

Issues associated with Integrating Transport and Environmental Models

Presenter

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Talk Content

- Talk based on recent experience for HA Managed Motorways
- Transport modeller's view
- Overview of processes involved
- Issues encountered when integrating models
- How the procedures may be improved

Traffic Modelling & Appraisal

- Traffic model required to model impact of scheme and for scheme appraisal
- Predict scheme impacts in terms of flows, speeds, and numerous traveller choices
- Macro models using aggregations and approximations based on mathematical relationships
- HA models tend to cover large regional geographical areas and complex choice
- Outputs used for economics, environment, and operational assessments
- Primary focus on the Treasury and providing robust value for money assessment that considers traffic growth uncertainty
- Investment decision tends to be Pass or Fail (does scheme pay for itself?)

Air Quality Modelling & Appraisal

- Environmental appraisal a legal requirement
- AQ models rely on traffic model outputs
- AQ screening criteria specified in DMRB:
 - Road alignment change $\geq 5\text{m}$
 - Daily traffic flows change $\geq 1,000$ AADT
 - HGV flows change ≥ 200 AADT
 - Daily average speed change $\geq 10\text{km/hr}$
 - Peak hour speed change $\geq 20\text{km/hr}$
- Assessed by link and aggregated by direction
- EU upper limit for nitrogen dioxide (NO₂) concentrations of 40 microgram's per cubic metre (of air)
- Detailed screening thresholds used

Scheme Programme Implications

- Exceedence thresholds based on traffic flow and speed, particularly sensitive to HGVs
- AQ screening requires traffic outputs from Do-Minimum and Do-Something
- Complex nature of traffic model and inaccuracy can lead to unanticipated exceedence locations
- Detailed model development defined through screening
- AQ monitoring data can take up to 6 months to collect (> model accuracy)
- Inconsistency found between traffic model and AQ model
- Traffic and then AQ modelling programme critical
- Significant upfront public cost for planning and design at risk while AQ investigated

Integration Issues

A. Model Specification – issues related to how the traffic models are developed which can make them incompatible with AQ analysis

B. Model Interpretation – issues related to how the data produced by traffic models is interpreted and used in the AQ modelling process

C. Accuracy and Uncertainty – general issues relating to the quality of the data produced by a traffic model

A. Model Specification Issues

A1. Model Area

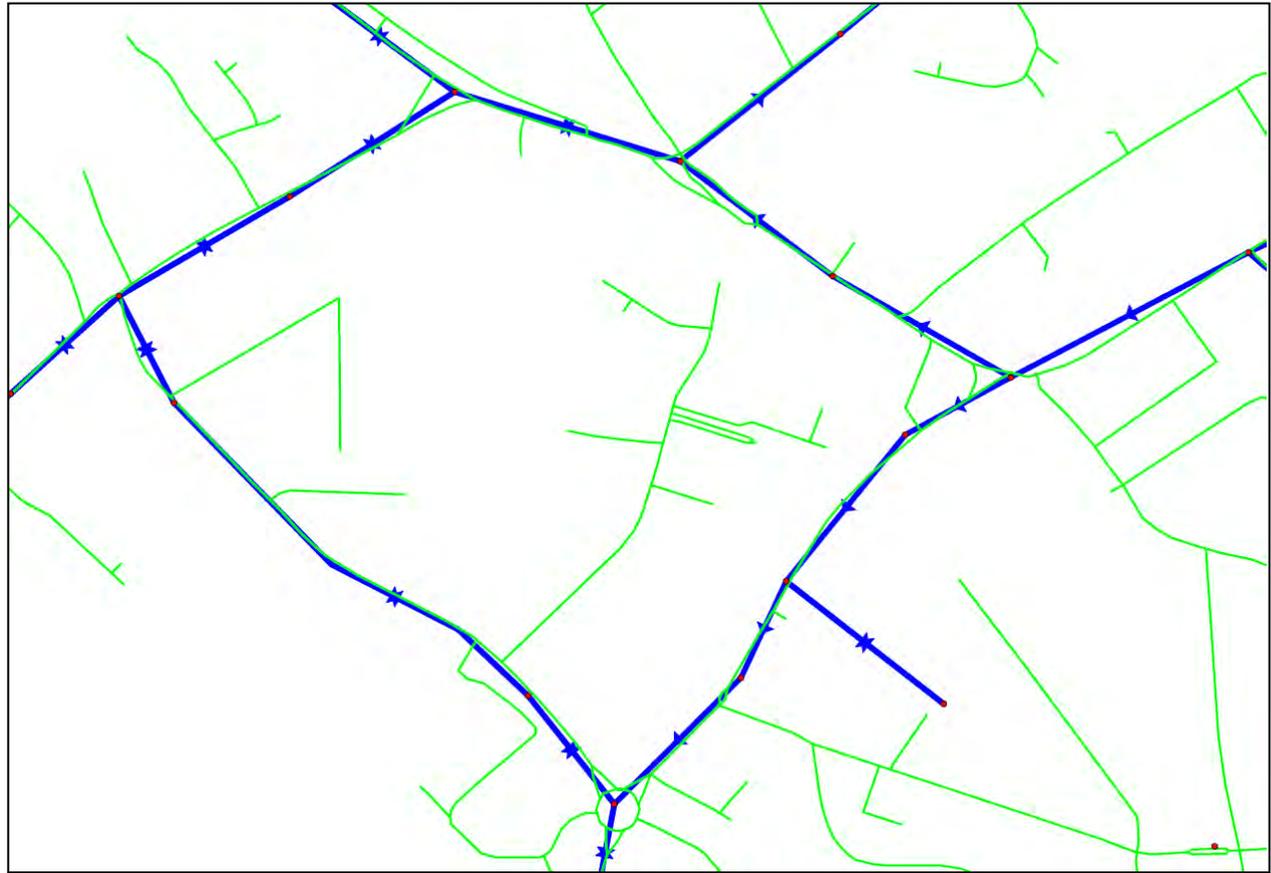
- Geographic model coverage allows for:
 - strategic re-routeing impacts of interventions
 - potential for alternative destinations
 - ensure full lengths of trips
- Little consideration of AQ issues
- Spatial model detail concentrated in Area of Interest or simulation area
- Environmental assessment therefore also limited to the simulation area
- But AQMAs can span simulation boundary
- Large areas may require outputs from two traffic models that are not consistent

A2. Traffic Model Validation

- Traffic models interested in origin–destination movements and journey routes
- Validation criteria checks translation of origin–destination trips to link flows
- Journey time criteria based on routes
- Neither guarantee accuracy at the link level

A3. Lack of Network Detail

- Network chosen to include significant roads and allow correct routing
- Links can often be missing approaching junctions
- No data collected for missing links
- Local validation issues where links missing



A4. HGV Modelling

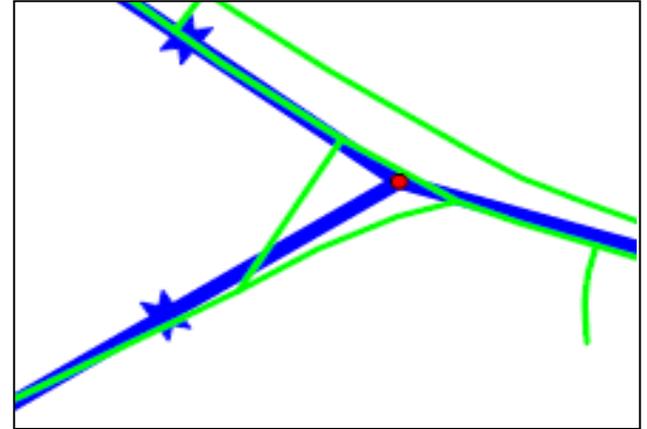
- AQ modelling is very sensitive to the volume and speed of HGVs
- HGV modelling is notoriously difficult with poor observed data and logistics not modelled
- New guidance moving away from link calibration for HGV
- Separate journey time validation for HGVs difficult in existing software packages



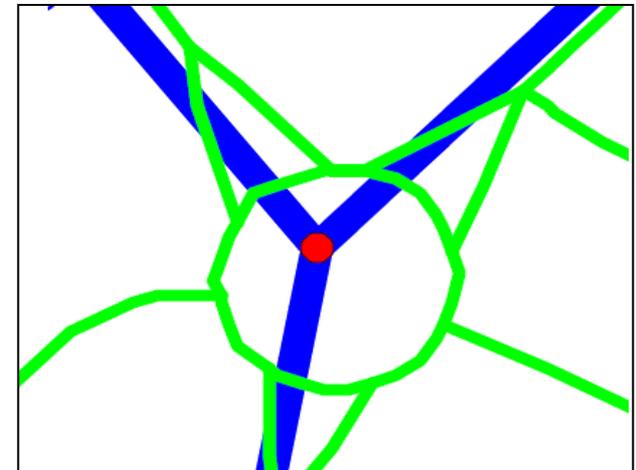
A5. Network Data

- Small variations in centreline distance can cause significant error in the AQ modelling process
- Road network definition different between traffic and AQ models particularly at junctions
- Some older models represent links as straight lines between nodes
- Significant effort to translate from traffic model to AQ GIS format
- AQ model data requirements can change between organisations

T-Junction



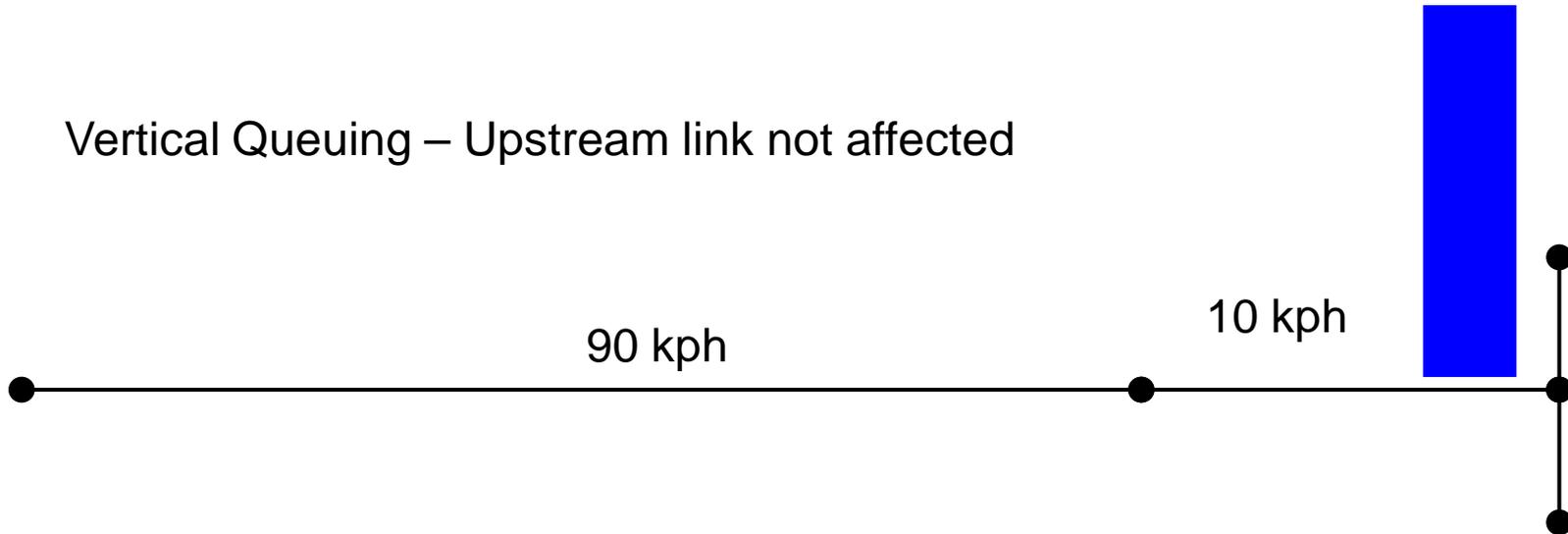
Roundabout



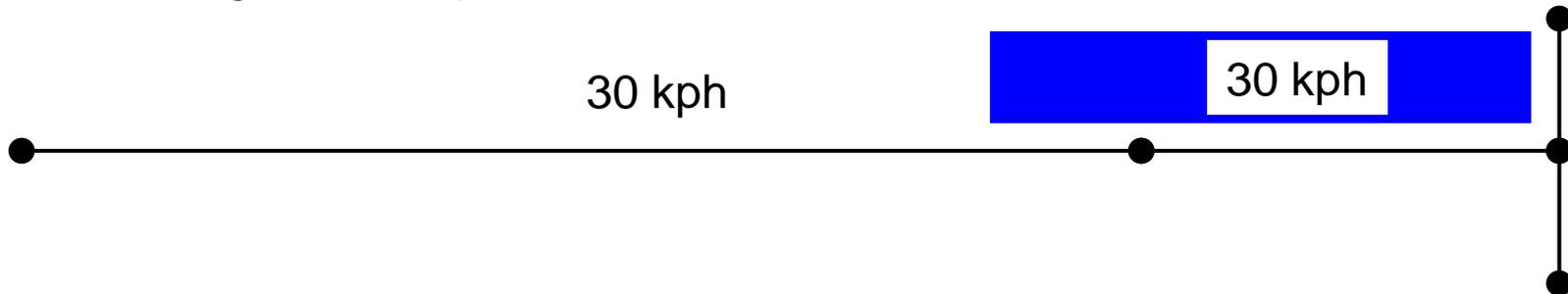
A6. Queuing Approximations

- Traffic models approximate queues as a vertical stack with no spatial representation.

Vertical Queuing – Upstream link not affected

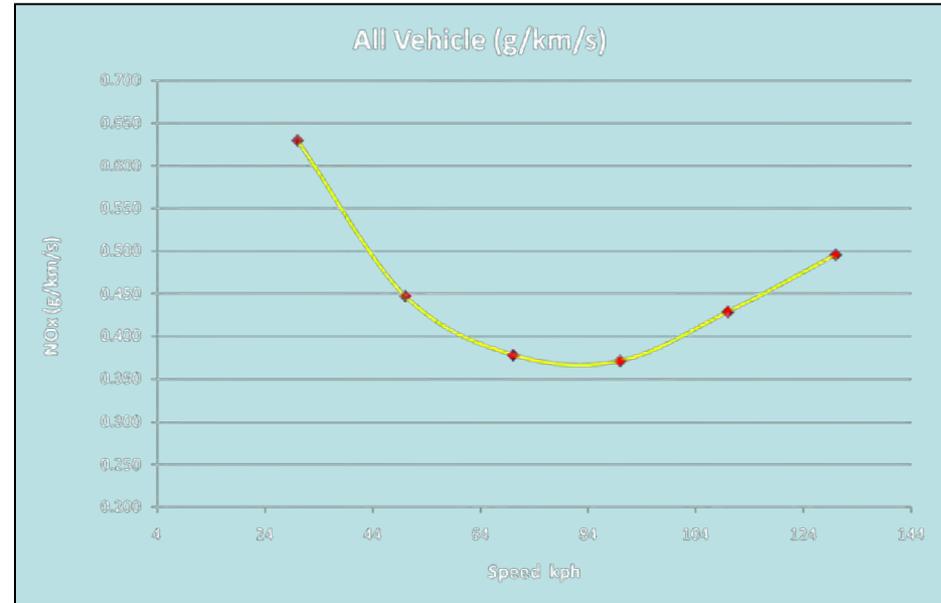


Blocking Back – Upstream link affected

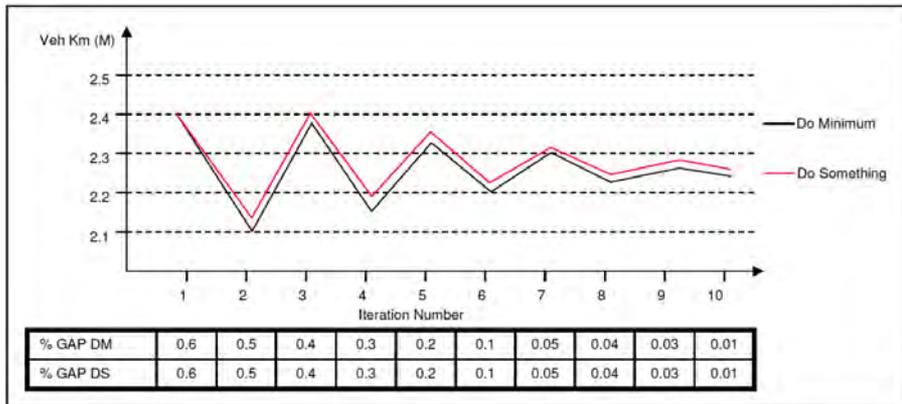


A7. Convergence

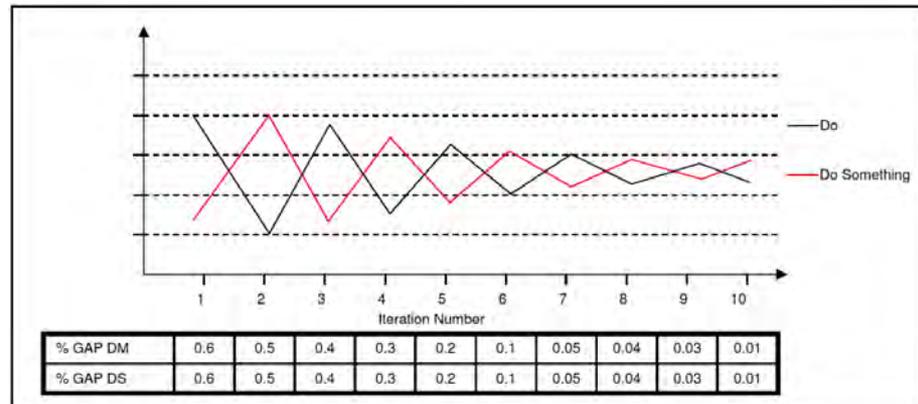
- Large strategic models in congested areas = detailed convergence issues = 'model noise'
- AQ models are very sensitive to small changes in flow and speed caused by 'model noise'
- 'Warm Start' convergence issues



Warm Start: Same Starting Point



Warm Start: Different Starting Point

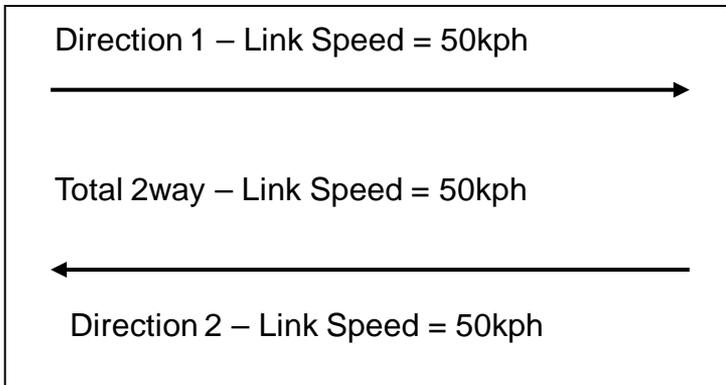
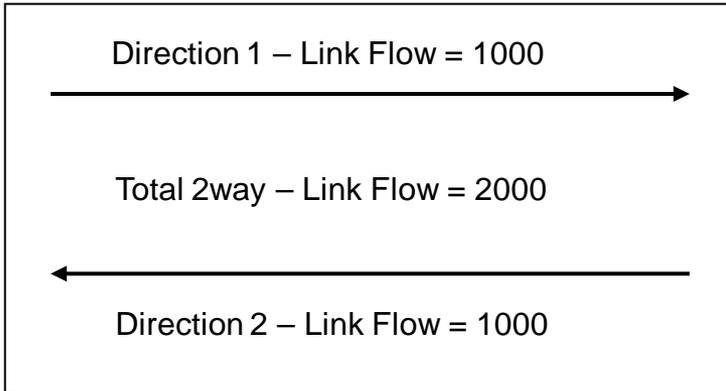


B. Model Interpretation Issues

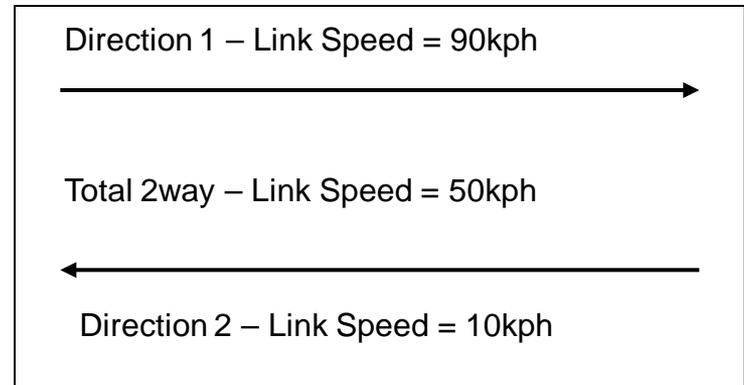
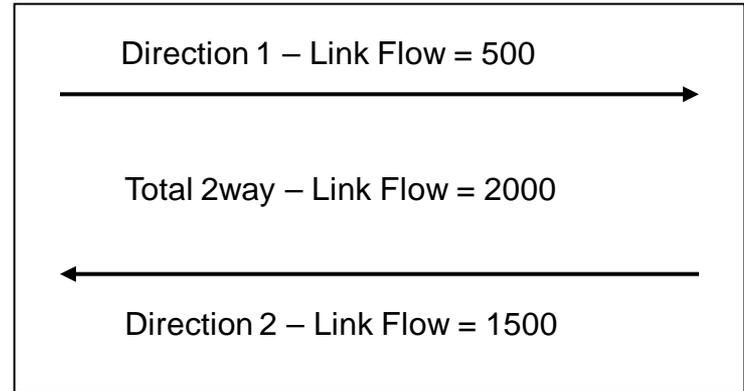
B1. Direction Aggregation

- Traffic model by direction BUT AQ aggregate of direction

Do Minimum



Do Something



B2. AQ Model Verification

- AQ model observed and modelled concentrations provides a 'Verification Factor'
- Verification factors > 1 overestimates differences between DS and DM concentrations

A verification factor of 2 calculated in the base year representing unobserved effects

Base Year

	NO2 Concentration
Observed	30
Modelled	15
Verification Factor	2

Forecast Year DM

	NO2 Concentration
Observed	36
Modelled	18

Verification Factor applied and exceedence found

Forecast Year DS

	NO2 Concentration
Observed	42
Modelled	21

A verification constant of 15 calculated in the base year representing unobserved effects

	NO2 Concentration
Observed	30
Modelled	15
Verification Increment	15

Verification Constant applied and exceedence removed

	NO2 Concentration
Observed	33
Modelled	18

	NO2 Concentration
Observed	36
Modelled	21

C. Accuracy and Uncertainty Issues

C1. Validation Coverage

- Regional traffic models have many thousands of links - M3M4 Model has 19,000 links in the simulation area
- Traffic counts available for M3M4 on 1,400 links
- Only 85% of these 1,400 have to reach the validation criteria
- There are 17,600 links in the model where we have no direct check
- Journey times (and speeds) have limited number of journey time surveys
- It is impractical to observe flow and speed on every link in the model

C2. Uncertainty In Model Flow

- Observed count of 50 HGV, a modelled flow of between 21 and 92 would give a GEH statistic of less than 5 = validated
- HGV count is +/- 28% = count of 50 could lie between 36 and 64
- If HGV count = 36 then a flow of 12 HGVs = validated
- If HGV count = 64 then a flow of 110 HGVs = validated
- AQ exceedences can be caused by an additional 8 HGVs

C3. Uncertainty in the Forecast model

- Traffic forecasts complex: GDP growth, population growth, values of time, etc
- Each of these forecast assumptions will have a degree of un-quantified uncertainty associated with them
- A traffic model is usually based upon a hierarchy of different choices each of which will have been calibrated against observed data
- Each calibration sits within a range of acceptable elasticities
- Different levels of calibration would provide different forecasts

General Improvements

- Improve understanding between traffic and AQ modellers
- Improve the combined modelling process
- Improve interface between traffic and AQ models
- Improve understanding of error in forecasts
- Wholesale refinement in traffic modelling unlikely
- Timescale or costs in developing more complex models unaffordable

Traffic Modelling Improvements

- Provide an early warning of likely locations of AQ issues to start monitoring early
- Increase key model details and reduce reliance on averages
- Do not supply data outside of simulation area boundary
- In the vicinity likely AQ problems
 - increase data collection
 - increase network detail
 - improve validation
- Smooth queues and allocate junction delays to the upstream links
- Better definition of network centrelines – common network data
- Ensure consistency between adjacent traffic models
- More sensitivity tests to improve range of link data

Air Quality Modelling Improvements

- Use traffic information 'as is' and by direction
- Reduce verification factors, increase variables and consider better ways to calibrate
- Check significance of traffic model flow to count – pivot off counts
- Reduce the emphasis on detailed thresholds using more sensitivity tests
- Increase emphasis on relative difference between DM and DS
- Only consider scheme opening year (when traffic forecasts most accurate)
- Be realistic and explain the weaknesses in the model to end users

Statistical Improvements

- Develop statistical methods to describe the uncertainty of traffic model forecasts and estimate an error distribution – @Risk Monte Carlo simulation
- Determine the probability of exceedences occurring
- Would the level of uncertainty discredit forecasts
- How would this traffic uncertainty be translated into AQ modelling uncertainty