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Project Appraisal Guidelines for National Roads Unit 5.3 - Travel Demand Projections

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1. Introduction

1.1 Overview

PAG Unit 5.1: Construction of Transport Models provides guidance on the development of transport models for use in the appraisal of transport infrastructure. The guidance addresses the scoping and construction of transport models which reflect transport demand and supply in a 'Base Year'.

This Unit of the Project Appraisal Guidelines (PAG) provides guidance on the preparation of future travel demand projections for use in modelling and appraisal.

The guidance set out in this Unit is applicable for the modelling and appraisal of National Road schemes, although the guidance is equally applicable to traffic on regional and local road schemes.

In certain circumstances, localised factors may dictate the use of alternative growth projections. The methodology for projecting future year demand needs to be set out in the Project Appraisal Plan (PAP) and agreed with the TII Strategic and Transport Planning Section prior to the commencement of the modelling/appraisal of a National Road scheme.

2. The Role of National Travel Demand Projections

Unbiased future travel demand projections are a critical input in ensuring that the capacity for transport infrastructure is neither too large nor too small to meet future travel demand. Furthermore, travel demand projections inform the economic and environmental appraisal of transport schemes and therefore play a fundamental role in deciding whether a scheme should progress and in the prioritisation of schemes.

Consistency in the appraisal of National Road projects is achieved by the use of common predictions of growth in transport demand which are based on national and local projections of demographic and economic factors. These demographic and economic factors are used to project the future demand for travel across all zones in the TII National Transport Model (NTpM). The procedures discussed in this PAG Unit outline the application of such growth projections to scheme modelling and appraisal.

Travel demand projections should not be viewed as what will happen in the future or what we want the future to look like, but instead what may happen based on our current understanding of how people make travel choices and the expected key drivers of travel demand. The benefits of major roads projects are generally appraised over an extended period of time (up to 60 years); therefore, scheme promoters and decision makers need to understand that projecting travel demand over an extended period is uncertain. See Section 9 of this Unit for further discussion on uncertainty relating to travel demand projections.

The adoption of this approach means that travel demand projections are realistic in the light of current trends and travel behaviour. Nevertheless, they should be regarded as constituting a set of Baseline Projections that may warrant revision in line with the implementation of future spatial strategies.

3. Demographic and Economic Growth Projections

Future travel demand projections were developed as part of the NTpM, based on demographic and economic projections at a zonal level. The NTpM includes travel demand projections for three future years, 2030, 2040 and 2050 across both private and public transport modes. The projections have been developed around those produced for the Project Ireland 2040: National Planning Framework (2018) by the Department of Housing, Planning and Local Government.

TII have developed three future growth scenarios for use in the NTpM. A central growth scenario and two sensitivity growth scenarios (Low and High) which are based on adjusted demographic and economic projections.

In order to estimate the level of demand across these modes, various demographic and economic projections were required. An overview of the demographic and economic models used to inform the future travel demand projections for the NTpM is provided below:

- **Population and Jobs Models**: The population and jobs models generate projections of future growth in population and jobs at Electoral Division (ED) level, which is subsequently aggregated to NTpM zone level. The central projection is based on the ESRI "50:50 City" Scenario from their Prospects for Irish Regions and Counties: Scenarios and Implications (2018)[1]. The low and high growth sensitivity scenarios are based on the CSO Population and Labour Force Projections 2017-2051 "M3F2" and "M1F1" scenarios respectively, which assume different levels of migration and fertility rates;
- **Car Ownership Model:** Detailed car ownership projections were developed using statistical models based on current trends and an analysis of saturation levels. Population growth, economic growth and car ownership saturation level assumptions were used to inform future projections of car ownership. Population growth was considered in respect of the National Planning Framework population projections, which assumed a higher level of denser development in urban areas. Car ownership was projected at county level then aggregated to national projections. NTpM zone car ownership projections were based on disaggregated county level projections at ED level;
- **Goods Vehicles:** Heavy Goods Vehicles Tonnes Carried (HGVTC) were predicted on the basis of Gross Value Added (GVA) in the transport generating sectors of the economy and housing activity. A measure of transport intensity was then developed (HGVTC/GVA) and this was used to predict average kilometres per tonne. HGVTC and average kilometres per tonne were then combined to derive HGV tonne kilometres. An assumption of Average Load per Vehicle Kilometre (ALVK) was then made and combined with HGV tonne kilometres to derive HGV kilometres of travel. The predicted average kilometres per tonne was then used to predict the share of long distance HGV kilometres of travel.
- **Travel Demand**: In order to convert future socio-economic projections (population, jobs, car ownership, etc.) into car vehicle trips and public transport passenger trips, a range of trip rate equations were required for each trip purpose and transport mode. These trip rate equations were developed based on the relationship between the number of trips in the base year and a range of socio-economic variables for the same base year.

[1] "*Prospects for Irish Regions and Counties – Scenarios and Implications" (January 2018) – Edgar L. W. Morgenroth, Economic & Social Research Institute*

Growth projections are implemented on the basis of zonal trip-ends, which in turn define growth throughout a trip matrix. This accounts for spatial variation in local and regional land use and demographic patterns as opposed to a more simplified approach of defining traffic growth by applying global growth factors to a trip matrix.

A detailed discussion on the background data and methodologies used to inform the estimates of future travel demand in the NTpM is presented in Volume 3 of the National Transport Model's suite of supporting documentation. This report is available to download from TII's library of publications: http://tii.ie/tii-library/strategic-planning/.

4. Demographic and Economic Growth Projections - Special Zones

The zone structure in the TII National Transport Model was refined as part of the latest model update to include zones solely representing ports and airports, in line with the National Ports Policy[2] and National Aviation Policy[3]. Tier 1, Tier 2 and regionally significant ports and airports have been included in the NTpM zoning structure.

Special forecasting processes were applied to all ports and airports zones in the NTpM. Details of these processes and of the updated zone structure of the NTpM is provided in the suite of NTpM supporting documentation which is available to download from http://tii.ie/tii-library/strategic-planning/.

[2] National Ports Policy (2013) – Department of Transport, Tourism and Sport
[3] A National Aviation Policy for Ireland (August 2015) – Department of Transport, Tourism and Sport

5. Application of Traffic Growth Projections

As outlined in PAG Unit 5.1: Construction of Transport Models, it is neither practicable nor efficient to develop highly complex models for low levels of investment where limited changes to travel patterns would be expected. Likewise, it is important that larger investments, which will lead to significant changes in travel patterns, are based on a detailed understanding of user responses to inform the economic, safety and environmental impacts of the scheme. The Project Appraisal Guidelines describe three levels of transport model functionality as follows:

- Simple Models, which reflect traffic volumes on the basis of link flows. Such models do not attempt any route assignment, and hence are only applicable for small networks where no change in traffic flows will result from a proposed scheme;
- Assignment Models which allocate demand matrices through traffic networks, thereby replicating route choice by vehicles for each origin-destination pair; and
- Variable Demand Models, which replicate demand responses where they might be expected to occur as a result of a scheme, for example in larger towns and cities with congested road networks. The demand responses considered here comprise changes in trip rates, choice of destination and travel mode.

The application of traffic growth will differ for each of these model types. Future projections can be undertaken by applying growth factors to link flows (Link Based Growth Projections) or by applying trip end growth to demand matrices (Zone-Based Growth Projections). Table 5.1 sets out the traffic growth projection methodology to be used in the three transport model categories defined.

Table 5.1: Criteria for Projecting Traffic Growth

Category	Simple Models	Assignment Models	Variable Demand Models
Description	Manual assignment calculations using fixed demand flows. Can comprise spreadsheet modelling, junction modelling or static microsimulation modelling	Models which use a fixed traffic demand matrix and assess impacts of reassignment only	Models which include consideration of demand responses (Trip Generation, Distribution and Mode Share)
Nature of Scheme	• Road safety schemes • Localised improvement • Schemes falling under Unit 12 or Unit 14	• New roads • Significant upgrades to existing roads • Rural areas • Small urban areas	• New roads • Significant upgrades to existing roads • Major urban areas including special zones
Likely Impacts of Scheme	• Rural road networks with no route-switching • Single or multiple junctions in urban areas with no route-switching	• Schemes which will lead to changes in routing • Areas with limited public transport • Areas where induction or suppression of traffic is not anticipated • May use microsimulation models to model complex merging/shockwaves	• Schemes which will generate traffic impact • Major urban areas where congestion will exist • Schemes which lead to large reductions in journey time • Areas where induction or suppression of traffic is anticipated • Schemes which will increase competition with public transport
Applicable Methodology	**Link-Based Growth Rates**	**Zone-Based Growth Rates**	

6. Link-Based Growth Rates

For simple models, traffic flows are generally represented as vehicular traffic flows on links, with limited information on origin, destination or trip length. In such cases, future year traffic growth is projected using growth rates which describe likely traffic growth that may occur over the appraisal period of the scheme.

The derivation of link-based growth rates is based on an aggregate projection of growth in vehicle kilometres within a defined geographical area, with appropriate classifications by vehicle type and projected period. This allows the specification of a series of growth rates which can be applied directly to traffic flows on simple networks to generate an appropriate estimate of future traffic flows.

The NTpM was used to generate aggregate growth in vehicle kilometres over the projected periods from 2016 to 2030, 2030 to 2040 and 2040 to 2050. In preparing growth projections, it was determined that there was limited correlation between road type and anticipated growth rates. Geographical location was instead determined to be the most significant factor influencing growth in vehicle kilometres.

The geographical regions selected were the Counties of the Republic of Ireland and the National Planning Framework Metropolitan Areas[4], which are illustrated in Figures 6.1 - 6.5. A boundary shapefile of the Metropolitan Areas is provided as an attachment to PAG Unit 5.3 which is available from the “Downloads” section of the TII Publications website under section PE-PAG-02017_Unit-5.3.

Traffic growth is also strongly determined by vehicle type, with growth in Light Vehicles (Cars & Light Goods Vehicles) being driven by different factors than growth in Heavy Vehicles (Ordinary Goods Vehicles 1 & 2). Growth rates are therefore calculated separately for the different vehicle types (Light Vehicles and Heavy Vehicles).

Link-based growth rates for each of the Metropolitan Areas and Counties of the Republic of Ireland is provided in Table 7.1 and Table 7.2 respectively across the three projected periods and for both Light and Heavy Vehicles. The link-based growth rates for each county excluded the Metropolitan Area growth.

The central growth rates are intended for use in project appraisal with the low and high growth rates to be used as sensitivity tests for economic and environmental impacts.

[4] As defined in Appendix 4 of the ‘Implementation Roadmap for the National Planning Framework’, Department of Housing, Planning and Local Government (July 2018).

Figure 6.1: Dublin Metropolitan Area

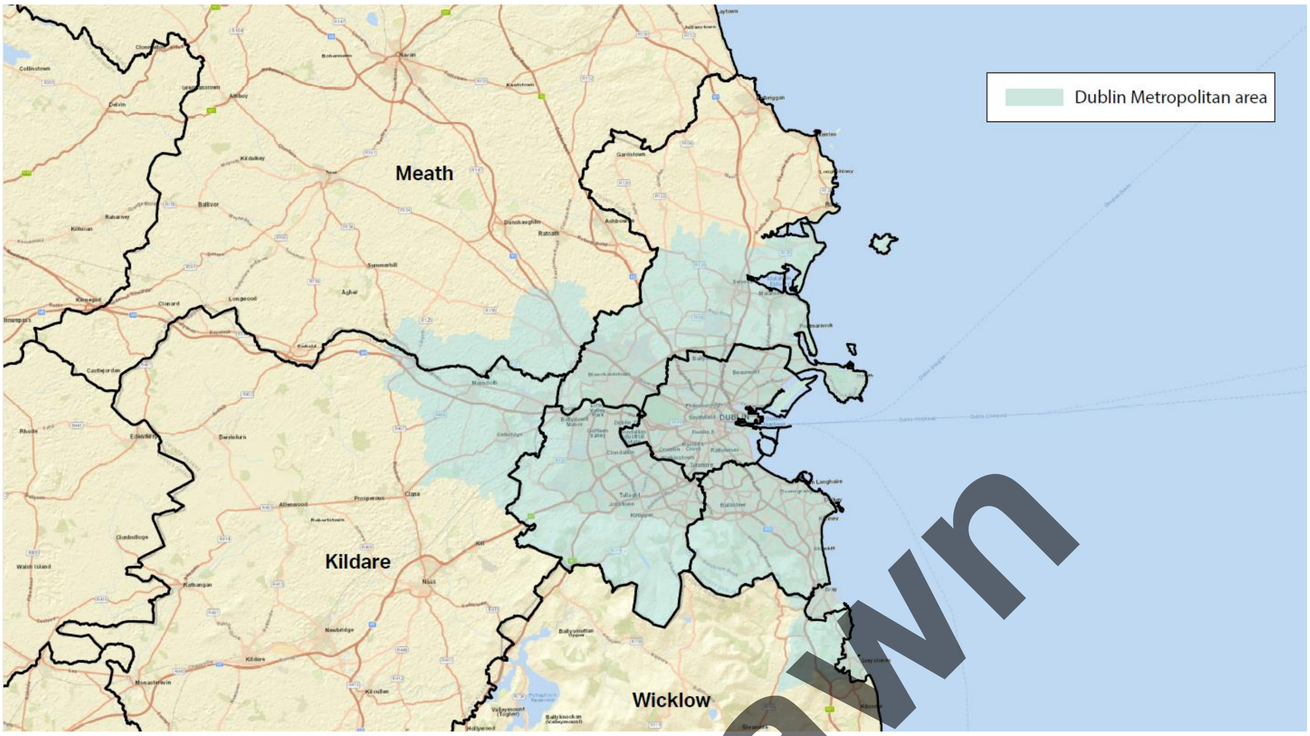


Figure 6.2: Cork Metropolitan Area

Figure 6.3: Limerick Metropolitan Area

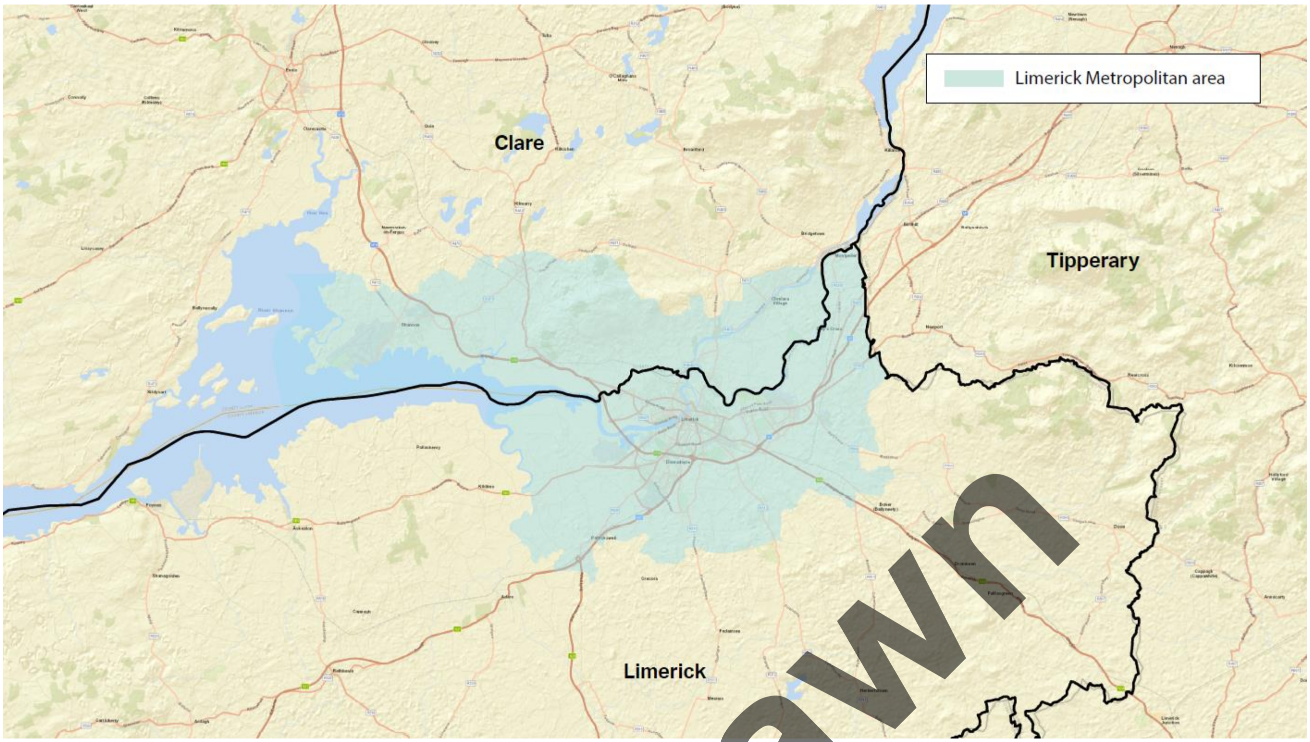


Figure 6.4: Galway Metropolitan Area

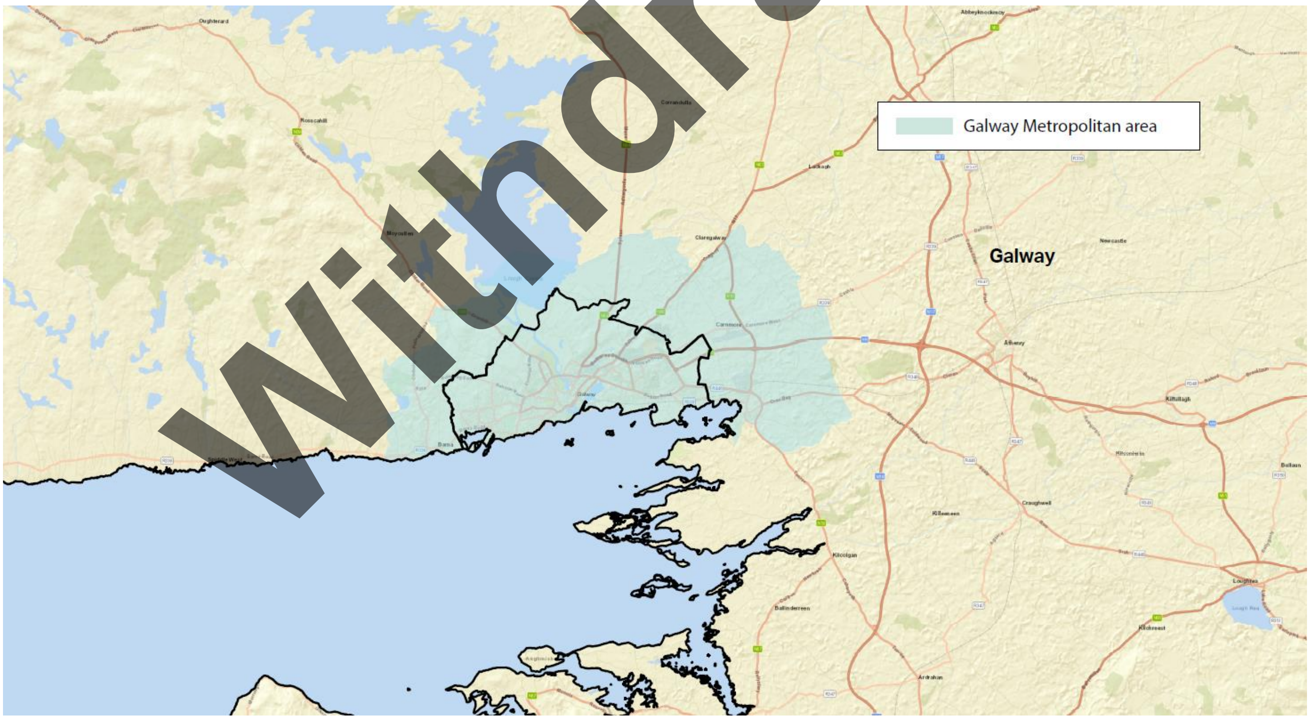


Figure 6.5: Waterford County Areas

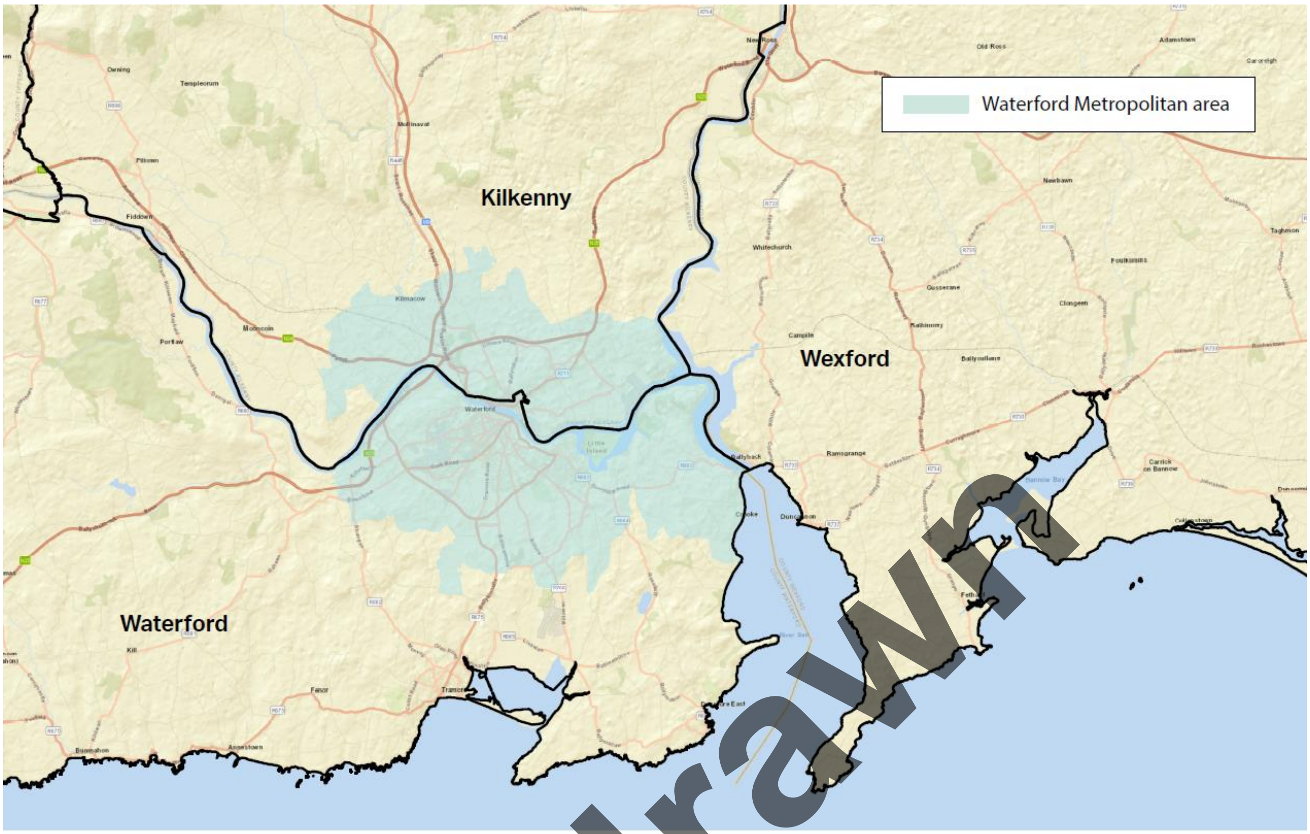


Table 6.1: Link-Based Growth Rates: Metropolitan Area Annual Growth Rates

Metropolitan Area	Low Sensitivity Growth Rates						Central Growth Rates						High Sensitivity Growth Rates					
	2016-2030		2030-2040		2040-2050		2016-2030		2030-2040		2040-2050		2016-2030		2030-2040		2040-2050	
	LV	HV	LV	HV	LV	HV	LV	HV	LV	HV	LV	HV	LV	HV	LV	HV	LV	HV
Dublin	1.0146	1.0280	1.0034	1.0116	1.0028	1.0144	1.0162	1.0295	1.0051	1.0136	1.0044	1.0162	1.0191	1.0328	1.0087	1.0172	1.0093	1.0256
Cork	1.0153	1.0279	1.0072	1.0128	1.0065	1.0164	1.0169	1.0294	1.0090	1.0149	1.0083	1.0182	1.0202	1.0328	1.0125	1.0185	1.0166	1.0276
Galway	1.0154	1.0201	1.0077	1.0164	1.0079	1.0203	1.0169	1.0217	1.0097	1.0182	1.0095	1.0220	1.0203	1.0250	1.0131	1.0217	1.0178	1.0313
Limerick	1.0158	1.0313	1.0052	1.0113	1.0050	1.0158	1.0174	1.0329	1.0070	1.0134	1.0069	1.0177	1.0218	1.0364	1.0106	1.0171	1.0146	1.0273
Waterford	1.0123	1.0301	1.0031	1.0131	1.0029	1.0175	1.0140	1.0317	1.0052	1.0153	1.0050	1.0194	1.0173	1.0352	1.0091	1.0194	1.0122	1.0300

Table 6.2: Link-Based Growth Rates: County Annual Growth Rates (excluding Metropolitan Area)

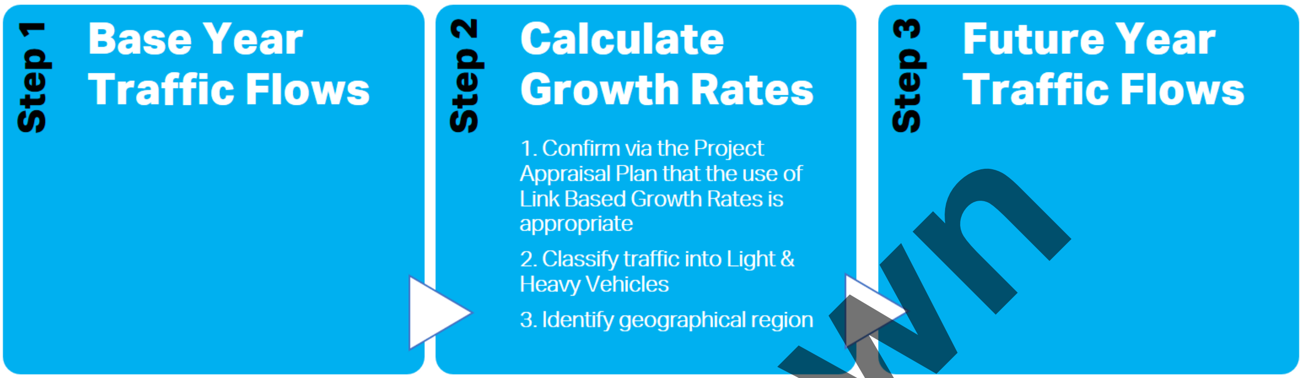
County	Low Sensitivity Growth Rates						Central Growth Rates						High Sensitivity Growth Rates					
	2016-2030		2030-2040		2040-2050		2016-2030		2030-2040		2040-2050		2016-2030		2030-2040		2040-2050	
	LV	HV	LV	HV	LV	HV	LV	HV	LV	HV	LV	HV	LV	HV	LV	HV	LV	HV
Dublin	1.0163	1.0303	1.0046	1.0123	1.0036	1.0143	1.0180	1.0317	1.0062	1.0139	1.0050	1.0158	1.0211	1.0348	1.0100	1.0170	1.0099	1.0250
Kildare	1.0180	1.0363	1.0044	1.0135	1.0035	1.0169	1.0197	1.0378	1.0062	1.0155	1.0053	1.0187	1.0229	1.0413	1.0098	1.0191	1.0107	1.0283
Laois	1.0130	1.0265	1.003	1.0105	1.0018	1.0136	1.0147	1.0280	1.0047	1.0125	1.0036	1.0155	1.0179	1.0314	1.0082	1.0160	1.0090	1.0248
Longford	1.0119	1.0298	1.0019	1.0104	1.0000	1.0138	1.0134	1.0313	1.0038	1.0124	1.0027	1.0157	1.0167	1.0347	1.0072	1.0161	1.0073	1.0256
Louth	1.0134	1.0347	1.0054	1.0153	1.0048	1.0180	1.0148	1.0363	1.0070	1.0174	1.0063	1.0198	1.0177	1.0397	1.0100	1.0211	1.0103	1.0295
Meath	1.0156	1.0349	1.0052	1.0164	1.0043	1.0189	1.0173	1.0365	1.0070	1.0186	1.0059	1.0207	1.0205	1.0400	1.0108	1.0226	1.0116	1.0304
Offlay	1.0103	1.0307	1.0021	1.0119	1.0014	1.0158	1.0118	1.0323	1.0042	1.0139	1.0033	1.0176	1.0152	1.0357	1.0081	1.0176	1.0100	1.0272
Westmeath	1.0145	1.0300	1.0042	1.0126	1.0033	1.0156	1.0161	1.0316	1.0062	1.0147	1.0053	1.0176	1.0194	1.0352	1.0101	1.0185	1.0100	1.0279
Wicklow	1.0140	1.0361	1.0033	1.0153	1.0029	1.0185	1.0157	1.0377	1.0051	1.0173	1.0047	1.0204	1.0189	1.0412	1.0091	1.0211	1.0110	1.0305
Cavan	1.0098	1.0295	1.0024	1.0108	1.0010	1.0140	1.0112	1.0311	1.0041	1.0127	1.0028	1.0158	1.0141	1.0345	1.0076	1.0164	1.0084	1.0256
Donegal	1.0097	1.0270	1.0024	1.0123	1.0017	1.0142	1.0111	1.0286	1.0039	1.0141	1.0035	1.0161	1.0139	1.0320	1.0072	1.0178	1.0094	1.0258
Galway	1.0243	1.0430	1.0087	1.0177	1.0088	1.0218	1.0259	1.0446	1.0109	1.0198	1.0105	1.0236	1.0294	1.0480	1.0148	1.0236	1.0181	1.0336
Leitrim	1.0044	1.0299	0.9973	1.0105	0.9927	1.0140	1.0060	1.0313	0.9990	1.0124	0.9971	1.0157	1.0090	1.0348	1.0025	1.0161	1.0029	1.0257
Mayo	1.0111	1.0314	1.0009	1.0128	1.0005	1.0173	1.0127	1.0330	1.0028	1.0148	1.0026	1.0192	1.0161	1.0364	1.0063	1.0186	1.0097	1.0290
Monaghan	1.0103	1.0236	1.0032	1.0093	1.0021	1.0119	1.0115	1.0252	1.0047	1.0112	1.0041	1.0138	1.0141	1.0285	1.0079	1.0147	1.0080	1.0234
Roscommon	1.0092	1.0267	1.0012	1.0115	1.0001	1.0152	1.0107	1.0284	1.0031	1.0135	1.0022	1.0172	1.0142	1.0318	1.0069	1.0174	1.0075	1.0270
Sligo	1.0133	1.0307	1.0028	1.0118	1.0018	1.0154	1.0147	1.0323	1.0045	1.0136	1.0041	1.0171	1.0178	1.0357	1.0082	1.0173	1.0107	1.0268
Carlow	1.0116	1.0309	1.0027	1.0124	1.0016	1.0161	1.0133	1.0324	1.0047	1.0144	1.0034	1.0178	1.0165	1.0359	1.0085	1.0180	1.0093	1.0275
Clare	1.0139	1.0402	1.0019	1.0138	1.0011	1.0179	1.0156	1.0417	1.0038	1.0157	1.0029	1.0197	1.0191	1.0451	1.0075	1.0193	1.0105	1.0292
Cork	1.0173	1.0361	1.0067	1.0141	1.0059	1.0181	1.0189	1.0377	1.0087	1.0160	1.0078	1.0200	1.0223	1.0411	1.0124	1.0197	1.0154	1.0297
Kerry	1.0094	1.0269	0.9990	1.0094	0.9983	1.0129	1.0111	1.0285	1.0011	1.0113	1.0000	1.0146	1.0144	1.0319	1.0048	1.0150	1.0079	1.0245
Kilkenny	1.0108	1.0253	1.0016	1.0109	1.0006	1.0147	1.0124	1.0268	1.0037	1.0129	1.0027	1.0166	1.0157	1.0302	1.0075	1.0166	1.0087	1.0261
Limerick	1.0199	1.0307	1.0071	1.0110	1.0069	1.0158	1.0215	1.0323	1.0092	1.0130	1.0088	1.0177	1.0249	1.0357	1.0129	1.0167	1.0163	1.0274
Tipperary	1.0102	1.0290	1.0019	1.0096	1.0008	1.0136	1.0119	1.0306	1.0037	1.0116	1.0027	1.0155	1.0152	1.0340	1.0073	1.0152	1.0084	1.0250
Waterford	1.0154	1.0342	1.0059	1.0157	1.0053	1.0203	1.0171	1.0358	1.0079	1.0179	1.0073	1.0220	1.0205	1.0393	1.0119	1.0218	1.0143	1.0319
Wexford	1.0051	1.0196	0.9999	1.0096	0.9989	1.0122	1.0068	1.0211	1.0022	1.0116	1.0006	1.0140	1.0100	1.0245	1.0060	1.0152	1.0077	1.0232

6.1 Applicability

The link-based growth rates set out in this section of the Unit should be used in Simple Models only. They should not be used to derive traffic growth in Assignment Models or Variable Demand Models, which require a separate method for future traffic growth projections, described in Section 7.

The application of link-based growth rates in simple models is given in Figure 6.6.

Figure 6.6: Application of National Traffic Growth Projections



For larger networks which straddle the defined geographical regions, it is acknowledged that the application of different growth rates to different elements of the network may lead to an imbalance in flows on the network. A process to addresses this issue should be set out in the Project Appraisal Plan and agreed with TII prior to the commencement of any modelling or scheme appraisal.

Due to the extended time horizon, traffic growth rates are only provided up to 2050. For the purposes of scheme appraisal, no traffic growth beyond 2050 should be assumed unless specifically agreed with TII. Exceptions to this approach may include longer term schemes for which a significant proportion of the 30 year appraisal period is post 2050.

7. Zone-Based Growth Rates

For larger schemes which are supported by assignment models, demand is input in the form of a matrix which allocates demand based on defined trips between geographical zones. In such cases, growth rates should be applied as increases in trip ends at a zonal level. The factoring of origins and destinations at a zonal level leads to the definition of target trip ends. This is then translated into a future year matrix through furnessing, which adjusts the demand matrix such that row and column totals match the target trip ends.

7.1 Internal Zones

Application of zone-based growth rates requires a different approach for internal and external zones within the Local Area Model (LAM). For internal zones, trip end growth rates for the AM, PM and Inter Peak Periods is read from a shapefile that is available from the Downloads page on the TII Publications website. These growth rates are applied to the row and column totals of the base year trip matrix to produce target trip ends for the future year matrix.

The shapefile provides demographic and economic information for each zone in the NTpM, in addition to annual growth rates for origin and destination trip ends. The shapefile uses a standard naming convention to identify all variables in the data. A description of this data is provided below in Table 7.1.

Table 7.1: Schedule of Data Contained in NTpM Shapefile

Category	Parameter	Description
Demographic	Pop/Emp/CO	Population/Employment/Car Ownership
	16/30/40/50	Applicable Year (2016/2030/2040/2050)
	L/C/H	Scenario (Low/Central/High)
Growth Factors	AM/IP/PM	Period of Assessment
	L/H	Vehicle Class (Light/Heavy)
	1/2/3	Period of Growth – (1 denotes 2016 to 2030, 2 denotes 2030 to 2040 and 3 denotes 2040 to 2050)
	O/D	Origin /Destination Trip End Factor
	L/C/H	Scenario (Low/Central/High)

Example 1		
Demographic	Emp_30C	Employment projection in 2030 for Central Growth Scenario

Example 2		
Demographic	CO_16	Car Ownership in 2016

Example 3		
Growth Factor	PML_1_OL	PM Peak period growth factor for Light Vehicles during period 2016-2030. Applies to Origin Trip Ends for Low Growth Scenario

Example 4		
Growth Factor	AMH_2_DC	AM Peak period growth factor for Heavy Vehicles during period 2030-2040. Applies to Destination Trip Ends for Central Growth Scenario

This information is contained within the downloadable file PAG Unit 5.3_NTpM Zone-Based Growth Rates.xlsx available from the “Downloads” section of the TII Publications website under section PE-PAG-02017_Unit-5.3.

For LAM's where internal zones are smaller than NTpM zones, the growth rates for the NTpM should initially be applied to all LAM zones within that NTpM zone. It is for this reason that it is advisable to ensure that LAM zones are defined as subzones of NTpM zones to avoid any overlapping of LAM zones between adjacent NTpM zones.

Within the LAM, there is some flexibility to reallocate growth between different LAM zones within a single NTpM zone, although the trip end growth for the collective LAM zones that form the NTpM zone should remain consistent with the zone-based trip end growth rates. For example, it may be possible to use County Development Plans/Local Area Plans to allocate/distribute the growth based on the locations of future zoned land for residential, industrial/office park developments, etc. These approaches should be well documented and are valid as long as the distributed growth within the LAM zones is constrained by the overall growth in the NTpM zone.

The projections provided in this PAG Unit are in the form of annual average trip end growth rates. This facilitates flexibility in their application for various scheme opening, design and forecast years. It must be remembered that these are derived from long term projections over a 14 – 34 year period. Therefore, they are not appropriate for use for short term projections, e.g. 1-5 years, nor should they be directly compared to observed growth rates in the short term. In reality, changes in traffic volumes over a short term period may be substantially higher or lower than these growth rates. However, allowing for economic cycles over the long term, where traffic volumes can rapidly grow but also decline year on year, the figures are a reasonable representation of the projected average annual growth over the appropriate period in question, i.e. 2016 to 2030, 2030 to 2040 and 2040 to 2050.

7.2 External Zones

A cordon reflecting the boundary of the LAM is extracted from the Base Year (2013) and Future Year (2030) NTpM. The resulting growth factor is annualised, and then applied to the external zones in the LAM over the appropriate period. The same procedure is applied to both the 2040 and 2050 NTpM, comparing it to the 2030 cordon, to establish growth in external zones beyond 2030.

7.3 Special Zones

The application of growth to special zones should be detailed in the Project Appraisal Plan (PAP) and agreed with the TII Strategic & Transport Planning Section prior to the commencement of modelling/appraisal of a National Road scheme.

7.4 Future Year Demand Matrices

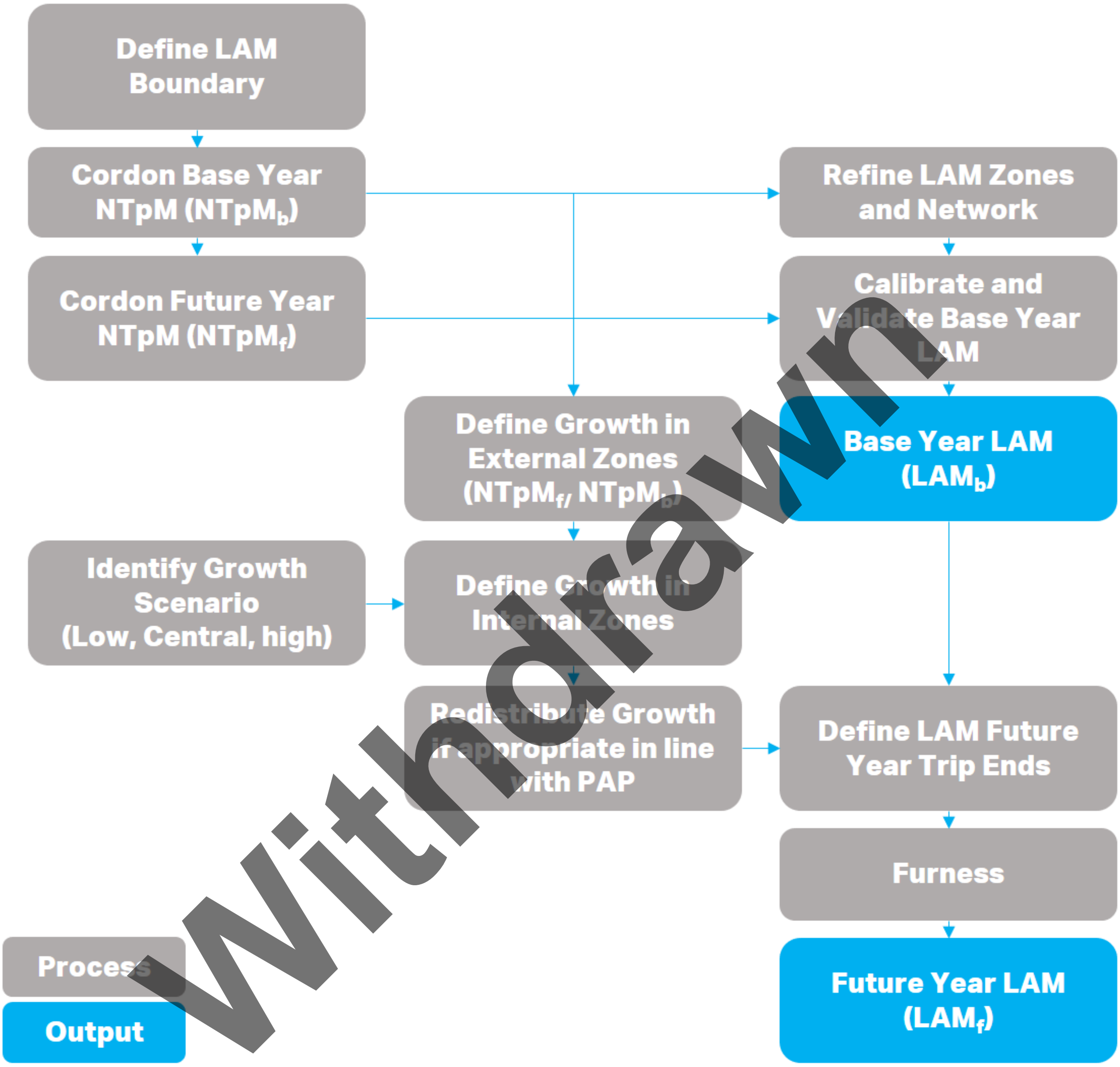
Once new trip end totals for each LAM zone (internal and external) have been developed, the future year trip matrix can then be derived via the 'Furness' trip distribution method, which manipulates matrix cells to match defined row and column totals. In undertaking this process, seeding of zero cells may be required using either a gravity modelling technique or through the application of distribution from an adjacent zone with similar travel patterns.

During the trip distribution process, the matrix totals must be constrained to the NTpM trip ends. Even where it is appropriate to include the impact of known developments in particular zones and where a gravity model or the adjacent zone technique is used. The total number of trips within the local matrices must be constrained to the NTpM totals for the same area.

Any assumptions about the nature and location of specific developments should be clearly explained in the Transport Modelling Report and a rationale provided for their inclusion. The resulting impact on growth factors for the remaining zones within the model should also be reported and any unexpected results explained.

The process for developing future traffic growth projections is presented in Figure 7.1. The National Traffic Model is the traffic module of the NTpM and is used to provide the relevant outputs for the LAM.

Figure 7.1: Traffic Growth Projection Methodology for Assignment Models



An analysis of the impact of the Furness Method on trip length distribution should be undertaken and reported in the Transport Modelling Report. The report should also demonstrate the difference in net growth that occurs as a result of the furnessing procedure, both at zonal level and through the full LAM matrix. Further details are provided in PAG Unit 5.1: Construction of Transport Models.

Variable Demand Models will use zone-based growth rates to produce the initial demand projections for the Do-Minimum and Do-Something scenarios in the future year model. VDM techniques can then be used to adjust the demand matrices to reflect the demand responses associated with the scheme proposal.

The application of growth to other travel modes requires projections for public transport growth to develop a future year Production Attraction (PA) matrix. Further guidance on the preparation of growth projections for use in multi-modal models should be sought from TII.

8. Application to Economic Appraisal

One of the main uses of traffic growth projections in Local Area Models is for the calculation of costs and benefits over the lifetime of the proposal and the calculation of the design parameters for the proposal. Cost and benefit calculations are used to derive the value for money a proposal may have when compared with other ways in which investment funding could be utilised. PAG Unit 6.1: Guidance on Conducting CBA provides guidance on the need for and use of cost-benefit analysis for road schemes.

The current methodology for assessing the costs and benefits set out in these Units requires the use of TUBA (Transport User Benefit Analysis) to calculate the Net Present Value (NPV) and Benefit to Cost Ratio (BCR) of the proposed scheme. TUBA is supplemented by COBALT (Cost and Benefit to Accidents – Light Touch) which provides estimates in relation to safety benefits. Both TUBA and COBALT use outputs taken directly from the transport model as their basis.

Further guidance on economic appraisal is provided in PAG Unit 6.1: Guidance on Conducting CBA.

9. Uncertainty in Travel Demand Projections

9.1 Overview

Making future projections over an extended time period is highly uncertain. The accuracy of the central growth scenario projections depends on the explicit projections of population, settlement patterns, employment and job location. In addition, the model incorporates a large number of implicit assumptions about the performance of the transport network and vehicles, the costs of travel, personal tastes and preferences and all of the other factors that actually determine individual decisions about travel behaviour.

Even though the assumptions in the central growth scenario should be unbiased, there is no guarantee that outturn real-world results will be the same as the forecasts in the central growth scenario. This creates risks that:

- the benefits of the transport scheme will not be as high as the forecast suggests, leading to an intervention that is either unnecessary or represents poor value for money; and / or
- the benefits of the transport scheme are higher than the forecast suggests, leading to failure to intervene where necessary; and / or
- the problems created by the transport scheme will be greater than the forecast suggests; and / or
- a cheaper investment than the one actually implemented would have been sufficient to achieve the objectives.

There are two sources of forecast error: uncertainty in the inputs (such as the location of development and/or scale of growth) and error in the model parameters and specification (how these inputs propagate through the model). The scheme promoter should summarise all known assumptions and uncertainties in the modelling and forecasting approach when assessing the need for, and development of, alternative scenarios. These alternative scenarios are used to understand the possible impact of an error in assumptions on the model forecasts.

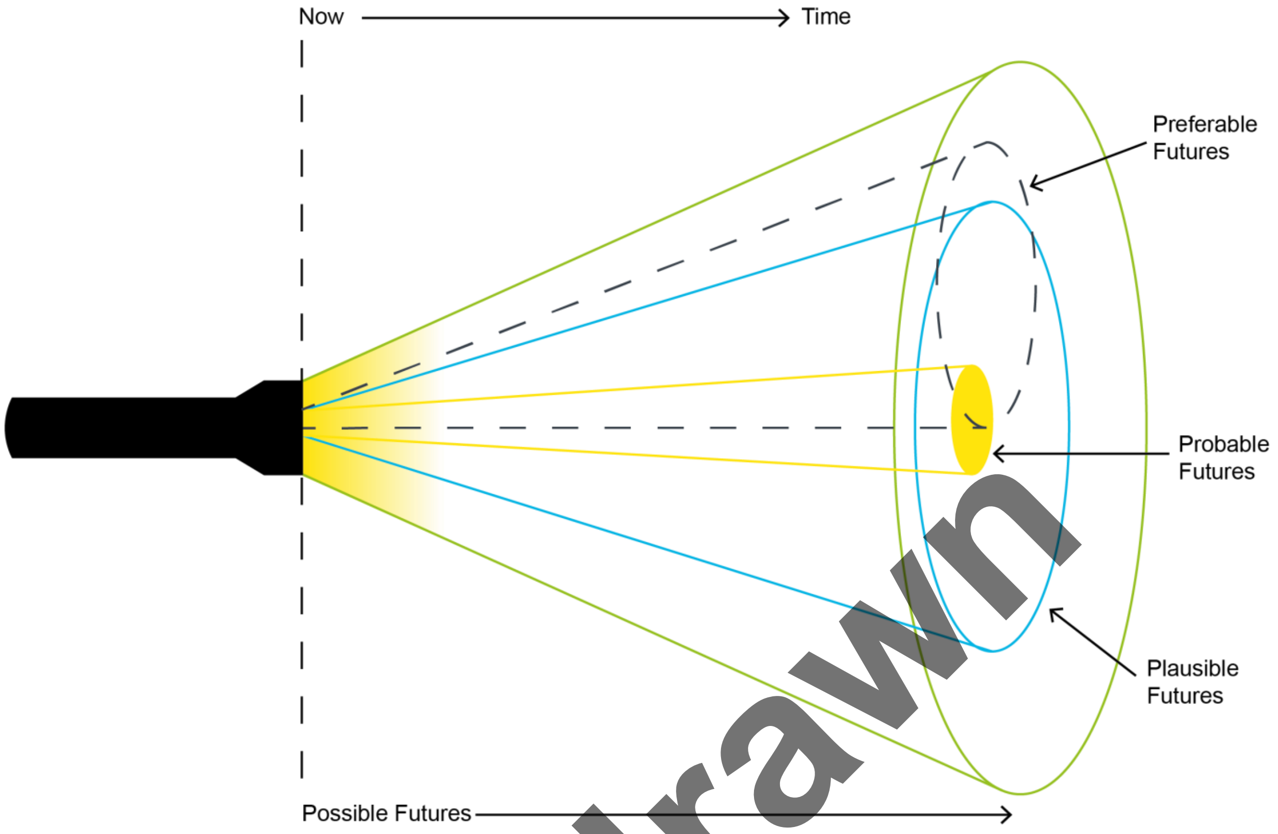
Decision-makers need to understand these risks and what impact this may have on the analysis, so it is important for the scheme promoter to communicate them well and quantify them if proportionate. Given the complexity of interactions between demand and supply in transport systems, the best way to quantify these risks is to use scenarios. The purpose of the scenarios is to ensure decisions taken are sufficiently robust to respond to various futures and operating environments. Scenario development addresses our inability to predict the future. Different assumptions can be tested using scenarios, and these changes re-run through the model to answer questions associated with answering 'Where are we heading?' and 'How do we get there? '

9.2 Definition of Alternative Scenarios

The planning and design of the National Roads network requires consideration of the future context in which these roads will be used. The design of any scheme must use a set of projections which ensure that the National Roads network is fit for purpose in 30+ years' time.

Figure 9.1 illustrates how the uncertainty around forecasting increases over time.

Figure 9.1. Uncertainly of Forecasts

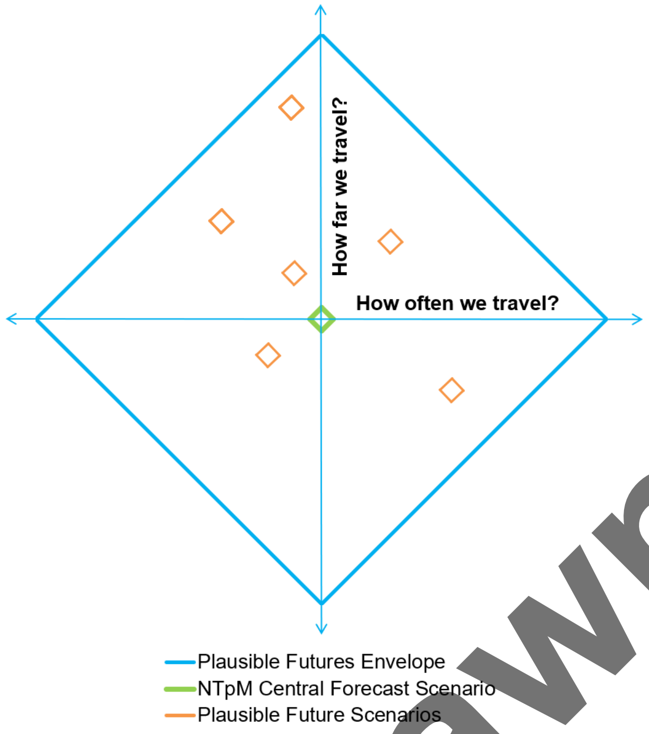


The central growth scenario within the NTpM represents the best forecast that is currently possible of transport activity on the National Roads network in 2030, 2040 and 2050.

The accuracy of this central growth scenario depends on the explicit forecasts of population, settlement patterns, employment and job location. In addition, the model incorporates a large number of implicit assumptions about the performance of the transport network and vehicles, the costs of travel, personal tastes and preferences and all of the other factors that actually determine individual decisions about travel behaviour.

To use the terms of Figure 9.1, the range of plausible futures around the central probable forecast (produced by the NTpM) is extremely large. However, it is possible to devise a set of scenarios covering other plausible futures and allow scheme promoters to develop plans and designs that are sufficiently “future proofed”. The approach aims to develop an ‘envelope’ of plausible change (as per Figure 9.2) to increase the likelihood that the actual 2030/2040/2050 future scenario, in terms of trip demand and patterns, falls within the ‘envelope’ ensuring the long term relevance of the scheme.

Figure 9.2. Conceptual Envelope of Plausibility



Values conceptual only

These possible scenarios are based on the following principles:

- **Accelerated or decelerated growth** – A situation where traffic grows faster or slower than is predicted in the central growth scenario, but the distribution of traffic around the road network is substantially the same.
  - For example, if population and the economy grow faster than expected (and this faster growth is distributed according to the NPF predictions) the road network could reach the state predicted for 2040 by 2035 or 2030.
  - This would not make schemes based on the central forecast invalid – they would remain completely appropriate, but may have to be implemented, maintained or upgraded faster than was originally planned.
- **Diverse traffic distribution** – Schemes need to be “future proofed” against situations where road travel develops in an unexpected way that changes the distribution of traffic around the network. This could happen in a large number of ways, but in all cases the issue for scheme promoters is that traffic will be distributed differently around the National Roads network.
- **Boundary of extremes** – Scenarios should define the boundaries of the set of plausible futures. A scenario is not a forecast of a specific future that is likely to transpire, rather it represents the effects of where a trend (or trends) developed differently from that which is currently expected. A scheme adapted for the extremes of trends will be adaptable to any range of plausible futures that actually emerges.
  - For example, scenarios might cover the extremes such as very high energy prices (costs of travel), where home working is commonplace (very low need for travel) or spatial or temporal travel restrictions are in place (congestion charging or tolling).

With these principles in mind, a number of scenarios have been developed to explore two key variables of future travel:

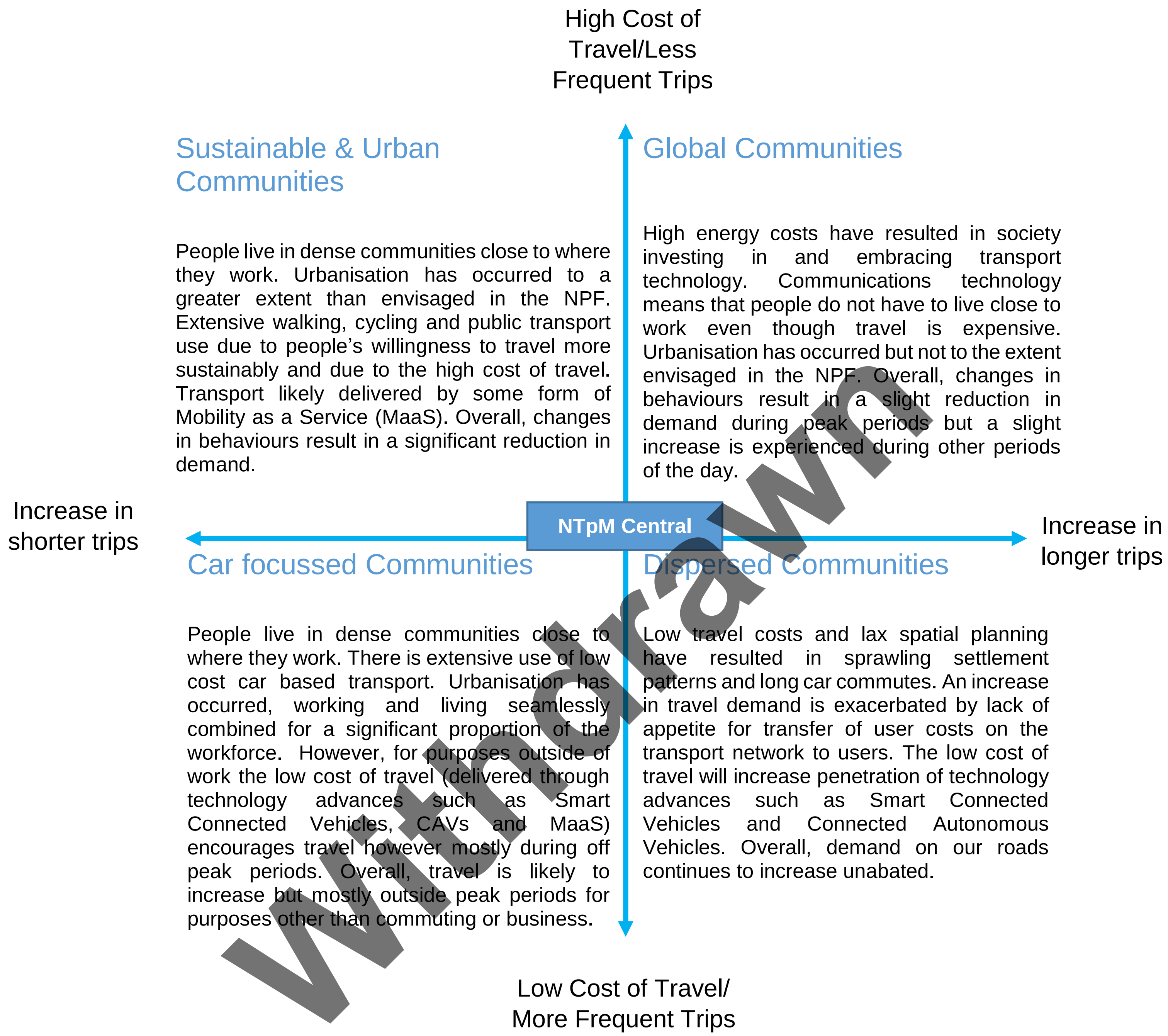
- **Journey length** - Unexpected technology changes, changes in traveller preferences or changes in settlement patterns result in journeys being significantly longer or shorter than is predicted in the central growth scenario. For example, increased population could lead to expanding cities and widespread long distance commuting. Alternatively, a combination of spatial planning and changing preferences could lead to many more people living in dense population centres where they are close to their place of work and all of their leisure and social destinations.
- **Journey cost / frequency –** Technology changes, changes in energy costs or changes in traveller preferences could lead to many more or many fewer journeys than are predicted in the central growth scenario. At one extreme, widespread adoption of connected and/or autonomous vehicles (CAVs) running on cheap electricity, and available at the touch of a smart phone, could slash the generalised cost of making a car journey and increase the potential number of motorists. This would lead to a much larger number of relatively short journeys than is currently predicted. At the opposite extreme, low adoption of CAVs and prohibitive taxes/tolls on fuel and private transport could lead to a higher generalised cost of car journeys and a much lower number of car journeys than is currently predicted.

Four sample scenarios have been devised based on these two variable "axes" (journey length and journey cost/frequency). The four sample scenarios represent the limits of plausible deviations (boundary of extremes) from the central growth scenario.

These four scenarios portray a society that is developing in one of the following directions:

1. **Sustainable & Urban Communities:** Individual motorised transport is an old-fashioned luxury good. People live in densely populated towns and cities and make maximum use of sustainable modes in the cities and public transport between the cities.
2. **Global Communities**: Technology means that location is not relevant for economic activity. People chose where to live based on their preferred lifestyle which reduces commuting related travel demand. Long trips are taken for cultural or personal reasons.
3. **Dispersed Communities**: People live in sprawling settlements and rely on individual motorised transport. Many journeys are long due to the sheer size of the suburbs and exurbs. Journeys are frequent as sustainable modes are not practical and public transport is difficult to provide.
4. **Car focussed Communities**: People live in densely populated towns and cities and make frequent use of individual motorised transport to travel around these settlements.

Figure 9.3. Future Scenarios



9.3 Assessment of Alternative Scenarios

It is the responsibility of scheme promotors to assess how alternative scenarios may impact on their scheme and take the necessary steps to identify what these scenarios may be. Once identified the potential impacts must be assessed through setting the extents of the boundaries of plausible futures. In terms of quantifying how these scenarios might impact on the road network predictions for the vehicle kilometre travelled (vkm) impact for each scenario should be developed taking cognisance of historical trends and case studies.

The alternative scenarios are additional to the TII PAG low, central and high projections used for base case appraisal and sensitivity analysis. Scheme promoters must ensure a robust appraisal is undertaken to the satisfaction of the TII Strategic & Transport Planning Section. Assistance can be provided by TII in order to incorporate one of these alternative scenarios into scheme appraisal as required.

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