THE QUADRO 2021 MANUAL

PART 3

THE APPLICATION OF QUADRO

Contents

Chapter

1. CHOOSING THE OPTIMUM MAINTENANCE JOB AND PROFILE

1.1 The main aim of QUADRO is to enable the user to identify the most economic maintenance job or profile. The economic decision rule for QUADRO is: "choose that job or profile which has the minimum total discounted works and user cost over the period being evaluated". It should be noted that this decision rule might need to be modified if there is a tight budget constraint. In such circumstances, choosing a high works cost option with low delay costs may mean delaying works at another site because of shortage of funds. The decision rule should be to minimise works and user costs over all the schemes in the maintenance budget, including the effect of delaying schemes.

1.2 Where QUADRO is being used in the economic appraisal of road schemes, the user should identify the preferred maintenance profile for the 'Do Minimum' and each of the 'Do Something' options in turn. The preferred profile should normally be the economically optimal profile, unless there are overriding non-economic considerations.

1.3 Where there are significant differences between maintenance options in factors outside QUADRO, these should be set out explicitly in conjunction with the economic results. This is discussed in Chapter 5.

1.4 Deleted.

1.5 When considering alternative maintenance jobs and profiles, it is important that the full range of feasible options is examined, particularly if the initially preferred option has a high total works and user cost. The range of alternatives will inevitably be specific to the road in question but examples of choices for consideration when using QUADRO are:

i) preventive versus structural maintenance and frequent small scale versus less frequent large scale maintenance;

ii) weekday versus night time or weekend working;

iii) alternative lengths of contracts;

iv) alternative staging of works along a stretch of road, either in terms of a short length of road or a whole route;

v) alternative traffic management arrangements and use of diversion routes.

The feasibility of such alternatives will be influenced by factors such as the availability of funds and the need to consider other sections requiring work in the vicinity.

1.6 When planning major maintenance works, it may be possible to achieve cost savings by integrating the planning of improvement works and maintenance. For example, where an existing stretch of road is both reaching the end of its life and has high traffic flows relative to its capacity, it may be economic to widen and reconstruct, integrating the work to minimise traffic delays. In such circumstances, there is no clear distinction between maintenance and new construction.

2. ECONOMIC APPRAISAL OF ROAD SCHEMES AND MAINTENANCE COSTS

2.1 When considering the economic viability of a new scheme it is clearly necessary to assess the future cost implications of maintaining the road network with and without the new scheme. Economic appraisals should distinguish 'traffic related' maintenance costs, which vary with the level of traffic on the road and 'non traffic related' costs which vary with the length of road (see Chapter 9 of the COBA Manual):

Non traffic related maintenance costs: drainage, footway/cycle tracks, safety fence/barriers, boundary fences, bridges/culverts/ subways, remedial earthworks, verge maintenance, sweeping, gully emptying, signals/signs/crossings, road markings, salt/snow plough/fencing and motorway compounds;

Traffic related maintenance costs: reconstruction, overlay, resurfacing, surface dressing and patching.

2.2 Non traffic related maintenance will not normally cause significant traffic delays and will not therefore normally be subject to a QUADRO assessment as part of the economic appraisal submission.

2.3 Traffic related maintenance costs. It can be assumed that when a vehicle reassigns from an old road to a new road, it ceases to impose wear and tear on the old road and instead imposes it on the new road. For the purposes of the economic appraisal of road schemes, net change in traffic related maintenance costs between the 'Do-Minimum' and 'Do-Something' situations is assumed to be insignificant. This is still a reasonable assumption in most cases where the old road is known to be in a sound structural condition.

2.4 However, for the majority of major road schemes, this assumption is inappropriate. For example, where the existing road is in a poor state of repair and the need for maintenance is imminent. If extra roadspace is provided either in terms of a new road or widening, some element of the maintenance works cost may be avoided if cheaper works are sufficient when the old road is relieved of traffic. Also, and more importantly, the extra roadspace enables maintenance works to be carried out with less delay to traffic. Table 2/1 shows hypothetical profiles of maintenance works for an existing single carriageway road in the 'Do Minimum' and the existing road and a new dual carriageway in the 'Do Something'.

2.5 The specification of maintenance works was discussed in Part 2 Chapter 4. Tables showing scheme specific works information, using a layout similar to Table 2/1, should always be included in the scheme appraisal to enable the QUADRO analysis to be more easily understood. Also, similar Tables will be helpful when maintenance jobs and options are being considered for existing roads.

	Job Description	Year of Job	Works Cost £m	Duration	Traffic Management	User Costs £m
Do Minimum						
Existing Road (S2)	1. Reconstruction	2020	3.6	24 wks	Shuttle Working	6.7
	2. Surface Dressing	2030	0.1	2 wks	" "	0.6
	3. Resurfacing	2040	0.6	8 wks	" "	1.2
			4.3			8.5
Do Something						
Existing Road (S2)	1. Resurfacing	2020	0.6	8 wks	Shuttle Working	0.4
	2. Surface Dressing	2040	0.1	2 wks	" "	0.1
New Road (D2AP)	1. Surface Dressing	2030	0.2	4 wks	1+1 c/flow	1.2
	2. Surface Dressing	2040	0.2	4 wks	" "	1.0
	3. Resurfacing	2046	1.2	16 wks	" "	2.4
			2.4			5.0

Table 2/1: Hypothetical Maintenance Works Cost Profiles (average 2010 values and prices)

2.6 In scheme appraisal it is necessary to assess the works and user cost maintenance implications on the network for the 'Do Minimum' and 'Do Something' options. QUADRO should be used to assess which is the economically optimal maintenance profile for each of the 'Do Minimum' and 'Do Something' options by referring to Phase 9 of the QUADRO printout. Having established the preferred profile of works and user cost for each 'Do Minimum' and 'Do Something' option, the user should refer to the profile of works and user costs in undiscounted terms also set out in Phase 9 of the QUADRO printout. This profile should be used as input data into the economic appraisal for the 'Do Minimum' or 'Do Something' road options in question.

2.7 If the economic appraisal program COBA is used, then the works and user costs are input separately. The program then discounts these costs from the job years and incorporates the discounted traffic related maintenance works and user costs in the calculation of the Present Value Benefits (PVB) and Present Value Costs (PVC). The profiles of discounted traffic and non-traffic maintenance costs for the 'Do Minimum' and the 'Do Something' option under assessment are listed in the COBA printout. The discounted expenditure or works saving of traffic related, and non-traffic related maintenance in the 'Do Something' compared to the 'Do Minimum' is subtracted from the 'Do Something' discounted scheme cost in the PVC calculation. The discounted saving of traffic related maintenance delay or user costs is added to the user benefits of the 'Do Something' option in the PVB calculation.

2.8 The hypothetical example given in Table 2/1 can be used to illustrate this process. Suppose that the 'Do Something' option (DS) is being compared to the 'Do Minimum' (DM):

i) the discounted traffic related maintenance works and user costs from QUADRO are,

	DM	DS	Saving of DS over DM
Works (or 'Capital')	£4.3m	£2.4m	£4.3m - £2.4m = £1.9m
Delay	£8.5m	£5.0m	£8.5m - £5.0m = £3.5m

(Note that if COBA is used then these values should be input in their undiscounted form by individual year of works, see Phase 9 of the QUADRO printout);

ii) the discounted non traffic related maintenance expenditure costs are,

DM	DS	Saving of DS over DM
£0.5m	£1m	£0.5m - £1m = - £0.5m (that is, an additional cost);

iii) the total maintenance expenditure saving of the 'Do Something' compared to the 'Do Minimum' is thus the traffic related works saving plus the non traffic related expenditure saving, that is,

£1.9m + (- £0.5m) = £1.4m,

the £1.4m expenditure saving is subtracted from the discounted scheme cost of the DS option, thus reducing the PVC of the DS by £1.4m;

iv) the total delay or user cost saving associated with traffic related maintenance is £3.5m from i) above. This is added to the total user benefit of the DS, thus increasing the PVB of the DS by £3.3m.

2.9 The above calculations can be carried out manually rather than inputting the QUADRO data into the economic appraisal program. If so, the user should refer to the discounted traffic related works and user cost totals for the preferred 'Do Minimum' (or 'Do Something') profile given in Phase 9 of the QUADRO printout. This provides the DM (or DS) figures which are equivalent to those at step i) in paragraph 2.8 above.

2.10 When specifying the traffic related maintenance cost input for economic appraisals, the user should specify different cost data for low and high traffic growth evaluations (see Chapter 4 below) in a table similar to Table 2/1 above together with user delay costs included for each DM and DS for low and high traffic growth evaluations.

2.11 Finally, it should be noted that QUADRO User Costs include accident and VOC costs as well as time costs. Accident costs from QUADRO should be added to the accident costs during normal operation when completing the Analysis of Monetised Costs and Benefits Table and Appraisal Summary Table as part of a scheme appraisal. VOCs and time costs from QUADRO both relate to transport economic efficiency and should be added together for inclusion in the Transport Economic Efficiency Table, Analysis of Monetised Costs and Benefits Table and Appraisal Summary Table. In the latter two tables, transport economic efficiency impacts during normal operation and construction/maintenance are combined rather than reported separately. It should also be noted that all of the tables require the transport economic efficiency impact of a scheme to be reported separately for business, commuting and other trip purposes. The split of User Costs is given in Phase 9 of the QUADRO printout.

3. APPRAISING DELAYS AT NON-MAINTENANCE ROADWORKS

3.1 Although QUADRO has been developed to evaluate maintenance jobs, its potential for application is wider. More generally it appraises the effect of reduced carriageway capacity and is particularly useful when there are possibilities of reassignment to diversion routes.

3.2 **The other major use of QUADRO is for appraising delays during the construction of a new road as part of a scheme appraisal**. Equally it may be useful when considering traffic operations during the construction period, for example, which diversion routes to use. Other possible applications include the assessment of carriageway restrictions that exist over fairly long time periods, such as major statutory undertakers' works, or the installation of central reserve safety barriers. The application of QUADRO to appraise delays at non-maintenance sites should be reasonably straightforward. Essentially the user will wish to ignore the works cost elements of QUADRO and simply supply data for the delay calculations.

Construction Period and Optimism Bias

3.3 In addition to cost overruns, the actual construction period of major maintenance projects is often longer than that envisaged. It is therefore necessary to allow for optimism bias in the estimate of construction duration using the guidance given in TAG Unit A1.2 – Scheme Costs.

Incidents Delays and Journey Time Variability ("Reliability")

3.4 Traffic delays caused by incidents that reduce capacity (such as accidents and vehicle breakdowns) can be considerable particularly where flows are high. Some incident costs are already included in the standard use of COBA and QUADRO, but some are not. COBA assesses the costs of accidents during the economic evaluation period (normally 60 years) based on casualty costs, damage to property, damage only accidents, etc. Traffic delays caused by these accidents are however not calculated by COBA. Also, the effects of vehicle breakdowns and associated delays are not included. QUADRO assesses the overall costs of incidents (that is, accidents and vehicle breakdowns) but only during periods of road works and/or construction works. Their frequency and the associated traffic delays and costs are calculated by QUADRO but only for the duration of the roadworks based on the type of incidents likely to occur in road works situations.

3.5 Neither COBA or QUADRO assess the impact of incidents on journey time variability. For motorways and dual carriageways, Highways England's MyRIAD (Motorway Incident Reliability and Delays) computer program can be used to calculate the journey time variability impacts of a DS scheme relative to the DM, but only during normal operation and not during the road works used to construct the scheme. MyRIAD will also calculate the delay impacts of incidents during normal operation, analogous to QUADRO's calculation of incident delays during road works. Journey time variability and incident delays are known collectively within MyRIAD as journey time reliability, consistent with the definition given in WebTAG. In short therefore, MyRIAD is used to calculate the reliability impacts of a scheme during normal operation and QUADRO will calculate the incident delay impacts during construction. For motorway, dual carriageway and single carriageway schemes, full reliability impacts can therefore be assessed during normal operation, but only part of the reliability impact during construction. It should be noted that the incident delay impacts calculated by QUADRO, although technically a reliability impact, should be included as part of the delay impact (transport economic efficiency impact) and not separated out for inclusion under the Reliability impact within the Appraisal Summary Table.

4. MAINTENANCE APPRAISAL UNDER UNCERTAINTY

4.1 QUADRO incorporates a single 'central' default traffic growth profile consistent with the DfT Road transport forecasts 2018 Scenario 1 (Ref 5.6). The single set of economic parameter assumptions in QUADRO are given in Part 2, and the national traffic forecasts are given in Part 5 Chapter 9.

4.2 Where local (that is, scheme specific) traffic forecasts have been produced in accordance with current guidance, it is required that an uncertainty range (low and high local traffic growth forecasts) around the central case figure is constructed. Hence there may be a range of user costs for any particular maintenance job. The cost of traffic delays on the high growth scenario will always be higher than low growth. The range of total maintenance costs should always be quoted when making decisions on maintenance jobs.

4.3 This may complicate the application of the economic decision rule set out in paragraph 1.1 above, if the ranking of options depends on whether high or low growth is assumed. Consider the following two examples.

<u>EXAMPLE 1</u>

Two maintenance strategies are being compared for an existing road, one involving resurfacing in years 10 and 20, the other involving reconstruction in year 20. The discounted works and user costs of the two alternative profiles are, (£m average 2010 prices);

	Low Traffic Growth £m	High Traffic Growth £m
Resurfacing	5	7
Reconstruction	4	6
Incremental cost of resurfacing	+1	+1

The conclusion is that on both high and low traffic growth the reconstruction strategy has lower costs, and so is economically preferred.

<u>EXAMPLE 2</u>

Suppose the figures are;

	Low Traffic Growth £m	High Traffic Growth £m
Resurfacing	5	6
Reconstruction	4	8
Incremental cost of resurfacing	+1	-2

The conclusion is that the choice is marginal. Reconstruction has a lower cost on low traffic growth and higher on high.

4.4 Unfortunately, it is not possible to allocate probability distributions to the range of low/high traffic growth outcomes; therefore it is not possible to put relative weights on the incremental costs of +1 and -2 in example 2 above. The choice between the options in the example would tend to favour resurfacing because the economic loss in choosing reconstruction should high traffic growth materialise is greater than the economic loss from resurfacing should low growth materialise.

4.5 The use of the low/high traffic forecasts may affect the specification of the maintenance profiles themselves, as well as the calculation of delays within the QUADRO program. This is because the expected volume of standard axles on any particular stretch of road in the future will normally be higher on the high growth forecast than on the low. This implies that the expected life of the road (measured in years) will be shorter on high growth compared to low. Thus the user should consider whether the profile of maintenance expenditure on high growth should show expenditure in earlier years than the profile on low growth, and possibly more, or higher cost, maintenance jobs over the 60 year appraisal period.

4.6 Because the use of a range of traffic forecasts affects the expected life of the pavement, it also affects the design of the pavement for a new road scheme. When considering the strength of the pavement design, the designer has to trade off the unnecessary higher cost of building a stronger pavement if low growth materialises compared to the earlier maintenance costs if a weaker pavement is designed and high growth materialises. QUADRO can be used to assess the future delays and works maintenance costs of different pavement designs. Provided that the cost of building an initially stronger pavement design is not very much higher, it will usually be economic to opt for a stronger pavement initially to avoid reconstruction and delay costs.

4.7 Apart from the uncertainty in the growth of traffic and economic parameter values, there are two other sources of uncertainty in a QUADRO appraisal, namely uncertainty with regard to the input data supplied by the user and uncertainty with regard to the traffic engineering and economic relationships inside the program. Concerning the first, the user is recommended to carry out sensitivity tests on key variables to establish the robustness of ranking of options, particularly for expensive jobs. This might apply, for example, to the specification of the timing of the maintenance profiles or the specification of the capacity of the roadworks site. Concerning the second, the traffic engineering relationships and economic parameter values used by the QUADRO program are constantly kept under review.

5. ASSESSING MAINTENANCE WORKS IN A WIDER FRAMEWORK

5.1 Reference was made in Chapter 1 to factors not quantified in QUADRO which are nonetheless significant in the appraisal of maintenance jobs and profiles. These are analogous to the factors listed in the Appraisal Summary Table (AST) used for the appraisal of new trunk road schemes. No comparable formal table has been developed for assessing maintenance jobs per se. However, the same philosophy should apply. That is, when maintenance jobs are being assessed using QUADRO, the economic results should be set out explicitly against factors not quantified in economic terms, to establish the trade offs between the two sets of factors where relevant.

5.2 In considering such factors the first point to note is that QUADRO does not assess the benefits to road users of road maintenance, in terms of reduced wear and tear on vehicles, reduced accidents on better road surfaces and so on. Such benefits are often economic in nature and potentially capable of monetary quantification. However, the necessary empirical relationships have not yet been established. Therefore, where one maintenance option differs from another in terms of the future quality of the road condition and hence benefits to road users, these should be quantified in non-monetary terms as far as possible to set against the monetary QUADRO results.

5.3 Maintenance jobs may also have environmental impacts, not assessed by QUADRO. For example, different surface treatments may cause different tyre noise effects and hence create differences in the dB(A) levels recorded in the vicinity of the road. While environmental factors are not likely to be so important for maintenance jobs as for new road schemes, they should nevertheless be considered and quantified in physical units where significant, including for the diversion route.

5.4 Finally, as with new road schemes, alternative maintenance jobs should be assessed in terms of their impact on existing policies, such as political or financial constraints.

5.5 As with the AST for new road schemes, there is no simple way of trading off the ranking of options from a QUADRO assessment against non-monetary factors. However, the implicit valuation approach described in the COBA Manual may be applicable, for example, where maintenance option A is preferred on QUADRO and option B on the basis of non monetary factors, the extra cost of option B is the minimum value which would have to be put on the non monetary benefits if option B is to be preferred overall.

6. DOCUMENTATION FOR QUADRO VALIDATION

6.1 When sending a QUADRO evaluation for validation, the following material is required:

i) a schedule of maintenance works and associated costs, similar to Table 2/1 above;

ii) full QUADRO printouts for central (or local low and high) traffic growth scenarios;

iii) a plan of the road network with and without maintenance works including the diversion route(s) and traffic management arrangements;

iv) details of the derivation of cost estimates for jobs and profiles;

v) details of the derivation of local data, in particular daily flow profiles (if used), the speed/flow relationship for the diversion route, vehicle proportions, traffic growth, traffic growth cut-offs and capacity at the maintenance site.

6.2 Deleted.

6.3 When the QUADRO assessment is part of an economic evaluation or when the assessment of maintenance strategies for existing roads makes use of forecasts of traffic flow, it is helpful if cross reference is made to the associated traffic model and economic evaluation documents. The cross referencing should demonstrate the consistency of the evaluations in terms of common AADT flow figures, common traffic forecast profiles and compatible network descriptions.

7. NOTES ON HOW TO VALIDATE A QUADRO APPRAISAL

7.1 These notes provide guidance on how to check a QUADRO appraisal. The information required when checking a QUADRO appraisal is set out in Chapter 6. Further information on the output from QUADRO appears in Part 6 Chapter 4.

7.2 The QUADRO printout is structured in terms of 'phases', each of which should be scrutinised. Phases 1 to 5 describe the input data and Phases 6 to 10 describe output data. They are discussed below.

PHASE 1

7.3 For a complete run check that all 10 phases are asterisked. Phase 1 also produces summaries of error and warning messages at the end of each profile, which should be checked.

PHASE 2

7.4 This phase lists the data input for the entire run, with each data line numbered. It should be referred to in the event of any Errors, Warnings or queries in the following phases.

PHASE 3

7.5 This summarises the values of basic variables used throughout the run, all of which may be specified by the user, otherwise default values will be used. User specified values are marked *C*.

PHASE 4

7.6 This describes the network flow, incident and accident characteristics and can be cross-referenced to Phase 2 (input data). For a full evaluation, both incidents and accidents data should be present. Any errors should be corrected and warnings should be queried if necessary, for example, if the values for particular variables appear unreasonable.

7.7 Check that the data input are reasonable, for example:

i) is year, length and cost of job correct for each job in the profile;

ii) are the main route and works site correctly specified;

iii) is the diversion route reasonable in terms of length and speed/flow slope - check derivation. If the MAX-Q-DELAY facility has been used to define the diversion route then a "NO DIVERSION" marker appears;

iv) are the specifications of incident durations and accident rates justified, particularly if the latter are markedly different from default values;

v) are traffic flows on the main and diversion routes reasonable and compatible with the traffic forecasts where appropriate.

PHASE 5

7.8 This table defines the works site capacity and any restrictions on the proportions of heavy vehicles that are allowed to divert. Where default values are used, this phase does not require much scrutiny, but in other cases unusual variations in capacity should be queried. Unrealistic levels of queuing will result from too low capacity values.

7.9 Check that the site capacities are correct. Check that periods of no-works, reduced or increased capacity (representing more or less lanes open) are reasonable.

PHASE 6

7.10 This phase describes the traffic flow output from the calculations carried out by the QUADRO program on the input data. It is one of the most important phases to scrutinise. There is a separate page for each day type and direction (primary and secondary). Columns 1 to 4 of the table describe the traffic flow in terms of 'demand' and normal flows on the main and diversion routes together with the values for the percentage of heavy goods vehicles (OGV1, OGV2 and PSV). If the demand flow reported in column 2 exceeds the "theoretical" capacity of the main route without works, that is, the normal overcapacity value calculated in COBA, then these flows are flagged "-". This means that queuing could already be occurring on the main route in the no-works situation. This queuing is not being modelled (nor valued) by QUADRO and the additional delays caused by the roadworks will be consequently overestimated.

7.11 Column 6 defines the works site capacity or 'supply'. (Note that this is quoted in veh/h and will change as the proportion of heavy vehicles passing through the site changes). Where demand exceeds capacity on the main route, traffic may divert to the diversion route. The flow remaining on the main route is given in column 7 and the flow diverting in column 8. The total flow on the diversion route (normal flow plus diverting) is given in column 9. The implication of this traffic behaviour in terms of queuing and speeds is shown in columns 10 to 16. The key items to examine are the average queue length, based on an average vehicle length of 10 metres and the main route and diversion route speeds with works. (Note that the 'with works' speeds are averaged over the sections between the diversion route end junctions, plus any extra upstream queue length). Where there are long queues and low speeds (which include the effect of queuing), it is worth checking carefully that the input data is reasonable, both in terms of the network specification and flow profiles. For example, the site capacity may be too low or flows too peaked. However, if the input data is reasonable, it is worth querying whether the queuing is acceptable. It may well be worth checking whether alternative site layouts or diversion routes could be tested. The average delay per vehicle in column 10 is a measure of the average extra journey time along the main route between the diversion route end junctions.

7.12 If the MAX-Q-DELAY facility has been used to define the diversion route, then this phase has a slightly different layout. The "Diversion Normal Flow" (col 4), "Percentage Heavy" (col 5), "Total Diversion Flow" (col 9), and "Diversion Mean Speeds" (cols 15-16) are not printed. Instead a value for "DIVERTED FLOW" is printed, that is, the number of vehicles "diverted" because the specified MAX-Q-DELAY value has been exceeded. The flag for reaching MAX-Q-DELAY within an hour is set whenever the delay value is reached within that hour, for example, when queues are building up or decaying. This means that the flag may be set even though the average delay over the hour printed in this Phase is less than the input MAX-Q-DELAY.

7.13 The results of the incident sub model are given below the main table. The key items to check are the number of vehicle hours delay per day and the number of breakdowns and accidents. Where delays are very long, alternative arrangements may be worth testing, for example, the effects of shorter incident duration if site surveillance can be improved.

PHASE 7

7.14 This is an important phase to examine. The tables show the discounted 'with' and 'without works' user costs for individual maintenance jobs. They also show the user cost differences by vehicle category and by day type, together with an overall summary of job costs. Where total user costs are high relative to works cost, this is a signal to check, firstly, whether the input data is correct and, secondly, whether the user costs can be reduced by alternative arrangements. Where user costs are disaggregated by vehicle category, it can be seen whether user costs are falling on cars or commercial vehicles, for example. The user costs are also further disaggregated by day type. In the "User Costs With Works" table, an "Incident Time" column (split by work and non-work) has been provided to highlight the impact that incidents can have on the final QUADRO results. If the 'Incident Time' values are high compared with the normal 'Time' values, then the specification of incident durations and/or diversion routes may need to be changed. In the two tables headed "User Cost Differences by Vehicle Category" and "User Cost Differences by Day Type", the 'Time' columns represent the totals of ordinary time and incident time added together.

PHASE 8

7.15 This table provides totals for accident numbers and costs for a profile. If accident numbers and costs for each job in the profile have been scrutinised individually, then this phase does not need checking. This Phase is not printed if the profile contains only one job.

PHASE 9

7.16 This disaggregates the total profile user costs by individual job, and also includes undiscounted works and user delay costs. It is one of the most useful phases to check. The specification of the profile should be checked, for example, is the scale and frequency of jobs reasonable? The QUADRO user should check which jobs are most expensive. Can alternative profiles be specified which would reduce total profile costs? Or can the details of the job be respecified to reduce user costs?

PHASE 10

7.17 This contains a number of Tables.

Table 1 – Conversion of Travel Costs to Market Prices by Vehicle Category
This is a new output Table presenting travel cost totals by vehicle category in Market Prices. Personal Travel covers travel by car, private LGVs and some PSV journeys. Freight covers travel by freight LGVs and OGV1 and OGV2. The Private Sector heading covers the remaining PSV journeys. Table 1 is printed for each profile of jobs.

Table 2A – Impacts of Construction and/or Maintenance in Market Prices
This is the 'Economic Efficiency of the Transport System (TEE)' Table. The Total Impact result represents the total market price valuation of the impacts of construction and/or maintenance works. It excludes the total cost of accidents. This can be found in Phase 9.

Table 2B – Public Accounts
This shows the summary of Public Accounts. QUADRO cannot make the distinction between Central or Local Government funding and it is the responsibility of the user to ensure that the results are reported correctly.

Table 2C – Analysis of Monetised Impacts
This Table summarises the monetised impacts as calculated by QUADRO. There may also be other

significant costs and benefits, some of which cannot be presented in monetised form. Where this is the case, the analysis presented in this Table does not provide a good measure of value for money and should not be used as the sole basis for decisions.

ERROR & WARNING MESSAGES

7.18 Errors should be corrected, otherwise the program will not complete the calculations. Warning messages should be checked to see if input data is either miscoded or inappropriate (see Part 6 Chapter 3).

CHECKING WORKS COST INPUT DATA

7.19 If works costs are input to QUADRO, then they should be checked carefully. The following should be checked: -

i) for each job, have all items been included (works, land if any, preparation and supervision)?

ii) are the local cost estimates as up to date as possible? Have the costs been correctly deflated to 2010 prices using the Treasury GDP Deflator Series?

iii) has the correct optimism bias factor been applied to the cost estimate?

CONCLUSION

7.20 Error and warning messages should be checked first. Phases 7 to 10 will indicate which jobs and which items of cost are most critical in the evaluation of profiles. Phase 6 can then be examined to see the modelled traffic behaviour which gives rise to the user costs, in conjunction with Phase 5 which sets out the traffic flow input. The input data should be checked at Phase 2 followed by Phases 3 to 5.

8. TYPICAL USER DELAY COSTS

8.1 Earlier parts of this manual discussed the ways that maintenance jobs and profiles can be determined and how overall maintenance costs (works plus user costs) are used in scheme appraisals. The assessment of works costs is fairly straight forward usually being based on recent contract rates or materials costs etc. However, user delay costs can vary considerably depending on traffic flow, works layouts and ease of diversion for example. It may therefore be useful to have an idea of the likely magnitude of user delay costs on different types of roads.

8.2 The values given in Table 8/1 were taken from sample runs of the QUADRO4 program covering various standards of road, different types of traffic management for ranges of traffic flows. It must be remembered that QUADRO results are very 'site specific' and that delay costs can have a wide range of values for seemingly 'similar' situations and traffic flows.

Type of Road (Max-Q-Delay used)	**Traffic Management Layout** (Site Length and Main Route Length)	**Flow AADT**	**Time** (pounds at market price)	**VOC** (pounds at market price)	**Accidents** (pounds at market price)
S2 (5 min)	Shuttle Working(500m,5km)	5000	7,000	1,000	1,000
		8000	12,000	1,000	1,500
		10000	16,000	1,500	2,000
WS2 (5 min)	Shuttle Working(500m,5km)	10000	17,000	1,500	2,000
		12000	22,000	2,000	2,500
		14000	34,500	3,000	3,000
	Lane Closure (1km, 2km)	10000	2,000	-1000	1,500
		12000	3,000	-1000	2,000
		14000	3,500	-1500	2,000
D2AP (10 min)	Contraflow 1+1 (2km, 10km)	10000	3,000	0	1,000
		20000	8,000	0	2,000
		30000	18,000	0	3,000
		40000	64,000	1,000	4,000
	Contraflow 2+1 (2km,10km)	20000	5,000	0	2,000
		30000	8,000	0	3,000
		40000	16,000	0	4,000
		60000	234,000	20,000	7.500
D3AP (15 min)	Contraflow 2+2 (2km,10km)	40000	16,000	-500	5,000
		60000	30,000	-1000	7,000
		80000	146,000	2,000	9.500
D3M (20 min)	Contraflow 2+2 (500m,5km)	40,000	10,000	-500	-2000
		60,000	16,500	-500	-2500
		80,000	38,000	-500	-3,500
		100,000	534,500	39,000	-4,000
	Contraflow 3+2 (2km,10 km)	80,000	22,000	-500	-3,500
		100,000	88,000	5,000	-4,500
		120,000	636,000	57,000	-4,000
		140,000	1,300,500	119,000	-1,000
D4M (20 min)	Contraflow 2+2 (500m,5km)	100,000	55,000	-2,500	-3,500
		120,000	76,000	-2,000	-4,500
		140,000	123,000	13,000	-5,000
		160,000	1,409,000	94,000	-5,000

Table 8/1 Typical User Costs (£, av. 2010 prices, per 7 day week)