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An Roinn Iompair
Department of Transport

Speed Limit Review 2023

Modelling Assessment Report

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This report has been prepared by AECOM Consultants on behalf of the Department of Transport, Transport Infrastructure Ireland and the National Transport Authority.
A peer review of this report has been undertaken by Prof. Brian Caulfield, Trinity College Dublin.

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Executive Summary

Overview

The Department of Transport (DoT) is investigating potential speed limit reductions that may be implemented on the Irish road network to support the Government's Road Safety Strategy. The Strategy has a long-term goal aimed at eradicating road traffic deaths and serious injuries on Irish roads by 2050 and reducing road deaths and serious injuries by 50% by 2030.

To assist the DoT, Transport Infrastructure Ireland (TII) and the National Transport Authority (NTA) were requested to assess and consider a range of potential speed limit reduction scenarios, in relation to their safety, Greenhouse Gas (GHG) emissions and travel time impacts.

As part of the assessment, TII has considered the potential impacts in relation to rural roads (i.e. greater than or equal to 60kph speed limit), while the NTA has considered urban road impacts (i.e. roads with a speed limit equal to or below 60kph). This report provides the detail of the assessments undertaken by TII and the NTA and the conclusions arising from the assessment.

It is intended that the conclusions of this assessment, which form part of a wider consideration of the potential impacts of speed limit reductions, will help to inform and provide context in terms of the DoT decision making process.

International Studies

As part of the assessment, a literature review of several international studies on the impact of reducing speed limits in terms of safety, environment and economy was undertaken. In summary, the literature review found that:

- **Safety -** The implementation of speed limit reductions resulted in significant safety benefits. However, it is noted that several of these studies looked at individual roads or corridors in isolation and did not consider the potential impacts of drivers re-routing to other roads
- **Environmental** - In terms of environmental (i.e. GHG emissions) impacts, the review provided mixed results. The studies which analysed observed data (as opposed to theorised or modelled outcomes) generally found that any positive environmental impacts were minimal or statistically insignificant
- **Economic** - Economic (i.e. travel time) impacts arising from the studies were also found to be mixed. The majority of studies reported negative economic impacts resulting from the increased journey times, which outweighed any monetised benefits seen from safety and GHG emissions savings from a Cost Benefit Analysis perspective

Previous TII Analysis

Previous analysis undertaken by TII in March 2022, which solely focused on the potential impacts associated with speed limit reductions on the strategic National Roads network only, indicated that there could be an overall net negative impact on road safety if only specific sections of the road network are targeted.

Under that analysis it was found that traffic re-routing away from higher safety standard roads such as motorways or dual carriageway to lower safety standard road such as regional roads may have an overall net negative safety impact. The assessment found that the higher the speed limit reduction applied to National Roads, the higher the potential for increased road collisions across the road network.

Following the March 2022 report, it was agreed with the DoT that the appropriate next step was to extend the speed limit reduction impact assessment to all roads, both rural and urban. A summary of the progression of the Speed Limit Impact Assessment to date is presented in Figure A.

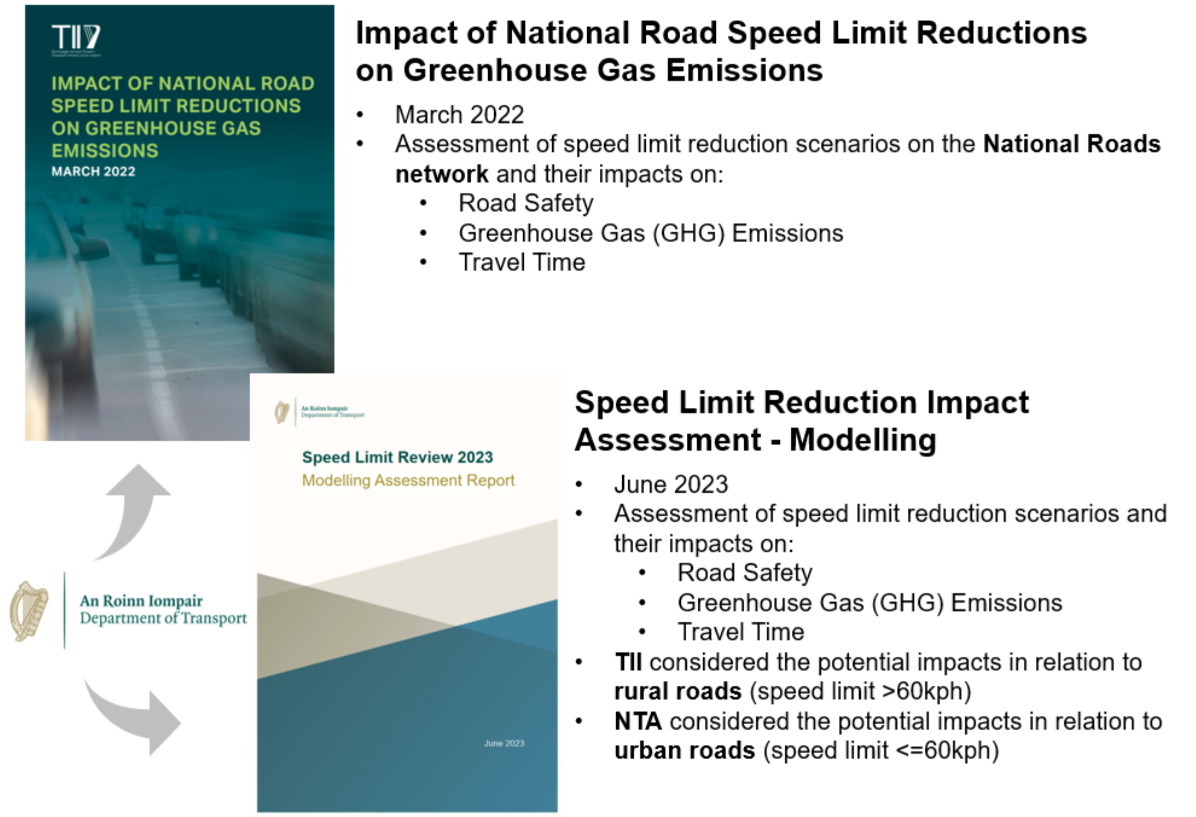

Figure A Progression of Speed Limit Reduction Assessments

Approach to Current Analysis

The current assessment summarised in this report, utilised several existing transport modelling and appraisal tools to simulate the behavioural responses of drivers to changes in speed limits and the associated impacts on safety, GHG emissions and travel time. The assessment focused on existing travel demand, travel patterns and vehicle fleets in Ireland, to provide a consistent and evidenced baseline against which a range of different speed limit reduction scenarios could be assessed.

These modelling tools allowed for the re-routing and variable demand responses (e.g. induced demand, change in travel mode) to a range of different speed limit reduction scenarios to be considered. Thereby, for example, allowing the potential impacts of drivers re-routing to quicker but lower quality roads (e.g. less safer routes) or changes in mode share to be taken into consideration as part of the assessment.

Findings of Modelling Assessment

The findings of the modelling assessment are in line with the international studies, demonstrating clear positive safety impacts, limited or negligible GHG emissions impacts and negative travel time impacts.

In summary, the results of this modelling analysis in relation to **Rural Roads** suggest that:

- The blanket approach scenarios (i.e. reductions applied across the road network) considered as part of this assessment, indicate that an approach which focuses on reducing speeds across all rural single carriageway roads, may have the best overall safety outcome. This is on the basis of maintaining and/or increasing traffic levels on the safest sections of roads in Ireland (i.e. motorways and dual carriageways) while also improving road safety across the rural single carriageway road network through lower speeds

- The implementation of a blanket approach however may be challenging, in particular in terms of compliance and enforcement. Expert judgement by road safety and enforcement authorities would indicate that compliance with speed limits, in particular on engineered roads which are designed for higher speeds, may be challenging in terms of public perception and buy-in

- The targeted scenarios suggested by DoT for consideration as part of this assessment (i.e. lowering speeds on particular road types) have the potential to lead to an overall net increase in distance travelled across the rural road network. This is due to drivers re-routing to find the quickest route between their origin and destination. The assessment indicates that this increase in distance travelled generally occurs on other sections of the single carriageway road network. While safety may improve on the targeted sections, this may be offset by increases in travel on less safe roads. Therefore, the overall network safety impacts may be somewhat limited

- The implementation of a targeted scenario should therefore seek to minimise the re-routing of traffic away from the safest roads in Ireland (e.g. motorways and dual carriageways). An optimal scenario, in terms of road safety, would focus on reducing speeds on undivided roads such as Local, Regional or National Secondary roads
- The potential impacts of the speed limit reduction scenarios on GHG emissions are limited. The net change in GHG emissions is considered to be negligible for the majority of the scenarios tested. In addition, scenarios which may have a limited positive impact if implemented in the short term would see these benefits diminish over time as the vehicle fleet transitions towards electrification
- All scenarios considered would increase journey times for road users

The full impacts of speed limit reductions on rural Local (non-national) roads have not been explicitly modelled as part of this assessment, due to the limitations of the available analysis tools. Therefore, the analysis of potential impacts on Local Roads in this assessment relied on available research in this area. The findings of this research, combined with the high-level modelling analysis, indicates the lowering the existing speed limit of 80kph to 60kph on rural Local Roads would have a positive safety impact overall.

In summary, the results of this modelling analysis in relation to **Urban Roads** suggest that:

- Reduced speed limits have the potential to improve road safety in both towns and cities, with a large increase in distance travelled at slower speeds and a corresponding reduction in distance travelled at faster speeds of 50kph and above
- Reduced speed limits have the potential to cause a modest reduction in car use within cities. However, a similar mode shift in smaller towns and villages is unlikely with the modelling results indicating less potential for mode shift from car following the introduction of the proposals
- GHG emission modelling suggests that the net impact on emissions will be negligible in both towns and cities. In cities, a small reduction in modelled car emissions was observed as a result of a reduction in car trips. However, this reduction may be offset by increased emissions from HGVs and Buses whose Internal Combustion Engines are less efficient at 30kph than 50kph. Emission results for towns suggest that the proposals will result in very minor increases in carbon emissions for all vehicles
- Reduced speed limits may lead to re-routing of traffic away from roads where reduced speed limits are implemented. In some instances, this may result in more traffic travelling on more suitable roads from a safety perspective. However, in some instances this may result in more traffic on less suitable, local and residential, roads

Summary & Conclusions

The modelling assessment suggests that reducing speed limits, whether in the context of rural or urban roads, has the potential to have a **positive safety impact overall**, which is in line with international studies. As outlined previously, certain approaches to reducing speed limits may lead to traffic re-routing to lower safety standard roads which may have a negative impact at a local level. Therefore, the implementation of speed limit reduction measures should consider the need to maintain traffic travelling on the safest and most appropriate routes.

From a GHG emissions perspective, the assessment suggests that the impacts would be **marginal overall and would diminish over time** as the national vehicle fleet transitions towards electrification and improved vehicle technology. At a local level there may be specific corridors or areas where a targeted speed limit reduction change could be implemented which may see a GHG emissions benefit.

In terms of travel time impacts, reducing speeds limits will lead to an increase in travel time for all vehicles which will lead to **an overall negative impact.**

The conclusions arising from the modelling assessment, which are broadly in line with international studies, form part of a wider consideration of the potential impacts of speed limit reductions undertaken by the DoT and therefore should not be considered in isolation.

1. Introduction

1.1 Overview

The Department of Transport (DoT) is investigating potential speed limit reductions that may be implemented on the Irish road network to support the Governments Road Safety Strategy[1]. The Strategy has a long-term goal aimed at eradicating road traffic deaths and serious injuries on Irish roads by 2050 and reducing road deaths and serious injuries by 50% by 2030.

To assist the DoT, Transport Infrastructure Ireland (TII) and the National Transport Authority (NTA) were requested to assess and consider a range of speed limit scenarios for rural and urban roads respectively, in relation to their potential safety, Greenhouse Gas (GHG) emissions and travel time impacts.

This note explores several international studies in relation to speed limit reductions which have been implemented or modelled elsewhere to provide context in relation to the potential impacts. It provides details of the modelling undertaken as part of this assessment and summarises the findings of a range of different modelled speed limit reduction scenarios considered in relation to both rural and urban roads.

For this assessment, rural roads are defined by speed limit, where all roads with a speed limit higher than 60kph located outside of built-up areas are considered as rural roads. To assess speed limit reductions in urban areas, 30 kph or 50 kph speed limits were assigned to roads within defined urban boundaries. The higher speed limit was applied to key radial routes and routes which facilitate strategic movements, with low levels of pedestrians and cycle activity, all other routes within urban boundaries were allocated a speed limit of 30 kph.

It is intended that the outputs of this modelling exercise, which forms part of a wider consideration of the potential impacts of speed limit reductions, will help to inform and provide context in terms of the DoT decision making process. The outputs are not intended to be the sole basis on which policy decisions are made in relation to speed limit proposals.

1.2 Background

In March 2022, TII published an assessment on the 'Impacts of National Road Speed Limit Reductions on Greenhouse Gas Emissions'[2]. This note focused on the potential impacts associated with speed limit reductions on National Roads only, as instructed by the DoT. The focus of the note was the quantification of GHG emission changes associated with speed limit reductions, while also outlining possible road safety and travel time impacts.

The analysis showed that lowering of speed limits on National Roads alone could provide some reductions in the levels of emissions, however there could be a negative impact on road safety. This was brought about by a portion of traffic avoiding the higher quality and safer standard roads (e.g. motorways and dual carriageways) in favour of more direct but less safe routes (e.g. regional roads). It was suggested by TII that the reduction of congestion in urban areas could yield more favourable results given the higher level of emissions associated with slower moving vehicles.

Following the March 2022 report, it was agreed with the DoT that the appropriate next step was to extend the speed limit reduction impact assessment to all roads, both rural and urban.

The main difference in approach between this assessment and the March 2022 assessment, is that the speed limit reductions scenarios are not solely focused on rural National Roads, but instead consider the entire Irish road network.

[1] Road Safety Strategy 2021-2030 - Our Journey Towards Vision Zero

[2] https://www.tii.ie/tii-library/strategic-planning/transport-research-and-information-notes(trins)/Impact-of-National-Road-Speed-Limit-Reductions-on-Greenhouse-Gas-Emissions.pdf

1.3 Irish Road Network

The entire Irish road network is over 99,000 km in length and is classified into three main categories:

- National Roads Network (NRN)[3], covering approximately 5,300km (approx. 5% of the Irish road network). This includes 1,000km of Motorway, 330km of Dual Carriageway and 3,970km of Single carriageway roads
- Regional Roads, covering 13,000km (approx. 13% of the Irish road network)
- Local Roads[4], covering over 81,000 km (approx. 81% of the Irish road network)

Rural or urban roads may form part of the National, Regional or Local Road network. Although the National Roads Network only forms a small proportion of the overall road network length in Ireland, it is estimated to facilitate approximately **45% of all vehicle kilometres travelled on the entire Irish road network**.

Divided roads (e.g. Motorways and Dual Carriageways) or undivided roads (e.g. single carriageways) on the Irish road network may form part of either the National Primary, National Secondary or Regional Road network. The current legal posted speed limits on Irish roads are set out in Table 1.1 for both general traffic (Cars & Light Goods Vehicles (LGV)) and Heavy Goods Vehicles (HGV).

Table 1.1. Default Speed Limits in Ireland

Irish Road Network	Rural Roads		Urban Roads (General & HGV)
	General Traffic (Cars & LGVs)	Heavy Goods Vehicles	
Motorways[5] - Divided	120kph	90kph	N/A
National Primary / Secondary Roads – Divided	100kph	80kph	50kph – 60kph
National Primary/Secondary Roads – Undivided	100kph	80kph	50kph – 60kph
Regional and Local Roads	80kph	80kph	30kph – 60kph

There are several ‘former’ National roads that changed classification from National to Regional Road, due to the opening of new sections of National Roads over the years. However their speed limit was not changed in some locations and is still 100kph. An example of this is the ‘former N8’ which was reclassified as a Regional Road (R639) when the M8 opened, but still maintains a speed limit of 100kph.

1.3.1 Road Safety Context (Fatal and Serious Collisions) - Irish Road Network

The average number of fatal and serious collisions over the 3-year period between 2017 and 2019[6], across the Irish road network was 144 and 1,259 respectively. This 3-year period is the baseline used by the Road Safety Authority (RSA) in line with the Road Infrastructure Safety Management (RISM) Directive.

Of these, 53 fatalities (37%) and 299 serious injuries (24%) resulted from collisions which occurred on the National Roads network, as summarised in Table 1.2. The remaining 91 fatal (63%) and 960 serious (76%) collisions occurred on Local and Regional roads. As noted previously, while the National Road

[3] Transport Infrastructure Ireland National Roads Network Indicators 2021
[4] Central Statistics Office (CSO) UN Sustainable Development Goal indicators
[5] There are a number of variations to the speed limits on Motorways such as sections of the M50 (100kph) and Dublin Tunnel (80kph).
[6] Baseline for RSA Vision Zero - Ireland’s Government Road Safety Strategy 2021 - 2030

network carries approximately 45% of all vehicle kilometres travelled (VKMT), it accounts for 25% of all fatal/serious collisions.

Table 1.2. Baseline (2018) Irish Road Network Fatalities, Serious Injuries and Annual VKMT

Road Network	Fatalities (%)	Serious Injuries	% Annual VKMT	Proportion of Fatal / Serious Collisions
National Roads	53 (37%)	299 (24%)	45%	25%
Local & Regional Roads	91 (63%)	960 (76%)	55%	75%
Total	**144 (100%)**	**1,259 (100%)**	**100%**	**100%**

1.4 Modelled Scenarios

The DoT requested that a range of **Rural Road** speed limit reduction scenarios be assessed. The objective of the assessment for rural roads was not to compare the scenarios to select a ‘preferred’ scenario, but instead to consider the potential impacts that may arise, in order for the DoT to make informed decisions considering this assessment and other inputs into the Speed Limit Review.

To simplify the analysis, the 7 rural road scenarios identified by the DoT were grouped into two specific categories:

- **Blanket Approach (Group 1):** Speed limit reduction applied across all rural roads regardless of road classification (National, Regional, Local)
- **Targeted Approach (Group 2):** Speed limit reduction applied on specific carriageway types (divided or undivided roads) and/or road classification (National, Regional, Local)

For the assessment of reduced speeds limits in **Urban Areas**:

- All streets within the urban boundary had a reduced speed limit of 30 kph applied
- All main distributor/strategic roads and key access routes into and around the urban boundary area had a 50 kph speed limit applied

A summary of the both the modelled rural road and urban areas scenarios assessed as part of this assessment are provided in Appendix A. The scenarios considered as part of this assessment are non-exhaustive, however they provide a range of impacts to help make informed decision in relation to potential speed limit reductions.

1.5 Analysis Tools

Several existing industry standard modelling and appraisal tools were used to inform this assessment. Different modelling tools were used due to the nature of different characteristics of the roads being assessed. These modelling tools have been used to inform the appraisal, planning and design of a wide range of projects in recent years in Ireland, including such projects as BusConnects, DART+, Luas and wide range of National Road schemes.

For rural roads, the TII National Transport Model (NTpM) was used to simulate behavioural response to the proposed speed limit scenarios and to inform the safety and travel time impacts. The TII Road Emissions Model (REM) was used to assess the GHG emissions impacts.

For urban roads, the NTA Regional Modelling System (RMS) supported by smaller Local Area Models were used together to assess the safety and travel time impacts. The NTA’s Environmental Appraisal Module (ENEVAL) was used to estimate the GHG emissions impacts.

Although the tools are different, they use similar approaches. Behavioural impacts in terms of vehicle routing, traffic levels and vehicles speed arising from the proposed speed limit reduction scenarios are estimated using transport models. The outputs of these transport models are then used as inputs to the emissions tools, which inform the assessment of environmental impacts. Both emissions tools (TII REM and NTA ENEVAL) use average speed and traffic volume data from the transport models to inform the estimate of GHG emissions.

The emissions tools incorporate vehicle emission rates from COPERT[7], which is the EU standard vehicle emissions calculator coordinated by the European Environmental Agency (EEA). COPERT is the EU standard vehicles emissions calculator adopted across most EU countries for reporting official emissions data.

An overview of each of these standard modelling and appraisal tools and a summary of their suitability in relation to this assessment is provided in Appendix B.

1.6 Data Recommendations

As part of this assessment several issues in relation to the availability/limitation of data were noted. The following provides some potential areas that could be enhanced from a road safety perspective:

- **Road Safety (Collision Rates)** – Section 3.4 of this report provides an overview of collision rates for different road types in Ireland. At present there is only one collision rate for all rural single carriageway roads (>60kph), regardless of the type of single carriageway (e.g. National Primary, National Secondary, Regional or Local Road). This is a limitation to the analysis of potential collisions in Ireland and it is recommended that further research/analysis is undertaken to understanding how collision rates vary in Ireland by sub-classifications of different road type.

- **Local Roads –** the TII NTpM includes a partial representation of Local Roads in Ireland. The potential impacts of a speed limit reduction applied to Local Roads have been considered at a high level as part of this modelling assessment. Given the remit of TII, this partial representation of the Local Road network (>81,000km) is appropriate in the NTpM. Further research/analysis could be considered to better understand travel patterns and demand on the Local Road network.

1.7 Estimating Collision Reduction

Given the complexities in relation to compliance and enforcement of speed limits in Ireland (discussed later in this report) and the data limitations noted above, it's not viable to provide an accurate estimation of the likely collision impacts associated with the speed limit reduction scenarios. The intention of this assessment is to provide DoT with findings which can inform a wider consideration of the potential impacts of speed limit reductions.

The international studies discussed in Section 2, indicate that speed limit reductions produce positive safety benefits, in particular when considered in isolation (e.g. short sections or corridors). However, the range of benefits identified in these studies is quite large (8% to 63%) and are very much dependent on the specific study and local conditions. Several of these studies looked at individual roads or corridors in isolation as part of modelled scenarios and did not consider the potential impacts of drivers re-routing to other roads that this current DoT assessment considers.

The analysis undertaken by TII in March 2022, which considered drivers re-routing, indicated that there could be an overall net negative impact on road safety if only specific sections (e.g. motorways) of the road network are targeted. This highlights the need to consider the wider network impacts of proposals.

[7] COPERT EU standard vehicle emissions calculator. Available from: https://www.eea.europa.eu/themes/air/links/guidance-and-tools/copert4-road-transport-emissions-model

2. International Experience

2.1 Overview

A literature review of international examples has been carried out to understand the observed and modelled impacts of decisions to amend speed limit policies, particularly where speed limits have been reduced. This includes identifying the effects of such decisions on the behaviours of drivers (e.g. speed choices) and other road users, road safety, congestion, economy and the environment. The 10 studies listed and summarised in Table 2.1 have been considered as part of this review. Further detail on each study is provided in Appendix C.

2.2 Literature Review - Summary Findings

The key findings have been categorised into separate sections relating to the safety, environment and economic impact of each of the studies. The principal conclusions emerging from the literature review are summarised below for each of the categories considered.

2.2.1 Safety

There is universal agreement across the studies reviewed that speed limit reductions produce positive safety benefits when considered in isolation (e.g. short sections or corridors). Reductions in collisions quoted across the various studies reviewed range from 8% to 63%, depending on study and casualty type.

However, it is noted that several of these studies looked at individual roads or corridors in isolation as part of modelled scenarios and did not consider the potential impacts of drivers re-routing to other roads. As outlined previously, the analysis undertaken by TII in March 2022, which considered drivers re-routing, indicated that there could be an overall net negative impact on road safety if only specific sections (e.g. motorways) of the road network are targeted. This highlights the need to consider the wider network impacts of proposals.

2.2.1.1 Collision Modification Factors

TII guidance on Road Safety Inspections recommend the use of Collision/Crash Modification Factors (CMF) to assess the risk of changes in road collisions following the implementation of various measures. CMF is the ratio of the expected collision frequency after a solution is implemented, to the estimated collision frequency.

The U.S. Highway Safety Manual[8] (HSM) outlines the concept of CMFs and provides guidance on their application. The CMF Clearinghouse[9] is a database maintained by the University of North Carolina Highway Safety Research Center and funded by the U.S. Department of Transportation Federal Highway Administration that includes all available CMFs observed in the US. The CMF Clearinghouse offers transport professionals a central, web-based repository of CMFs, using a star quality rating system to indicate the quality or confidence in the results of the study producing the CMF, considering study design, sample size, standard error, potential bias, and data source.

The CMF Clearinghouse was reviewed as part of the literature review. Results hosted on the CMF website indicate that speed reduction, as a road safety countermeasure, has the potential to reduce the number of collisions by 9%-56% CRF (Crash Reduction Factor). The wide variance results from different appraisal methods, different road types (mostly wide-plain rural roads), as well as degree of road speed reduction.

Notably, Gayah, Donnell, Yu, and Li (2018)[10] found that speed limit compliance worsened as the difference between the engineering recommended speed and posted speed limits increased, identifying a 5mph (8 kph) reduction below engineering recommended speed to be optimal.

[8] http://www.highwaysafetymanual.org/
[9] https://www.cmfclearinghouse.org/
[10] https://www.sciencedirect.com/science/article/abs/pii/S0001457518305499

2.2.2 Environment

Many of the studies (e.g. Haworth et al., most results reviewed by Archer et al., Thiedig, Cerema, Sandberg Hanssen et al., some results from Lopez-Aparicio et al.) show positive environmental benefits from speed limit reductions. However, it must be emphasised that most of these did not account for potential re-routing impacts of speed limit reductions (Lopez-Aparicio et al. used a regional transport model and so presumably represented such effects, although this is not made explicit).

Findings of positive environmental effects are by no means universal. Folgerø et al., along with some of the studies reviewed by Archer et al. and some results from Lopez-Aparicio et al., indicate that reducing speed limits can increase the levels of certain emissions. Additionally, some of the studies (e.g. Cerema and other results from Lopez-Aparicio et al.) that did find positive environmental benefits show them to be negligible, and others (e.g. Haworth et al., Cerema, Alcaraz Carrillo de Albornoz et al.) found them to be significantly less (in monetised terms) than the safety benefits of reduced speed limits.

2.2.3 Economy

The evidence on the economic impacts of lower speed limits is very mixed and is dependent, at least in part, on the particular CBA methodology used, the value of time adopted and on the range of impacts valued. The studies by Thiedig and Cerema are the only ones reviewed here to show a consistently positive economic benefit; Lopez-Aparicio et al. also find a net benefit, but only if real-world, as opposed to strict, compliance with the new speed limit is assumed (and minimal changes to journey times as a result).

By contrast, Forester et al., Haworth et al., Sandberg Hanssen et al. and Folgerø et al., plus Lopez-Aparicio et al. for the case of strict compliance, find net economic disbenefits. Thus, only two of the seven studies reviewed that calculated economic benefits reported them to be positive.

It should be noted that existing methods of economic appraisal and cost benefit analysis are limited and use value of time to monetise the journey time impacts of transport interventions. Similarly, typical collision costs and emission values (monetary value of carbon) are used to monetise safety and emission impacts respectively.

This method of economic appraisal is weighted overwhelmingly towards journey time savings, where small changes in individual journey times can be very significant when monetised (using existing values of time)[11], applied to a large number of users and aggregated over 30/60-year appraisal periods. As a result, any transport project which increases journey times (such as a speed limit reduction) tends to result in significant monetised disbenefits, as reflected in many studies examined as part of this review.

The exception to this is studies where discounted values of time have been used, small increases in journey time disregarded (as discussed in the Australian studies) or changes have been made to other standard appraisal parameters.

2.3 Literature Review Conclusions

In summary, the literature review found that:

- **Safety -** Overwhelmingly the implementation of speed limit reductions resulted in significant safety benefits. However, it is noted that several of these studies looked at individual roads or corridors in isolation and did not consider the potential impacts of drivers re-routing to other roads

  The analysis undertaken by TII in March 2022, which considered drivers re-routing, indicated that there could be an overall net negative impact on road safety if only specific sections (e.g. motorways) of the road network are targeted. This highlights the need to consider the wider network impacts of proposals

- **Environment** - In terms of environmental / emissions impacts, the review provided mixed results. Studies which analysed observed data (as opposed to theorised or modelled outcomes)

[11] https://www.gov.ie/pdf/?file=https://assets.gov.ie/260307/1a7ff966-44cf-4aed-b1a0-bc9c746d294a.pdf#page=null Module 8 Detailed Guidance on Appraisal Parameters

generally found that any positive environmental impacts were minimal or statistically insignificant

- **Economy** - Economic impacts from the studies reviewed were also seen to be mixed. The majority of studies reported negative economic impacts resulting from the reduced journey times outweighing monetary benefits seen from safety and environmental savings

Table 2.1. International Studies Summary

Country	Author / Date	Title	Study Type	Urban/Rural	Study Focus	Impact Summary
United Kingdom	Bornioli et al. (2020)[12]	"Effects of city-wide 20mph (30km/hour) speed limits on road injuries in Bristol, UK"	Observed – following implementation of speed limit reduction (30mph to 20mph)	Urban	Safety	**Positive**
United States	Forester et al. (1984)[13]	"A Cost–Benefit Analysis of the 55 MPH Speed Limit"	Observed – following implementation of speed limit reduction	Rural	Safety	**Positive**
					Economy	**Negative**
Australia	Haworth et al. (2001)[14]	"Evaluation of a 50 km/h Default Urban Speed Limit for Australia"	Observed – following implementation of speed limit reduction (60 to 50kph)	Urban	Safety	**Positive**
					Environment	**Neutral**
Australia	Archer et al. (2008)[15]	"The Impact of Lowered Speed Limits in Urban and Metropolitan Areas"			Economy	**Neutral**
Germany	Thiedig (2018)[16]	"An economic cost-benefit analysis of a general speed limit on German highways"	Modelled Scenario – Cost Benefit Analysis	Rural	Safety	**Positive**
					Environment	**Positive**
					Economy	**Positive**
France	Cerema (2020)[17]	"Lowering of the maximum authorised speed to 80 km/h"	Observed – following implementation of speed limit reduction (90 to 80kph)	Rural	Safety	**Positive**
					Environment	**Neutral**
					Economy	**Positive**

[12] https://injuryprevention.bmj.com/content/injuryprev/26/1/85.full.pdf
[13] https://www.jstor.org/stable/1057981
[14] https://www.infrastructure.gov.au/sites/default/files/migrated/roads/safety/publications/2001/pdf/evalu_urb_speed.pdf
[15] https://www.monash.edu/__data/assets/pdf_file/0007/216736/The-impact-of-lowered-speed-limits-in-urban-and-metropolitan-areas.pdf
[16] https://refubium.fu-berlin.de/bitstream/handle/fub188/23321/discpaper2018_17.pdf
[17] https://www.cerema.fr/fr/centre-ressources/boutique/abaissement-vitesse-maximale-autorisee-80-kmh

Country	Author / Date	Title	Study Type	Urban/Rural	Study Focus	Impact Summary
Norway, Sweden and Finland	Sandberg Hanssen et al. (2020)[18]	"Dissimilarities between the national cost/benefit models of road projects: Comparing appraisals in Nordic countries	Modelled Scenario – Cost Benefit Analysis	Rural	Safety	**Positive**
Norway	Folgerø et al. (2020)[19]	"Going fast or going green? Evidence from environmental speed limits in Norway"	Modelled Scenario – Cost Benefit Analysis	Rural	Environment	**Neutral**
Norway	Lopez-Aparicio et al. (2020)[20]	"Costs and benefits of implementing an Environmental Speed Limit in a Nordic city"	Modelled Scenario – Cost Benefit Analysis	Rural	Economy	**Negative**
Spain	Alcaraz Carrillo de Albornoz et al. (2022)[21]	"Road speed limit matters – Are politicians doing the right thing?"	Modelled Scenario – Cost Benefit Analysis (Applied to Case Studies)	Rural	Safety	**Positive**
					Environment	**Positive**
London	Future Transport Research 2022[22]	Urban transport modelling - An investigation into the effects of urban traffic, speed limits and driving style on travel times, fuel efficiency and CO2 and NOx emissions	Modelled Scenario	Urban	Environment	**Positive**
Netherlands	EEA 2008[23]	Success stories within the road transport sector on reducing greenhouse gas emissions and producing ancillary benefits	Speed control measure (applied to 3.5 km motorway section)	Rural	Environment	**Positive**

[18] https://doi.org/10.1016/j.trip.2020.100235
[19] https://doi.org/10.1016/j.trd.2020.102261
[20] https://doi.org/10.1016/j.scitotenv.2020.137577
[21] https://doi.org/10.1016/j.seps.2021.101106
[22] https://futuretransport.info/wp-content/uploads/2022/05/Urban-Transport-Modelling-2022-05-16.pdf
[23] https://www.eea.europa.eu/publications/technical_report_2008_2

Country	Author / Date	Title	Study Type	Urban/Rural	Study Focus	Impact Summary
European Environmental Agency	EEA 2011[24]	Do lower speed limits on motorways reduce fuel consumption and pollutant emissions?	Modelled Scenario	Rural	Environment	**Positive**
European Environmental Agency - Article	EEA[25]	Reducing speed limits on motorways: how good is it for the environment?	Modelled Scenario	Rural	Environment	**Positive but issues with compliance**

[24] https://www.eea.europa.eu/themes/transport/speed-limits-fuel-consumption-and/speed-limits/download.pdf

[25] https://www.eea.europa.eu/articles/reducing-speed-limits-on-motorways - Article archived due to outdated content

3. Key Concepts

3.1 Overview

There are several key concepts that need to be taken into consideration as part of this assessment of speed limit reductions. These include:

- Mode shift
- Vehicle Routing and Journey Time
- Road Safety
- Vehicle Emissions

A brief overview each of these areas is provided in the following sections.

3.2 Mode Shift

Lowering of speed limits may have an impact on mode shares in both rural and urban areas. Due to the higher availability of alternative modes of transport and the different nature of rural and urban trips, higher rates of modal shift would be expected in urban areas. Reducing road speed limits will reduce the differential between car and bus journey times, therefore making the trip by public transport or walking/cycling more attractive.

3.3 Vehicle Routing & Journey Time

Vehicular journey times are directly impacted by speed limits. Adjusting a speed limit (up or down) may have a direct impact on the route a driver may choose to take between their origin and destination. Drivers often make marginal decisions when choosing the route on which they travel and often seek out the quickest route to get to their destination. This can lead to diversions on to less suitable, residential, roads, in urban areas, or the use of lower standard roads in relation to rural roads (e.g., a driver re-routing away from a motorway to a single carriageway). The potential for this re-routing has increased in recent years with driver mapping and navigation guidance becoming ubiquitous on mobile phone devices.

This is also particularly an issue in the Irish rural context, where there is a high level of interaction across different roads classifications (e.g. the majority of the Motorway network in Ireland has a parallel 'former' National Road in close proximity which is generally of high design quality).

3.4 Road Safety

3.4.1 Road Type & Collision Rates

Due to segregation of traffic by direction, the lower number of at-grade junctions and a variety of other factors, the risk of collisions on divided roads (e.g. motorways and dual carriageways) and the severity of collisions is significantly reduced. In general, divided roads are safer than undivided roads (e.g. single carriageways).

For example, motorways have a Personal Injury Collision (PIC) rate that is four times lower than the PIC rate for a rural (over 60 kph) single carriageway road as illustrated in Table 3.1. While rural dual carriageway roads are more than twice as safe as rural undivided roads from a PIC rate perspective.

Table 3.1. Collision Rates Extracted from TII PAG Unit 6.11 National Parameter Values

Road Type	PIC Rate/million vehicle kilometres	
Motorway (120 kph)	0.020	
	<60 kph	**>60 kph**
Dual Carriageway	0.140	0.033
2 lane single carriageway	0.213	0.080

From a road safety point of view, the higher the road standard (e.g. in terms of its cross section, alignment, treatment of junctions etc.) the lower its collision rate. Therefore, to obtain positive safety impacts, it is desirable to have more vehicle kilometres travelled on higher standard roads (divided roads) and less on undivided roads.

The collision rates presented above and used in this scenario assessment do not distinguish between single carriageways on the Regional or Local Road network versus single carriageway roads on National Road Network. National Roads are generally of a higher quality and therefore should be considered safer.

3.4.2 Single Carriageway Speed

Another significant influence of the risk and severity of collisions is the speed of traffic on the road. This is particularly the case for rural single carriageway roads. The proportion of injury collisions relative to the total number of collisions at different reported[29] speed limits on single carriageway roads indicates that the most severe risk of injury is associated with collisions on sections of the single carriageway network at higher speeds.

The proportion of injury collisions declines with the reduction of reported speed limit (the collisions are less likely to result in injury at slower speeds). This is illustrated by the data provided in Table 3.2.

Table 3.2. Provisional Road Collisions Recorded by An Garda Síochána between 2014 and 2021

Reported Speed Limit (kph)	Total Collisions	Injury Collisions	Material Damage Only Collusions	Proportion of Injury Collisions (%)
100	22,108	4,742	17,366	21%
80	58,602	10,032	48,570	17%
60	16,825	2,491	14,344	15%
50	133,709	18,402	115,307	14%
30	25,629	3,272	22,357	13%

Evidence from other sources[30] also shows that reduced speeds greatly increase the safety of pedestrians and cyclists. Figure 3.1 shows the likelihood of a pedestrian fatality compared to the speed of vehicle colliding with the pedestrian, based on Swedish data.

This demonstrates that a reduction of speed limits from 50kph to 30kph is expected to significantly reduce the chance of pedestrian fatalities from traffic collisions.

[29] Provisional road collisions data recorded by An Garda Síochána between 2014 and 2021 (some individual records may be subject to change)
[30] Source: Interdisciplinary working group for accident mechanics (1986); Walz et al. (1983) and Swedish Ministry of Transport (2002).

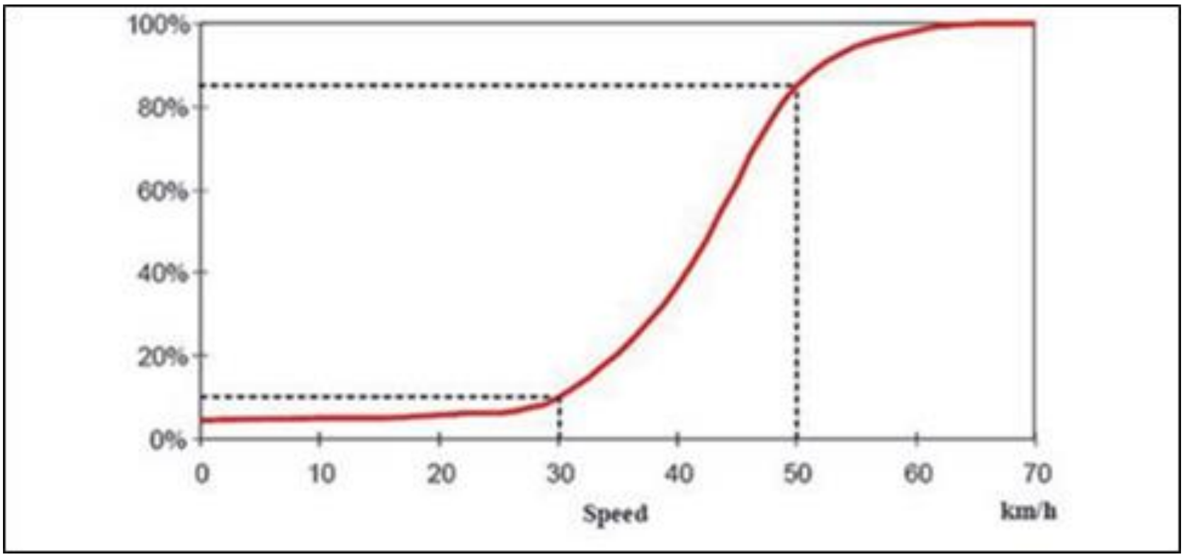

Figure 3.1. Probability of Fatal Injury from a Vehicle Colliding with a Pedestrian

Further to this, Wramborg, P. (2005) produced estimates, which are illustrated in Figure 3.2, of the probabilities of a fatality upon collision for an automobile collision either:

- With cyclist and pedestrian
- With the side of an automobile
- Frontal or with a hard object

This analysis also shows notable safety benefits from reduced speeds, in particular for pedestrian and cyclist safety.

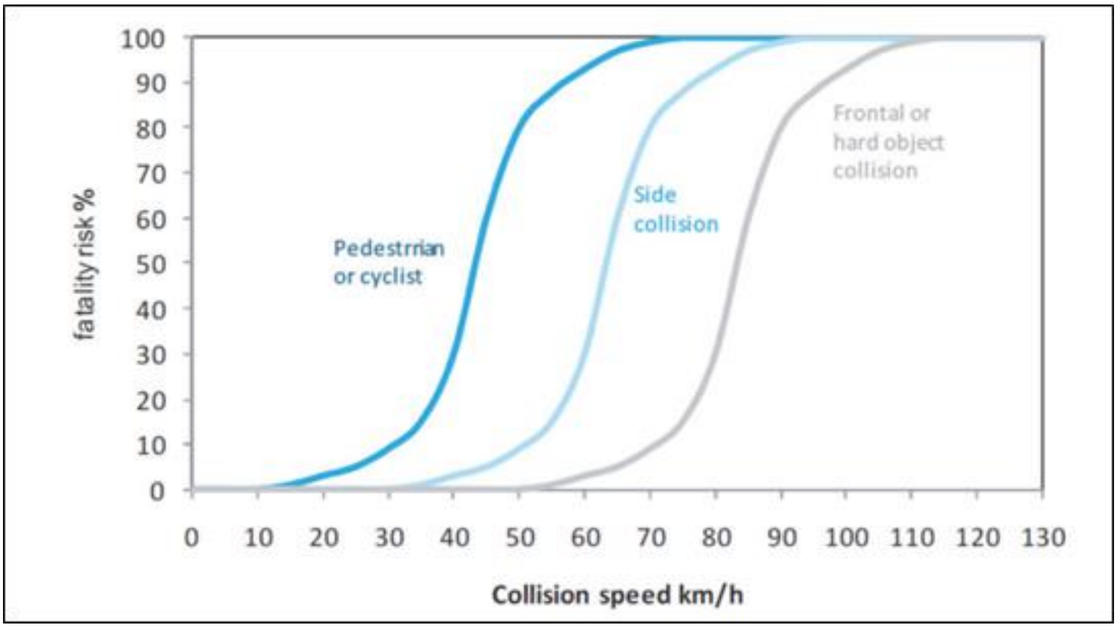

Figure 3.2. Probability of Fatal Injury by Collision Type[31]

[31] Wramborg' s Model for Fatality Probability versus Vehicle Collision Speeds (Wramborg (2005)

3.5 Vehicle Emissions

As illustrated in Figure 3.3, the relationship between the speed a vehicle is travelling and the volume of emissions that are produced is approximately 'U-shaped', e.g. it is non-linear. Emission rates are at their highest at lower speeds, but the volume of emissions produced reduces as speed levels increase until around 70kph.

Above 70kph, emission rates begin to increase again as vehicle speeds rise. In the context of the speed limit reduction scenarios, reducing speed limits will not always directly equate to a reduction in vehicle emissions due to this non-linear relationship.

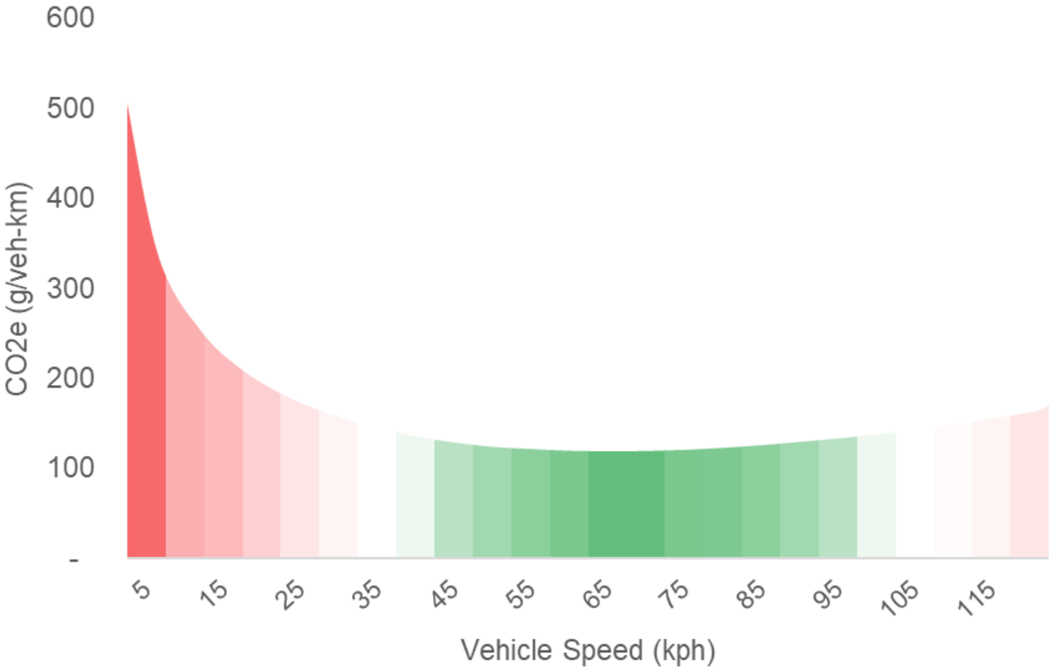

Figure 3.3. Average Road Vehicle COPERT Emission Rates by Vehicle Speed (weighted by 2018 County Dublin Fleet)

As previously discussed in Section 1.4, the TII and NTA emissions tools have been used to assess the potential GHG emissions associated with each of the scenarios. These tools incorporate the 2018 vehicle emission rates for the National Irish fleet. A more detailed breakdown of the emission rates by a range of vehicle types is presented in Table 3.3. The cells in this table were colour coded to show lowest emissions in the shade of green, highest emissions in the shades of red and all values in between in shades of yellow and orange.

Higher emission rates are related to lower speeds (e.g. <30 kph) which are not impacted as part of the assessment on rural roads but are applicable in the urban areas assessment. By looking at rural speeds only (>60 kph), it is clear that emission rates reduce from 120 kph to about 70 kph for the majority of vehicle types. However emission rates tend to increase again as speeds reduce below 70 kph.

Table 3.3. Classified GHG (in CO_2e) COPERT Emissions Rates at Different Speeds weighted by Irish National Fleet Breakdown, g/veh-km

Vehicle Type	5 kph	10 kph	20 kph	30 kph	40 kph	50 kph	60 kph	70 kph	80 kph	90 kph	100 kph	110 kph	120 kph
Small Petrol Car	511.04	286.67	177.47	144.22	130.43	124.77	123.48	124.95	128.37	133.29	139.44	146.65	154.81
Medium Petrol Car	605.56	350.67	221.74	178.55	157.81	146.84	141.43	139.76	140.94	144.46	150.01	157.42	166.54
Large Petrol Car	894.73	516.51	323.71	257.89	225.35	207.38	197.71	193.67	193.93	197.74	204.65	214.38	226.75
Small Diesel Car	358.71	221.95	145.09	113.97	96.14	85.08	78.65	75.90	76.38	79.83	86.09	95.07	106.69
Medium Diesel Car	383.36	246.60	169.74	138.63	120.79	109.74	103.30	100.56	101.04	104.48	110.74	119.72	131.35
Large Diesel Car	432.55	295.78	218.92	187.81	169.98	158.92	152.49	149.74	150.22	153.67	159.93	168.90	180.53
Small Hybrid Car	331.37	187.90	116.97	94.54	84.71	80.27	115.76	116.62	119.62	124.33	130.49	137.96	146.62
Medium Hybrid Car	387.92	226.95	144.70	116.57	102.75	95.26	134.21	132.38	133.46	136.97	142.63	150.26	159.74
Large Hybrid Car	558.62	326.90	208.01	166.89	146.31	134.80	188.77	184.92	185.21	188.97	195.78	205.41	217.67
Small PHEV Car	147.68	80.37	47.61	37.63	33.49	31.80	103.74	105.21	108.63	113.55	119.71	126.92	135.08
Medium PHEV Car	174.49	98.02	59.34	46.39	40.16	36.87	116.55	114.88	116.06	119.58	125.13	132.54	141.66
Large PHEV Car	258.81	145.35	87.51	67.76	58.00	52.61	164.73	160.70	160.95	164.76	171.67	181.41	193.77
LGV	792.02	430.67	252.96	198.14	175.64	167.47	168.02	174.85	187.43	205.77	230.39	261.98	301.67
Small HGV	647.98	541.93	406.96	343.16	314.09	304.21	306.04	317.28	339.38	376.26			
Medium HGV	1141.64	925.07	672.22	546.14	479.16	446.98	436.04	439.76	458.47	500.17			
Large HGV	2524.17	1892.73	1454.43	1223.04	1039.15	917.27	863.43	862.71	887.91	912.95			

4. Analysis of Scenarios – Rural Roads

4.1 Overview

In order to assess the potential impacts of speed limit reductions in rural areas, a range of alternative scenarios were considered and assessed using the appropriate modelling tools. A total of 7 scenarios were identified by DoT and assessed to provide context on the potential range of impacts that may occur, the scenarios[32] are as follows:

- **Scenario 1 -** 10 kph reduction applied across the entire rural road network (where existing speeds are greater than 60 kph)
- **Scenario 2** - 10 kph speed reduction applied on all single carriageway roads
- **Scenario 3** - speed limit of 80 kph applied to all National Secondary Roads only
- **Scenario 4** - speed limit of 60 kph applied to all Local Roads only
- **Scenario 5** - speed limit of 70 kph applied to all National Secondary and Regional Roads
- **Scenario 6** - speed limit on all rural divided roads reduced by 10kph and all rural single carriageway roads reduced by 20 kph
- **Scenario 7** - speed limit of 80 kph on all National Secondary Roads and 60 kph on all Local Roads

The objective of the assessment for rural roads was not to compare the 7 scenarios in order to select a 'preferred' scenario, but instead to consider the potential impacts that may arise, in order for DoT to make informed decisions in the round. To simplify the analysis, the 7 scenarios were grouped into two specific categories:

- **Blanket Approach (Group 1):** Speed limit reduction applied across all roads regardless of road classification (National, Regional, Local) i.e. Scenarios 1, 2 and 6
- **Targeted Approach (Group 2):** Speed limit reduction applied on specific carriageway types (divided or undivided roads) and/or road classification (National, Regional, Local) i.e. Scenarios 3, 4, 5, and 7

Further details of each scenario are provided in Appendix A.

4.2 Key Performance Indicators (Rural Roads)

To assess the scenarios, four Key Performance Indicators (KPI) were considered. Two KPIs were identified in relation to safety and one each in relation to GHG emissions and travel time. The four KPI are as follows:

- **Road Safety** impacts - measured by the change in total vehicle kilometres travelled on divided/undivided roads and change in total vehicle kilometres travelled at speeds of 80 kph or higher on single carriageway roads
- **Environmental** impacts – measured by the percentage change in total GHG emissions, reported in CO_2 equivalent (CO_2e) against the 2018 baseline scenario
- **Travel Time** impacts **-** measured by the percentage change in total travel time (hours) across the modelled road network

The potential modal shift impacts of the scenarios were also considered as part of the KPI assessment. Variable demand modelling results indicated that marginal modal shift impacts are projected as a result of the scenarios considered. This is because public transport offers a less competitive alternative

[32] Existing legal speed limits for HGVs in Ireland are lower than general traffic (please refer to Table 1.1 for the default posted speed limits in Ireland). Existing speed limits for HGV were therefore only reduced in Scenarios 4-7 where the proposed speed was lower than the legal speed limit.

relative to a private car in the majority of rural areas in Ireland. Please refer to Appendix B for further details.

The key summary findings from the analysis are provided in the sections below. The modelled results for each of the modelled scenarios are included in Appendix D of this report.

4.3 Safety Impacts

As noted previously and outlined in the literature review, reducing speed will lead to positive safety impacts when considered in isolation. For this assessment, the impacts on the whole transport network must be considered. Network wide effects include the re-routing of drivers and the overall change in distance travelled. The following sections provide a summary of the safety impacts of the Group 1 and Group 2 scenarios.

4.3.1 Blanket Approach (Group 1)

As noted in Section 3, changes in speed limit can lead to some drivers re-routing to find the optimal route between their origin and destination. This can involve a driver re-routing from a road of a higher safety standard (e.g. Motorway) to one of a lower safety standard (e.g. Regional Road). The Group 1 scenarios seek to minimise the level of traffic re-routing by lowering the speed limit on all roads to maintain the overall road safety hierarchy.

To maintain the road safety hierarchy, interventions should seek to maintain and or increase the level of traffic on divided roads, while also minimising the re-routing of traffic. Table 4.1 shows the range of impacts in terms of the modelled change in traffic on divided and undivided roads for the Group 1 scenarios. The detailed results, presented in Appendix D, indicate that maintaining the road safety hierarchy may be best achieved by reducing speeds on undivided roads only to maximise the attractiveness of divided roads.

Table 4.1. Total Change in Total vkm Travelled (Divided and Undivided Roads)

Scenario	Total Change in vkm Divided Roads	% Change in vkm Divided Roads	Total Change in vkm Undivided Roads	% Change in vkm Undivided Roads
Group 1	28,313 to 640,781	0.1% to 1.9%	-725,902 to 551,750	-0.8% to 0.6%

Table 4.2 shows the range of impacts in terms of the modelled change in traffic on single carriageway roads above and below 80kph for the Group 1 scenarios. The detailed results, presented in Appendix D, indicate that all scenarios have a potential positive impact by reducing levels of traffic travelling at or above 80kph on single carriageway roads.

Table 4.2. Total Change in Total vkm Travelled (Single Carriageway Roads)

Group	Total Change in vkm >=80kph	% Change in vkm >=80kph	Total Change in vkm <80kph	% Change in vkm <80kph
Group 1	-7,457,730 to -13,964,859	-5.7% to -10.7%	6,731,829 to 14,516,609	5.2% to 11.2%

In summary, the results of this modelling analysis indicate that:

- The **blanket approach** scenarios considered as part of this assessment, indicate that an approach which focuses on reducing speeds across the rural single carriageway road network only, may have the best overall safety outcome. This is on the basis of maintaining and/or increasing traffic levels on the safest types of roads in Ireland (i.e. motorways and dual carriageways) while also improving road safety across the rural single carriageway road network through lower speeds
- The implementation of a blanket approach however may be challenging, in particular in terms of **compliance and enforcement**. Expert judgement by road safety and enforcement authorities would indicate that compliance with speed limits, in particular on engineered roads

which are designed for higher speeds, may be challenging in terms of **public perception and buy-in**

4.3.2 Targeted Approach (Group 2)

The Group 2 scenarios seek to understand the potential impact on road safety of targeted interventions on particular road types.

Table 4.3 shows the range of impacts in terms of the modelled change in traffic on divided and undivided roads for the Group 2 scenarios. The detailed results, presented in Appendix D, indicate that certain targeted approaches increase vehicle kilometres travelled on undivided roads. However, it is possible to achieve an increase in vehicle kilometres travelled on divided roads with specific targeted strategies.

Table 4.3. Total Change in Total vkm Travelled (Divided and Undivided Roads)

Group	Total Change in vkm Divided Roads	% Change in vkm Divided Roads	Total Change in vkm Undivided Roads	% Change in vkm Undivided Roads
2	62,549 to 653,208	0.2% to 1.9%	-605,633 to 462,257	-0.6% to 0.5%

Table 4.4 shows the range of impacts in terms of the modelled change in traffic on single carriageway roads above and below 80kph for the Group 2 scenarios. The detailed results, presented in Appendix D, indicate that all scenarios have a potential positive impact by reducing levels of traffic travelling at or above 80kph on single carriageway roads.

It is noted that the potential re-routing impacts of drivers under scenarios which propose a speed limit reduction on rural Local Roads have not been explicitly modelled as part of this assessment, due to the limitations of the available analysis tools. However the findings of research presented in this report and the high-level assessment of potential impacts on Local Roads, indicates that lowering the existing speed limit of 80kph to 60kph on rural Local Roads would have a positive safety impact overall.

Table 4.4. Total Change in Total vkm Travelled (Single Carriageway Roads)

Group	Total Change in vkm >=80kph	% Change in vkm >=80kph	Total Change in vkm <80kph	% Change in vkm <80kph
2	-306,984 to -13,212,612	-0.2% to -10.1%	413,430 to 13,674,870	0.3% to 10.5%

In summary, the results of this modelling analysis indicate that:

- The **targeted scenarios** considered as part of this assessment (i.e. lowering speeds on particular road types) have the potential to lead to an overall net increase in vehicle kilometres (distance) travelled across the road network as drivers re-route to find the quickest route between their origin and destination. Overall, the assessment indicates that this increase in travel, in general, may occur on other sections of the single carriageway road network. So, while safety may improve on the targeted sections, the overall network safety impacts may be somewhat limited
- The implementation of a targeted scenario should therefore seek to minimise the re-routing of traffic on the safety types of roads in Ireland (e.g. motorways and dual carriageways) and focus on the lower safety standard roads such as Local, Regional or National Secondary roads

.

4.4 Environmental Impacts

Table 4.5 provides a summary of the impact of the scenarios in terms of the change in GHG emissions reported in CO_2 equivalent[33] (CO_2e) relative to the 2018 baseline. In 2018[34], 12.2 megatonnes (Mt)[35] of CO_2e were emitted from transport in Ireland[36] and this is the baseline against which the impact of each scenario is assessed.

The overall impact on GHG emissions related to the speed limit reduction scenarios are considered to be negligible for the Group 2 scenarios. The Group 1 scenarios generated the highest potential reduction in GHG emissions as these scenarios include proposed implementation of speed limit reductions across the entire rural road network.

Table 4.5. Total Change in Greenhouse Gas Emissions Relative to 2018 Baseline

Scenario Group	Total Change in CO_2e Tonnes Emitted	CO_2e Impact Range against 2018 Baseline (12.2 Mt)
1	-49,900 to –69,993	-0.6% to -0.1%
2	-7,987 to 17,438	-0.1% to 0.1%

4.5 Travel Time Impacts

As expected, the total modelled network travel time as illustrated in Table 4.6 increases in all scenarios tested with a proposed lowering of speed limits. The presented change in travel time relates to morning peak hour model.

Table 4.6. Total Change in Travel Time

Group	Total change in Hours during AM Peak	Travel Time AM Peak Impact Range
1	3,133 to 5,502	0.8% to 2.2%
2	510 to 2,097	0.1% to 0.8%

The Group 1 scenarios generated higher travel time impacts as these scenarios include the proposed implementation of speed limit reductions across the entire rural road network (up to 2.2%). The Group 2 scenarios generated up to 0.8% increase in travel time.

4.6 Rural Road Impact Assessment Summary

A high-level summary of the rural road impacts following the modelling assessment is presented in Table 4.7.

Table 4.7. Rural Road Impacts Assessment Summary

Group	Safety	GHG Emissions	Travel Time
1	Positive	Positive (in short-term)[37]	Negative
2	Positive (but lower than Group 1)	Neutral	Negative

[33] CO_2e – Carbon dioxide equivalent
[34] The 2018 baseline is used as this is a consistent reference point for the Government's Climate Action Plan (CAP).
[35] 12.2Mt this equates to 2.4 tonnes of Greenhouse Gas per capita in Ireland.
[36] Source – EPA https://www.epa.ie/publications/monitoring--assessment/climate-change/air-emissions/irelands-provisional-greenhouse-gas-emissions-1990-2021.php
[37] The makeup of the Irish vehicle fleet will change over time due to technological change and the use of energy saving technologies in car development. This also includes greater uptake of Hybrid Electric Vehicle (HEV), Plug in Hybrid Electric Vehicle (PHEV), Battery-Electric Vehicle (BEV) and alternative fuelled vehicles in the Irish fleet. Therefore the overall impact on GHG emissions as a result of a speed limit reduction will dimmish over time.

Overall, the modelling indicates that the Group 1 scenarios perform more favourable relative to the Group 2 scenarios in terms of Safety and GHG Emissions. This is achieved by maintaining or increasing the level of traffic on higher safety standard roads by minimising drivers re-routing and lowering speeds on lower safety standard roads.

5. Analysis of Scenarios – Urban Roads

5.1 Overview

To assess speed limit reductions in urban areas, roads within defined urban boundaries were applied two speed limits, either 30kph or 50kph. The higher speed limit was applied to key radial routes and routes which facilitate strategic movements, with low levels of pedestrians and cycle activity, all other routes within urban boundaries were allocated a speed limit of 30kph. Additionally, a number of models have been used, representing different geographic areas. The reason for this is so that the analysis captures the different travel patterns and behaviours associated with different cities and towns.

Because of the differences in travel patterns, as well as the differing levels of Public Transport service provision between cities and smaller urban settlements, it was decided to separate the analysis into two parts:

- Speed limit reductions in cities
- Speed limit reductions for medium sized towns

In terms of the city analysis, speed limit reductions in the city centres of Cork City and Dublin City have been assessed using the NTA's South West Regional Model and East Regional Model respectively. The same analysis was undertaken for both cities, the detailed results are provided in Appendix E.

To estimate the impact on speed limit reductions in smaller urban settlements, eight medium-sized Irish towns[38] were selected as representative samples. These towns have been selected to ensure that different types of transport networks and geographies were included in the analysis. The towns selected for this analysis were: Mallow, Sligo, Tuam, Letterkenny, Athy, Ashbourne, Tipperary and Clonmel. The impact of speed limit reductions on these towns has been modelled using the NTA Regional Modelling System and Local Area Models. Figure 5.1 illustrates the locations of the towns & cities which have been used to analyse speed limit reductions for the purposes of assessing impact on urban roads.

It should be noted that speed limit reductions in urban areas will only make a difference in areas free of congestion. In congested areas, or during time periods where average speed is below the reduced speed limit (i.e. <30kph), a reduction in the speed limit from 50kph to 30kph will not make an actual difference in either vehicle speed or journey time for road users.

[38] A range of medium size towns (5,000 – 20,000 population) across Ireland were selected in order to provide a typical Irish town representative sample from a both geographical and road layout perspective

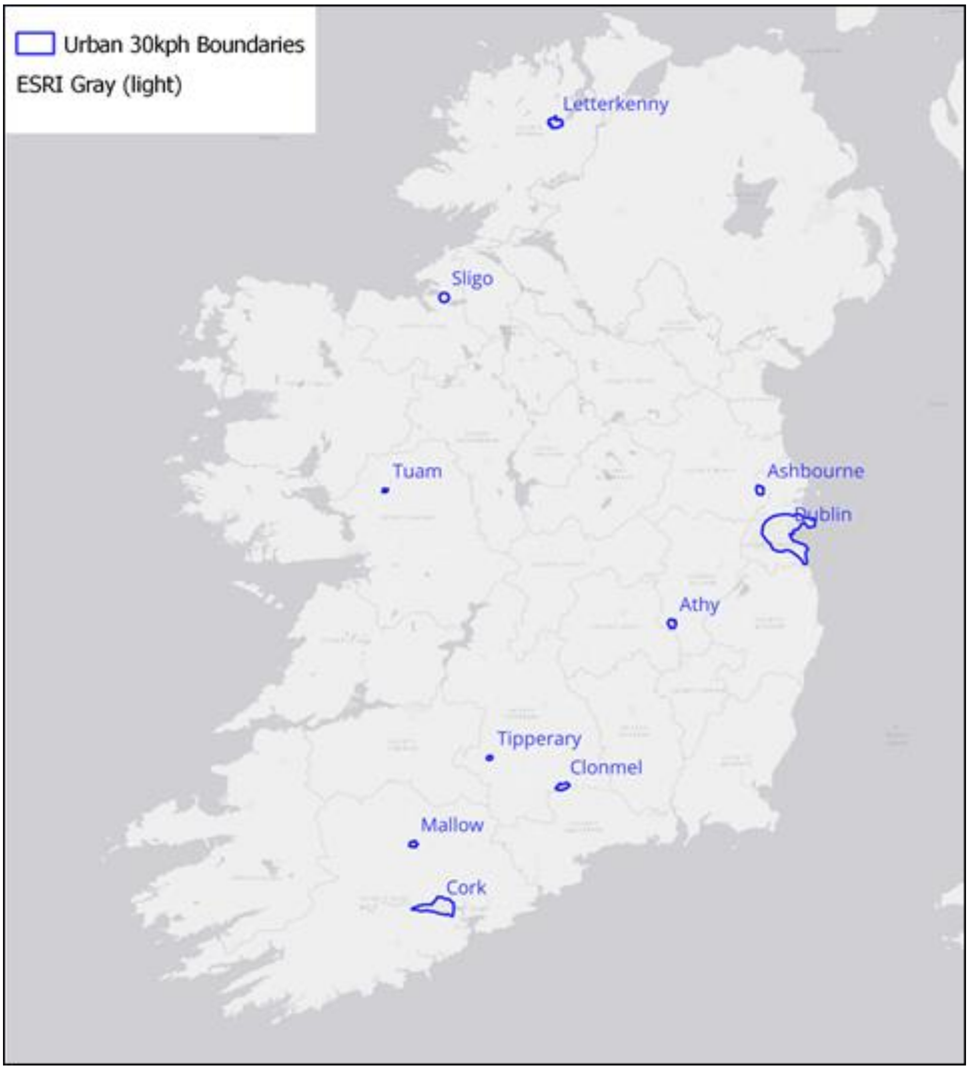

Figure 5.1. 30kph Areas used in the Urban Analysis

5.2 Key Performance Indicators (Urban Roads)

Four key performance indicators were identified for the urban roads analysis, these are:

- **Modal Share** impacts – the most desirable outcome of the speed limit reduction would be the avoidance of the use of private car, this was measured using modal share impacts from model runs
- **Road Safety** impacts – measured by percentage difference in vehicle kilometres travelled and overall reduction in total vehicle kilometres travelled
- **Environmental** impacts – were measured by percentage difference in emissions against baseline scenario
- **Travel time** impacts – were measured by percentage difference in travel time

Below sections provide summary outputs, full results are provided in Appendix E.

5.3 Modal Share

In Dublin, the reduction in speed limits is projected to result in a reduction in total car trips by almost **1%**[39] in the study area and a corresponding increase in trips made by walking, cycling and public transport. Figure 5.2 shows the total mode share for the study area (area within the M50) in the Do-Minimum and Do-Something Scenario.

[39] This equates to a reduction of approximately 6,000 car per day in the study area across the modelled time periods

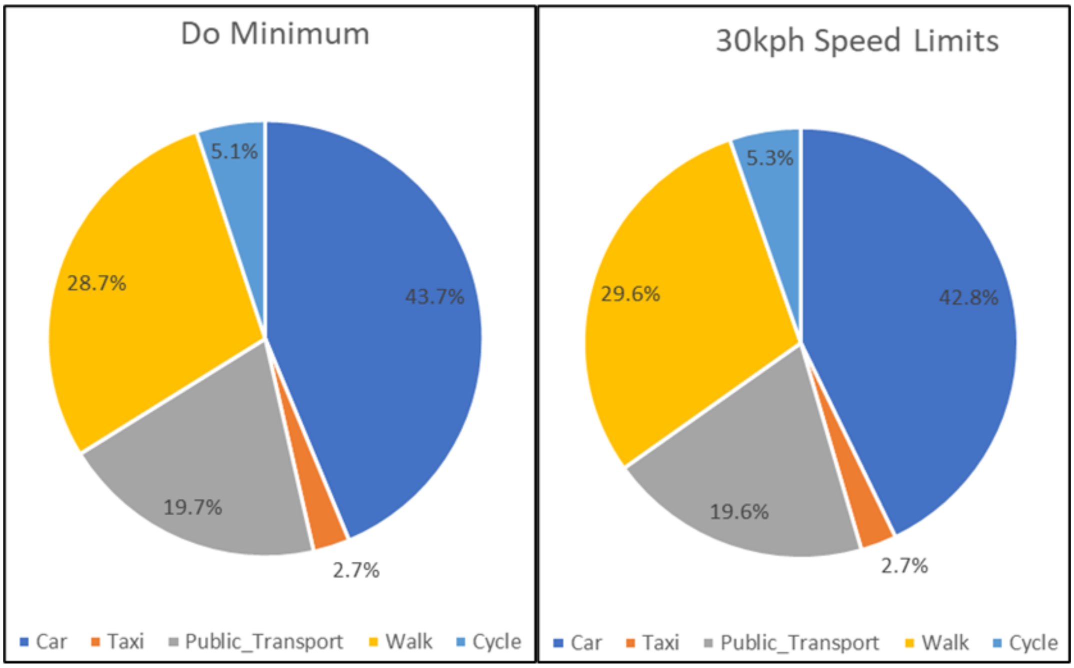

Figure 5.2. ERM Dublin (Within M50) Origin Trips Modal Share, with/without 30kph Speed Limits (excluding 50kph radials)

In Cork, the reduction in speed limit changes is projected to result in a small reduction in total car trips in the study area by **0.6%**[40] and a corresponding increase in trips made by walking, cycling and public transport. Figure 5.3 shows the total mode share for the study area (Cork City) in the Do-Min and Do-Something Scenario.

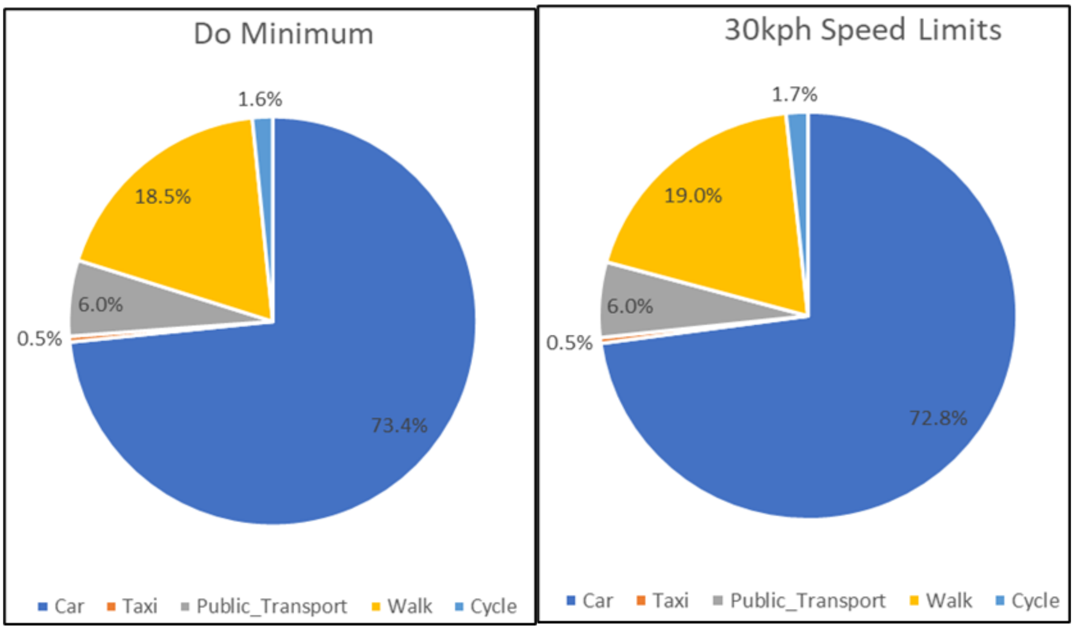

Figure 5.3. SWRM Cork City (Study Area) Origin Trips Modal Share, with/without Speed Limit Reductions

Implementing speed limit reductions within the urban boundary of medium-sized towns was not found to produce a significant shift away from car use.

5.4 Safety Impacts

To assess the safety impact of the proposed speed limit changes, an analysis of total vehicle kilometres travelled at various speeds in the Do-Minimum (e.g. Baseline) and Do-Something scenarios was carried out. An analysis of the safety implications of driving at different speeds (contained within Section 3.4 of this report) demonstrated that the likelihood of a collision resulting in a fatality is significantly lower at

[40] This equates to a reduction of approximately 2,000 car per day in the study area across the modelled time periods

30kph than at 50kph or above. The implication of this is that the more vehicle kilometres travelled at 30kph, as opposed to 50kph or higher, the safer the road network.

The change in vehicle kilometres on the entire Eastern Regional Model (ERM) area and the area within the M50 are outlined in the Table 5.1 and show an overall reduction in kilometres travelled by 3% within the M50.

Table 5.1. Dublin (24hr) Vehicle kms by Speed Category

Modelled Speed Limit (kph)	Entire ERM		Within M50	
	Absolute Difference	% Difference	Absolute Difference	% Difference
Under 30	36,234	10%	35,909	10%
30	**3,621,852**	**893%**	**3,572,938**	**1104%**
40	-2,356,819	-75%	-2,350,523	-95%
50	-1,283,928	-11%	-1,439,324	-64%
60 and over	-420,730	-1%	-131,156	-2%
Total	**-403,393**	**-1%**	**-312,154**	**-3%**

This demonstrates that the speed limit reduction results in a significant increase in vehicle kilometres at 30kph and a corresponding drop in vehicle kilometres at speeds of 40kph and above. This suggests that the introduction of a speed limit reduction in urban areas is expected to achieve a noticeable positive safety benefit. Results are presented above for modelling assessments in Dublin. Similar scale impacts are evident from assessments in Cork and the smaller urban settlements.

5.5 Environmental Impacts

The summary of emission modelling outputs for the two cities are shown in Table 5.2 for the entire ERM, within the M50 boundary and for the entire SWRM. The full set of outputs (all emissions forecasts) are contained within Appendix E.

Table 5.2. Annual Change in GHG Emitted due to Speed Limit Reductions in Cities

	Full ERM		Within M50		Full SWRM	
Vehicle Type	Change in CO2e (tonnes) emitted	% Difference	Change in CO2e (tonnes) emitted	% Difference	Change in CO2e (tonnes) emitted	% Difference
Car	-14,229	-1%	-9,181	-2%	-2,295	0%
Goods	11,586	1%	5,471	3%	3,177	1%
Non-Urban Bus	421	1%	409	4%	98	1%
Urban Bus	1,209	5%	1,173	7%	373	8%
Total	**-1,014**	**0%**	**-2,128**	**0%**	**1,353**	**0%**

Table 5.2 demonstrates that the reduced speed limits lead to a reduction in GHG emissions for Cars, arising as a result of a reduction in the total number of car trips undertaken (due to mode shift). However, there is an increase in GHG emissions for goods vehicles and buses as these vehicles are less efficient (in terms of GHG emissions) at 30kph than at 50kph.

The net impact is a very marginal decrease in GHG annual tonnes which equates to less than a 0.03% of total emissions. Results from all sources (e.g. entire ERM, within M50, entire SWRM and results from Town models) show similar patterns, with some savings coming from mode shift away from cars, which are more pronounced in large cities and an increase in emissions from buses and heavy good vehicles.

5.6 Travel Time Impacts

As expected, the total modelled network travel time as illustrated in Table 5.3 increases in all scenarios tested with a proposed lowering of speed limits.

Table 5.3. Total Change in Travel Time

Scenario	Total Change in PCU Hours	Travel Time Impact Range
Cities	637 to 1,115	1% to 1.7%
Towns	68	0.1%

In cities, the impact of speed limit change generated higher travel time impacts as these scenarios cater for larger number of trips, however as mentioned at the beginning of this chapter speed limit reductions in urban areas will only make a difference in areas free of congestion (i.e. in congested areas or during time periods where average speed is below the reduced speed limit, there will be no actual difference in either vehicle speed or journey time for road users).

6. Summary

6.1 Rural Roads

The analysis of rural roads, which utilised the TII National Transport Model and Road Emissions Model, focused on the safety, GHG emissions and travel time impacts of the scenarios in the context of the rural road network in Ireland (roads with a speed limit above >60 kph).

In summary, the results of this modelling analysis in relation to Rural Roads suggest that:

- The blanket approach scenarios (i.e. reductions applied across the road network) considered as part of this assessment, indicate that an approach which focuses on reducing speeds across all rural single carriageway roads, may have the best overall safety outcome. This is on the basis of maintaining and/or increasing traffic levels on the safest sections of roads in Ireland (i.e. motorways and dual carriageways) while also improving road safety across the rural single carriageway road network through lower speeds
- The implementation of a blanket approach however may be challenging, in particular in terms of compliance and enforcement. Expert judgement by road safety and enforcement authorities would indicate that compliance with speed limits, in particular on engineered roads which are designed for higher speeds, may be challenging in terms of public perception and buy-in
- The targeted scenarios suggested by DoT for consideration as part of this assessment (i.e. lowering speeds on particular road types) have the potential to lead to an overall net increase in distance travelled across the rural road network. This is due to drivers re-routing to find the quickest route between their origin and destination. The assessment indicates that this increase in distance travelled generally occurs on other sections of the single carriageway road network. While safety may improve on the targeted sections, this may be offset by increases in travel on less safe roads. Therefore, the overall network safety impacts may be somewhat limited
- The implementation of a targeted scenario should therefore seek to minimise the re-routing of traffic away from the safest roads in Ireland (e.g. motorways and dual carriageways). An optimal scenario, in terms of road safety, is to focus on reducing speeds on undivided roads such as Local, Regional or National Secondary roads
- The potential impacts of the speed limit reduction scenarios on GHG emissions are limited. The net change in GHG emissions estimated using the strategic modelling tools is negligible for most of the scenarios tested. In addition, scenarios which may have a limited positive impact if implemented in the short term would see these benefits dimmish overtime as the vehicle fleet transitions towards electrification
- All scenarios considered would increase journey times for road users

The full impacts of speed limit reductions on rural Local (non-national) roads have not been explicitly modelled as part of this assessment, due to the limitations of the available analysis tools. Therefore, the analysis of potential impacts on Local Roads in this assessment relied on available research in this area. The findings of this research, combined with the high-level modelling analysis, indicates the lowering the existing speed limit of 80kph to 60kph on rural Local Roads would have a positive safety impact overall.

6.2 Urban Roads

The analysis of urban roads, which utilised the NTA's Regional Modelling System and ENEVAL emissions tool, focused on the safety, GHG emissions and travel time impacts of the proposals both in the context of cities in Ireland and medium sizes towns.

In summary, the results of this modelling analysis suggest that:

- Reduced speed limits have the potential to improve road safety in both towns and cities, with a large increase in distance travelled at slower speeds and a corresponding reduction in distance travelled at faster speeds of 50kph and above

- Reduced speed limits have the potential to cause a modest reduction in car use within cities. However, a similar mode shift in smaller towns and villages is unlikely with the modelling results indicating less potential for reduced car mode share following the introduction of the proposals.
- GHG emission modelling suggests that the net impact on emissions will be negligible in both towns and cities. In cities, a small reduction in modelled car emissions was observed as a result of a reduction in car trips. However, this reduction may be offset by increased emissions from HGVs and Buses whose Internal Combustion Engines are less efficient at 30kph than 50kph. Emission results for towns suggest that the proposals will result in very minor increases in carbon emissions for all vehicles
- Reduced speed limits are likely to result in re-routing of traffic away from roads where reduced speed limits are implemented. In some instances, this will result in more traffic travelling on more suitable roads from a safety perspective. However, in some instances this re-routing may result in more traffic on less suitable, local and residential, roads
- All scenarios considered would increase journey times for road users

6.3 Potential Impact of the Uptake of Electric Vehicles on GHG Emissions

The makeup of the Irish vehicle fleet will change over time due to technological change and the use of energy saving technologies. This includes greater uptake of Hybrid Electric Vehicle (HEV), Plug in Hybrid Electric Vehicle (PHEV), Battery-Electric Vehicle (BEV) and alternative fuelled vehicles in the Irish fleet.

As part of this assessment an exercise was undertaken to assess the potential impact of a 2030 future fleet scenario when applied to the speed limit reduction scenarios. In summary, the overall proportion of potential GHG emissions savings related to the speed limit scenarios, will reduce over time as lower emission vehicles will make up a larger proportion of the Irish vehicle fleet in the future. The details of this assessment are provided in Appendix F.

6.4 Air Quality (Non-GHG Emissions)

Both the TII REM and NTA ENEVAL tools can, if required, calculate both the change in Greenhouse Gas (e.g. climate) and Non-Greenhouse Gas (e.g. air quality impacts) impacts as a result of a proposed intervention. In relation to non-GHG emissions, the tools use data from the UK Defra Emissions Factors Toolkit[41] for analysis of local air quality impacts.

While Air Quality impacts were not explicitly requested to be considered as part of this assessment (the modelling and assessment of air quality impacts is complex given the spatial/population/receptor data that is required to assess the impacts) the results of the rural road scenarios in relation to the following non-GHG are presented in Appendix G for information purposes only:

- NO_x – Nitrogen Oxides
- NO_2 – Nitrogen Dioxide
- PM_{10} – Particulate Matter
- $PM_{2.5}$ – Fine Particulate Matter

6.5 Further Discussion: Compliance with Speed Limits

Although not explicitly considered as part of this modelling assessment, the impact of the non-compliance of divers to post speed limits in Ireland is discussed in the following sections in relation to the potential impact in terms of road safety and GHG emissions.

[41] Emissions Factors Toolkit v10.1 https://laqm.defra.gov.uk/review-and-assessment/tools/emissions-factors-toolkit.html

6.5.1 Road Safety Authority – Free Speed Survey

The Road Safety Authority (RSA) undertake vehicle speed surveys at various locations across the Irish road network to identify the 'free speed' at which vehicles travel. The RSA define 'free speed' as the *"speed at which drivers choose to travel when unconstrained by road geometry (e.g. sharp bends, intersections or hills), weather conditions (e.g. rain) or traffic conditions (e.g. congestion)."* The survey provides the percentage of drivers not adhering to the posted speed limit across different types of roads in Ireland.

A summary of the percentage of non-compliant drivers on different road types from the latest published RSA report[42] in 2018 is as follows:

- Urban roads (50 kph) - 52%
- Urban roads without residential roads (50 kph) - 65%
- Rural roads (100 kph) - 27%
- Motorways (120 kph) – 23%
- Dual Carriageways (100 kph) – 44%
- Regional roads (80 kph) – 50%

The results of the 2018 survey show that there is a high level of non-compliance with speed limits in Ireland across the road network. Preliminary results[43] from the 2021 free speed surveys showed that:

- 77% of drivers broke the posted speed limit of 50 kph in urban areas
- More cars broke the speed limit at weekends
- Overall, 50% of motorists exceeded the speed limit by up to 10 kph and 33% by between 10 and 20 kph
- The percentage of speeding drivers on rural roads with posted speed limit of 100 kph was 29% and on motorways (120 kph) it was 15%

The preliminary results of the 2021 RSA free speed survey demonstrates that compliance with speed limits continues to be an issue in Ireland.

6.5.2 Speed Compliance Case Study – M7 Pilot Scheme

In 2018, TII identified a 9km section of the M7 motorway between Junctions 26 (Nenagh West) and 27 (Birdhill) where compliance with the posted speed limit (120 kph) was approximately 60% over the years 2014 - 2018, as illustrated by the red bars in Figure 6.1. Between 2019 and 2021 the Gardaí increased their presence on this section of the M7 for mobile speed detection (orange bars in Figure 6.1) which led to an increase in compliance to 69% by 2021.

In 2021, this section of the M7 was then selected to pilot an Average Speed Camera System. Permanent camera infrastructure was installed in late 2021. Following the full implementation of the system and its enforcement in April 2022 (green bar in Figure 6.1) the compliance rate increased to approximately 94%.

This case study demonstrates the benefit that enforcement can have in terms of compliance with posted speed limits. While it is acknowledged that implementing and enforcing Average Speed Safety Camera systems across the road network may not be feasible, targeted implementation on particular sections may be warranted.

[42] Free Speed Study, Survey Report 2018, Road Safety Authority, Research Department December 2018,
[43] https://www.rsa.ie/docs/default-source/road-safety/annual-conference-2022/rrd_res_20221021_vbconferencepresfinal.pdf?sfvrsn=fa7b9352_5, RSA International Conference 26 October 2022

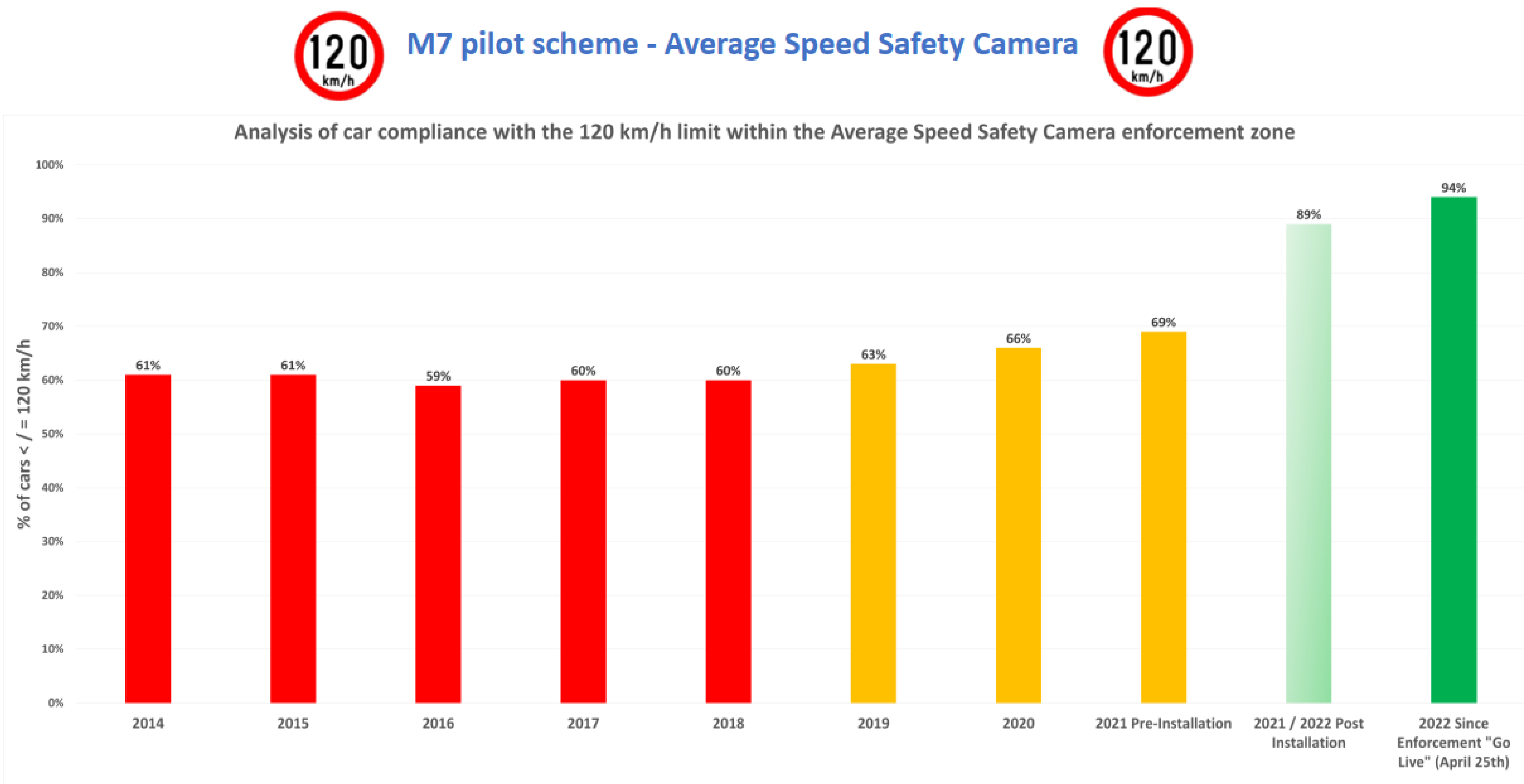

Figure 6.1. Compliance with the 120 kph speed limit on the M7

6.5.3 Speed Compliance Summary

The findings of the RSA free speed survey demonstrate that there are issues with the compliance of drivers to posted speed limits in Ireland. The evidence presented in Section 3.4.2 of this report in relation to collisions on undivided roads, shows the link between higher speeds and fatalities. In addition, the evidence presented in Section 3.5 of this report on vehicle emission rates shows the potential benefits of reducing higher speeds in terms of reductions in GHG emissions.

Therefore, both safety and emissions benefits could be generated through improvements in compliance with speed limits. However, the scale of this benefits has not been assessed as part of this current assessment and further work is recommended to examine this.

Appendix A Rural & Urban Speed Limit Scenarios

A.1 Rural Speed Limit Scenarios Overview

For rural roads, a total of seven scenarios were assessed as follows:

- **Scenario 1 -** 10 kph reduction applied across the entire rural road network (where existing speeds are greater than 60 kph)
- **Scenario 2** - 10 kph speed reduction applied on all single carriageway roads
- **Scenario 3** - speed limit of 80 kph applied to all National Secondary Roads only
- **Scenario 4** - speed limit of 60 kph applied to all Local Roads only
- **Scenario 5** - speed limit of 70 kph applied to all National Secondary and Regional Roads
- **Scenario 6** - speed limit on all rural divided roads reduced by 10kph and all rural single carriageway roads reduced by 20 kph
- **Scenario 7** - speed limit of 80 kph on all National Secondary Roads and 60 kph on all Local Roads

The detail of these scenarios is provided below and summarised in Table A1. All rural speed limit scenarios were assessed using the TII National Transport Model *(refer to Appendix B for details of the TII National Transport Model).*

It is noted that the TII National Transport Model does not include a full representation of the Local Road network in Ireland. As such the potential re-routing impacts of drivers under scenarios proposed by the DoT in relation to speed limit reductions on Local Roads (i.e. Scenarios 4 and 7) have not been explicitly modelled, but instead have been interpolated using modelled runs which utilised the Regional Road network.

Table A.1. Rural Speed Limit Reduction Scenarios (Existing & Proposed Speed Limits)

Rural Speed Limit Reduction Scenario[44]	Group	Divided Roads (120/100 kph)	Single Carriageway Roads			
			National Roads		Non-National Roads	
			Primary (100 kph)	Secondary (100 kph)	Regional (80 kph)	Local (80 kph)
Scenario 1	1	-10 kph	-10 kph	-10 kph	-10 kph	-10 kph
Scenario 2	1	-	-10 kph	-10 kph	-10 kph	-10 kph
Scenario 3	2	-	-	-20 kph (Max 80 kph)	-	-
Scenario 4	2	-	-	-	-	-20 kph (Max 60 kph)
Scenario 5	2	-	-	-30 kph (Max 70 kph)	-10 kph (Max 70 kph)	-
Scenario 6	1	-10 kph	-20 kph	-20 kph	-20 kph	-20 kph
Scenario 7	2	-	-	-20 kph (Max 80 kph)	-	-20 kph (Max 60 kph)

[44] Due to variations in speed limits within each road category Scenario 1, Scenario 2 and Scenario 6 reduced the speed limit by 10 or 20 kph as specified in Table A.1 above on all roads where current speed limit is above 60 kph. In Scenarios where maximum speed is specified in Table A.1 above (Scenario 3, Scenario 4, Scenario 5 and Scenario 7) speed reductions were only applied to roads exceeding the maximum speed proposed.

A.2 Urban Speed Limit Scenarios Overview

Urban Speed limit scenarios were divided into two parts:

1. Speed limit reductions in cities
2. Speed limit reductions for medium sized towns

For the assessment of reduced speeds limits in Urban Areas:

- All streets within the urban boundary had a reduced speed limit of 30 kph applied,
- All main distributor/strategic roads and key access routes into and around the urban boundary area had a 50 kph speed limit applied.

In terms of the city analysis, speed limit reductions in the city centres of Cork City and Dublin City have been assessed using the NTA's South West Regional Model and East Regional Model respectively *(refer to Appendix B for details of the NTA's South West Regional Model and East Regional Model*).

The medium sized towns selected for this analysis were:

- Mallow
- Sligo
- Tuam
- Letterkenny
- Athy
- Ashbourne
- Tipperary
- Clonmel

The impact of speed limit reductions on these towns has been modelled using the following models:

- East Regional Model (ERM): for Athy and Ashbourne
- South West Regional Model (SWRM): for Mallow
- West Regional Model (WRM): for Tuam, Sligo and Letterkenny
- Mid-West Regional Model (MWRM): for Tipperary
- South East Regional Model (SERM): for Clonmel
- Mallow Local Area Model (LAM)
- Letterkenny Local Area Model (LAM)

Appendix B Analysis Tools

B.1 Introduction

Four existing industry standard modelling and appraisal tools have been used to inform this assessment. These are as follows:

- **TII National Transport Model** – used to simulate behavioural response on the rural road network to proposed speed limit reduction scenarios and inform the safety and travel time impacts of the assessment
- **TII Road Emissions Model** – used to quantify the GHG emissions impacts from the scenarios assessed using TII National Transport Model
- **NTA Regional Modelling System** - used to simulate behavioural response in the urban area networks to proposed speed limit scenarios and inform the safety and travel time impacts of the assessment
- **NTA ENEVAL** - used to quantify the GHG emissions impacts from the scenarios assessed using the NTA Regional Modelling System

Each DoT scenario was modelled using either the TII National Transport Model (NTpM) or the NTA Regional Modelling System. The traffic related outputs (e.g. traffic flow, average speed) of each scenario modelled in the TII NTpM or NTA REM were then used as inputs to the TII Road Emissions Model (REM) and NTA ENEVAL. The TII REM or NTA ENEVAL were then run for each scenario to calculate the potential change in GHG emissions.

Impacts associated with each of the DoT scenarios were assessed using a baseline scenario of 2020 travel and network conditions and the Irish vehicle fleet in 2020. A brief overview of each of these analysis tools is provided in the following sections.

B.2 TII National Transport Model – Overview

The TII National Transport Model[45] (NTpM) is a strategic multi-modal transport assignment model. The model includes all Motorways, National Primary, National Secondary, Regional Roads and a portion of Local Roads in Ireland as illustrated in Figure B.1. It also includes inter-urban bus and heavy rail services nationwide.

TII has developed, enhanced and maintained the NTpM over the past 15 years to support its strategic management of and planning for the National Roads Network. The model contains information on travel for several trip types between over 1,100 spatial zones, including all principal ports and airports.

The model provides an accurate representation of traffic volumes (both general traffic and Heavy Goods Vehicles) and the speed at which these vehicles travel, for all links across the National Roads Network. It utilises permanent traffic count data from the TII network of over 350 Traffic Monitoring Units[46] (TMU) to calibrate and validate its representation of traffic volumes across its network. In addition, journey time data is collected based on mobile phone data to provide an accurate representation of journey time and average speeds on the network.

The road traffic assignment element of the model represents vehicle drivers' choice of route between start (origin) and end (destination) point based on the 'Generalised Cost' of travel. This cost includes the travel time, travel distance and any tolls along a specific route for vehicular traffic. Changes in travel time associated with a change in average speed have a direct impact on the route a vehicle may choose to take between its origin and destination.

[45] https://www.tii.ie/tii-library/strategic-planning/
[46] https://trafficdata.tii.ie/publicmultinodemap.asp

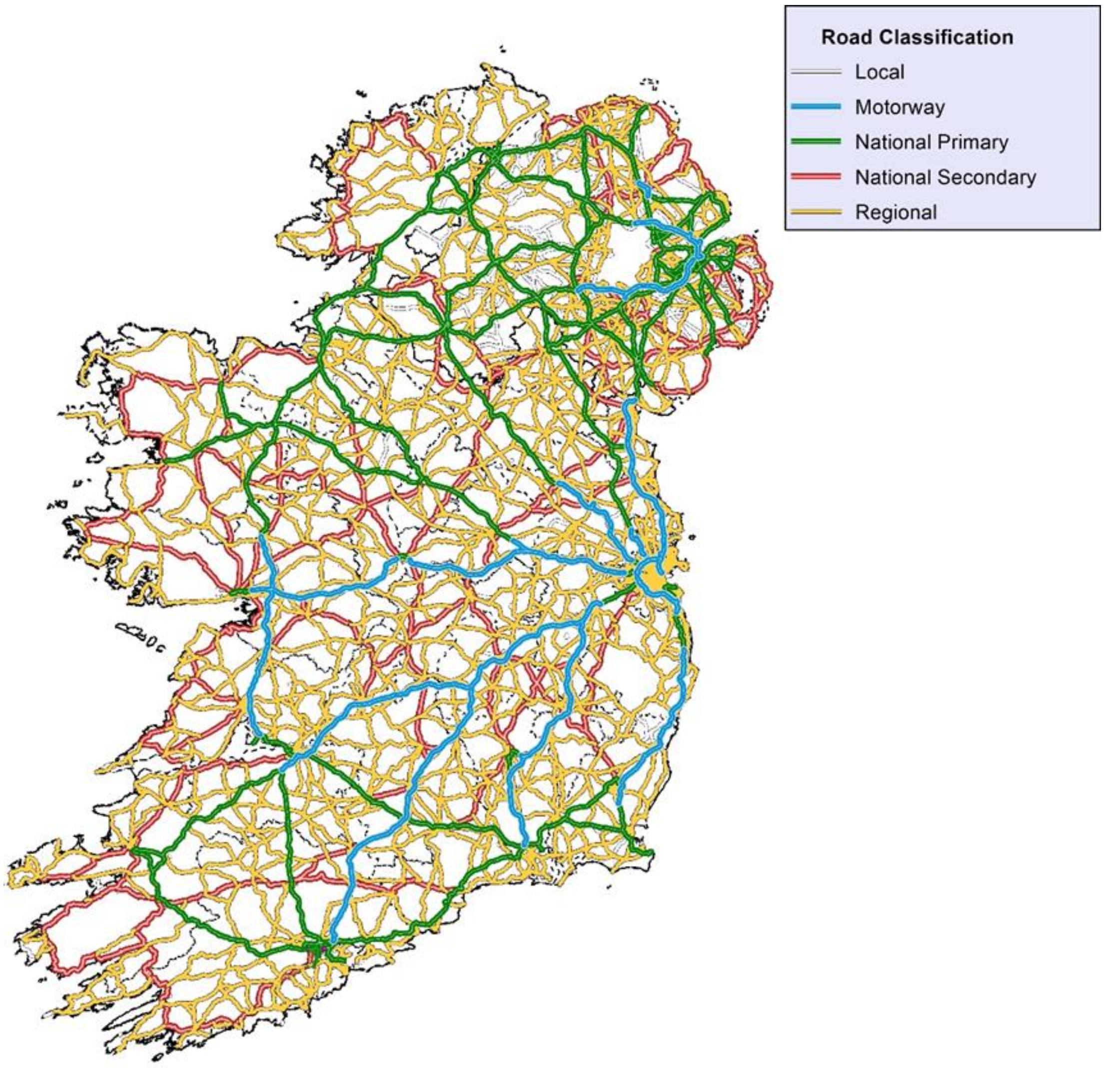

Figure B.1. TII National Transport Model (Road Network)

B.3 TII Road Emissions Model – Overview

To understand the impact of Greenhouse and Non-Greenhouse Gas emissions associated with vehicle travel on the National Roads Network, TII developed a Road Emission Model[47] (REM) in 2022. The TII REM is capable of estimating vehicle emissions associated with travel from 2018 onwards.

The emissions calculated by the TII REM include; Nitrogen Oxides (NOx), Particulate Matter (PM_{10}) and Carbon Dioxide equivalent (CO_2e)[48] from the vehicle fleet on a county basis. This is done using existing fleet information from sources such as the Central Statistics Office (CSO)[49] for goods vehicles and the MaREI research centre for Energy, Climate and Marine at University College Cork (UCC)[50] for cars. Future projections of vehicle fleet make up from UCC MaREI (cars) and AECOM (goods vehicles) are also available in the REM.

The model incorporates vehicle emission rates from COPERT[51], which is the EU standard vehicle emissions calculator coordinated by the European Environmental Agency (EEA). It also includes data

[47] https://www.tiipublications.ie/library/GE-ENV-01107-01.pdf

[48] CO_2e: Carbon dioxide equivalent (CO_2e) is a term for describing different direct greenhouse gases in a common unit. For any quantity and type of greenhouse gas, CO_2e signifies the amount of CO_2 which would have the equivalent global warming impact. The seven direct greenhouse gases recognised by the Kyoto Protocol, and included within the definition of CO_2e, are: CO_2, CH_4, N_2O, HFCs, PFCs, SF_6 and NF_3. Most CO_2e datasets, for road transport, include only CO_2, CH_4, N_2O.

[49] Central Statistics Office data search https://data.cso.ie/#

[50] University College Cork (2021) Irish Car Stock Model v2.1

[51] COPERT EU standard vehicle emissions calculator. Available from: https://www.eea.europa.eu/themes/air/links/guidance-and-tools/copert4-road-transport-emissions-model

from the UK Defra Emissions Factors Toolkit[52] for analysis of local air quality impacts. This information is combined to generate estimates of Greenhouse and Non-Greenhouse Gas emissions for all road links input into the REM.

The TII REM, used in conjunction with the TII NTpM, facilitates an understanding of the emissions associated with changes in key high-level variables including the physical road network, road network speed limits, population and employment distributions, vehicle ownership, mode shift, travel cost and changes to the vehicle fleet.

B.4 NTA Regional Modelling System – Overview

The NTA has developed a Regional Modelling System (RMS) for Ireland to assist in the appraisal of a wide range of potential future transport and land use options. The RMS comprises of several component models and tools, including:

- National Demand Forecasting Model (NDFM)
- Five Regional Models (RM), five large-scale, detailed, multi-modal regional transport models
- Secondary Analysis and Appraisal Tools (SAA)

Each of the five regional models are focused on the travel-to-work areas of the major population centres of Dublin, Cork, Galway, Limerick, and Waterford. The areas covered by these five Regional Models is shown in Figure B.2.

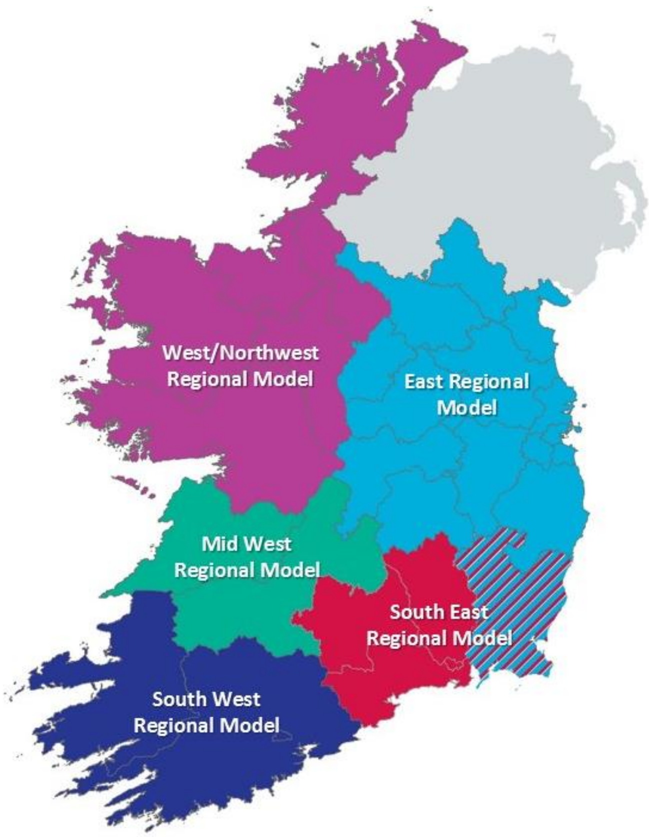

Figure B.2. NTA Regional Modelling System

Each of the five regional models include; full geographic coverage of each region, detailed representations of all major surface transport modes including active modes, road and public transport networks and services, representation of travel demand for five time periods (AM, 2 Inter-Peaks, PM and Off-Peak). The RMS encompasses behavioural models calibrated to 2016 Household Survey data

[52] Emissions Factors Toolkit v10.1 https://laqm.defra.gov.uk/review-and-assessment/tools/emissions-factors-toolkit.html

that predict changes in trip destination and mode choice in response to changing traffic conditions, transport provision and/or policies which influence the cost of travel.

These attributes make the regional models particularly well suited for this study as all impacts of the proposed speed reductions, including modal shift, trip distribution and trip re-routing will be captured by the RMS.

B.5 NTA ENEVAL - Overview

For post-modelling Environmental Impact analysis, The NTA's Environmental Appraisal module, ENEVAL, was used to produce estimates of the GHG emissions impact of the modelled scenarios.

ENEVAL is a FORTRAN (FTN95) program, which performs a range of environmental assessments for the public transport and highway assignment models. The program uses link speeds, junction delay times and flow data to perform a range of environmental evaluations. This is done utilising COPERT (Calculation Of Pollution Emissions from Road Transport) emissions curves, which estimate emissions by vehicle speed for different vehicle types. COPERT is the EU standard vehicles emissions calculator adopted across most EU countries for reporting official emissions data.

The emissions estimated by the environmental appraisal process include the following:

- NOx – Nitrogen Oxides
- NO2 – Nitrogen Dioxide
- PM10 – Particulate Matter
- PM2.5 – Fine Particulate Matter
- HC – Hydro-Carbons
- CO - Carbon Monoxide
- CO2 - Carbon Dioxide
- C6H6 – Benzene
- CH4 – Methane
- C4H6 - 1, 3 Butadiene

B.6 Model Assumptions and Generalisations

As with any statistical modelling approach, there are generalisations and assumptions used in the TII NTpM and NTA RMS. A number of these generalisations are worth nothing in the context of this assessment.

Modelled Vehicular Speeds

Behaviour in these strategic models is aggregated to typical peak hourly periods. This is the accepted basis for the analysis of transport networks at a strategic level. The models represent vehicle speeds in terms of an average speed over the modelled hour. The maximum average speed at which a vehicle can travel is capped at the posted speed limit for the road. This means that when testing a change to speed limits, the model effectively assumes that all affected vehicles will reduce their average hourly speed accordingly.

Congested Conditions

These strategic tools analyse the behaviour of people and the performance of the networks over a peak hourly period, they do not represent all of the dynamics of stop/start congested traffic conditions. This is acceptable for many use cases for the models, where network capacity is analysed over peak hourly periods. In the case of vehicle emissions, stop/start congested conditions significantly increase emissions from vehicles. Some of these impacts cannot be fully captured by these modelling tools.

When assessing proposed measures using the models, a test scenario is compared against a baseline scenario and the changes in behaviour are analysed. The generalisations and assumptions discussed above are consistent to both the baseline and test scenarios. For example reducing the speed limit of a congested road will have no impact if the congested speed is already lower than the proposed reduced speed limit.

B.7 Suitability of Modelling Approach

The use of the NTpM and RMS for this assessment is considered appropriate, given the extensive statistical calibration and validation of the models to observed vehicle flow and speed conditions discussed above. The databases behind the REM and ENEVAL are sourced from a number of world leading organisations in the area of air quality and climate science. In particular, the COPERT emissions calculator used in the REM and ENEVAL is accepted as the EU standard procedure, in accordance with the requirements of international conventions and protocols and EU legislation.[53]

It is intended that the outputs of this analysis will form part of a wider consideration of impacts and will help to inform and provide context to the DoT decision making process. It is important to fully understand the assumptions and generalisations used in the modelling approach. These will not have a significant impact on this analysis of outputs at a strategic level. Furthermore, decisions will not be made solely on the findings of this strategic analysis, the outputs will be used to inform a wider assessment of speed limits on Irish roads. On this basis, the TII NTpM and TII REM are considered appropriate tools to use for this task.

B.8 Other Impacts (Mode Shift – Rural Roads Assessment)

The Variable Demand Model (VDM) element of the TII NTpM accounts for the potential modal shift associated with the speed reductions for all scenarios tested. The VDM is an incremental model which takes travel costs (e.g. time, distance, tolls and fares) from a reference scenario as a starting point, and then forecasts the change in demand (e.g. mode share and trip distribution changes) as a function of the changes in travel costs between the reference and test scenarios (in this case the proposed speed limit reductions on the rural road network).

The VDM run results indicated that there are marginal projected modal shift impacts associated with the proposed speed limit reductions on the rural road network. The highest modelled increase in public transport demand was observed in Scenario 6, 0.61% increase, which also resulted in drop in vehicular demand by 0.02%. These results are in line with expectations for these strategic tests. In rural Ireland there are limited viable alternatives to the car, so even with the increased travel time associated with the speed limit reduction scenarios, there is likely to be a minimal amount of modal shift to other modes.

[53] https://www.emisia.com/utilities/copert/

Appendix C Literature Review

C.1 Introduction

This literature review identified studies which evaluated the impacts of changes in speed limit in different countries to provide context and inform the current study being undertaken by DoT. The purpose of this review is to establish the likely impacts of a reduction in speed limit, based on observed data and international examples. This will inform the best approaches to changes to speed limits which may be implemented in Ireland.

As part of this review the following studies/ examples have been reviewed:

- United Kingdom – Bornioli et al. (2020), "Effects of city-wide 20mph (30km/hour) speed limits on road injuries in Bristol, UK"
- United States – Forester et al. (1984), "A Cost–Benefit Analysis of the 55 MPH Speed Limit"
- Australia – Haworth et al. (2021), "Evaluation of a 50 km/h Default Urban Speed Limit for Australia"
- Australia – Archer et al. (2008), "The Impact of Lowered Speed Limits in Urban and Metropolitan Areas"
- Germany – Thiedig (2018), "An economic cost-benefit analysis of a general speed limit on German highways"
- France – Cerema (2020), "Lowering of the maximum authorised speed to 80 km/h - Final assessment report - July 2020"
- Norway, Sweden and Finland – Sandberg Hanssen et al. (2020), "Dissimilarities between the national cost/benefit models of road projects: Comparing appraisals in Nordic countries"
- Norway – Folgerø et al. (2020), "Going fast or going green? Evidence from environmental speed limits in Norway"
- Norway - Lopez-Aparicio et al. (2020), "Costs and benefits of implementing an Environmental Speed Limit in a Nordic city"
- Spain – Alcaraz Carrillo de Albornoz et al. (2022), "Road speed limit matters – Are politicians doing the right thing?"
- Future Transport Research (2022) - Urban transport modelling – An investigation into the effects of urban traffic, speed limits and driving style on travel times, fuel efficiency and CO2 and NOx emissions
- Netherlands, Rotterdam – European Environment Agency EEA 2008, Success stories within the road transport sector on reducing greenhouse gas emission and producing ancillary benefits
- Article – European Environment Agency EEA 2011, Do lower speed limits on motorways reduce fuel consumption and pollutant emissions?

The key findings from each of these studies will be summarised in the following sections. The findings have been categorised into separate sections relating to the safety, environment and economic findings of these studies.

C.2 Safety Impacts

C.2.1 Bornioli et al. (2020) – United Kingdom

In 2019, following the implementation of a 20 mph (32 km/h) speed limit on Bristol (UK) urban roads, Bornioli et al. (2020) investigated the effect on the number of urban road injuries. Each injury was coded with its area code, severity, the intervention period (pre-intervention or post-intervention), the speed limit of the road and sociodemographic features of the injured people.

The study found that both serious and slight injuries were lower after the lower speed limits were introduced, and fatal injuries were reduced by 63%. However, no information on the traffic flow was given. Overall, the study suggests that even a slight reduction in speed could have a significant impact on the reduction of fatalities and serious injuries and that the implementation of reduced speed limits has led to a significant improvement in road safety.

C.2.2 Forester et al. (1984) – United States

Forester et al. (1984) assessed the effect on road fatalities of the 55 mph (89 km/h) national speed limit introduced in the United States in 1974 and estimated both the additional years of life gained from preventing fatalities, and the additional travel time resulting from the reduced speed limit. The study estimates the new limit reduced fatalities by approximately 7,466 annually, with an annual gain of 316,600 years of life. The study also estimates that the new limit results in an additional 456,300 years of life annually being spent in travel time.

C.2.3 Haworth et al. (2001) – Australia

Haworth et al. (2001) examine the reduction of the national urban speed limit in Australia from 60 km/h to 50 km/h, with reference to trials of 50 km/h limits in Australia and experience in other countries. In respect of the Australian trials, they present evidence of reductions in crashes ranging between 8% and 21% (see Table C.1).

Table C.1 Safety Effects of 50km/h Trials in Australia

Jurisdiction	Scope	Reduction in Crashes
New South Wales	All crashes	21%
Queensland	Fatal crashes (Queensland Transport estimate)	18%
Queensland	Fatal crashes (Meers and Roth estimate)	15%
Queensland	All crashes	8%

C.2.4 Archer et al. (2008) – Australia

In a subsequent Australian study, Archer et al. (2008, 13–14) presented the following evidence concerning the safety effects of the 50km/h Default Urban Speed Limit in Australia (see Table C.2).

Table C.2. Safety Effects of 50km/h Trials in Australia

Jurisdiction	Scope	Reduction in Crashes
New South Wales	All crashes	25.3%
Queensland	Casualty crashes	8%
Queensland	Fatal crashes	18%
Victoria	All crashes	8%
Victoria	Fatal/serious injury crashes involving pedestrians	25–40%
Western Australia	Casualty crashes (metropolitan area)	21%
Western Australia	Crashes involving pedestrians (metropolitan area)	51%
Australian Capital Territory	Police reported crashes	2.1%

C.2.5 Thiedig (2018) – Germany

Thiedig (2018) presents a Cost Benefit Analysis (CBA) of the introduction of a 130 km/h speed limit for passenger cars on two sections of highway (which currently have no general speed limit) in the German state of North Rhine-Westphalia, based on a comparison with the adjoining sections in the Netherlands (where such a limit already applies). Thiedig estimates that the policy will result in positive annual net social benefits in relation to safety for both road sections (ibid., Figure 8.1).

C.2.6 Cerema (2020) – France

Cerema (2020) describe an assessment of the French reduction in speed limit on two-way roads without a central reservation from 90 km/h to 80 km/h; the limit was lowered in 2018 and the assessment carried out over the following 18 months.

Cerema state the following with reference to the safety effects of this reduction:

> *The impact of the measure corresponds to a 12% drop in the number of people killed on the relevant road network which does not include motorways and conurbations, compared to the remainder of the French road network (with an estimated error rate of 3.6%).*
>
> *[F]or the 18 months following implementation of the measure, for which the…data are definitive and validated…a reduction of 331 people killed is observed on the relevant network, compared to the reference period, 2013 to 2017. Taking account of the months of January and February 2020, for which the data are estimated, the reduction in the number of people killed totals 349 over a period of 20 months.*
>
> *On the remainder of the French road network there is a different trend, with a stagnation in the number of people killed compared to the reference level.*
>
> *The impact of the measure is more moderate on the number of accidents causing bodily injury or death. On the relevant network, the number stabilised at the baseline level. However the reduction in severity of accidents should be noted, with a 10% reduction in the mortality rate. (ibid.)*

They estimate a net socioeconomic benefit due to reduced crashes of €1.2 billion; although there is a substantial disbenefit due to increased travel times, the combined safety and fuel consumption/CO2 emission benefits outweigh this.

C.2.7 Nordic Studies

Sandberg Hanssen et al. (2020) compare the national CBA models in Norway, Sweden and Finland as applied to an illustrative hypothetical speed limit reduction (from 90 km/h to 80 km/h). Accidents are among the parameters considered in the analyses; however, they are addressed primarily from the point of view of how differing treatments of accident costs affect the comparison between the models, rather than in absolute terms. The speed limit reduction is shown to have positive safety benefits (negative costs) in the Swedish and Finnish models, regardless of which of the three sets of parameters is applied to each model (ibid., Table 3). Model limitations made it impossible to obtain reliable results for Norway (ibid, 5).

Lopez-Aparicio et al. (2020) present an emissions and cost-benefit analysis of the effects of environmental speed limits (ESLs) introduced on certain main roads in Oslo, Norway, to address PM10 emissions during winter. Accidents are shown to reduce under both of the compliance scenarios examined ("real-world" compliance, based on observed speeds following the implementation of the limits, and full compliance, which assumes 100% compliance with the limits and thus lower speeds). There are falls of 24.7% in fatalities, 19.4% in major injuries and 13.6% in minor injuries for real-world compliance; for full compliance, the corresponding reductions are 50.9%, 42.8% and 32.3%, respectively (ibid., Table 4).

C.2.7 Alcaraz Carrillo de Albornoz et al. (2022) - Spain

Alcaraz Carrillo de Albornoz et al. (2022) propose a methodology for determining an optimal speed limit based on CBA and applied it to two Spanish case studies. They develop expressions for the costs of journey time, vehicle operation, accidents, climate change and air pollution as functions of the speed limit (communication and enforcement costs of a speed limit change are also considered but are independent of the limit itself, and noise, vibration and road wear and tear are excluded as insignificant), then set the sum of their derivatives with respect to the speed limit equal to zero in order to calculate the optimal limit.

In the first case study (a short-lived 2011 reduction in the speed limit on Spanish highways and freeways from 120 km/h to 110 km/h, intended to reduce fuel consumption), the reduction is found to be justified, insofar as the optimal limit for such roads is 70 km/h. Although the policy was originally justified in terms of reducing fuel consumption, the main benefit is instead found to be a reduction in casualties (ibid., 7).

In the second case study (a reduction in the speed limit on Madrid's M-30 ring road from 90 km/h to 70 km/h, imposed only on days with high pollution levels), the optimal limit is again found to be even lower than the reduced one (60 km/h). Again, the safety benefits are found to be larger than the pollution-related ones originally used to justify the policy (ibid., 9).

C.3 Environmental Impacts

C.3.1 Haworth et al. (2001) – Australia

Haworth et al. examined, among other impacts, the effect of reduced speed limits on traffic-related air pollution costs in Australian urban areas. Using the EU MASTER (Managing Speeds of Traffic on European Roads) framework, the study showed that a general 50 km/h limit would result in reduced pollution, but the monetary savings due to this factor were "relatively modest" in comparison with the savings in accident costs (Haworth et al., op. cit., 48).

C.3.2 Archer et al. (2008) – Australia

Archer et al. conducted a literature review (not limited to Australia) of the environmental impacts of speed limit reductions in the areas of energy efficiency, fuel use, emissions and noise. The evidence shows lower speeds to be associated with reduced fuel consumption and, generally, reduced emissions (although this is not necessarily true for all pollutants), as well as reduced noise levels (Archer et al., op. cit.,31–37).

C.3.3 Thiedig (2018) – Germany

Thiedig examined the hypothesis that the introduction of a speed limit on German highways "leads to improved fuel economy and reduces local and global emissions" (Thiedig, op. cit., 46). Thiedig applied emission factors from the German "Handbook of Emission Factors for Road Transport" to an estimated speed distribution based on Dutch data (reflecting the existence of a 130 km/h highway speed limit in the Netherlands).

The measure was shown to result in positive annual social benefits from improved fuel economy and reduced emissions, with about 63% of the benefits accruing to fuel economy and the balance split equally between global CO2 emissions and combined local air pollutants (ibid., 56). The environmental benefits can be seen to be larger than those from reduced accident rates on both of the road segments examined (ibid., 58).

C.3.4 Cerema (2020) – France

Cerema (op. cit.) report that the reduction of the French rural speed limit from 90 km/h to 80 km/h gave rise to "a slight decrease in the main atmospheric pollutants and noise nuisance, although the latter reduction is not perceptible to the human ear." (TRL (2022) state that the pollutant reduction in Cerema's study, described as "from 3% to 4.5%", was "not statistically significant" and that the noise reduction amounted to "less than 0.8 dB(A)").

C.3.5 Nordic Studies

Sandberg Hanssen et al. (op. cit.) discuss how the costs and benefits, including environmental ones, of a hypothetical speed limit reduction vary between the Norwegian, Swedish and Finnish national appraisal models; however, they do not address the environmental impacts of the measure in absolute terms. Every combination of model and parameters is shown to lead to positive environmental benefits (negative costs), although these are small for some combinations (ibid. Table 3).

Folgerø et al. (2020) examine the effects of the winter seasonal lowering of the speed limit on designated main roads in Oslo from 80 km/h to 60 km/h, a policy that was introduced as a pilot project in 2004, withdrawn in 2012 and reintroduced in 2016 (ibid., 4). They find no evidence that the reduced limit improves air quality; there is “some weak evidence” that it increases concentrations of nitrogen oxides, whereas estimates for PM10 and PM2.5 are “uncertain,” with “about the same probability of worsening as improving” these emissions.

Lopez-Aparicio et al. (op. cit.) find that implementing an environmental speed limit on certain main roads in Oslo (apparently the same policy as examined by Folgerø et al.) leads to “almost negligible” changes in NOx and CO2 emissions if real-world compliance with limits is assumed; if full compliance is assumed (e.g. greater speed reductions than the real-world scenario), there are moderate increases in emissions (1.9% and 0.2% respectively), mainly due to the fact that the assumed uniform speed changes across time periods lead to “a shift of rush hour emissions towards higher levels of congestion” (ibid., 6).

However, PM10 and PM2.5 emissions are reduced by 5% and 2%, respectively, relative to baseline in the “real-world compliance” scenario and by 12% and 6%, respectively, in the “full compliance” scenario (ibid.,7). Population exposure over two days to PM10 daily values between 65 and 85 µg m−3 is reduced by between 600 and 1,600 persons, with a further reduction of 2,500–3,600 persons for full compliance. Population exposure to 15–20 µg m−3 annual mean PM10 concentration is reduced by about 2,000 persons, or by 7,000–8,000 persons assuming full compliance. There is an average reduction in noise to inhabitants of the corridors examined of above 0.5 dB for real-world compliance and above 1.1 dB for full compliance, a reduction that Lopez-Aparicio et al. describe as “roughly equivalent to reducing the traffic volume by 20[%] and 40%...respectively” (ibid., 9).

C.3.6 Alcaraz Carrillo de Albornoz et al. (2022) - Spain

Alcaraz Carrillo de Albornoz et al. (op. cit.) examine two cases of reduced speed limits on main roads in Spain, introduced respectively to reduce fuel consumption and pollution, using the perspective of a theoretical optimal speed limit. Although they find that both limits are justified insofar as the respective optimal limits are even lower, the major benefit in both cases is attributable to reduced collisions rather than to reduced fuel consumption or pollution (ibid., 7, 9).

C.3.7 Urban transport modelling – An investigation into the effects of urban traffic, speed limits and driving style on travel times, fuel efficiency and CO_2 and NOx emissions - Future Transport Research (2022)

The study found that the energy required to accelerate vehicles to the speed limit was the largest contributor to fuel consumption in urban traffic conditions. Vehicles are often more efficient at higher speeds, but this does not account for the energy required to reach these speeds. The study found that cruising at speed of 50 kph, accounting for the acceleration phase in only more efficient than cruising at speed of 30 kph if the vehicle can drive for almost 0.5km without stopping, which is unlikely under urban traffic conditions. The study also showed using the traffic model representative of London traffic, that there is only little improvement in average speed of travel for speed limits above 40 kph and that the increase in emissions at higher speed limits was greater than the increase in average speed.

C.3.8 EEA (2008)

This study implemented speed control measures in Rotterdam in Netherlands. The measure has proved successful in reducing emissions in a targeted area (3.5 km stretch of motorway) by reducing and strictly enforcing speed limits. In the first year of operation the measure saved approximately 1,000 tonnes of CO_2, however more widespread controls on speed would be required to achieve CO_2 emission reduction on a larger scale. The study however did not provide any assessment on how this could be implemented and what would be other impacts associated with the reduction in speeds on motorways.

C.4 Economic Impacts

C.4.1 Forester et al. (1984) – United States

Forester et al. (op. cit.) presents a cost benefit analysis (CBA) of the introduction of the 1974 55 mph (89 km/h) national speed limit. When time is valued at the 1981 average hourly wage, the benefit/cost ratio (BCR) for the limit ranges between 0.35 and 0.42, indicating a negative economic return. The highest BCR quoted in the paper is achieved when time is valued at 30% of the average hourly wage and lives are valued based on a revealed preference study, but, at 0.84, it is still less than a value of 1 which would indicate a neutral economic impact. The authors note that "unless time is valued at less than one-quarter of the average wage…the 55 mph limit could not be justified on exclusively economic grounds (ibid., 639). They conclude that the "results do not make a strong case for maintaining the…limit" (ibid., 640).

In a comment on the study by Forester et al., Miller (1984) states that the original study's assumption that the figure for total miles driven at any speed on all roadways is equal to the number of miles of travel for which a 4.8 mph (8 km/h) drop in average speed resulted from the limit's introduction is erroneous and results in "at least a doubling of the estimated time lost due to the change" (ibid., 547). Miller goes on to state that correcting this alleged error would lead to a positive BCR for two of the four travel-time values examined by Forester et al. He also makes further criticisms of the methodology but does not specify how these might affect the results.

C.4.2 Haworth et al. (2001) – Australia

In connection with their examination of the effects of a 50km/h urban speed limit in Australia, Haworth et al. (op. cit.) conducted a CBA considering accident, air pollution, vehicle operating and travel time costs. The study estimates that the Australia-wide introduction of a 50km/h urban limit would generate positive monetised safety benefits, although, depending on the assumptions concerning travel time and crash costs, these might not be sufficient to produce an overall net benefit for the policy (ibid., 47–52).

Overall, the results show that the policy results in a net disbenefit, but this is attributable to travel time increases that "correspond to very small increases in time for a very large number of trips" (ibid., 5.5.1), and the authors thus recommend in favour of its implementation. (It may also be noted that noise and CO_2 emissions were excluded from the analysis).

C.4.3 Archer et al. (2008) – Australia

In a subsequent Australian study, Archer et al. (2008) notes that:

> *In most cases…studies suggest significant overall benefits to society as a result of lowering speed limits. However, when these benefits are weighed against the costs associated with increased travel times the net result is often negative. This has led to a debate relating to the assumptions of the economic rationalist approaches and how safety and travel time benefits and costs are estimated. Particular concern lies with the question of how appropriate and meaningful it is to aggregate small increments in travel time, and whether individual's [sic] tasks or activities will be noticeably affected by increases of a few seconds. (ibid., xv)*

Archer et al. go on to examine the question of CBA of speed limits in greater detail. Discussing the earlier Australian study by Haworth et al., they state:

> *There were also a number of other assumptions that led to the estimation of benefits being overly conservative. In particular, some of the emissions and noise data were not included in the calculations, neither were the possible benefits of improved speed compliance on collector and arterial roads, or the benefits of [reductions in] unreported accidents. The associated costs of the reduced travel speeds were however overestimated due to the fact that route or destination substitution effects and trip suppression effects were not included. (ibid., 42)*

They also state that:

> *Haworth and Colleagues…identified a fundamental problem in comparing the costs of travel time…and the cost of crashes…The problem is related to the fact that the time lost as a result of lower travel speeds is valued at a higher rate than the time lost as a result of crashes. This problem is well recognised in the research literature. A further dilemma among previous analyses of travel time effects related to reduced speed limits is that related to the meaningfulness of valuing very small changes in travel time across large numbers of vehicles. (ibid., 42)*

C.4.4 Thiedig (2018) – Germany

Thiedig (op. cit.) found positive annual net social benefits for the introduction of a speed limit on German highways in the case of both road sections examined, with the combined effects of improved safety, fuel economy and emissions reductions more than counteracting travel time losses (ibid., 58). An estimate of the private benefits of the policy (which considers only travel time, fuel economy – in this case, with taxes included in the fuel price – and the so-called internalized share of accident costs, estimated at 76%) also shows a positive result (ibid., 59-60).

C.4.5 Cerema (2020) – France

Following the reduction of the speed limit from 90km/h to 80km/h on undivided rural roads in France, an economic analysis of the impact of such policy was conducted (Cerema, op. cit.). This analysis reported a positive socio-economic balance of €700 million over one year, broken down as follows:

- Annual monetary loss of between €721 million and €917 million for journey times – for journeys of around 30km, the average increase in journey time was estimated to be 30 to 40 seconds. For journeys of around 80km, the average increase in journey time is around 1 to 2 minutes. The increase in journey time is then estimated to cause a loss of €721 million in a low traffic flow scenario (220 billion km), and a loss of €917 million in a high traffic scenario (280 billion km)
- Annual monetary gain of €1.2 billion for road safety (considering prevented deaths, hospitalised injuries, and minor injuries)
- Annual monetary gain of between €251 million (low traffic scenario) and €320 million (high traffic scenario) for the fuel saving
- Annual monetary gain of between €54 million (low traffic scenario) and €65 million (high traffic scenario) related to greenhouse gas emissions

Interestingly, the monetary loss caused by the lengthening of the journey time is lower than the monetary gain derived from road safety.

C.4.6 Nordic Studies

Sandberg Hanssen et al. (op. cit.) compare the national CBA models in Norway, Sweden and Finland as applied to an illustrative hypothetical speed limit reduction (from 90 km/h to 80 km/h). The principal parameters considered in the CBA are time, life/accidents and environmental impacts (CO2, PM10 and NOx emissions – noise is mentioned but is not discussed in detail, and it is unclear whether it is valued in the analyses). All the models show that reduced accident and environmental costs fail to offset increased time costs; thus, the measure fails to produce a positive net societal benefit.

The Norwegian model shows the largest increase in time costs. Some of the differences between models are attributable to differences in parameters (notably, Norway uses high values for time, accidents and NOx emissions, although Sweden has the highest value for CO2 emissions and Finland for PM10 emissions), but the outcomes differ even when the same parameters are applied across models; Hanssen et al. attribute this to “the less explicit, often in-built programming or coding peculiarities of each national model” (ibid., 5-6).

Folgerø et al. (op. cit., Table 4) present a CBA of an environmental speed limit (ESL) on certain main roads in Oslo. The CBA considers travel time, fuel consumption, air quality, accidents and noise. The analysis shows a net societal disbenefit from the policy.

Lopez-Aparicio et al. (op. cit.) also present a CBA of ESLs in Oslo. (As previously discussed, the policies examined appear to be the same as in the study by Folgerø et al.) The parameters considered in the CBA are NOx and CO2 emissions, PM10 population exposure, fuel consumption, noise exposure, accidents and time costs (ibid., 5). The ESLs are shown to have “low to negligible effects” on PM2.5, NOx or CO2 emissions at the speeds considered, but PM10 and noise emissions are “significantly reduced” (ibid., 12). However, the monetised benefits of these emissions reductions are not always sufficient to offset the additional time costs resulting from the ESLs. A net benefit occurs if observed speed data from the period when the ESLs were in force (e.g. reflecting real-world compliance with the limits) is used, but there is a net cost under a theoretical scenario of strict compliance with the ESLs (involving greater reductions than the real-world scenario), principally due to the difference in journey time costs.

C.5 Summary Impacts

The principal conclusions emerging from this review are summarised below for each of the categories considered.

C.5.1 Safety

There is universal agreement across the studies reviewed that speed limit reductions produce positive safety benefits. Reductions in collisions quoted across the various studies reviewed range from 8% to 63%, depending on study and casualty type.

C.5.2 Environment

Many of the studies (e.g. Haworth et al., most results reviewed by Archer et al., Thiedig, Cerema, Sandberg Hanssen et al., some results from Lopez-Aparicio et al.) show positive environmental benefits from speed limit reductions. However, it must be emphasised that most of these did not account for potential re-routing impacts of speed limit reductions (Lopez-Aparicio et al. used a regional transport model and so presumably represented such effects, although this is not made explicit).

Findings of positive environmental effects are by no means universal. Folgerø et al., along with some of the studies reviewed by Archer et al. and some results from Lopez-Aparicio et al., indicate that reducing speed limits can increase the levels of certain emissions. Additionally, some of the studies (e.g. Cerema and other results from Lopez-Aparicio et al.) that did find positive environmental benefits show them to be negligible, and others (e.g. Haworth et al., Cerema, Alcaraz Carrillo de Albornoz et al.) found them to be significantly less (in monetised terms) than the safety benefits of reduced speed limits.

C.5.3 Economy

The evidence on the economic impacts of lower speed limits is very mixed and is dependent, at least in part, on the particular CBA methodology used, the value of time adopted and on the range of impacts valued. The studies by Thiedig and Cerema are the only ones reviewed here to show a consistently positive economic benefit; Lopez-Aparicio et al. also find a net benefit, but only if real-world, as opposed to strict, compliance with the new speed limit is assumed (and minimal changes to journey times as a result).

By contrast, Forester et al., Haworth et al., Sandberg Hanssen et al. and Folgerø et al., plus Lopez-Aparicio et al. for the case of strict compliance, find net economic disbenefits. Thus, only two of the seven studies reviewed that calculated economic benefits reported them to be consistently positive.

It should be noted that existing methods of economic appraisal and cost benefit analysis are limited and use value of time to monetise the journey time impacts of transport interventions. Similarly, typical accident costs and emission values (monetary value of carbon) are used to monetise safety and emission impacts respectively. This method of economic appraisal is weighted overwhelmingly towards journey time savings, where small changes in individual journey times can be very significant when monetised (using existing values of time), applied to a large number of users and aggregated over 30-year appraisal periods. As a result, any transport project which increases journey times (such as a speed limit reduction) tends to result in significant monetised disbenefits, as reflected in the majority of studies examined as part of this review. The exception to this is studies where discounted values of time have been used, small increases in journey time disregarded (as discussed in the Australian studies) or changes have been made to other standard parameters.

C.6 Conclusion

In short, the review contained within this chapter found that, overwhelmingly the implementation of speed limit reductions resulted in significant safety benefits.

In terms of environmental / emissions impacts, the review provided mixed results. However studies which analysed observed data (as opposed to theorised or modelled) generally found that any environmental impacts were minimal or statistically insignificant.

Economic impacts from the studies reviewed were also seen to be mixed. The majority of studies reported negative economic impacts resulting from the reduced journey times outweighing monetary benefits seen from safety and environmental savings.

Appendix D Rural Road Modelling

Table D.1 Change in Total Vehicle Kilometres Travelled Group 1 (Divided and Undivided Roads) Relative to 2018 Baseline

Scenario	Description	Change in Total Vehicle Kilometres Travelled				
		Divided Roads	Divided Roads %	Undivided Roads	Undivided Roads %	Total Change
1	**10 kph** reduction applied to the **entire rural road network**	28,313	+0.1%	-28,408	0.0%	-95
2	**10 kph** speed reduction applied on all **rural single carriageway roads**	640,781	+1.9%	-725,902	-0.8%	-85,121
6	Speed limit on all rural **divided roads** reduced by **10kph** and all **rural single carriageway** roads reduced by **20 kph**	288,931	+0.8%	551,750	0.6%	840,681

Table D.2 Change in Total Vehicle Kilometres Travelled Group 2 (Divided and Undivided Roads) Relative to 2018 Baseline

Scenario	Description	Change in Total Vehicle Kilometres Travelled				
		Divided Roads	Divided Roads %	Undivided Roads	Undivided Roads %	Total Change
3	Speed limit of **80 kph** applied to all **National Secondary Roads** only	62,549	+0.2%	106,446	0.1%	168,995
4	Speed limit of **60 kph** applied to all **Local Roads**	102,878	+0.3%	125,099	0.1%	227,977
5	Speed limit of **70 kph** applied to all **National Secondary** and **Regional Roads**	214,249	+0.6%	462,257	0.5%	675,557
7	Speed limit of **80 kph** on all **National Secondary** Roads and 60 kph on all **Local Roads**	653,208	+1.9%	-605,633	-0.6%	47,575

Table D.3 Change in Total Vehicle Kilometres Travelled Group 1 on Single Carriageways per Speed Limit (Relative to 2018 Baseline)

Scenario	Description	Change in Total Vehicle Kilometres Travelled			
		>=80kph	>=80kph %	<80kph	<80kph %
1	**10 kph** reduction applied to the **entire rural road network**	-8,006,916	-6.2%	7,978,508	6.1%
2	**10 kph** speed reduction applied on all **rural single carriageway roads**	-7,457,730	-5.7%	6,731,829	5.2%
6	Speed limit on all rural **divided roads** reduced by **10kph** and all **rural single carriageway** roads reduced by **20 kph**	-13,964,859	-10.7%	14,516,609	11.2%

Table D.4 Change in Total Vehicle Kilometres Travelled Group 2 on Single Carriageways per Speed Limit (Relative to 2018 Baseline)

Scenario	Description	Change in Total Vehicle Kilometres Travelled			
		>=80kph	>=80kph %	<80kph	<80kph %
3	Speed limit of **80 kph** applied to all **National Secondary Roads** only	-306,984	-0.2%	413,430	0.3%
4	Speed limit of **60 kph** applied to all **Local Roads**	-2,352,882*	-1.8%	2,477,982*	1.9%
5	Speed limit of **70 kph** applied to all **National Secondary** and **Regional Roads**	-13,212,612	-10.1%	13,674,870	10.5%
7	Speed limit of **80 kph** on all **National Secondary** Roads and 60 kph on all **Local Roads**	-2,223,666*	-1.7%	1,618,003*	1.2%

* *The full extent of changes in vehicle kilometres travelled on Local Roads could not be explicitly modelled as part of this assessment*

Table D.5 Total Change in Greenhouse Gas Emissions (CO_2e) - Relative to 2018 CAP Baseline

Scenario	Description	Total Change in Greenhouse Gases (CO_2e) 2018 Vehicle Fleet	
		Tonnes Emitted	% Change from 2018 baseline
1	**10 kph** reduction applied to the **entire rural road network**	-69,993	-0.6%
2	**10 kph** speed reduction applied on all **rural single carriageway roads**	-7,987	-0.1%
3	Speed limit of **80 kph** applied to all **National Secondary Roads** only	-3,153	0.0%
4	Speed limit of **60 kph** applied to all **Local Roads**	17,438	0.1%
5	Speed limit of **70 kph** applied to all **National Secondary** and **Regional Roads**	-6,358	-0.1%
6	Speed limit on all rural **divided roads** reduced by **10kph** and all **rural single carriageway** roads reduced by **20 kph**	-49,900	-0.4%
7	**S**peed limit of **80 kph** on all **National Secondary Roads** and **60 kph** on all **Local Roads**	13,071	0.1%

Table D.6 Total Change in Travel Time (Hours) (2018 Do-Minimum v Do-Something Scenario)

Scenario	Description	Change in Total Hours (Do-Minimum v Do-Something)	Total Hours % (Do-Minimum v Do-Something)
1	**10 kph** reduction applied to the **entire rural road network**	3,133	1.3%
2	**10 kph** speed reduction applied on all **rural single carriageway roads**	1,934	0.8%
3	Speed limit of **80 kph** applied to all **National Secondary Roads** only	358	0.1%
4	Speed limit of **60 kph** applied to all **Local Roads**	510	0.2%
5	Speed limit of **70 kph** applied to all **National Secondary** and **Regional Roads**	2,097	0.8%
6	Speed limit on all rural **divided roads** reduced by **10kph** and all **rural single carriageway** roads reduced by **20 kph**	5,502	2.2%
7	**S**peed limit of **80 kph** on all **National Secondary Roads** and **60 kph** on all **Local Roads**	2,045	0.8%

Appendix E Urban Road Modelling

E.1 Scenarios

To determine the impact of reduced speed limits, 2020 Models have been run for the following scenarios:

- **Do-Nothing**: Existing (2020) transport network
- **Do-Something 1**: Reduce all speed limits within defined urban boundaries from 50kph to 30kph
- **Do-Something 2**: A refinement of Do-Something 1, whereby only those roads / streets appropriate for 30kph speeds are reduced to 30kph. Key radial routes and routes which facilitate strategic movements, with low levels of pedestrian and cycle activity, were given speed limits of 50kph

Following evaluation of initial modelling results, it was considered appropriate that the Do-Something 2 scenario was the most feasible of the two Do-Something scenarios considered and therefore this scenario was brought forward for detailed analysis. The remainder of this appendix will present the results for this scenario.

E.2 Key Performance Indicators

The impacts of the modelled scenarios tested have been categorised under the following headings:

- High Level Impacts
- Safety Impacts
- Environmental Impacts
- Economic Impacts

These impacts have been analysed using the following Key Performance Indicators (KPIs):

- <u>High Level Impacts</u>
  - Mode Share
  - Re-routing
- <u>Safety Impacts</u>
  - Total Kilometres travelled at various speed limits
- <u>Environmental Impacts</u>
  - Change in Total Emissions, including Carbon Emissions
- <u>Economic Impacts</u>
  - Change in Total Travel Time
  - Change to average journey time

E.3 Overview of Speed Limit Modeling for Cities

To determine the impact of reducing speed limits in cities, the cities of Dublin and Cork were selected and analysed using the East Regional Model (ERM) and South West Regional Model (SWRM) respectively. Dublin is significantly larger (in terms of size and population) than the other cities in Ireland and as a result has different transport patterns and behaviours. Therefore, to ensure the analysis is representative, two cities, as opposed to one, have been assessed using the NTA Regional Modelling System (RMS).

Figures E.1 and E.2 show the Do-Something assumptions adopted for the Dublin and Cork tests. In summary, the Do-Something Scenario involved reducing speed limits in the city centre areas to 30kph, except for key radial routes into and around the city which were given speed limits of 50kph.

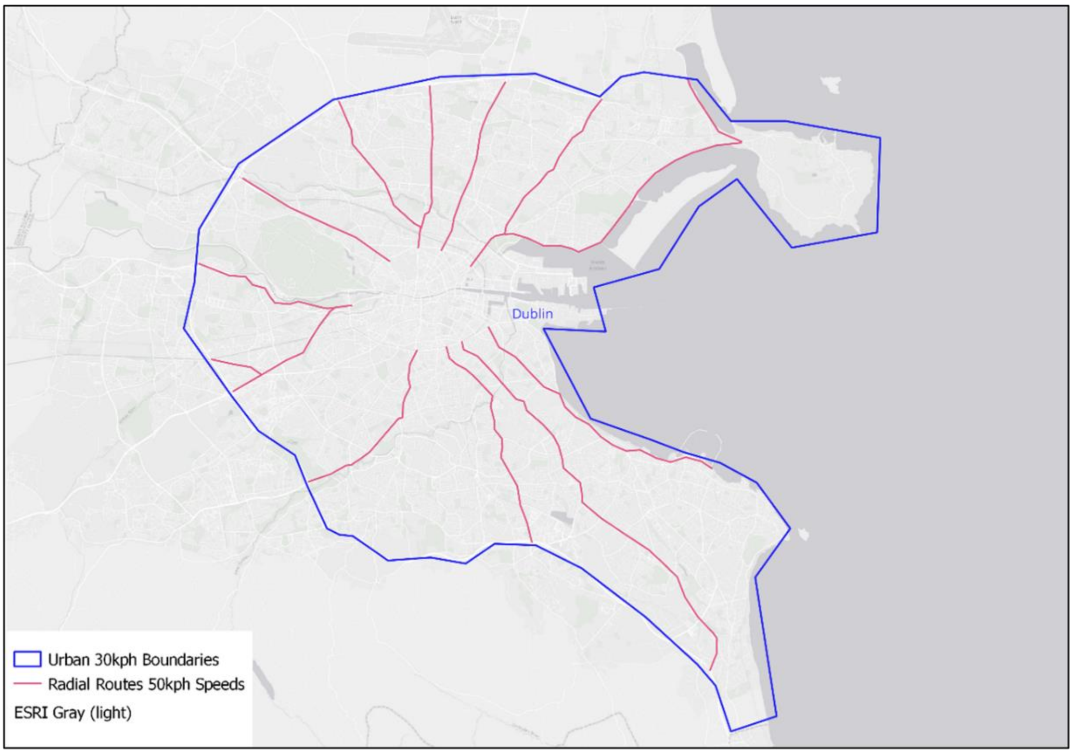

Figure E.1 Dublin 30kph Speed Limit Areas

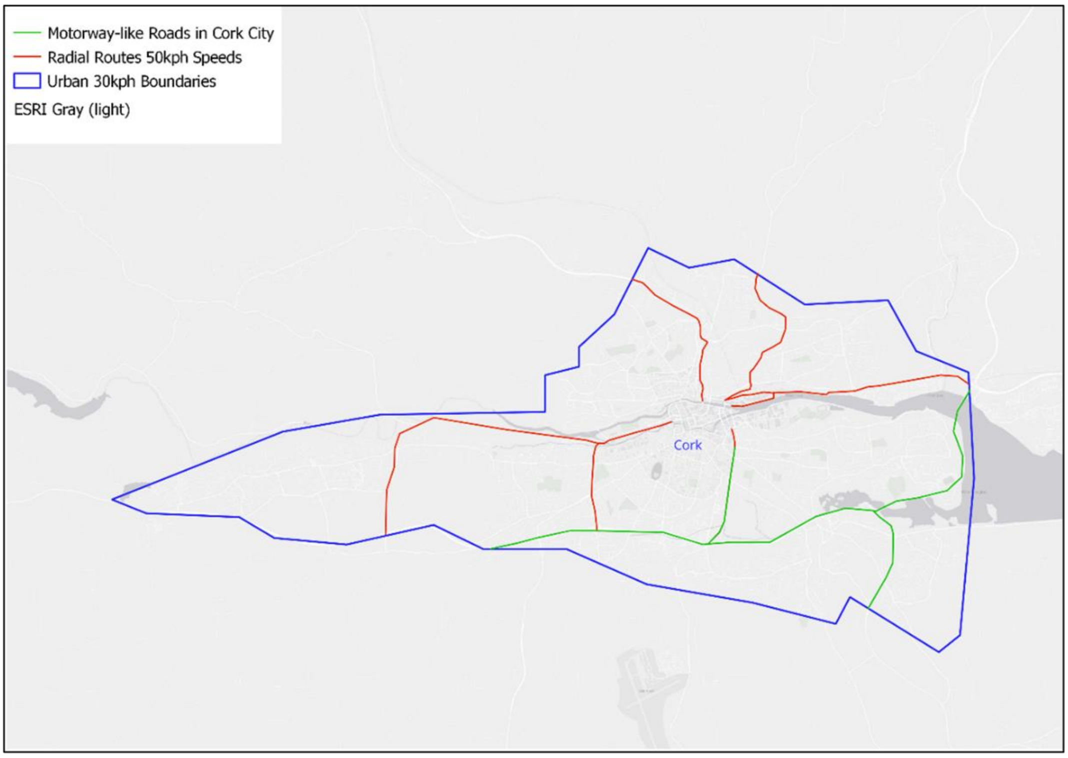

Figure E.2 Cork 30kph Speed Limit Areas

On urban motorways or "motorway-like" roads (fully segregated dual carriageway with only grade-separated junctions) existing speed limits have been retained. This includes the M50 in Dublin as well as the N40 and N27 (south of Cork city centre) through Cork.

The remainder of this appendix will summarise the impacts of the above model tests for both Dublin and Cork in turn.

E.4 Dublin City – Road Network Impacts

The impact of the speed limit reductions on modelled average annual daily traffic is shown in Figure E.3 below, with the reduction to modelled HGV average annual daily traffic shown in Figure E.4.

Figures E.3 and E.4 demonstrate that the introduction of reduced speed limits in the city results in traffic (both car and HGV) re-routing away from the roads with reduced speed limits and on to the higher speed, strategic network (radials, Port Tunnel and M50). The M50 is seen to experience the greatest increase in traffic and vehicles opt to use this motorway to travel around the city as opposed to travelling through it.

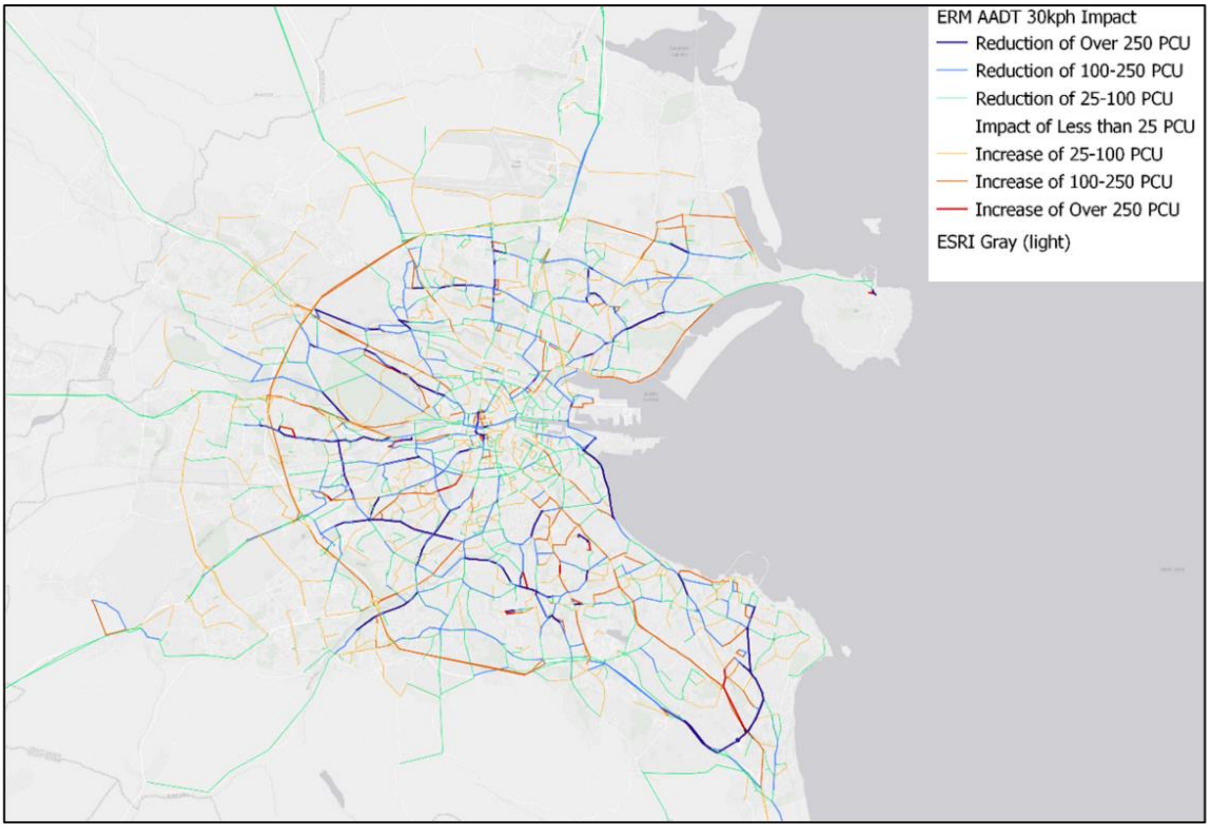

Figure E.3 Change in Modelled AADT (all traffic)

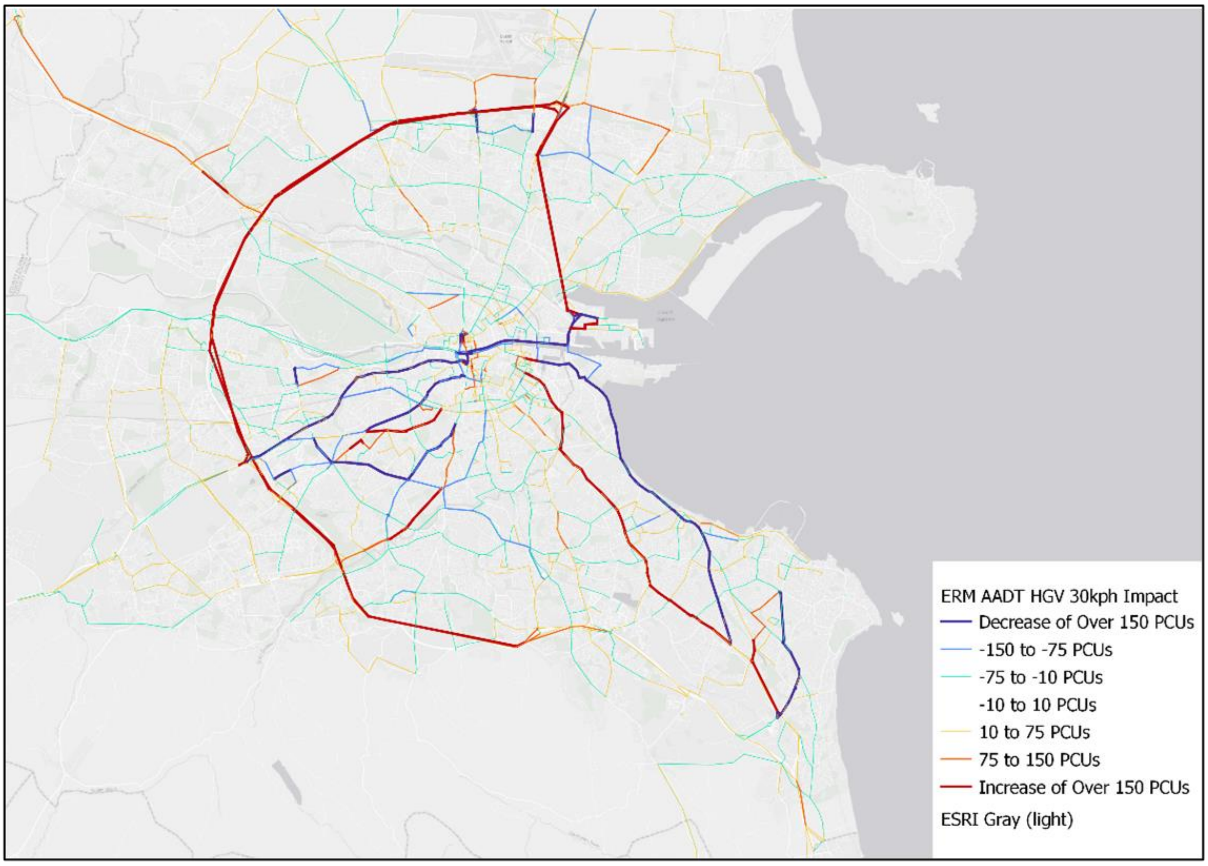

Figure E.4 Change in Modelled HGV AADT

E.5 Dublin City – Safety Impacts

The vehicle kilometre impacts on the entire Eastern Regional Model (ERM) area and the Study Area (within M50) for the Do-Something Scenario are outlined in the E.1 and Table E.2, respectively.

Table E.1 Dublin (24hr) Vehicle kms by Speed Category (Entire Eastern Regional Model)

Modelled Speed Limit (kph)	Baseline Vehicle km	Do-Something (30kph) Scenario Vehicle km	Absolute Difference	% Difference
Under 30	378,122	414,356	36,234	9.6%
30	405,681	4,027,533	3,621,852	892.8%
40	3,151,435	794,615	-2,356,819	-74.8%
50	11,726,606	10,442,678	-1,283,928	-10.9%
60 and over	39,994,408	39,573,678	-420,730	-1.1%
Total	55,656,252	55,252,859	-403,393	-0.7%

Speed limit reduction results in a significant increase in vehicle kilometres at 30kph and a corresponding drop in vehicle kilometres at speeds of 40kph and above. Looking at only the area for which the speed limit reductions are applied, the relative decrease in vehicle kilometres is more pronounced, as shown in Table E.2.

Table E.2 Dublin (24hr) Vehicle kms by Speed Category (Within the M50)

Modelled Speed Limit (kph)	Baseline Vehicle km	Do-Something (30kph) Scenario Vehicle km	Absolute Difference	% Difference
Under 30	357,996	393,905	35,909	10.0%
30	323,619	3,896,557	3,572,938	1104.1%
40	2,474,113	123,590	-2,350,523	-95.0%
50	2,255,712	816,388	-1,439,324	-63.8%
60 and over	5,698,234	5,567,078	-131,156	-2.3%
Total	**11,109,673**	**10,797,518**	**-312,154**	**-2.8%**

E.6 Dublin City – Environmental Impacts

The emission impacts of the speed limit reductions are shown in Table E.3 and E.4 for the entire model area and study area only, respectively.

Table E.3 ENEVAL GHG (CO_2e) Impact of Speed Limit Reductions (Entire ERM)

Vehicle Type	Baseline CO_2e (tonnes)	Do-Something (30kph) Scenario CO_2e (tonnes)	Absolute Difference	% Difference
Car	2,362,434	2,348,205	-14,229	-1%
Goods	1,541,746	1,553,332	11,586	1%
Non-Urban Bus	55,447	55,868	421	1%
Urban Bus	24,875	26,084	1,209	5%
Total	**3,984,501**	**3,983,488**	**-1,014**	**0%**

The table above demonstrates that the reduced speed limits cause a reduction in GHG emissions for Cars, arising as a result of a reduction in the total number of car trips undertaken (mode shift). However, there is an increase in carbon emissions for goods vehicles and buses as these vehicles are less efficient (in terms of carbon emissions) at 30kph than at 50kph. The net impact is a very marginal decrease in GHG annual tonnes which equates to less than a 0.025% of total emissions.

Analysis of the area for which the speed limit is applied, within the M50, shows a similar pattern with decreased emissions from cars and increased emissions from Bus and HGVs. Analyses of the study area shows a slightly more significant reduction in GHG emissions; however it should be noted that many car trips re-route to the M50 in the Do-Something scenario and the emissions from these vehicles (which will be above the Do-Min scenario) are not captured in the results in Table E.4.

Table E.4 ENEVAL GHG (CO_2e) Impact of Speed Limit Reductions (Study Area Only)

Vehicle Type	Baseline CO_2e (tonnes)	Do-Something (30kph) Scenario CO_2e (tonnes)	Absolute Difference	% Difference
Car	410,390	401,209	-9,181	-2%
Goods	211,074	216,544	5,471	3%
Non-Urban Bus	9,276	9,685	409	4%
Urban Bus	17,224	18,398	1,173	7%
Total	**647,964**	**645,836**	**-2,128**	**0%**

E.7 Cork City – Road Network Impacts

The impact of the speed limit reductions on modelled average annual daily traffic is shown in Figure E.5 below, with the reduction to modelled HGV average annual daily traffic shown in Figure E.6. The Figures demonstrate that, to avoid the reduced speed limits, both cars and HGVs route away from roads with reduced speed limits towards motorways (e.g. N40) and radial routes un-affected by the reduced speed limits.

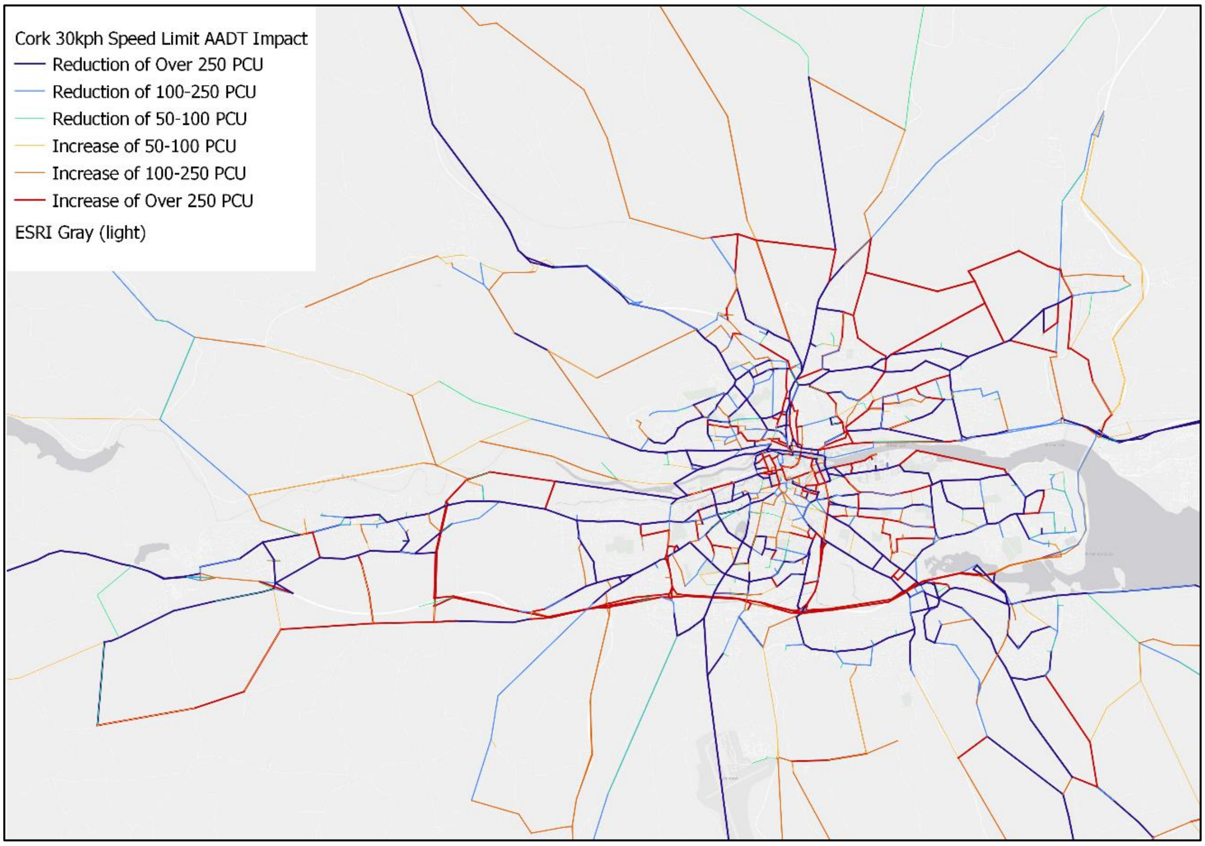

Figure E.5 Change in Modelled AADT (all traffic)

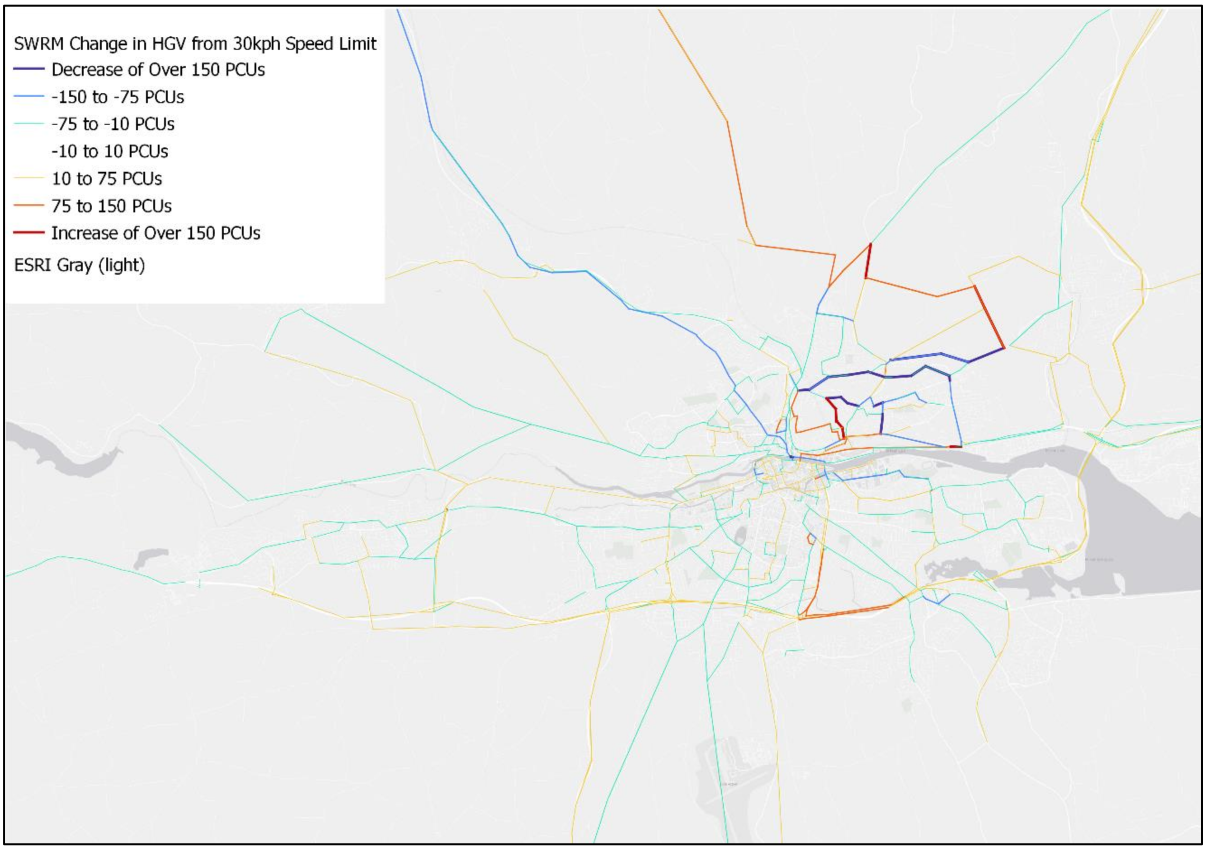

Figure E.6 Change in Modelled HGV AADT

E.8 Cork City Analysis (Safety)

To better assess the safety impact of the proposed speed limit changes, an analysis of total kilometres travelled at various speeds in the Do-Minimum and Do-Something Scenarios was carried out. The vehicle kilometre impacts for the Do-Something Scenario are outlined for the entire model area and Study Area in the Tables E.5 and E.6 respectively.

These tables both show a significant increase in vehicle kilometres travelled at the safer, slower, speeds and a reduction in kilometres travelled at faster speeds.

Table E.5 24hr Vehicle kms by Speed Category (Entire South West Regional Model)

Modelled Speed Limit (kph)	Baseline Vehicle km	Do-Something (30kph) Scenario Vehicle km	Absolute Difference	% Difference
Under 30	22,997	25,072	2,076	9.0%
30	118,454	1,012,827	894,373	755.0%
40	459,815	65,476	-394,338	-85.8%
50	2,620,702	2,037,752	-582,950	-22.2%
60 and over	14,406,836	14,377,744	-29,092	-0.2%
Total	**17,628,803**	**17,518,871**	**-109,932**	**-0.6%**

Table E.6 24hr Vehicle kms by Speed Category (Study Area Only)

Modelled Speed Limit (kph)	Baseline Vehicle km	Do-Something (30kph) Scenario Vehicle km	Absolute Difference	% Difference
Under 30	22,997	25,072	2,076	9.0%
30	115,713	906,583	790,870	683.5%
40	422,253	59,840	-362,413	-85.8%
50	646,340	139,803	-506,537	-78.4%
60 and over	1,221,340	1,220,057	-1,283	-0.1%
Total	**2,428,644**	**2,351,355**	**-77,289**	**-3.2%**

E.9 Cork City – Environmental Impacts

The emission impacts of the speed limit reductions are shown in Table E.7 for the entire model area.

Table E.7 ENEVAL GHG (CO_2e) Impact of Speed Limit Reductions (Entire SWRM)

Vehicle Type	Baseline CO_2e (tonnes)	Do-Something (30kph) Scenario CO_2e (tonnes)	Absolute Difference	% Difference
Car	876,511	874,215	-2,295	0%
Goods	487,928	491,105	3,177	1%
Non-Urban Bus	13,020	13,117	98	1%
Urban Bus	4,600	4,973	373	8%
Total	**1,382,059**	**1,383,412**	**1,353**	**0%**

E.10 Town Analysis – Safety Impacts

To better assess the safety impact of the proposed speed limit changes, an analysis of total kilometres travelled at various speeds in the Do-Minimum (Baseline) and Do-Something Scenarios was carried out. The vehicle kilometre impacts in the study area (town boundaries) are outlined in Table E.8.

As with the city analysis, this shows that there is a significant transfer of vehicle kilometres from higher speeds to lower, safer speeds.

Table E.8 24hr Vehicle kms by Speed Category (All Towns)

Modelled Speed Limit (kph)	Baseline Vehicle km	Do-Something (30kph) Scenario Vehicle km	Absolute Difference	% Difference
Under 30	6,047	6,395	347	6%
30	40,359	391,524	351,165	870%
40	82105	51755	-30350	-37%
50	578,822	252,582	-326,240	-56%
60 and over	1,155,491	1,127,167	-28,322	-2.5%
Total	**1,310,288**	**1,276,640**	**-33649**	**-3%**

E.11 Town Analysis – Environmental Impacts

The total emission impacts of the town speed limit reductions, as modelled within the relevant NTA Regional Models, are shown in Table E.9. For simplicity this table details the total emissions changes, as opposed to presenting 8 individual results for each town.

These results show negligible changes in emissions for all vehicle types with a very minor net increase in Carbon Dioxide forecast. These values are so small that they are considered insignificant.

Table E.9. ENEVAL GHG (CO_2e) Impact of Speed Limit Reductions (Sum of all Tows Assessed)

Vehicle Type	Baseline CO_2e (tonnes)	Do-Something (30kph) Scenario CO_2e (tonnes)	Absolute Difference	% Difference
Car	5,809,175	5,809,138	-37	0.0%
Goods	3,444,998	3,447,691	2,692	0.1%
Non-Urban Bus	144,175	144,421	246	0.2%
Urban Bus	33,136	33,198	62	0.2%
Total	**9,431,484**	**9,434,448**	**2,964**	**0.0%**

Table E.9 demonstrates that the speed limit reductions result in a reduction in GHG emissions for cars, but an increase for goods vehicles and buses and an overall marginal increase (less than 1%) in GHG emissions. The reduction in GHG emissions for cars is a result of a mode shift and reduction in the number of car trips on the network.

HGVs and Buses experience an increase in GHG emissions as these vehicles are less efficient (in terms of emissions) at the slower speeds of 30kph than at 50kph. Therefore, the reduce speed leads to increased emissions for these vehicles.

Looking at only the area for which the speed limit is applied, the emissions impact looks less positive, as is shown in Table E.10. This reflects the study area getting the full dis-benefit from the reduced speed limit (vehicles tend to emit CO_2e more at 30kph vs 50kph) but missing out on a small amount of the benefit from car demand reduction, due to some of this occurring outside the study area (car trips to Cork City from outside switching to alternative modes of transport).

Table E.10 ENEVAL GHG (CO_2e) Impact of Speed Limit Reductions (Study Area Only)

Vehicle Type	Baseline CO_2e (tonnes)	Do-Something (30kph) Scenario CO_2e (tonnes)	Absolute Difference	% Difference
Car	152,112	152,002	-110	0%
Goods	61,596	63,246	1,650	3%
Non-Urban Bus	1,302	1,380	78	6%
Urban Bus	3,454	3,812	357	10%
Total	**218,465**	**220,441**	**1,975**	**0%**

Appendix F Potential Impact of the Uptake of Electric Vehicles on Emissions

F.1 Rural Roads

The makeup of the vehicle fleet will change over time due to technological change and the use of energy saving technologies in car development. This also includes greater uptake of Hybrid Electric Vehicle (HEV), Plug in Hybrid Electric Vehicle (PHEV), Battery-Electric Vehicle (BEV) and alternative fuelled vehicles in the Irish fleet.

A vehicle fleet projection, developed by UCC MaREI and AECOM, is available as a fleet scenario in the TII REM. This projection is referred to as the ‘2030 Projected Vehicle Fleet’. This fleet scenario was used to estimate the impact of the speed limit reduction scenarios for rural roads in a future with a projected uptake in lower emission vehicles.

Table F.1 shows the change in GHG emissions emitted between the baseline and the scenarios relative to the 2018 Baseline using the 2030 Projected Vehicle Fleet.

Table F.1 Total Change in GHG Emissions Relative to 2018 Baseline (2030 Project Vehicle Fleet)

Scenario Group	Total Change in GHG (CO_2e) Tonnes Emitted	CO_2e Impact Range against 2018 Baseline (12.2 Mt)
1	-55,316 to –2,108	-0.5% to 0.0 %
2	–5,388 to 5,264	0.0%

Table F.2 shows the change in GHG emissions emitted between based on the 2018 Irish Vehicle Fleet, this shows the proportional impact of the speed limit reduction scenarios will reduced over time as the proportion of lower emission vehicles increases

Table F.2 Total Change in Greenhouse Gas Emissions Relative to 2018 Baseline

Scenario Group	Total Change in CO_2e Tonnes Emitted	CO_2e Impact Range against 2018 Baseline (12.2 Mt)
1	-69,993 to –3,153	-0.6% to 0.0%
2	-7,987 to 17,438	-0.1% to 0.1%

F.2 Urban Roads

Like rural roads the impact on emissions with the uptake of electric vehicles in the future was also tested in urban areas. The results are similar in all tested models concerning urban roads and show only a very marginal change (<0.1%), the level of which is considered negligible.

Appendix G Air Quality Impacts of Tested Scenarios

G.1 Air Quality – Non-Greenhouse Gas Emissions

The emissions estimated by the TII's REM for rural roads and NTA's ENEVAL for urban roads include the following:

- NO_x – Nitrogen Oxides
- NO_2 – Nitrogen Dioxide
- PM_{10} – Particulate Matter
- $PM_{2.5}$ – Fine Particulate Matter

Table G.1 presents the change in Non-Greenhouse Gas Emissions for each of the seven rural road scenarios, while Table G.2 presents the same information for urban scenarios.

Table G.1 Total Change in Non-Greenhouse Gas Emissions – Rural Roads

Scenario	Description	Non-Greenhouse Gas Emissions			
		NOx	NO_2	PM_{10}	$PM_{2.5}$
1	**10 kph** reduction applied to the **entire rural road network**	-2.2%	0.0%	-0.4%	-0.6%
2	**10 kph** speed reduction applied on all **rural single carriageway roads**	0.5%	0.1%	0.1%	0.0%
3	Speed limit of **80 kph** applied to all **National Secondary Roads** only	0.1%	0.0%	-0.1%	-0.1%
4	Speed limit of **60 kph** applied to all **Local Roads**	0.6%	0.0%	0.0%	0.0%
5	Speed limit of **70 kph** applied to all **National Secondary** and **Regional Roads**	1.2%	0.0%	-0.2%	-0.3%
6	Speed limit on all rural **divided roads** reduced by **10kph** and all **rural single carriageway** roads reduced by **20 kph**	-0.7%	-0.1%	-0.5%	-0.7%
7	Speed limit of **80 kph** on all **National Secondary Roads** and **60 kph** on all **Local Roads**	0.7%	0.1%	-0.2%	0.1%

Table G.2 Total Change in Non-Greenhouse Gas Emissions – Urban Roads

NTA Model	Non-Greenhouse Gas Emissions			
	NOx	NO_2	PM_{10}	$PM_{2.5}$
East Regional Model	0.0%	0.0%	0.0%	0.0%
South West Regional Model	0.2%	0.1%	0.1%	0.1%
West Regional Model	0.1%	0.0%	0.0%	0.0%
Mid-West Regional Model	0.0%	0.0%	0.0%	0.0%
South East Regional Model	0.1%	0.0%	0.0%	0.0%

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