracy/ability to differentiate between proposals' vfm**: to what extent can the approach provide useful information on the relative vfm of different options/projects, in order to usefully inform decision making?
- **Scope of impacts appraised**: ideally any approach used should be able to reflect the full range of social costs and benefits over the longer term, beyond the current 60-year appraisal.
- **Consideration of capacity**: a candidate approach must explicitly consider whether, when, and the extent to which capacity constraints on the network could curtail benefits growth in the longer term, even where exogenous demand may continue to grow.
- **Proportionality**: there is a trade-off between the complexity of modelling and the resource burden that places on promoters. Proposed approaches should not place a large analytical burden on promoters without commensurate benefit.
- **Plausibility**: approaches should not rely on bold extrapolations which are extremely hard to validate using available forecasts or modelling tools.
- **Representation of uncertainty**: any approach needs to fully recognise, and where possible quantify, the additional uncertainty associated with benefit estimates over a longer timeframe.

**Potential ways forward**

11 What are your thoughts on our proposed criteria for identifying the preferred approach?

# Seeking Your Views

## Responding to the consultation

Responses to the questions outlined in this document, or more general feedback on the subject matter, should be sent to tasm@dft.gov.uk, with the subject 'Appraisal Periods Consultation' by Friday 15th January 2021.

A full list of consultation questions is included in annex A below.

## Stakeholder events

We will be holding two online engagement workshops, on this consultation on Friday 18th December 2020 and Friday 8th January 2021, both from 10:00-12:00. To attend, please email tasm@dft.gov.uk, with the subject and date as follows 'Appraisal Periods Consultation: workshop attendance dd/mm/yyyy' giving at least 3 working days' notice.

We also invite requests for 1:1 engagement sessions, so just drop us a line. However, our consultation response will only formally consider written submissions.

## How we will use your responses

First and foremost, we look forward to using your responses, and any additional evidence submissions, to help develop our final approach to tackling the appraisal periods question in TAG.

The consultation will run for six weeks. Once the consultation is closed, we will analyse your responses to help inform our next steps. A consultation response document will then be issued in due course, setting out any planned updates to TAG. We aim to do this before the end of February 2021.

We would like to publish your responses, so please indicate if you are content for us to do this in your response. However, you are welcome to submit a confidential response.

## Updating guidance

Our ambition is to finalise and bring forward forthcoming changes to TAG by the end of February 2021.

# What will happen next

A summary of responses, including the next steps, will be published within three months of the consultation closing. Paper copies will be available on request.

If you have questions about this consultation please contact:

Name: Iven Stead

Address: Great Minster House, 33 Horseferry Road, London SW1P 4DR

Phone Number: 07585 992769

Email address: iven.stead@dft.gov.uk

# Annex A: Full list of consultation questions

### Overall Approach

1 Do you think there is a case for including long-term benefits, beyond the existing 60-year appraisal period? What do you think are the main challenges associated with this?

### Market-based residual value approaches

2 In light of our assessment of alternative approaches, are there other methods we may not have considered? In particular, should we be focusing on the wide range of possible social, economic and environmental impacts over the longer term, which are unlikely to be fully captured in a market-based valuation?

### Treatment of uncertainty

3 What do you consider to be the key sources of uncertainty associated with appraising benefits over a longer timeframe?

4 To what extent do you believe that limiting the appraisal period to a set timeframe is an appropriate way of handling uncertainty? Are there other approaches which might better balance uncertainty with the potential longer-term benefits of investment?

### Differential impacts by project

5 To what extent do you think that current practice in relation to appraisal periods materially biases against particular schemes or options? What do you consider the source of this bias to be?

### Inter-generational effects

6 Do you think there is a case for reflecting potential inter-generational effects in appraisal?

### Appraisal accounting

7 Do you have any further thoughts on the interaction between the discount rate and the approach to uplifting appraisal values which we should consider in the event that appraisal periods are extended?

### Profiling other appraisal impacts over the long-term

8 Are there any further considerations we have omitted with regards to profiling relevant cost or benefit streams over a longer appraisal period, including environmental, social and wider economy impacts?

### Other appraisal period issues

9 How should we determine the appropriate appraisal period for a programme or package of schemes, with potentially different opening dates? Should this differ from the approach taken for a standalone project?

### Supporting decision making

10 How can we best ensure that decision makers understand the potential value of longer-term assets and the risks, uncertainties and limitations of the analysis in relation to long-term benefits?

### Potential ways forward

11 What are your thoughts on our proposed criteria for identifying the preferred approach?

# Annex B: Consultation principles

The consultation is being conducted in line with the Government's key consultation principles which are listed below. Further information is available at https://www.gov.uk/government/publications/consultation-principles-guidance

If you have any comments about the consultation process please contact:

Consultation Co-ordinator
Department for Transport
Zone 1/29 Great Minster House
London SW1P 4DR
Email consultation@dft.gsi.gov.uk

# Annex C: Impact of a longer appraisal period – illustrative analysis

Consider a simple hypothetical scheme appraisal example constructed under the following assumptions which are designed to (broadly) represent current typical practice, with the exception of the last (which is a subject of this consultation):

- demand grows at a constant annual rate, denoted *d*, up to the cap year;
- demand is flat-lined after 20 years from now with population-based extrapolation thereafter at a rate of $p$ = 0.15% p.a. where $p$ stands for a constant annual population growth rate (chosen to be in line with the March 2020 OBR long-run projection average annual population growth);
- benefits (e.g. user hours of time saved) are directly proportional to demand;
- the scheme opens in 2020;
- GDP per capita (and therefore value of time, following TAG) grows at a constant annual rate of 1.5% in line with the March 2020 OBR long-run projection; and

Under these simplifying assumptions, the discounted benefit stream can be plotted for a range of demand growth values ($d$). This is shown in figures 9 and 10 below, with the former showing discounted benefits under the current approach to uprating appraisal values and the latter showing benefits if we reduce the appraisal values growth rate in line with the fall in the discount rate (as discussed earlier in this document). This means that the appraisal values growth rate starts at 1.5% p.a., then falls to 1% p.a. when the discount rate drops to 3% and so on, so that the net discount rate is 2% until the discount rate itself drops to below 2% which happens after year 200. After that point, appraisal values are held flat.

**Figure 9: discounted benefit stream according to the rate of demand growth (flat-lined after year 20), growth rate of appraisal values invariant to discount rate**

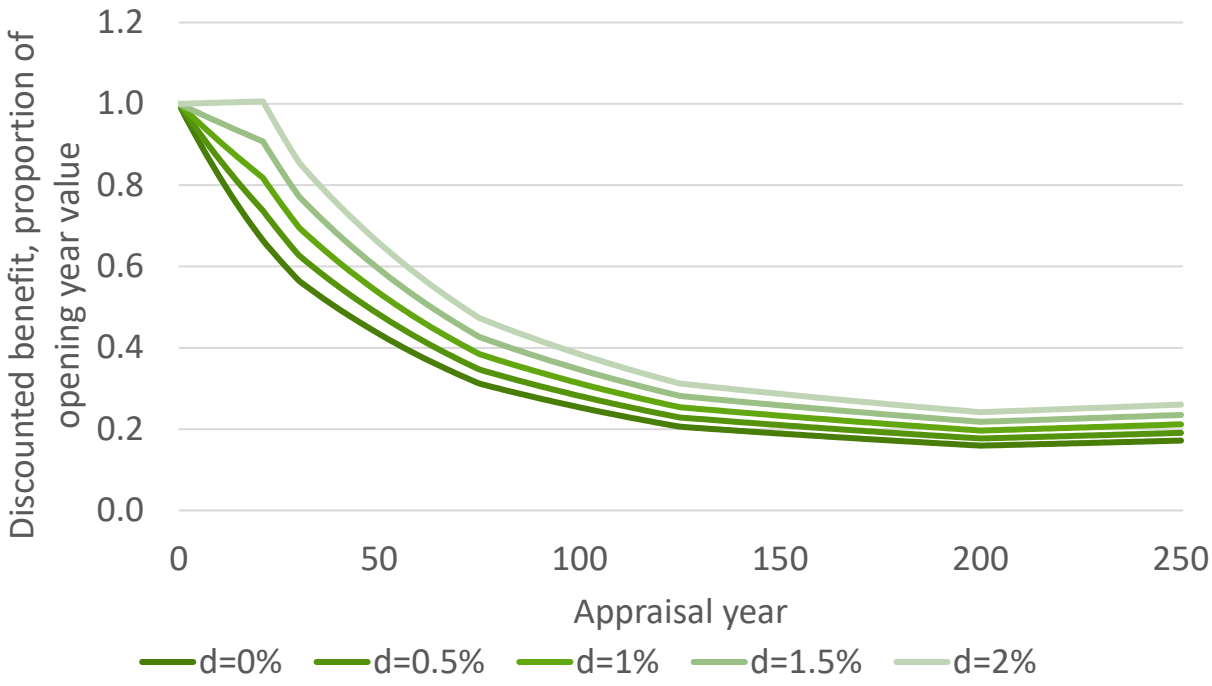
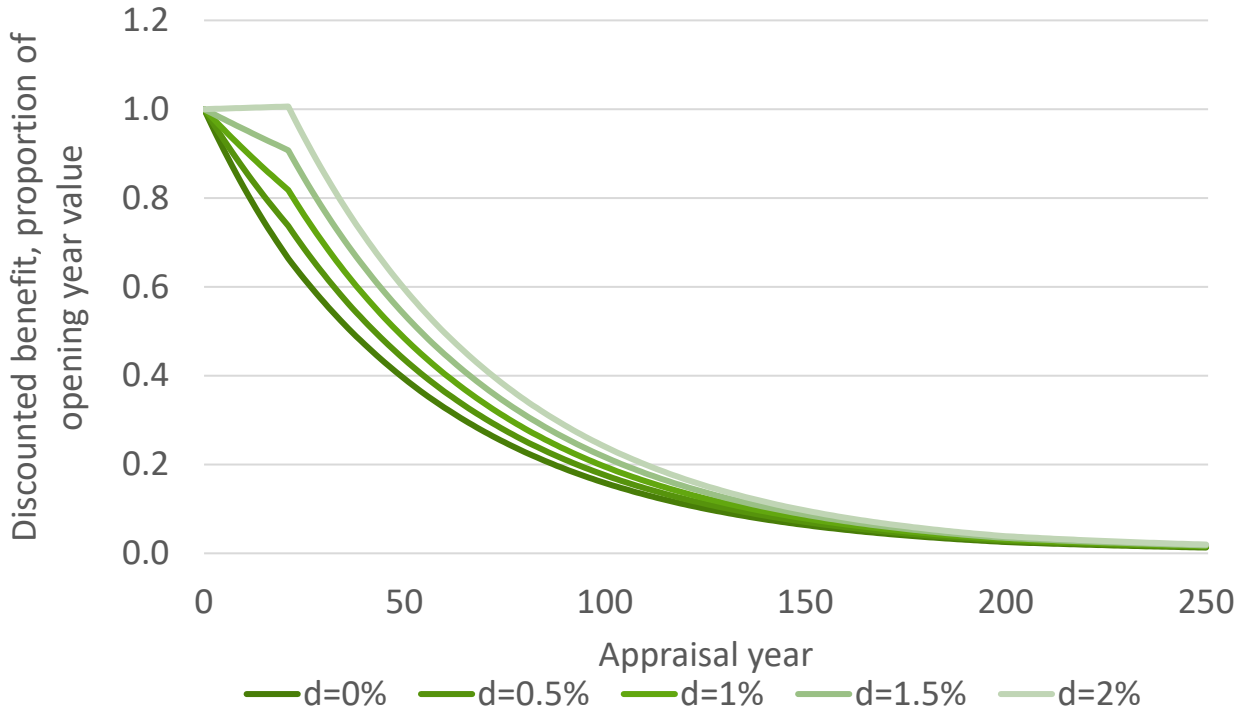



**Figure 10: discounted benefit stream according to the rate of demand growth (flat-lined after year 20), growth rate of appraisal values declines proportionally with the discount rate**



The present value of benefits under a range of population extrapolation assumptions can also be computed - see figures 11 and 12 below. A scheme opening year of 2020 is used in figure 11 whereas figure 12 uses an opening year of 2040. All of these calculations assume demand growth within in the initial 20 years of 1% per year.

**Figure 11: present value of benefits by appraisal period and value of *p* (population extrapolation parameter), with different approaches to appraisal values growth (scheme opening year 2020)**

| | *p=1%* | | *p=0.3%* | | *p=0.15%* | | *p=0%* | |
|---|---|---|---|---|---|---|---|---|
| **Appraisal period** | **Values growth decline** | **Values growth flat** | **Values growth decline** | **Values growth flat** | **Values growth decline** | **Values growth flat** | **Values growth decline** | **Values growth flat** |
| 60 | 46 | 48 | 43 | 44 | 43 | 44 | 42 | 43 |
| 100 | 65 | 73 | 56 | 61 | 54 | 59 | 52 | 57 |
| 200 | 89 | 144 | 66 | 90 | 63 | 83 | 60 | 77 |
| 250 | 95 | 202 | 68 | 103 | 64 | 93 | 61 | 84 |
| Perpetual | Infinite | Infinite | 70 | Infinite | 66 | Infinite | 62 | Infinite |

*This table shows that, if appraisal values are uprated at a constant growth rate, the present value of benefits is very sensitive to the appraisal period and eventually tends towards infinity, regardless of the assumed rate of population growth underpinning benefits extrapolation. Conversely, if the growth in appraisal values declines in line with the discount rate, the present value of benefits does not increase materially for appraisals longer than 200 years, except where a large (1%) annual rate of population growth is used to extrapolate benefits. The impact of the population extrapolation assumption is more significant for longer appraisal periods.*

**Figure 12: present value of benefits by appraisal period and value of *p* (population extrapolation parameter), with different approaches to appraisal values growth (scheme opening year 2040)**

| | *p=1%* | | *p=0.3%* | | *p=0.15%* | | *p=0%* | |
|---|---|---|---|---|---|---|---|---|
| **Appraisal period** | **Values growth decline** | **Values growth flat** | **Values growth decline** | **Values growth flat** | **Values growth decline** | **Values growth flat** | **Values growth decline** | **Values growth flat** |
| 60 | 57 | 60 | 50 | 53 | 49 | 52 | 48 | 51 |
| 100 | 72 | 85 | 59 | 67 | 57 | 65 | 55 | 62 |
| 200 | 92 | 163 | 67 | 95 | 63 | 87 | 60 | 80 |
| 250 | 98 | 234 | 68 | 110 | 64 | 97 | 61 | 87 |
| Perpetual | Infinite | Infinite | 70 | Infinite | 66 | Infinite | 62 | Infinite |

*This table is similar to the previous one and shows that appraisal benefits are generally higher with a later opening year, but the overall pattern of results is generally similar to figure 11. With a later scheme opening year, the population extrapolation assumption has a slightly stronger influence on the present value of benefits.*