An tÚdarás um Bóithre Náisiúnta
National Roads Authority

Project Appraisal Guidelines

Unit 12.0 National Secondary Roads Projects

March 2011

Project Appraisal Guidelines

Unit 12.0
Low Volume National Secondary Roads Projects

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1.0	March 2011	New Guidance

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1. Introduction

1.1. This PAG Unit recommends methods of appraisal that are likely to be suitable for use in projects to upgrade National Secondary Roads (NSR).

1.2. This PAG Unit should not be used for guidance for the appraisal of other schemes which are not low volume national secondary roads. *PAG Unit 1.0: Introduction* should be referred to for guidance.

Applicability

1.3. The NRA has a programme of Low-Volume NSR schemes. The schemes within this programme are predominantly upgrades to lengths of existing national route in rural areas. The expected carriageway standard for such schemes is a Type2 or Type3 single-carriageway road. Such schemes are generally characterised by:

- Relatively low cost per km;
- Relatively little route choice, as rural networks are often sparse; and
- Little opportunity for variable-demand responses.

1.4. On the principle that all appraisal should be proportionate to the scale and likely impact of the project being proposed, this unit describes methods that are applicable to this type of scheme. Similar methods are likely to be appropriate for assessing proposed upgrades to rural regional roads, or upgrades to sections of single-carriageway national primary route in more remote rural areas.

1.5. For improvements to the NSR network which are more localised in nature, such as treatment of accident “black spots”, see *PAG Unit 14.0: Non-Major Schemes*.

1.6. For more major schemes on the NSR network, or for improvements in the vicinity of major urban areas (towns or cities of population > 10,000 people) more detailed methods of modelling and appraisal may be required.

References

1.7. The guidance in this note should be read in conjunction with other units of the Project Appraisal Guidance (PAG). It is intended as a guide for those project-managing or progressing NSR schemes as to the steps that need to be undertaken and the levels of detail that are appropriate.

2. The Appraisal Process

Documentation

2.1. NSR upgrade schemes are intended to be relatively simple and low-cost road improvements. The appraisal process should correspondingly be more streamlined than for urban or Major Inter-Urban projects.

2.2. A single report may be produced to summarise the appraisal deliverables for the proposed scheme. This report is referred to as the Project Appraisal Report (PAR) throughout this PAG Unit. The report should include:

- A chapter fulfilling the role of a Project Brief, identifying the need for and objectives of the scheme, and a history of the development of the project;
- One or more chapters fulfilling the role of a Transport Modelling Report, describing the building of the traffic model and presenting the forecasted impact of the scheme;
- A chapter on the Cost Benefit Analysis (CBA) of each scheme option;
- A one-page Project Appraisal Balance Sheet (PABS) for each scheme option, summarising all of the impacts of the scheme, together with supporting text describing the derivation of the multi-criteria scores; and
- A concluding chapter summarising the Business Case for the scheme in terms of the anticipated monetised and non-monetised benefits likely to be achieved.

Project Stages

2.3. *PAG Unit 2.0: Project Management* sets out standard NRA management procedures, and project roles for the appraisal of road schemes. For NSR schemes, the same processes apply, but the need for formal appraisal and review can be reduced because of the lower expenditure involved. Figure 12.1 illustrates the recommended process.

2.4. The primary appraisal work should be focussed on Route Selection Stage, informing the choice between scheme options. At that point, only preliminary design and cost information are likely to be available. That appraisal should then be updated at subsequent stages, as the design and cost of the scheme are refined over time and more information becomes available.

2.5. At Route Selection Stage, typically three options might be presented, representing the major decisions to be taken in selecting the route of the proposed improvement (e.g. offline to the west of the existing road, offline to the east of the existing road, online). Where (for cost or other reasons) only an online option is considered, it is permissible to appraise only a single option.

2.6. At scheme design stage, the previous appraisal – traffic model, cost-benefit analysis and multi-criteria appraisal - should if necessary be refreshed or updated and the PAR re-issued, so as to reflect the proposed scheme design and junction strategy. At this stage incremental analysis should be carried out and documented, to justify:

- The proposed carriageway standard, if this is higher than the minimum (Type 3) standard; and
- Any proposed scheme design options (such as provision of a new structure, or additional junctions) which substantially increase the cost of the scheme.

This version of the appraisal should then be used to inform statutory processes (EIA and Oral Hearing).

2.7. An example of the recommended format and level of detail for presenting appraisal results is provided in *PAG Unit 12.1: National Secondary Roads Project Appraisal Report.*

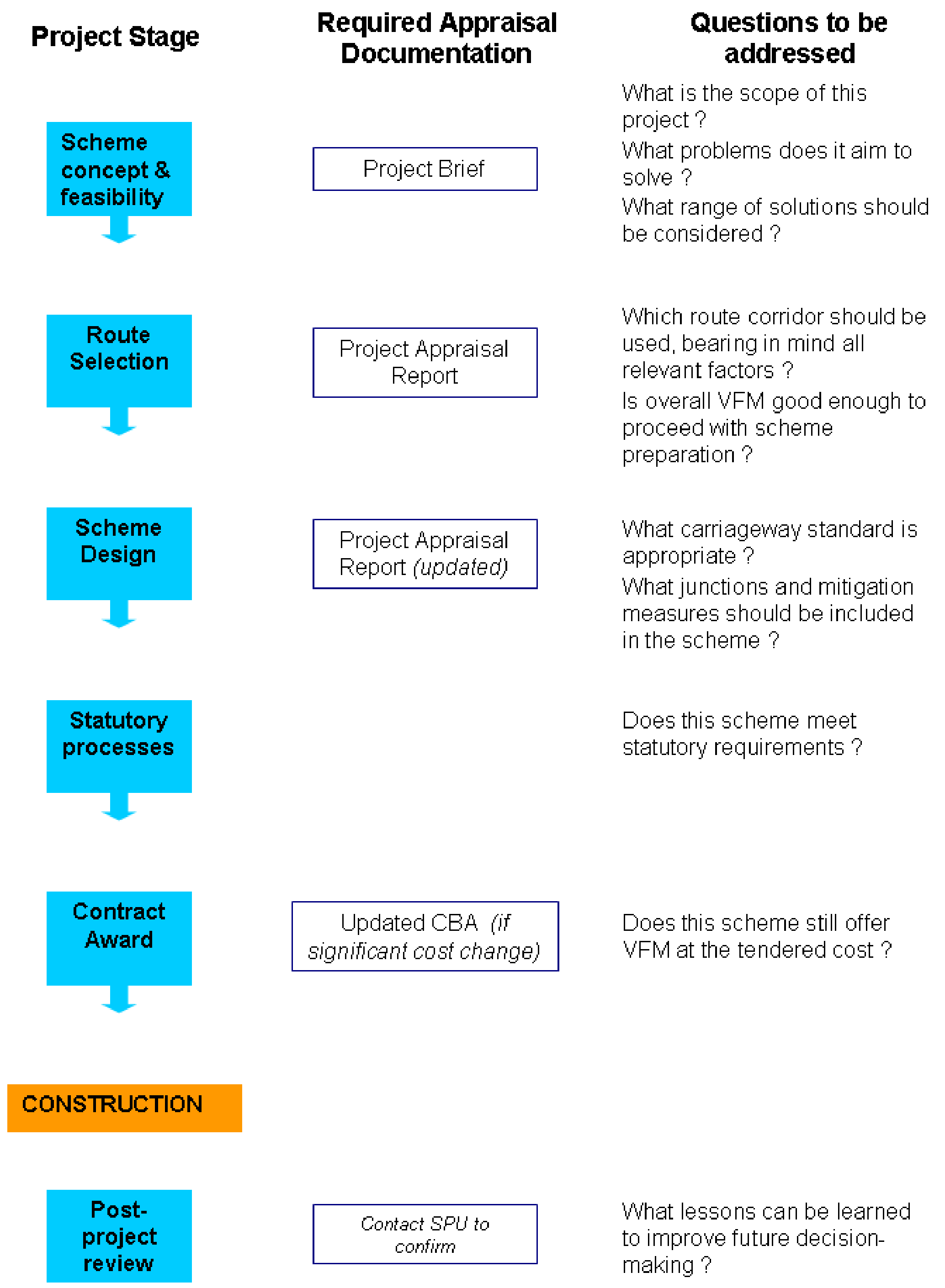

Figure 12.1 – Appraisal Requirements at each Project Stage

2.8. At contract award stage, it is unnecessary to revisit the appraisal unless:

- The tendered scheme costs have increased by more than 10% over those estimated at scheme design stage;
- Observed traffic growth in the area (as measured at the nearest permanent traffic counter) is substantially lower than that forecast; or
- Previously-planned major development that was allowed for in the traffic forecasting now appears unlikely to proceed.

If such a change has occurred, then the cost-benefit appraisal should be re-run to verify whether the scheme still offers acceptable value for money.

2.9. Detailed post-project review should be carried out on only a sample of NSR schemes – the process of selecting schemes for such review will be carried out by the NRA Strategic Planning Unit.

Approach to Appraisal

2.10. Transport appraisal is a process to establish the merits of a proposed intervention in the transport system. Sound governance requires that the probable impacts of the proposed scheme need to be assessed, both relative to other options for addressing the same problem ("is this the best solution?") and relative to other proposals – addressing different objectives - that are competing for government expenditure ("is this a priority for funding ?").

2.11. Appraisal should be carried out relative to a Do-Minimum case – the most-likely future scenario if the scheme does not go ahead. Where there are major uncertainties, these should be addressed by consideration of different forecasting scenarios.

2.12. The process involves quantifying the impacts of the proposed improvement – first in terms of volumes and speeds of traffic, and then in terms of derived economic and environmental impacts.

2.13. *PAG Unit 1.0: Introduction* refers to the need for a consistent and comprehensive appraisal framework, to facilitate comparisons across scheme options and across projects. In order to achieve this, a degree of standardisation is desirable in the calculations carried out and in the presentation of the results.

3. Traffic Modelling

Purpose of the Traffic Model

3.1. A traffic model should be built for the purpose of estimating:

- Traffic flows likely to use the proposed improved road, to inform the design process;

- Traffic flow changes resulting from the scheme, both on the improved route and in the surrounding area, as a basis for assessment of consequent environmental and safety impacts; and
- Changes in journey times and vehicle operating costs resulting from the scheme, as these form the major element of the economic benefit of the scheme.

3.2. An overview of types of transport model and principles of modelling in general is contained in *PAG Unit 5.0: Transport Modelling.*

Demand Responses

3.3. Any transport improvement may in principle cause a number of different travel responses from users of the transport system, including trip re-routing, trip re-timing, trip frequency change, and mode- and destination-switching. Before building any traffic model, a preliminary assessment should be undertaken of the responses that are likely to be significant given the scale and location of the scheme. Unnecessary modelling of non-significant responses can substantially increase the costs of the traffic model, and should be avoided.

3.4. Improvements to NSRs in rural areas will in general have a limited impact on patterns of trip-making. The unimproved road may well offer faster journey times than alternative routes. In many cases it is likely that traffic reassignment within the local area is the only demand response that should be modelled.

Geographic Coverage

3.5. In extreme cases where the road network is sparse there may be no alternative routes that can carry any significant volumes of traffic. In such cases the geographic extent of the model can be limited to the length of the proposed scheme.

3.6. More generally, the modelled area should encompass all routes that are reasonable alternatives to the section proposed for improvement, extending outward from the scheme no further than is necessary to include the “points of divergence” – points at which routes using the scheme diverge from the alternatives.

Time Periods

3.7. The time periods to be modelled should be sufficient to give a robust estimate of peak hour levels of congestion, and of total daily traffic flows.

3.8. NSRs can exhibit a variety of traffic patterns. Near urban areas, traffic patterns may be dominated by commuting flows, giving a conventional double-peaked daily profile. More rural areas typically exhibit a daily traffic flow profile with:

- Highest flow in the evening peak hour 17:00-18:00;
- A limited (sometimes nonexistent) morning peak;
- Flows increasing through the interpeak period; and
- Weak tidality.

3.9. Local automatic traffic counter data (from a nearby permanent counter or from a temporary counter recording flows over a two-week period) should be used to assess local traffic flow profiles and inform choice of modelled time periods.

3.10. The normal minimum should be to model a weekday peak period (AM or PM peak) and an interpeak period.

3.11. A good starting point for modelling is available by using the National Traffic Model (NTM). The NTM covers AM peak and interpeak periods. This strategic model can only provide a coarse initial estimate of travel demand, and more refined traffic modelling will always be required.

3.12. Where the local model is being built from a clean sheet, an appropriate and efficient approach is likely to be to model the weekday AM or PM peak hour and an average interpeak hour only, as this covers the period of maximum delays and gives an adequately robust estimate of total daily flows in rural areas.

Vehicle Categories

3.13. Traffic flows on most NSRs are dominated by the private car. Because of the greater environmental impact of Heavy Commercial Vehicles, it is recommended that these be modelled separately. Therefore an appropriate level of detail might be to build trip matrices for two classes of vehicles - Light Vehicles (cars, taxis, light goods vehicles, motorcycles, minibuses) and Heavy Commercial Vehicles (HGVs and full-size buses).

Survey Data Requirements

3.14. In most cases new data collection will be necessary. Before commissioning surveys, it is important to check whether any existing recent data is available, to avoid unnecessary duplication. Where there is existing recent data that adequately represents current travel patterns (once recent trends are taken into account), new surveys should be designed to supplement this.

3.15. In order to observe representative traffic conditions, traffic surveys should be undertaken in school term during “neutral months”, avoiding periods of the year when flows are untypically high or low (e.g. avoiding December, January, Easter and Bank Holiday weekends).

3.16. Roadside interview surveys are relatively expensive and intrusive. Their use is appropriate in order to establish patterns of origins and destinations in urban networks, or to establish trip purpose mix where it is believed that this is significantly different from the national average.

3.17. For rural NSR schemes, a lower-cost approach to data collection will often be appropriate. This might comprise:

- Automatic Traffic Counter (ATC) data for a two-week period at a single site on the route section that is proposed for improvement (not required if the NRA have a permanent counter along the relevant route section);

- Junction turning counts at each junction where the route to be improved meets a national or regional route or significant minor route. These counts need to cover the modelled time periods, and should all be taken on the same day if possible, during the two-week period that the ATC is operating;
- Journey time surveys along the route to be improved, to be carried out in both directions over several days during the two-week period that the ATC is operating. Journey times should start at different clock times within each modelled period, to avoid being over-influenced by short-period congestion (such as that associated with school opening times); and
- Origin Destination Surveys through less intrusive methods (e.g. vehicle matching).

3.18. If the proposed scheme includes substantial new road links (rather than simply upgrades to existing road links) then the survey data may need to be expanded to include origin destination surveys, so as to identify the proportion of traffic that will be attracted to use the new link.

Refinement of Local Model

3.19. The National Traffic Model (NTM) is a strategic national model which includes all national and regional roads in rural areas, with additional network detail in urban settlements. Where a cordon from the NTM is taken as a starting point for development of the local model, this cordoned model should be enhanced by:

- Inclusion of significant minor roads with appropriate speed-flow curves;
- Coding of junction models for any junctions at which substantial delays occur in the base year peak hour; and
- Splitting the NTM model zones so as to better represent the distribution of trip origins and destinations across the study area. A correspondence table showing which model zones are part of which NTM zone should be maintained. The resulting zoning system should be of a consistent scale with the resolution of the road network.

3.20. Where a new local model is being built, consistency with the NTM should be achieved by:

- Having internal model zones that nest within NTM zones, so as to provide a consistent basis for forecasting; and
- Using a set of links from the NTM network (with accompanying speed-flow curves) as the starting point for the local model network.

3.21. GIS files for the NTM network and zoning system are available from the NRA Strategic Planning Unit.

Model Calibration

3.22. Calibration is a process of adjusting the model so as to better represent observed traffic conditions. There are two major elements – network adjustments and matrix adjustments.

3.23. It may be necessary to iterate between these two processes in order to obtain a good representation of base year traffic conditions. Where there is little route choice, a single iteration may suffice.

Network Adjustments

3.24. Observed journey times should be compared with modelled journey times, and adjustments made to the speed-flow relationships for each link of the model so as to improve the fit. Where junctions are modelled, junction capacities should be adjusted if it appears that modelled junction delay is substantially over-estimating or under-estimating observed delays.

Generalised Cost Adjustments

3.25. *PAG Unit 6.11: National Parameter Values Sheet* provides values of time for use in economic appraisal. For consistency, it is recommended that the same values should be used in the development of the generalised cost formulation (the mixture of time and distance that drivers are assumed to minimise in selecting their route) for models. Where the local model is based on a cordon from the NTM, the generalised cost formulation will already be consistent with values used in economic appraisal; for most local models these generalised costs should be retained unchanged. Exceptionally, it may be necessary to adjust the generalised costs used in order to reflect observed travel behaviour.

Matrix Adjustments

3.26. If overall traffic levels are substantially higher or lower than those in the initial model, a global factor should be applied to bring these into line, prior to detailed matrix estimation.

3.27. Matrix estimation works by applying a minimum of factoring to the existing "prior" matrix in order to make it consistent with traffic counts.

3.28. Care is required to check that the resulting flows are plausible, as (for example) any discrepancy between adjacent counts can lead to the model attributing unreasonably large flows to an intermediate zone.

Model Validation

3.29. For NSR schemes, validation should consist of:

- A check of modelled flows against count data not used in the calibration process; and
- Comparison between modelled and observed journey times.

3.30. The guidance - see *PAG Unit 5.0: Transport Modelling* - emphasises that validation should not be a mechanistic process, but is concerned with ensuring that the model is fit for its intended purpose.

3.31. In a rural location where there is relatively little route choice, the most important output from the model is the overall change in journey times/speeds, as this will affect the economic and environmental appraisal of the scheme. This is therefore the most critical aspect of the quality of the model for the validation process to address.

Forecasting Assumptions

3.32. Having verified that the model is an adequate representation of the base year situation, the next step is to forecast forward to the Do-Minimum future year scenarios.

Do-Minimum

3.33. The traffic model should be run for:

- The opening year of the proposed scheme (which is taken to be year 1 of the 30-year appraisal period); and
- The design year (= opening year + 15).

3.34. Where TUBA is to be used for economic appraisal, a third future year is required, representing the final year of the appraisal period, or the year after which traffic growth is assumed to be negligible. With the current forecasts, that third year should be taken to be 2040.

3.35. For rural road schemes, it will be appropriate to apply growth factors consistent with the growth in the NTM - see *PAG Unit 5.3: Traffic Forecasting* for the method of applying such growth. Where a zone of the local model clearly corresponds to one or more zones of the NTM, then NTM zonal growth factors should be used. Where an external zone of the local model carries traffic to/from a wider area, a growth factor should be taken from a screenline across appropriate links of the NTM.

3.36. If major development is proposed in the vicinity of the scheme, then the traffic generated or attracted by this development needs to be estimated separately (for example using Central Statistics Office data, such as POWCAR, to inform first principles estimation of trip rates) and added in to the future year trip matrices. Other local model zones within the study area should have their growth reduced to compensate, so that net growth is consistent with the national model forecasts. In those circumstances where major development is proposed in the vicinity of the scheme then it is necessary to ensure that the requirements of Spatial Planning and National Roads – Guidelines for Local Authorities have been followed, and the Strategic Planning Unit consulted.

3.37. As well as change over time in trip matrices, it is necessary to take account of any planned changes to the road network within the study area (apart from the proposal being appraised). For many rural schemes this will not be a significant issue.

3.38. When reporting results from a series of alternative future scenarios with and without other highway improvements or land use developments, the convention is that these other changes should form part of the "core" Do-Minimum scenario if and only if they are "committed" – i.e. have planning permission (or equivalent) and funding in place. Alternative future scenarios involving "uncommitted" schemes should be reported as sensitivity tests.

Do-Something

3.39. Having run the model for the Do-Minimum scenarios, the scheme should be added into each future year network and the model re-run to give comparable Do-Something results, ensuring that the speed-flow curves used to represent the scheme are consistent with the coding of other roads in the network.

3.40. It is important that the difference between Do-Minimum and Do-Something results reflects the full impact of the scheme and nothing else; in other words that there is no change in modelling assumptions between the two cases.

3.41. For example, if the proposed scheme involves closure of minor roads so that local traffic accesses the major road network at a different point, it may become apparent that the Do-Minimum modelling assumptions (regarding the position of centroid connectors or the inclusion of local roads in the modelled network) are not fully appropriate for the Do-Something case. If this occurs, it is necessary to revise the Do-Minimum modelling work, so as to ensure strict comparability of assumptions between the two scenarios.

4. Economic Appraisal

Reasons for use of TUBA

4.1. Guidance on the use of TUBA is to be found in *PAG Unit 6.5: Guidance on Using TUBA.* The TUBA software is less well known than the COBA program, but applies many of the same sort of calculations.

4.2. In practice, the principal difference is that TUBA uses as the basis for its calculations journey times from the traffic model, whereas COBA uses traffic flow data from the traffic model and calculates its own journey times based on its own speed-flow curves and junction modelling.

4.3. For NSR schemes, where the majority of benefits are likely to come from higher link speeds, the use of TUBA is recommended as being generally more efficient and less liable to user error.

4.4. TUBA has a number of features (such as the ability to assess multi-modal benefits) that are unlikely to be required for the appraisal of NSR schemes. This section describes the use of TUBA in the simple case that is likely to be appropriate for appraisal of NSR schemes.

Summary of Inputs to TUBA

4.5. TUBA requires two input files – a scheme file and an economic file.

4.6. The economic file contains economic parameter values, and also defines the number of time periods, number of vehicle classes etc for the TUBA run. Economic values from the default economics file *PAG Unit 6.6: TUBA Standard Input Files* should be used unaltered unless there are particular reasons for varying these assumptions, in which case the Strategic Planning Unit should be consulted. Any such variation should be clearly documented.

4.7. In preparing the scheme file, the user should start from *PAG Unit 6.6: TUBA Standard Input Files* and enter scheme-specific information in the relevant places. This information is likely to comprise:

- Location of matrices output from the traffic model;
- Annualisation factors;
- Costs of building the scheme; and
- Maintenance costs.

Matrices Input to TUBA

4.8. TUBA calculates benefits at the level of travel between each pair of zones, rather than link-by-link. Each traffic-related input therefore goes into TUBA as a matrix.

Four types of matrices are required:

- A Volume matrix (V) of trips between each zone pair;
- A Distance matrix (D) of network distance between each zone pair;
- A Time matrix (T) of modelled journey time between each zone pair; and
- A Charge matrix (C) containing any toll charges or other out-of-pocket costs for vehicle travel between each zone pair. For many NSR schemes this Charge matrix will be zero.

Annualisation Factors

4.9. The trip matrices from the traffic model refer only to the modelled hours of the day. In order to calculate total economic benefit, TUBA needs to know how many hours in a year each modelled hour represents.

4.10. However many time periods are being modelled, the basic approach is the same. As an initial estimate, local ATC data is used to estimate the numbers of hours of the week for which traffic levels are at peak hour levels (or peak hour and interpeak hour levels). These estimates should then be modified so as to give an unbiased estimate of total benefits from all hours of the week.

4.11. The process for calculating this adjustment is illustrated in *PAG Unit 12.1: National Secondary Roads Project Appraisal Report.*

Costs of Building the Scheme

4.12. The costs of building the scheme should be entered into TUBA under 4 headings – Construction, Land, Preparation and Supervision. For each heading, the TUBA input file requires both a total cost (at 2009 prices) and a profile showing how this cost is spread over different years. See *PAG Unit 6.7: Preparation of Scheme Costs* for details of how these costs should be estimated.

Maintenance Costs

4.13. For NSR projects, maintenance cost savings may form a significant part of the economic benefit of the scheme, and should therefore be included in the TUBA run. A total maintenance cost and profile over time needs to be entered for the Do-Minimum case, and then a separate maintenance cost and profile for the Do-Something case.

4.14. Typical default maintenance costs and spend profiles appropriate for rural NSR schemes are outlined in Table 12.1. These are recommended for use at Route Selection and Design phases. The Do-Minimum maintenance cost is considered to depend principally on the existing condition of the road – the poorer the existing condition, the sooner maintenance will be needed and the higher the total discounted cost. Four sample profiles are used, depending on the average roughness index (IRI) of the existing road. The Do-Something maintenance cost is considered to depend on two factors – the level of traffic and the quality of the subgrade. Four sample profiles are used, representing each combination of Low and High traffic flow and Good or Poor quality subgrade. Maintenance costs are estimated per square metre of road surface, so the costs need to be multiplied by both the length of the scheme and the average width of the carriageway.

Table 12.1: Maintenance Cost Profiles

	Do-Minimum				Do-Something			
IRI	0 to 2.5	2.6 to 3.5	3.5 to 5	>5	Low Traffic-Good Subgrade	High Traffic-Good Subgrade	Low Traffic-Poor Subgrade	High Traffic-Poor Subgrade
Opening Year	0.59%	1.09%	2.07%	2.29%	0.68%	0.69%	0.57%	0.59%
+1	0.59%	1.09%	2.07%	2.29%	0.68%	0.69%	0.57%	0.59%
+2	0.59%	1.09%	4.66%	36.64%	0.68%	0.69%	0.57%	0.59%
+3	0.59%	1.09%	1.04%	0.38%	0.68%	0.69%	0.57%	0.59%
+4	0.59%	3.83%	1.04%	0.38%	0.68%	0.69%	0.57%	1.18%
+5	1.18%	1.09%	1.04%	0.38%	0.68%	1.39%	1.14%	1.18%
+6	1.18%	1.09%	2.07%	0.38%	0.68%	1.39%	1.14%	1.18%
+7	4.12%	1.09%	2.07%	0.38%	1.35%	1.39%	1.14%	1.18%
+8	1.18%	2.19%	2.07%	0.38%	1.35%	1.39%	1.14%	2.37%
+9	1.18%	2.19%	4.66%	0.76%	1.35%	7.64%	2.29%	9.47%
+10	1.18%	2.19%	2.07%	0.76%	1.35%	0.69%	2.29%	0.59%
+11	1.18%	2.19%	2.07%	0.76%	7.43%	0.69%	9.14%	0.59%
+12	2.35%	4.92%	2.07%	0.76%	0.68%	0.69%	0.57%	0.59%
+13	2.35%	2.19%	3.11%	2.67%	0.68%	0.69%	0.57%	0.59%
+14	2.35%	2.19%	49.74%	0.38%	0.68%	0.69%	0.57%	1.18%
Design Year	5.29%	2.19%	0.52%	0.38%	0.68%	1.39%	0.57%	1.18%
+16	1.18%	2.19%	0.52%	0.38%	0.68%	1.39%	0.57%	1.18%
+17	1.18%	2.19%	0.52%	0.38%	0.68%	1.39%	0.57%	1.18%
+18	1.18%	3.28%	0.52%	0.76%	1.35%	1.39%	1.14%	1.18%
+19	2.35%	52.46%	0.52%	0.76%	1.35%	1.39%	1.14%	2.37%
+20	2.35%	0.55%	1.04%	0.76%	1.35%	2.78%	1.14%	2.37%
+21	2.35%	0.55%	1.04%	2.67%	1.35%	2.78%	1.14%	61.54%
+22	2.35%	0.55%	1.04%	0.76%	1.35%	2.78%	1.14%	0.59%
+23	2.35%	0.55%	1.04%	0.76%	1.35%	2.78%	2.29%	0.59%
+24	55.29%	0.55%	1.04%	0.76%	2.70%	58.33%	2.29%	0.59%
+25	0.59%	1.09%	2.07%	1.53%	2.70%	0.69%	2.29%	0.59%
+26	0.59%	1.09%	2.07%	1.53%	2.70%	0.69%	2.29%	0.59%
+27	0.59%	1.09%	2.07%	1.53%	2.70%	0.69%	59.43%	1.18%
+28	0.59%	1.09%	2.07%	1.53%	2.70%	0.69%	0.57%	1.18%
Final Year	0.59%	1.09%	2.07%	35.88%	56.76%	0.69%	0.57%	1.18%
Total Undiscounted Cost	85	91.5	96.5	131	74	72	87.5	84.5
	(€ per square metre)				(€ per square metre)			

4.15. At tender phase, estimates based on local data should be used if available.

Checking TUBA Outputs

4.16. Having run the TUBA program, it is important to check the TUBA output file to ensure that the software has run correctly. The most important sections to check are:

- The first section “Input Summary”, to ensure that the program has read the key scheme input parameters as intended;
- The second section “Errors and Warnings”, to ensure that there are no errors, and that any warnings displayed relate to valid but unusual features of the scheme (such as an unusually high degree of journey shortening from straightening out the road) rather than any form of mistake in the inputs; and
- The final sections (TEE table, Public Accounts, Analysis of Monetised Costs and Benefits) to ensure that results are plausible.

5. Multi-Criteria Appraisal

Introduction

5.1. The Project Appraisal Balance Sheet (PABS) provides a one-page summary of the merits of each scheme option, based on a multi-criteria analysis. It aims to present the totality of the impact of the scheme, including:

- A short qualitative statement describing each impact;
- Monetary values for those elements which are monetisable and included in the CBA; and
- Quantitative indicators of impact, where possible.

5.2. Each impact is scored on a scale of 1 (severe negative impact) to 7 (strong positive impact), with a score of 4 representing a neutral or minimal impact. For those impacts capable of quantification, the score should be derived from an appropriate quantitative indicator, and presented to one decimal place. For those impacts not capable of quantification, an integer score should be assigned according to whether the impact is:

7 - Major or highly positive;
6 - Moderately positive;
5 - Minor or slightly positive;
4 - not significant or Neutral;
3 - Minor or slightly negative;
2 - Moderately negative; or
1 - Major or highly negative.

5.3. A sample PABS table is shown in Table 12.2. The header identifies clearly the option that is being appraised, notes the budget cost of the scheme (in current prices), and summarises the problems that the proposal is intended to address. The five appraisal criteria are divided into 18 sub-criteria; the proposed scheme option is assessed against each one of these, with a combination of qualitative statements, quantitative indicators and monetised values. Note that monetised costs and benefits are at 2009 prices. Any negative benefits should be clearly indicated with a minus sign and shown in a different colour, to avoid confusion. All monetised benefits are summed up in the Present Value of Benefits (PVB), and compared with the Present Value of Costs (PVC) to give a Benefit:Cost Ratio (BCR).

Table 12.2: Sample Project Appraisal Balance Sheet

Project Appraisal Balance Sheet - Summary Table							
Scheme Option:		**Description:**	**Problems Identified:**				**Budget Cost (million)**
N99 upgrade from Ballytown to Kilchurch within existing corridor		12.3km upgrade to Type 3 standard, 95% online	Lane width <3m for nearly all of this corridor. Poor sight distances for approx 50% of corridor. High incidence of accidents throughout				**€9.99**
Objective	**Sub-objective**	**Qualitative impacts**	**Quantitative assessment**		**Monetised (€ million over 30 yrs)**		**Score**
Environment	**Air Quality**	Greenhouse gas impacts from construction; slight increase in emissions from increased speeds	8700	tonnes additional CO_2 over 30 years	value of change in carbon emissions	**−€0.33**	3.2
	Noise and vibration	Realignment moves traffic away from dwellings at Kilchurch Cross			Value of change	€ 0.03	4.2
	Landscape & visual quality	Minimal impact, adequately mitigated by proposed planting					4
	Biodiversity	3% of Ballytown Meadows SAC lost to road realignment					3
	Cultural Heritage	Construction work will impinge on view from Ballytown Castle					4
	Land Use	Minimal land acquisition, fully reflected in scheme cost					4
	Water resources	Localised impact of runoff on small streams					4
Safety	**Accident reduction**		12	accidents saved over 30 years	Value of change	€ 0.41	4.8
	Security	New facility provided for walkers and cyclists					7
Economy	**Transport Efficiency and Effectiveness**		120	vehicle-hours per day in travel time savings	Non-business	€ 6.12	5.1
					Business	€ 5.12	
			4500	current traffic levels AADT	Active travel	€ 0.12	

					Residual value	€ 2.12	
	Wider economic impact	Increased output in imperfectly-competitive markets				€ 0.51	7.0
	Funding	Not assessed			**PVC**	€ 5.55	4
Accessibility and Social Inclusion	**Vulnerable groups**	Better non-car access to Ballytown (popn 1,800)					7
	Deprived geographic areas		3	CLAR zones gain improved access to Hub/Gateway			4.6
Integration	**Transport integration**	Route supports a Bus Eireann service					5
	Land-use integration	Scheme features in the County Dev. Plan					4.3
	Geographical integration	Improves access to the international airport					5.1
	Integration with other government policies	Route of regional significance					4.0
					PVB	€14.08	
					BCR	*2.5*	

Environmental Criteria

5.4. The NRA has produced a series of Environmental Planning Guidelines to promote best practice in the area of environmental impact assessment. These guidelines cover the general environmental assessment process and also specific environmental topics including air, noise, ecology, cultural heritage, and geology. These guidelines should be referenced at project inception phase for the recommended approach to environmental appraisals at route selection and preliminary design stages. These guidelines are all available to download from www.nra.ie.

5.5. Project managers should carry out an initial assessment to determine the requirement for Environmental Impact Assessment, in line with the DEHLG guidance on thresholds.

5.6. Where an EIA is deemed necessary, the NRA Guidelines on Environmental Impact Assessment should be followed (with particular reference to Section 3.0 on scope and information to be contained in an EIS) together with the best-practice approaches provided in each of the topic-specific guidance notes on air quality, noise, ecology, cultural heritage, and geology.

5.7. Where a road scheme does not trigger the need for mandatory or discretionary EIA, an appropriate level of environmental appraisal should nonetheless be undertaken to identify localised impacts and to suggest appropriate mitigation measures to address these.

5.8. The Environmental section of the PABS sheet is a highly-condensed summary of the work that needs to be undertaken in order to meet statutory and good-practice requirements for appraisal of the likely environmental impacts of a project.

Air Quality Score

5.9. Air quality impacts from road schemes can arise during both the construction stage and the operational stage. Construction stage impacts predominately relate to the emissions of greenhouse gases (principally Carbon Dioxide CO_2) from both energy use and embodied carbon in construction materials. Operational stage emissions include both greenhouse gases (principally Carbon Dioxide CO_2) as well as non-greenhouses gases (Oxides of Nitrogen NOx, Particulate Matter PM_{10} and Total Hydrocarbons THC) and are a direct emission from vehicular traffic on the road network.

5.10. Greenhouse gases will arise from construction stages of a road scheme through the site materials employed (asphalt, aggregates, etc.), vehicles delivering this material and personnel to the construction site, and from energy use on the site.

5.11. For the purposes of these guidelines, a generic assessment of the construction of a standard kilometre of road “lane” is applied using the UK Environment Agency carbon calculator. This is an Excel spreadsheet that calculates the embodied carbon dioxide (CO_2) of materials, CO_2 associated with their transportation as well as personal travel, site energy use and waste management. The simplified emission factor for this assessment has been set at 400 tonnes of CO_2 per lane-km by the UK Environment Agency and a monetisation factor of €39/tonne (2015) has been applied based on the Department of Finance circular of June 2009.

5.12. Table 12.3 below should be completed for all route options considered, to calculate the approximate greenhouse gas emissions from each option. Calculation of construction emissions for a Do-Nothing option (baseline) should be set at €0, however, if the Do-Minimum option includes some alignment or surface works this may give rise to a non-zero figure, which should be estimated in proportion.

Table 12.3: Template for Calculating Monetised Impacts During Construction

Route Option	**Length (km)** **A**	**No. of lanes** **B**	**Emission factor (tonnes CO_2 per km)** **C**	**Total Emissions (tonnes CO_2)** **A x B x C**	**Monetisation Factor (€ per tonne)[1]**	**Monetary Impact (€)**
Do-Minimum			400		€39	€
Scheme Option A			400		€39	€
Scheme Option B			400		€39	€
etc						

Notes: 1 Dept. Finance CO_2 factor (€39 per tonne in 2015).

5.13. To assess air quality at the operational stage, the procedures for comparing route options are as per those presented in Chapter 3 and Appendix 3 of the NRA "Guidelines for the Treatment of Air Quality during the Planning and Construction of National Road Schemes". The guidelines require the following information to be collated for each road link in the traffic model, for the Do-Minimum and for each scheme option:

- AADT (Annual Average Daily Traffic) flow for design year;
- Link Length (km);
- Average Speed (km/hr); and
- Fraction of LGV and HCV.

5.14. This information is then loaded into the Regional Impact Assessment Model of the UK Design Manual for Roads and Bridges (Volume 11, Section 3, Part 1) which is a simple MS Excel based spreadsheet tool available at http://www.standardsforhighways.co.uk/tech_info/index.htm. The spreadsheet calculates total vehicular emissions of NOx, PM_{10}, hydrocarbons and greenhouse gases (as Carbon). Total emissions for each route option should be reported in the format presented in Table 12.4.

Table 12.4: Template for Calculating Monetised Impacts during Operation

Route Option	Pollutant	Total Emissions (tonnes/annum)	Monetisation Factor (€ per tonne)	Monetary Impact (€ per annum)
Do-Minimum	THC		400	
	NOx		2,000	
	PM_{10}		27,600[1]	
	C		11[2]	
	Total Monetised Impact			€
Scheme Option A	THC		400	
	NOx		2,000	
	PM_{10}		27,600[1]	
	C		11[2]	
	Total Monetised Impact			€
Scheme Option B	THC		400	
	NOx		2,000	
	PM_{10}		27,600[1]	
	C		11[2]	
	Total Monetised Impact			€
etc				

Notes: 1 PM_{10} monetised factor derived from Heatco $PM_{2.5}$ Monetisation Factor.
2 C monetised factor derived from Dept. Finance CO_2 factor (€39 per tonne in 2015).

5.15. The monetisation factors are derived from HEATCO Deliverable 5, 2005 (NOx, PM_{10}, THC) as well as the June 2009 circular from the Department of Finance (greenhouse gases).

5.16. The combined monetised impacts for the construction and operational phases of the projects should be combined to identify the total monetised impact. Construction impacts are a once-off, whereas the operational impacts should be calculated over 30 years of operation, with no discounting applied. Table 12.5 sets out the requirements for reporting total impacts.

Table 12.5: Template for Calculating Total Monetised Impacts for Route Options

Route Option	Construction Impact (€) (Table 12.3)	Operational Impact per annum (€) (Table 12.4)	Operational Period (30 years)	Total Operational Impact (€)	Total Impact (€)
	A	B	C	B x C = D	A + D
Do-Minimum			30		
Scheme Option A			30		
Scheme Option B			30		
etc					

5.17. The final scoring system for air quality is based on measuring the change in emissions in relation to the baseline (Do-Minimum) route option. Increases in monetised emissions are scored as negative impacts and reduced emissions are scored as positive impacts. The scale of the changes is taken from the impact magnitudes employed in the NRA Guidance for Air Quality and are presented in Table 12.6.

Table 12.6: Scoring System for Air Quality

Description	$Score_{route}/Score_{Do\text{-}Min}$	Score range
Highly negative	> 1.25	1.0 to 1.5
Moderately negative	1.15 – 1.25	1.5 to 2.5
Slightly negative	1.05 – 1.15	2.5 to 3.5
Neutral	0.95 – 1.05	3.5 to 4.5
Slightly positive	0.85 – 0.95	4.5 to 5.5
Moderately positive	0.75 – 0.85	5.5 to 6.5
Highly positive	< 0.75	6.5 to 7.0

Noise and Vibration Score

5.18. Noise impacts from road schemes can arise during both the construction phase and the operational phase.

5.19. Construction stage impacts predominately relate to mobile and stationary equipment that is utilised in the construction of road schemes. Whilst it is important to note this factor as part of the total environmental impact assessment of the scheme, it is not usually quantified, and is unlikely to be a significant factor in the choice between scheme options.

5.20. Noise impacts associated with the operational stage of a road scheme can be separated into two main components, noise from:

- Vehicle engines and windrush, which is a function of type, number and speed of vehicles; and
- The interaction of vehicle tyres with the road surface, which depends on road structure - design, construction and materials.

5.21. The procedures for route corridor selection in relation to noise are presented in Chapters 4 and 5 of the NRA publication “Guidelines for the Treatment of Noise & Vibration in National Road Schemes”, 2004.

5.22. Prediction of noise impacts at the early stages of planning and design is difficult as the noise impact will depend on existing baseline conditions, proximity of the alignment to sensitive receptors, topography, speed, composition of traffic and traffic flows. This information is typically gathered at the preliminary design stage and is used to carry out an assessment in line with NRA Guidelines and with the Department of Transport (Welsh Office) document ‘Calculation of Road Traffic Noise’ (CRTN) 1988.

5.23. The scoring system for noise & vibration is based on a modified CRTN Model using the following data:

- AADT (Annual Average Daily Traffic);
- Link Length (km);
- Average Speed (km/hr); and
- % HCVs.

5.24. This information is inputted into a modified CRTN spreadsheet, which incorporates the various stages of the CRTN for predicting noise from a road scheme.

5.25. The number of households affected by noise impacts should be identified using Geodirectory data. Geodirectory is a complete database of buildings in the Republic of Ireland.

5.26. The spreadsheet calculates the noise level as an Lden value, the number of persons exposed, % of adult persons highly annoyed. The total monetised noise impact is calculated based on the format presented in Table 12.7. It should be applied to all links which experience a significant change in traffic flow or traffic speed as a result of the scheme.

5.27. The monetisation factors are derived from HEATCO Deliverable 5, 2005. Tables 6.9 and 6.11 of the document are used for the calculation of monetised impacts for Ireland and adjusted to market price and value.

Table 12.7: Template for Calculating Monetised Impacts for Route Options during Operation

	Step 1	Step 2	Step 3	Step 4	Step 5	Step 6
Link	**Lden[1]**	**No of Properties [2]**	**Number of Persons exposed [3]**	**% of Adult Persons highly annoyed [4]**	**Calculation of Impacts [5]**	**Monetised Impacts [6]**
Do-Minimum Case						
Link 1						
Link 2						
...						
Total						
Scheme Option A						
Link 1						
Link 2						
...						
Total						
Scheme Option B						
Link 1						
Link 2						
...						
Total						

Scheme Option A – Do-Minimum [7]	
Scheme Option B – Do-Minimum [7]	

Notes:
1 Quantification of Lden from modified CRTN for Do-Something Scenario.
2 Number of properties within 300m of road from Geodirectory data or manual property count.
3 Number of persons exposed is calculated using property count data multiplied by 2.8 persons per household (average from Census data).
4 Using Table 6.11 from HEATCO, the % of adult persons highly annoyed is calculated.
5 Calculation of impacts (multiply percentage of highly annoyed persons by number of persons exposed).
6 Using Table 6.9 of HEATCO, multiply cost per person by number of persons exposed (from Note 3).
7 Subtraction of total costs for the Do-Minimum case from each Do-Something option.

5.28. In order to convert the total monetised value of noise impacts into a score on a 1-7 scale, three steps are required.

- The monetised value of noise reduction has to be added up over each year of the 30-year appraisal period, and discounted back to the present value year used in the economic appraisal, to give a total figure (PVimpact);
- The ratio of the present value of the impact to the present value of scheme cost (PVimpact/PVC) has to be calculated, to ensure that size of the project will not bias any comparisons; and
- A ratio of zero corresponds to a score of 4. On the basis that a highly positive scheme has a BCR of 2.5 or better, and that noise reduction would be expected to contribute no more than 5% of the total benefit, a ratio of 0.125 or higher corresponds to a score of 7. Other scores are then calculated by linear interpolation:

$$\text{Score} = PV_{impact} / PVC \times 3 / 0.125 + 4$$

<u>Landscape and Visual Quality Score</u>

5.29. Visual sensitivity is a combination of the sensitivity of the human receptor (i.e. resident; commuter; tourist; walker; recreationist; or worker) and the quality of view experienced by the viewer. The impact to visual receptors will be localised within the zone of visual influence (ZVI) and will be dependant of topography, existing land use etc. and is therefore best assessed when specific information is available on the receptors within a specific ZVI. At an early stage qualitative comment would be possible depending on the type of road proposed – online vs. offline – relative to the existing land use / cover however, quantification or monetisation would not be possible. Any qualitative assessment should be carried out by a suitably qualified landscape and visual specialist.

5.30. The scoring should take into account:

- The numbers of people likely to be affected;
- The sensitivity of the human receptors (tourists, walkers and those engaged in recreational activity should be considered as more sensitive to landscape than residents, and residents as more sensitive than workers or commuters);
- The quality of view experienced by the viewer; and

- The relative significance of the proposed change within the landscape as a whole.

Biodiversity Score

5.31. A monetary value is not assigned to biodiversity, however it is possible to score and prioritise impacts based on a risk approach that takes into account:

- The importance of the site, based on degree of legislative protection (SAC under EU legislation, NHA under National legislation);
- The proportion of the site likely to be impacted, and whether impacts are temporary or permanent; and
- Previous experience of similar designated areas.

5.32. Scores for each option should be assigned based on expert judgement and should be determined by a suitably-qualified ecologist. For all routes under consideration, an assessment should be made to the extent and duration of direct and indirect impacts according to the NRA Guidelines for the Assessment of Ecological Impacts of National Roads.

5.33. Under the EU Habitats Directive, an Appropriate Assessment (AA) must be carried out where a project has the potential to impact on a Natura 2000 site (SAC or SPA). The first step in the AA process is screening; all projects should carry out this step and record the outcome. Where necessary, step two and subsequent steps should be carried out, in line with the Department of the Environment's published guidance. The appraisal score will reflect the outcome of this Appropriate Assessment process, in accordance with Table 12.8 below.

5.34. A "severe negative" impact should in most cases mean that an option is removed from further consideration – such impacts cannot be traded-off against other criteria. The remaining categories are mapped to the seven-point scoring scale as displayed in the table below.

Table 12.8: Risk Matrix for Biodiversity Impacts (Terrestrial Sites)

Score/ Impact	Internationally Important	Nationally Important	High Value Locally Important	Moderate Value Locally Important	Low Value Locally Important
0 Severe Negative	Any permanent impacts	Permanent impacts on a large part of a site			
1 Major Negative	Temporary impacts on a large part of a site	Permanent impacts on a small part of a site	Permanent impacts on a large part of a site		
2 Moderate Negative	Temporary impact on a small part of a site	Temporary impact on a large part of a site	Permanent impacts on a small part of a site	Permanent impact on a large part of a site	
3 Minor Negative		Temporary impacts on a small part of a site	Temporary impacts	Permanent impact on a small part of a site	Permanent impact on a large part of a site
4 Neutral	No impacts	No impacts	No impacts	No impact or temporary impact	Temporary impact or impact on a small part of a site
5 Minor Positive				Permanent beneficial impacts on a small part of a site	Permanent beneficial impacts on a large part of a site
6 Moderate Positive			Permanent beneficial impacts on a small part of a site	Permanent beneficial impacts on a large part of a site	
7 Major Positive	Permanent beneficial impacts	Permanent beneficial impacts	Permanent beneficial impacts on a large part of a site		

Based on NRA Guidelines on the Assessment of Ecological Impacts of National Road Schemes, 2006.

5.35. Where there is scope for mitigation measures, it is important to be clear about whether the scheme as appraised is with or without these measures and their associated cost.

Cultural Heritage Score

5.36. Cultural Heritage is an important issue, as linear infrastructure is well known for potential conflicts with known and previously undiscovered archaeology, architecture and cultural heritage features. Information on the historic environment within Ireland is generally obtained from the Register of Sites and Places / Sites and Monuments Record and the Records of Protected Structures (RPS) included in relevant County Development Plans.

5.37. The scoring system for cultural heritage follows the same principle as the one for biodiversity. Monetary values are not assigned to cultural heritage elements. Instead, the impact ranges for each option should be scored and prioritised based on a matrix approach that takes into account:

- Type and level of impact;
- Type of monument;
- Area of potential; and
- Distance between the site and the route.

5.38. Scores for each option should be assigned based on expert judgement and should be determined by a suitably-qualified heritage specialist in accordance with the table below. The objective of the assessment at this point should be to produce a common assessment and detailed technical and comparative evaluation of each route option. All recorded archaeological features that are potentially affected by each route option should be identified, and consideration given to development of options that avoid significant adverse impacts from the road scheme.

5.39. A “profound negative” impact should in most cases mean that an option is removed from further consideration – such impacts cannot be traded-off against other criteria. The remaining categories are mapped to the seven-point scoring scale as displayed in the table below. For all monuments identified, an assessment should be made as to the extent and duration of direct and indirect impacts according to the NRA Guidelines for the *Assessment of Archaeological Heritage Impacts of National Roads and Guidelines for the Assessment of Architectural Heritage Impacts of National Roads.*

Table 12.9: Risk Matrix for Cultural Heritage Impacts

Impact	Direction	Score	Description
Profound	Negative	**0**	Applies where mitigation would be unlikely to remove adverse effects. Reserved for totally adverse negative effects only. These effects arise where an archaeological site is completely and irreversibly destroyed by a proposed development.
Significant	Negative	**1**	An impact which, by its magnitude, duration or intensity, alters an important aspect of the environment. An impact like this would be where part of a site would be permanently impacted upon, leading to a change of character, integrity and data about the archaeological feature/site.
	Positive	**7**	
Moderate	Negative	**2**	Applies where a change to the site is proposed which though noticeable, is not such that the archaeological integrity of the site is compromised and which is reversible. For example where an archaeological feature can be incorporated into a modern day development without damage and all procedures used are reversible.
	Positive	**6**	Arises where a change to the site is proposed which enhances the archaeological integrity of the site, for example increases the buffer zone or improves landscape around the site or incorporates a feature undamaged for its original purpose into a modern day development thereby increasing its long-term protection.
Slight	Negative	**3**	An impact which causes changes in the character of the environment which are not significant or profound and do not directly impact or affect an archaeological feature or monument.
	Positive	**5**	
Imperceptible	Neutral	**4**	An impact capable of measurement but without noticeable consequences.

Source: NRA Assessment of Archaeological Heritage Impacts of National Roads, 2006.

5.40. Where there is scope for mitigation measures, it is important to be clear about whether the scheme is appraised with or without these measures and their associated cost.

Land Use Score

5.41. The CORINE land cover database provides an inventory of land use using satellite imagery. At the strategic level, it can be a useful tool in determining the types of land uses likely to be impacted by development planning decisions. The database divides land cover into the following categories:

Table 12.10: Land Use Categories in the CORINE Land Cover Database

Arable land and permanent crops	Waterbodies
Artificial surfaces	Open spaces with little or no vegetation
Forests and transitional woodland scrub	Natural grassland or heathland
Pastures and mixed farmland	Wetlands

5.42. Although the categories are broad they none the less provide an indication of whether economic, recreational, natural or built environment are the main receptors of changes in land use. Scoring should follow the methodology outlined for biodiversity, with greatest weight placed on land cover types that are considered most preferable to conserve (e.g. wetlands).

5.43. This heading can also cover "effects on land use through land-take, severance or reduction of viability, which prevents or reduces its value for intended use" which are not covered elsewhere in the assessment framework. This is particularly important with regard to agriculture.

5.44. For rural road schemes, impacts relating to agricultural land are most likely due to:

- Loss of agricultural use;
- Less useful by reason of severance; or
- Less useful by reason of soil degradation during construction or pollution from run-off.

5.45. The PABS table should quantify the estimated land-take from the scheme, and the type of land affected. In many cases the impact will be fully reflected in the element of scheme costs that refers to costs of land acquisition. If this is the case then the land use impact should be scored as 4 (negligible) to avoid double-counting.

5.46. Where the impact is not fully reflected in the cost – e.g. where land of no commercial value has a significant worth for recreational purposes – then the score should reflect this. Positive impacts are possible, e.g. where straightening a road releases into public use additional land which is of some amenity value.

Water Resource Score

5.47. The scope of water resources relates to aquatic ecology. For all aquatic sites, an assessment should be made with reference to the NRA *Guidelines on the Assessment of Ecological Impacts of National Road Schemes*. The scoring system for water resources will follow the same principle as the one for biodiversity. Hence, it is not proposed to assign monetary value to water resource elements. Instead, it is possible to score and prioritise impacts based on a matrix approach that takes into account:

- The importance of the waterbody e.g. presence of protected species such as salmon, lamprey, freshwater pearl mussel, crayfish;

- Extent of the water body likely to be impacted and whether impacts are temporary or ongoing; and
- Rarity of suitable habitat for protected species.

5.48. Scores for each option should be assigned based on expert judgement and should be determined by a suitably-qualified ecologist in accordance with the tables below. A "severe negative" impact should in most cases mean that an option is removed from further consideration – such impacts cannot be traded-off against other criteria. The remaining categories are mapped to the seven-point scoring scale as displayed in the tables below.

Table 12.11: Water Resources Scores

Impact	Direction	Score
Severe	Negative	**0**
Major	Negative	**1**
Moderate	Negative	**2**
Minor	Negative	**3**
Not significant	Neutral	**4**
Minor	Positive	**5**
Moderate	Positive	**6**
Major	Positive	**7**

Table 12.12: Risk Matrix for Water Resources Impacts

Internationally Important				
	Temporary	Short-term	Medium-term	Long-term
Extensive	Major	Severe	Severe	Severe
Localised	Major	Major	Severe	Severe
Nationally Important				
	Temporary	Short-term	Medium-term	Long-term
Extensive	Major	Major	Severe	Severe
Localised	Moderate	Moderate	Major	Major
High Value Locally Important				
	Temporary	Short-term	Medium-term	Long-term
Extensive	Moderate	Moderate	Major	Major

Localised	Minor	Moderate	Moderate	Moderate
Moderate Value Locally Important				
	Temporary	Short-term	Medium-term	Long-term
Extensive	Minor	Minor	Moderate	Moderate
Localised	No Significant	Minor	Minor	Minor
Low Value Locally Important				
	Temporary	Short-term	Medium-term	Long-term
Extensive	No Significant	No Significant	Minor	Minor
Localised	No Significant	No Significant	No Significant	No Significant

Source: NRA Guidelines on the Assessment of Ecological Impacts of National Road Schemes, 2006.

5.49. Where there is scope for mitigation measures, it is important to be clear about whether the scheme is appraised with or without these measures and their associated cost.

Safety Criteria

Accident Reduction Score

5.50. Improving the quality of a single-carriageway road will tend to reduce the number of personal injury accidents. But increasing the speed of traffic on the road will tend to increase the severity of such accidents. The relative size of these two effects will determine whether the economic cost of accidents along the improved route increases or decreases as a result of the improvement.

5.51. Significant levels of accident benefit or disbenefit may also arise where improved journey times cause traffic to be attracted from a less-safe or more-safe alternative route.

5.52. Changes in accident numbers and severities are monetisable. The COBA software does this, taking into account not only the discount rate for monetisable benefits but also relevant trends in accident rates, accident severities, and the value that people place on avoiding casualties. However, the accident rates in COBA are relatively high-level averages, which do not distinguish between different standards of improved or unimproved road.

5.53. The recommended approach for NSR schemes is either to use a simplified (possibly one-link) COBA model with user-defined accident rates, or to set up a spreadsheet model which allows for COBA-consistent discount rate and change over time in traffic levels, accident rates and value of accidents.

5.54. The outcome of this process will be an estimate of Present Value of Benefit (PVB) from accident savings (which may be positive or negative). This should then be compared with the PVC of the scheme. If the ratio of this benefit to the PVC exceeds 0.38 then the scheme achieves a maximum positive score of 7.0, otherwise a proportionally lower score is calculated:

$$\text{Score} = 4 + 3 \times (PVB_{accidents} / PVC) / 0.38$$

Security Score

5.55. This subcriterion is to do with the fear of mishap in using the transport system. This is difficult to quantify; the current recommended approach is to use the simplest form of assessment. On this basis a NSR scheme should score 7 if it provides a significant length of footpath / cycleway along a road which was previously perceived as dangerous to walk on, and 4 otherwise.

Economic Criteria

Transport Efficiency & Effectiveness (TEE) Score

5.56. The TUBA run as described in Section 4 above gives the Present Value of Cost (PVC) for the scheme, and a partial estimate of the Present Value of Benefits (PVB), split into:

- Benefits to business users;
- Benefits to non-business (consumer) users; and
- Benefits relating to reduction in carbon emissions.

These items can be entered directly into the PABS table.

5.57. At route selection stage, no assessment is required of the user delays that would occur during construction and maintenance. Additional calculations are required for estimating "Active Travel" benefits – the benefits of increases in walking and cycling resulting from the scheme – and an estimate of the residual value of the scheme at the end of the 30-year standard appraisal period.

Active Travel

5.58. "Active Travel" benefits accrue if the scheme provides a footpath and cycleway alongside part the National Route so as to improve walking and cycling access to a local settlement. These benefits are a combination of the health improvements arising from increases in walking and cycling with the willingness of walkers and cyclists to pay for improved journey ambience.

5.59. As a broad rule of thumb, provision of footpath and cycleway may be justified on economic grounds where the density of dwellings along the route (within 250m of the centreline) exceeds around 40 dwellings per km.

5.60. At route selection stage, a broad estimate of these benefits may be obtained from the following formula:

$$A = 6.1 \times d - 31$$

Where; A is the Active Travel benefit in €000/km
d is the density of dwellings per km

so that for example, at d=40 the PVB from walking & cycling is of the order of €213,000 per km.

Residual Value

5.61. At the end of the 30-year appraisal period, the scheme will have some residual asset value, and an estimate of this should be included as part of the calculation of scheme benefits. An appropriate estimate of the residual value is obtained by adding the land cost to one-quarter of the construction cost (both in 2009 prices, as entered into TUBA). This residual value is then treated as a benefit which is obtained at the end of the appraisal period (opening year + 30). For inclusion in the total PVB it has to be discounted back to the present value year (currently 2009) using the standard discount rate.

5.62. Alternatively, residual value can be calculated as the benefits that can accrue over a further 10 years beyond the 30-year appraisal period. Guidance on the calculation and application of residual value should be sought from the Strategic Planning Unit.

Score

5.63. In order to derive a TEE score, the four elements of PVB – benefits to business traffic, to non-business traffic, to walkers & cyclists, and the benefit to government of the residual value of the scheme - are added together and compared with the PVC of the scheme. If this ratio exceeds 1.75 then the scheme achieves a maximum positive score of 7.0, otherwise a proportionally lower score is calculated:

$$\text{Score} = 4 + 3 \times (PVB_{wider\_econ\_impact} \ / \ PVC) / 0.125$$

Wider Economic Impacts Score

5.64. Economic research suggests that there are a number of other economic impacts above and beyond journey time savings, principally relating to business responses to better accessibility. Of these, the most relevant for NSR schemes is to do with an economic gain from increased output by firms under conditions of imperfectly competitive markets. A broad estimate of this impact can be obtained by uprating the business time savings by one tenth. The monetised benefit from wider economic impacts should therefore be taken to be 10% of the business benefit from the TEE sub-criterion.

If the ratio of this benefit to the PVC exceeds 0.125 then the scheme achieves a maximum positive score of 7.0, otherwise a proportionally lower score is calculated:

Funding Score

5.65. Funding issues are specified as an appraisal sub-criterion within the Common Appraisal Framework, but are not likely to be a source of significant benefit or disbenefit for NSR schemes. The heading should be included in the PABS table for completeness, but should be scored as 4 (neutral) in all cases.

5.66. On completion of the economic assessment, the overall PVB at the bottom of the table should be calculated as the sum of all the monetised (positive and negative) benefits. The BCR should be calculated as the ratio of PVB:PVC.

Accessibility and Social Inclusion Criteria

Vulnerable Groups Score

5.67. This sub-criterion relates to the benefit to non-car-owners of providing walking or cycling facilities.

- If the scheme does not include walking & cycling facilities, score 4;
- If the scheme includes walking & cycling facilities, for either the whole length of the scheme or for a length of at least 5km, providing access to a settlement of 1500+ population, score 7; and
- Otherwise, score 5.

Deprived Areas Score

5.68. This sub-criterion relates to improving access to and from disadvantaged geographical areas. An appropriate accessibility index should be constructed as follows:

- Identify the set of Census Enumeration Districts (EDs) which are considered likely to experience a significant benefit from the scheme, and obtain for each ED (e) the Census 2006 population Popn(e);
- Remove from this set any EDs which are not designated under the CLAR programme, so that the index refers only to deprived rural areas;
- For each ED (e) in the set, use the National Traffic Model or any appropriate journey planning software to estimate the minimum journey time in units of minutes (Te) from that ED to the nearest Gateway or Hub settlement;
- For each ED in the set, use the local traffic model to assess the time saving in units of minutes (ΔTe) that the scheme offers to that particular journey (from the ED to its nearest Gateway or Hub);
- Calculate an indicator statistic A for the gain in accessibility as:
  $A = \Sigma_e \; Te \times \Delta Te \times Popn(e) / 18 \text{ mins}$.
  This is a weighted sum of journey time savings in person-minutes; and

- Calculate a score corresponding to this indicator statistic, as
  Score = 4 + A / (10 x PVC)
  where PVC is the present value of cost from the economic appraisal. If this score is greater than 7, then count it as 7.

Integration Criteria

Transport Integration Score

5.69. This sub criterion relates to the integration of the scheme with other modes of transport or road networks. There are three aspects.

To a base score of 4.0:

- Add 1.0 if a scheduled bus service uses the route proposed for improvement;
- Add 1.0 if the proposal includes cycle facilities along a route that is designated as part of the National Cycle Network; and
- Add 1.0 if the proposal includes improvements to a junction with a National Primary Route.

Land-use Integration Score

5.70. This sub-criterion relates to the integration of the scheme option in government policy. Strategic schemes of the highest national priority would be expected to be named at all levels of government policy and would therefore score most highly, whereas local schemes would only be expected to be named at the lowest level of policy.

To a base score of 4.0:

- Add 0.3 if the route is identified for improvement in the NSS;
- Add 1.8 if the route is identified for improvement in Transport 21;
- Add 0.3 if the route is identified for improvement in the National Development Plan;
- Add 0.3 if the corridor is identified for improvement in the relevant Regional Planning Guidelines; and
- Add 0.3 if the corridor is identified for improvement in the relevant County Development Plan(s).

Geographical Integration Score

5.71. This judgment-based sub-criterion measures the extent to which road improvements contribute to the policy aim of improving international access, either by improving connectivity to major ports and airports, or by improving cross-Border access to Northern Ireland. To achieve a maximum score of 7, a scheme should form part of a major cross-Border route or a direct access to a major port or international airport.

Improvements to a route which directly serves a less-major port or regional airport might score 5.5.

Other Government Policy Score

5.72. This judgment-based sub-criterion measures the extent to which road improvements contribute to the policy aim of balanced regional development, by improving the accessibility of non-Dublin Gateway towns and cities, and improving connections between non-Dublin Gateway towns and cities. To achieve a maximum score of 7, a scheme should make a significant increase to the hinterland of a non-Dublin Gateway town/city and offer reductions in journey times from there to multiple other non-Dublin Gateways. A route that is not adjacent but carries some traffic to a non-Dublin Gateway, without any inter-Gateway traffic, might score 4.5.

6. Further Information

This PAG Unit summarises appropriate methods for appraisal of NSR schemes. It should be read in the context of the full Guidance, which sets out in more detail the principles of sound project appraisal practice, and the range of methods which may be appropriate to different types of scheme.