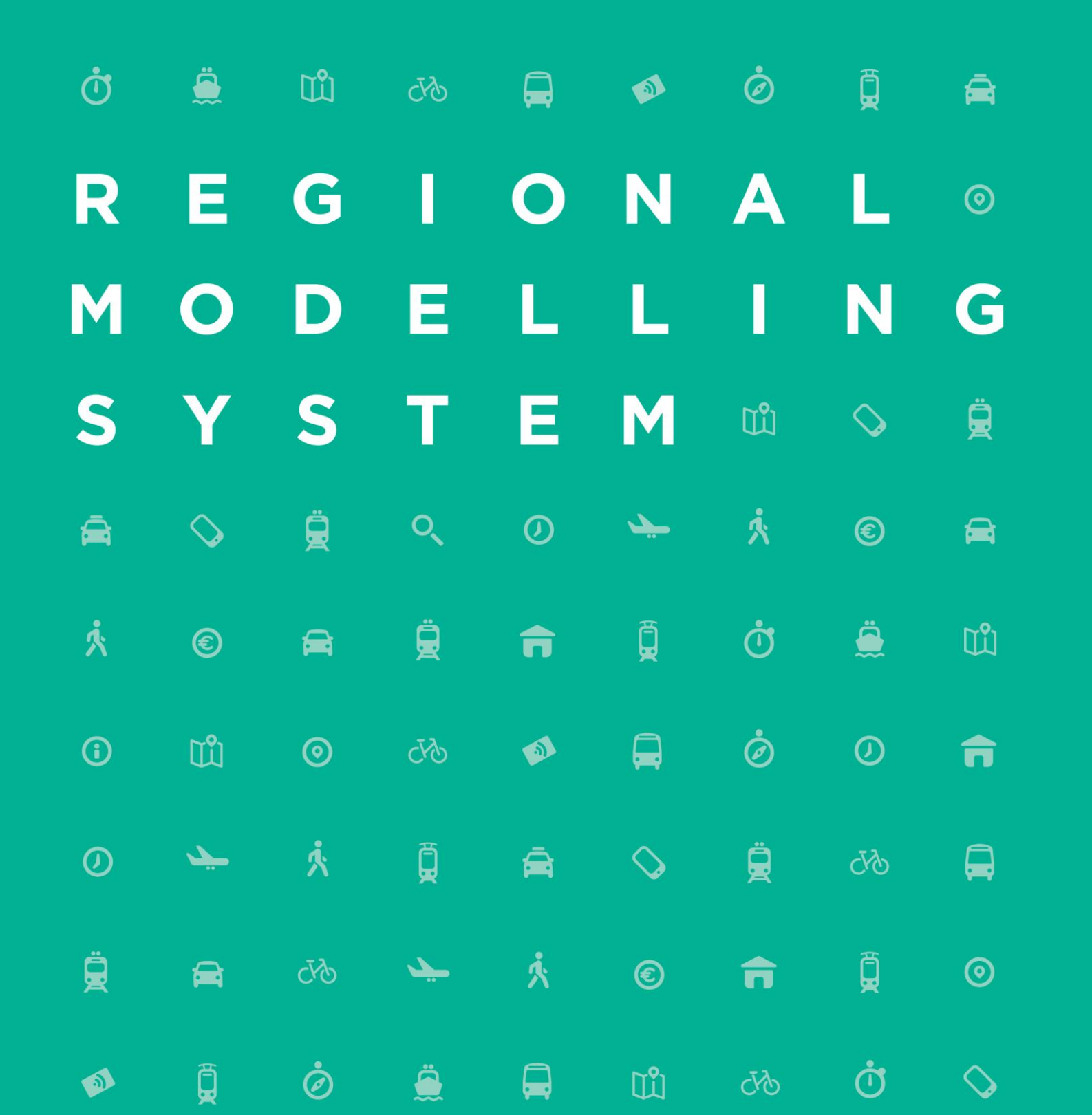

Modelling Services Framework

East Regional Model

Zone System Development Report

Údarás Náisiúnta Iompair
National Transport Authority

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Foreword

The NTA has developed a Regional Modelling System (RMS) for Ireland that allows for the appraisal of a wide range of potential future transport and land use alternatives. The RMS was developed as part of the Modelling Services Framework (MSF) by the National Transport Authority (NTA), SYSTRA and Jacobs Engineering Ireland.

The National Transport Authority's (NTA) Regional Modelling System comprises the National Demand Forecasting Model, five large-scale, technically complex, detailed and multi-modal regional transport models and a suite of Appraisal Modules covering the entire national transport network of Ireland. The five regional models are focussed on the travel-to-work areas of the major population centres in Ireland, i.e. Dublin, Cork, Galway, Limerick, and Waterford.

The development of the RMS followed a detailed scoping phase informed by NTA and wider stakeholder requirements. The rigorous consultation phase ensured a comprehensive understanding of available data sources and international best practice in regional transport model development.

The five discrete models within the RMS have been developed using a common framework, tied together with the National Demand Forecasting Model. This approach used repeatable methods; ensuring substantial efficiency gains; and, for the first time, delivering consistent model outputs across the five regions.

The RMS captures all day travel demand, thus enabling more accurate modelling of mode choice behaviour and increasingly complex travel patterns, especially in urban areas where traditional nine-to-five working is decreasing. Best practice, innovative approaches were applied to the RMS demand modelling modules including car ownership; parking constraint; demand pricing; and mode and destination choice. The RMS is therefore significantly more responsive to future changes in demographics, economic activity and planning interventions than traditional models.

The models are designed to be used in the assessment of transport policies and schemes that have a local, regional and national impact and they facilitate the assessment of proposed transport schemes at both macro and micro level and are a pre-requisite to creating effective transport strategies.

1 Introduction

1.1 Regional Modelling System

The NTA has developed a Regional Modelling System for the Republic of Ireland to assist in the appraisal of a wide range of potential future transport and land use options. The Regional Models (RM) are focused on the travel-to-work areas of the major population centres of Dublin, Cork, Galway, Limerick, and Waterford. The models were developed as part of the Modelling Services Framework by NTA, SYSTRA and Jacobs Engineering Ireland.

An overview of the 5 regional models is presented below in both Table 1.1 and Figure 1.1.

Table 1.1 List of Regional Models

Model Name	Standard Abbreviation	Counties
West Regional Model	WRM	Galway, Mayo, Roscommon, Sligo, Leitrim, Donegal
East Regional Model	ERM	Dublin, Wicklow, Kildare, Meath, Louth, Wexford, Carlow, Laois, Offaly, Westmeath, Longford, Cavan, Monaghan
Mid-West Regional Model	MWRM	Limerick, Clare, Tipperary North
South East Regional Model	SERM	Waterford, Wexford, Carlow, Tipperary South
South West Regional Model	SWRM	Cork and Kerry

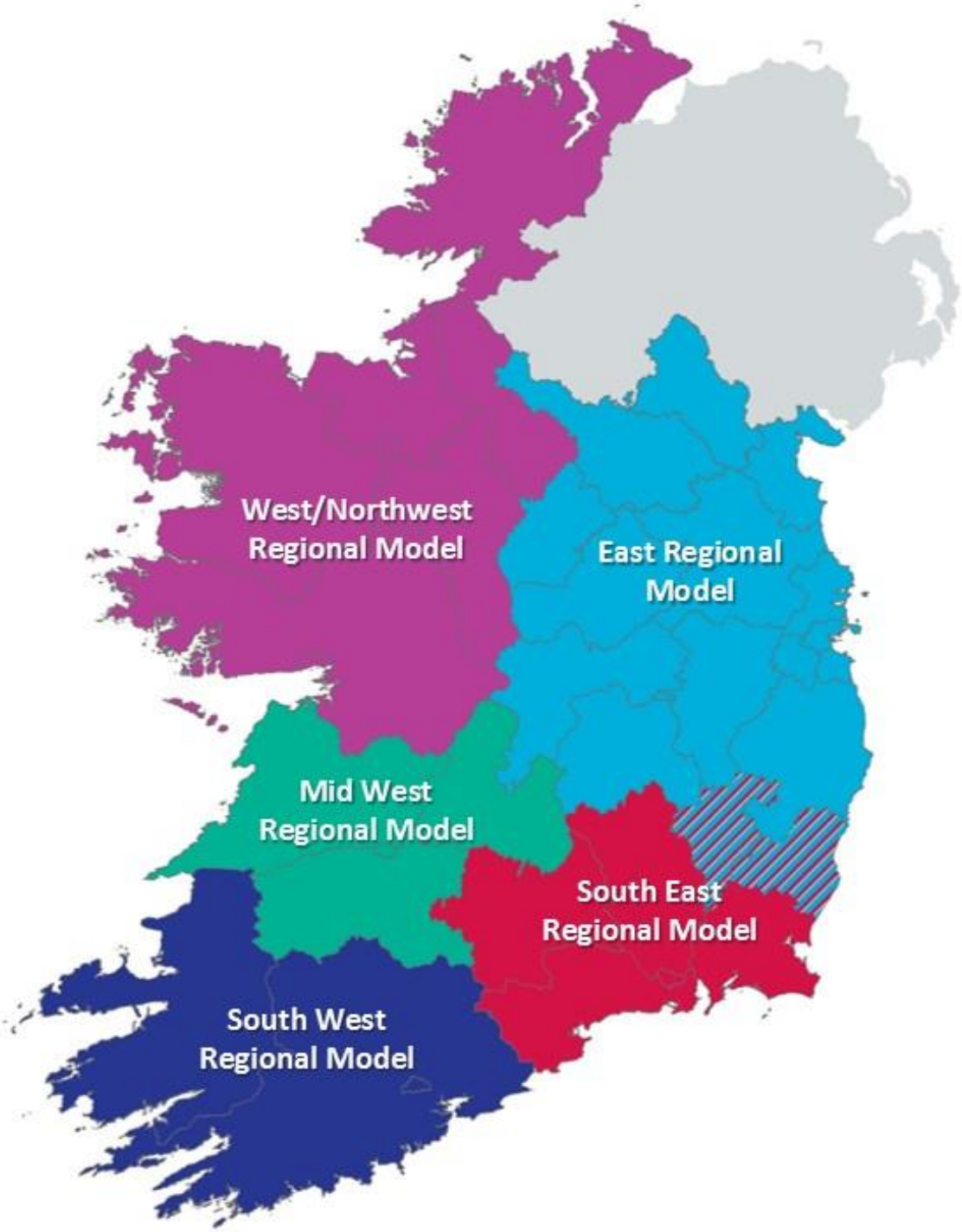

Figure 1.1 Regional Model Areas

1.2 Regional Modelling System Structure

The Regional Modelling System is comprised of three main components, namely:

- The National Demand Forecasting Model (NDFM)
- 5 regional models; and
- A suite of Appraisal Modules

The modelling approach is consistent across each of the regional models. The general structure of the ERM (and the other regional models) is shown below in **Error! Reference source not found.**. The main stages of the regional modelling ystem are described below.

1.2.1 National Demand Forecasting Model (NDFM)

The NDFM is a single, national system that provides estimates of the total quantity of daily travel demand produced by and attracted to each of the 18,488 Census Small Areas. Trip generations and attractions are related to zonal attributes such as population, number of employees and other land-use data. See the NDFM Development Report for further information.

1.2.2 Regional Models (RM)

A regional model is comprised of the following key elements:

Trip End Integration

The Trip End Integration module converts the 24 hour trip ends output by the NDFM into the appropriate zone system and time period disaggregation for use in the Full Demand Model (FDM).

The Full Demand Model (FDM)

The FDM processes travel demand and outputs origin-destination travel matrices by mode and time period to the assignment models. The FDM and assignment models run iteratively until an equilibrium between travel demand and the cost of travel is achieved.

See the RMS Spec Full Demand Model Specification Report, RM Full Demand Model Development Report and ERM Full Demand Model Calibration Report for further information.

Assignment Models

The Road, Public Transport, and Active Modes assignment models receive the trip matrices produced by the FDM and assign them in their respective transport networks to determine route choice and the generalised cost for origin and destination pair.

The Road Model assigns FDM outputs (passenger cars) to the road network and includes capacity constraint, traffic signal delay and the impact of congestion. See the RM Spec Road Model Specification Report for further information.

The Public Transport Model assigns FDM outputs (person trips) to the PT network and includes the impact of capacity restraint, such as crowding on PT vehicles, on people's perceived cost of travel. The model includes public transport networks and services for all PT sub-modes that operate within the modelled area. See the RM Spec Public Transport Model Specification Report for further information.

Secondary Analysis

The secondary analysis application can be used to extract and summarise model results from each of the regional models.

1.2.3 Appraisal Modules

The Appraisal Modules can be used on any of the regional models to assess the impacts of transport plans and schemes. The following impacts can be informed by model outputs (travel costs, demands and flows):

- Economy;
- Safety;
- Environmental;
- Health; and
- Accessibility and Social Inclusion.

Further information on each of the Appraisal Modules can be found in the following reports:

- Economic Module Specification Report;
- Safety Module Specification Report;
- Environmental Module Specification Report;
- Health Module Specification Report; and
- Accessibility and Social Inclusion Module Specification Report.

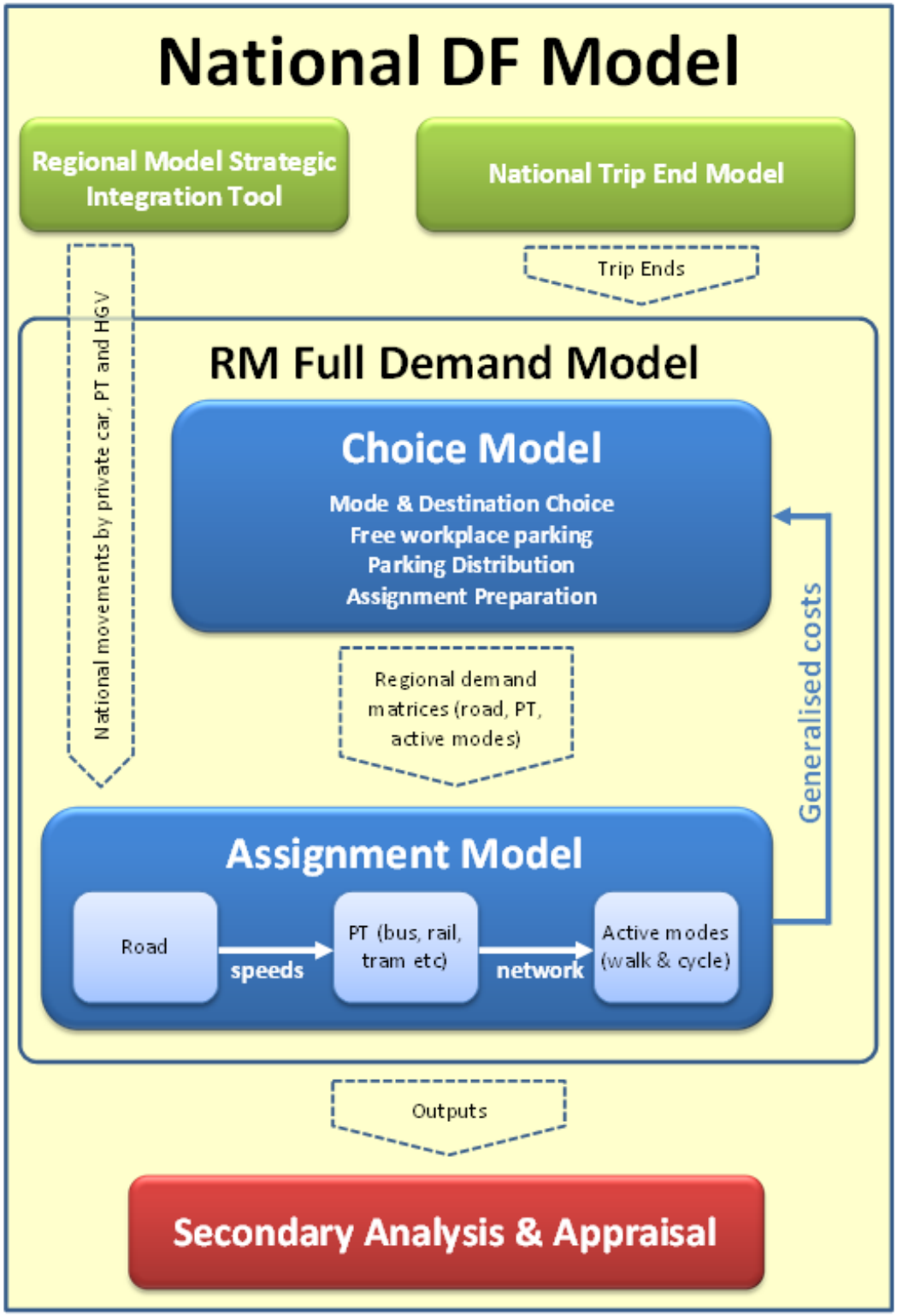

Figure 1.2 National and Regional Model Structure

1.3 Approach

The ERM zone system development provides the methodology, guidance and techniques to develop the Regional Modelling System through a 'Repeatable

Methods' approach. This led to the development of the methodology outlined in the 'Zone Delineation Generic Guide'.

1.4 Report structure

This report focuses on the development of an appropriate Zone System for the East Regional Model (ERM) and includes the following chapters:

- **Chapter 2: ERM Zone System Development:** provides information on the specification of the ERM Zone System and an overview of the First Pass Zone System development including the initial review of historic zoning systems;
- **Chapter 3: ERM Zone Development Review Process:** details the review process carried out on the ERM Zone System and the further development of the ERM zone system through the second, third and fourth (and final) passes;
- **Chapter 4: ERM Sectoring and numbering system:** outlines the sectoring and hierarchical zone numbering system for the ERM.
- **Chapter 5: Comparison Zoning v3.2 and v4.2:** analysis of the two zoning systems and the issues addressed by the new system.
- **Chapter 6: ERM Final Zoning System**: presents the final zoning system.

2 ERM Zone System Development

2.1 Introduction

The zone system is used to segregate the modelled area into a number of disaggregate areas, enabling travel patterns to be separated and described in detail for each relevant origin-destination (OD) movement. The resultant travel demand associated with each zone is loaded onto or assigned to the modelled network using a series of zone centroid connectors.

The regional model zone delineation process aims to create a zone system which allows accurate modelling in the area concerned. The process, which has been established for all regional models, involves taking Census Small Areas, (the smallest spatial level at which data for building demand is available) and manipulating zone boundaries to create zones that take account of physical boundaries (motorways, rivers, etc.), and representative homogenous land use types and activity. This chapter describes the step-by-step development of the ERM zone system.

2.2 ERM Regional Zone System Overview

Zone System Development was based on the conclusions the Regional Modelling System scoping phase with the following objectives:

- to develop a new zone system for the East Regional Model (ERM) that makes full use of the range of available data, including Census Small Areas;
- to interact closely with the NTA and iteratively refine the zone system based on their transport appraisal and land use planning requirements; and
- to develop a standard approach to zoning for other regional models to follow.

The key deliverables from the ERM zone development task:

- a new zone system for the ERM model and supporting methodology notes;
- a report defining the standard approach to zoning in all regional models; and
- a project summary report (this report).

The chronology of events leading to the development of Final ERM Zoning system is as follows:

- meeting with NTA asking for more details in counties outside GDA (July 2015);
- zones disaggregated in these areas (July 2015);
- review and further changes to the zoning (August 2015);

- meeting with the NTA (24th September 2015) to present the zoning (v4.0, 1,994 zones);
- feedback from the NTA indicating that counties (Carlow, Wexford (southern part of), and Kilkenny) are not needed in ERM as these areas are covered by SERM; and
- reduction of total number of zones to 1,854 (v4.2, 1,851 zones+ 3 special zones).

2.3 Zone System Development Stages

The main steps in the process were as follows:

- Preliminary (Scoping) Development work: this step helped to clarify the outline requirements for the zone system (e.g. criteria for boundary definition) and identify key data sources;
- First pass system: this stage produced the first complete zone system for the ERM. The zone system was then examined to identify where improvements could be made and hence if the criteria for zone definition could be improved and/or applied more consistently;
- Second pass zone system: this stage produced a new zone system based on the first pass system and on a more prescriptive set of criteria for boundary definition, in addition to new data sets; and
- Finalisation stages: a number of review iterations were performed to further refine the zone system based on the NTA's local knowledge and modelling expertise.

2.4 Preliminary Development

The starting point for zone system development was a review of the existing GDA Model zone system with respect to:

- areas where there is anticipated development (residential & employment);
- areas where these is anticipated infrastructure (e.g. Bus Rapid Transit, DART underground);
- alignment with proposed model form considerations (e.g. school drop off, park and ride, station access, geographical coverage, parking);
- other existing models (e.g. RPA, Micro Simulation);
- 2011 Census Small Areas – to check consistency and alignment with existing zones; and
- GIS background layers to check zonal boundaries alignment with natural barriers, e.g. railways, water, major roads, fields etc.

The purpose of this review was to get a feel for the likely level of detail to be included in the new zoning system, using the existing system as a benchmark. The preliminary development stage is summarised in Appendix A1.

2.4.1 Data Review

The Zone Delineation Guide identifies a number of zone characteristics, such as population and employment, which are correlated with travel activity levels. To understand the level of travel activity across the modelled area, the Small Area Population Statistics (SAPS) database, which contains the population and administration data for the 2011 Census, was interrogated. This GIS shapefile was cross-referenced with the Place of Work, School or College Census of Anonymised Records (POWSCAR) travel data (both data sets based on the 2011 Census). This level of geocoded detail allows for each CSA to be assigned the following data:

- total population;
- number of trips (Work and Education) from the Small Area in the AM peak; and
- number of trips (Work and Education) to the Small Area in the AM peak.

This data was used to build a database of population and trip generation across the modelled area to compare activity levels.

Electoral Districts were also used through the zone definition process. CSAs are subsets within Electoral Districts (EDs). ED boundaries are commonly used as the unit of geographic information in Ireland and as such, the NTA wish to maintain a transparent relationship between EDs and the model zone system. It is also important to maintain the ED as the lowest common denominator between new zones and old so that 2001, 2006 & 2011 versions can be compared at the ED level.

In addition, data from a number of other sources was extracted and assigned to the relevant CSA. This included:

- MyPlan data: MyPlan is a database containing data relating to existing land use types in urban areas;
- Geo Directory data: Geo Directory is a database of addresses with geographic coordinates, each of which is categorised as either residential or commercial, with different addresses in the same building included; and
- Road and rail networks.

2.4.2 Model Area Definition

The model boundary was defined as part of the Modelling Services Framework Model Scoping Task, shown below in Figure 2.1. Following on from the Data Review, the next step in developing the zone system was Model Area Definition.

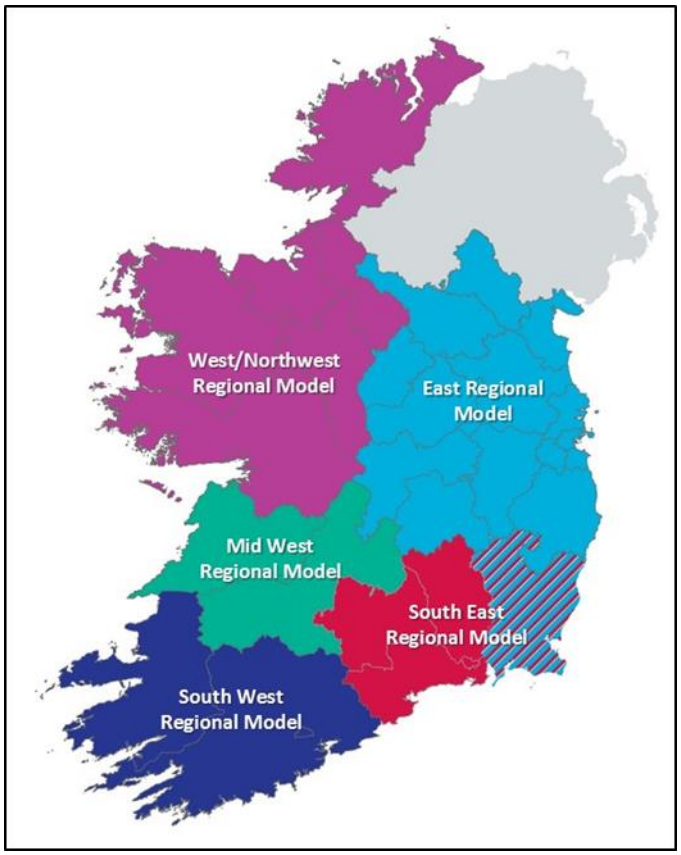

Figure 2.1 Regional Models of Ireland

The ERM will be used to forecast changes in traffic levels and congestion on existing routes, appraise the benefits of proposed transport interventions and policies, and predict the impact associated with land use development plans. These types of model application require a relatively detailed zone system and network to capture evidence relating to a wide range of potential impacts.

The ERM model network is composed of a simulation area, which includes modelling of individual junction layouts, and a buffer network which contains less detailed junction coding. As the zones tend to be of similar level of activity, the zoning is more detailed in city/town centres than in rural areas.

2.4.3 Review of the Greater Dublin Area Model (Base Year 2006)

This section describes the review of the Greater Dublin Area (GDA) Model, developed by the NTA, which includes 666 zones. This review was undertaken as part of the RMS model scoping phase.

The GDA Model 666 zone system is shown in Figure 2.2 below. Zone and network detail are greater where transport demand is highest such as in the city centre. Zone sizes become larger with distance from the city centre, particularly outside the M50, where there is less population, employment, education or industry to generate transport demand. Many of the towns and their hinterlands in outer areas

are represented by only one zone, e.g., Navan and Naas. The NTA noted during this initial review that better representation of network detail was required in these areas, and hence that smaller zones should be used to enable appropriate modelling of local travel.

Population and employment forecasts were provided in spreadsheet form and processed to produce 'traffic light' system to note future 'pressures' on GDA zones (e.g. higher employment or population). This assessment with respect to NTA planning forecasts highlighted where population and employment growth exceeded certain thresholds[1]. This showed that a more disaggregate level of zoning would be required to better accommodate the high levels of trip making likely to be associated with the planning forecasts.

The review of the existing zone system also examined the density and/or locational distribution of the following attributes of the transport and land use system:

- school locations (to examine the number of schools per zone);
- stations (to examine the number of stations per zone);
- GDA existing networks;
- RPA zone system;
- NavTeq base network layer (digital road network mapping with navigation data);
- Bing Maps geographical background layer; and
- documents noting future infrastructure considerations.

[1] See Appendix A2 {20130211 Ireland Planning Data Analysis v1.5}

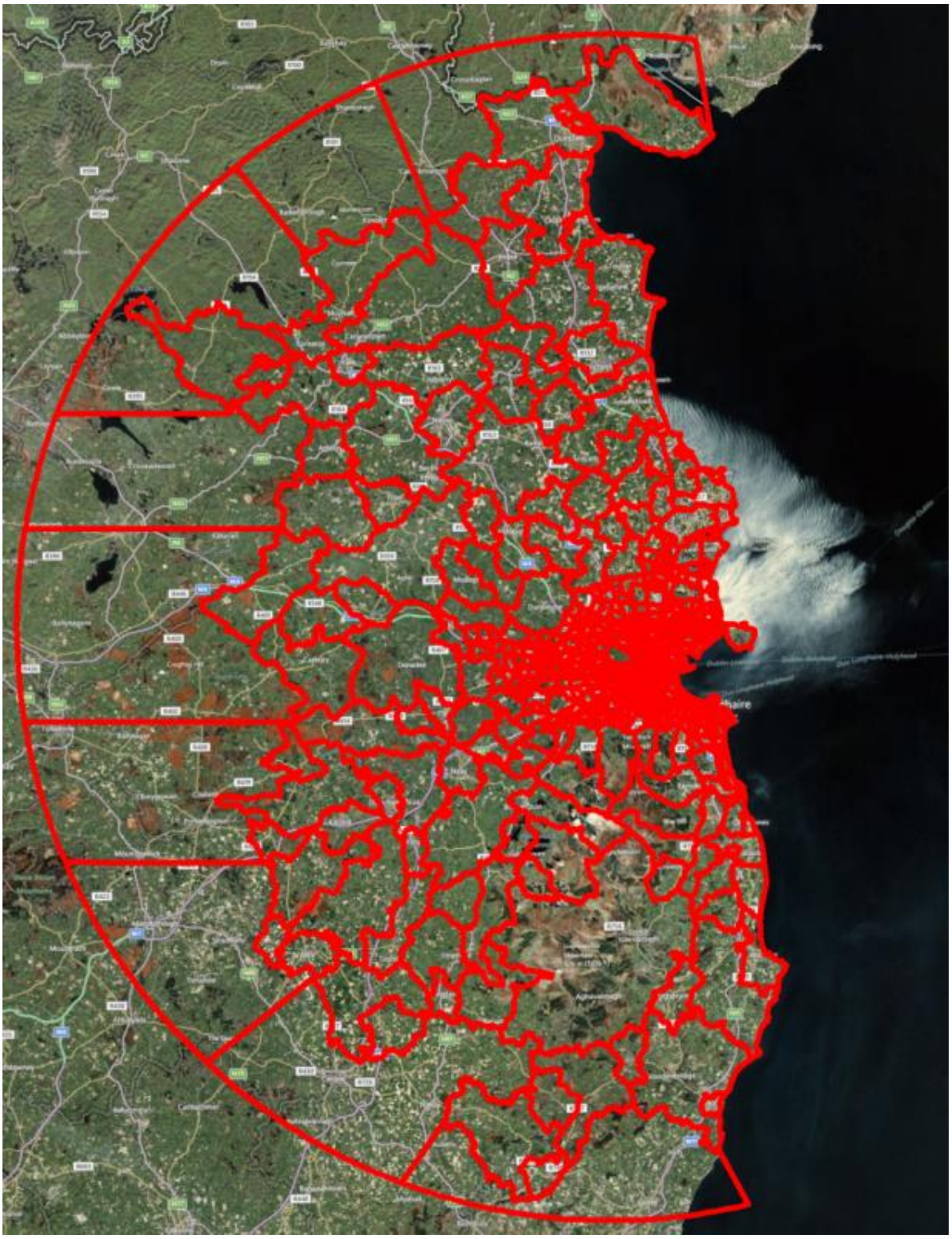

Figure 2.2 GDA Model Zone Boundaries (666 System)

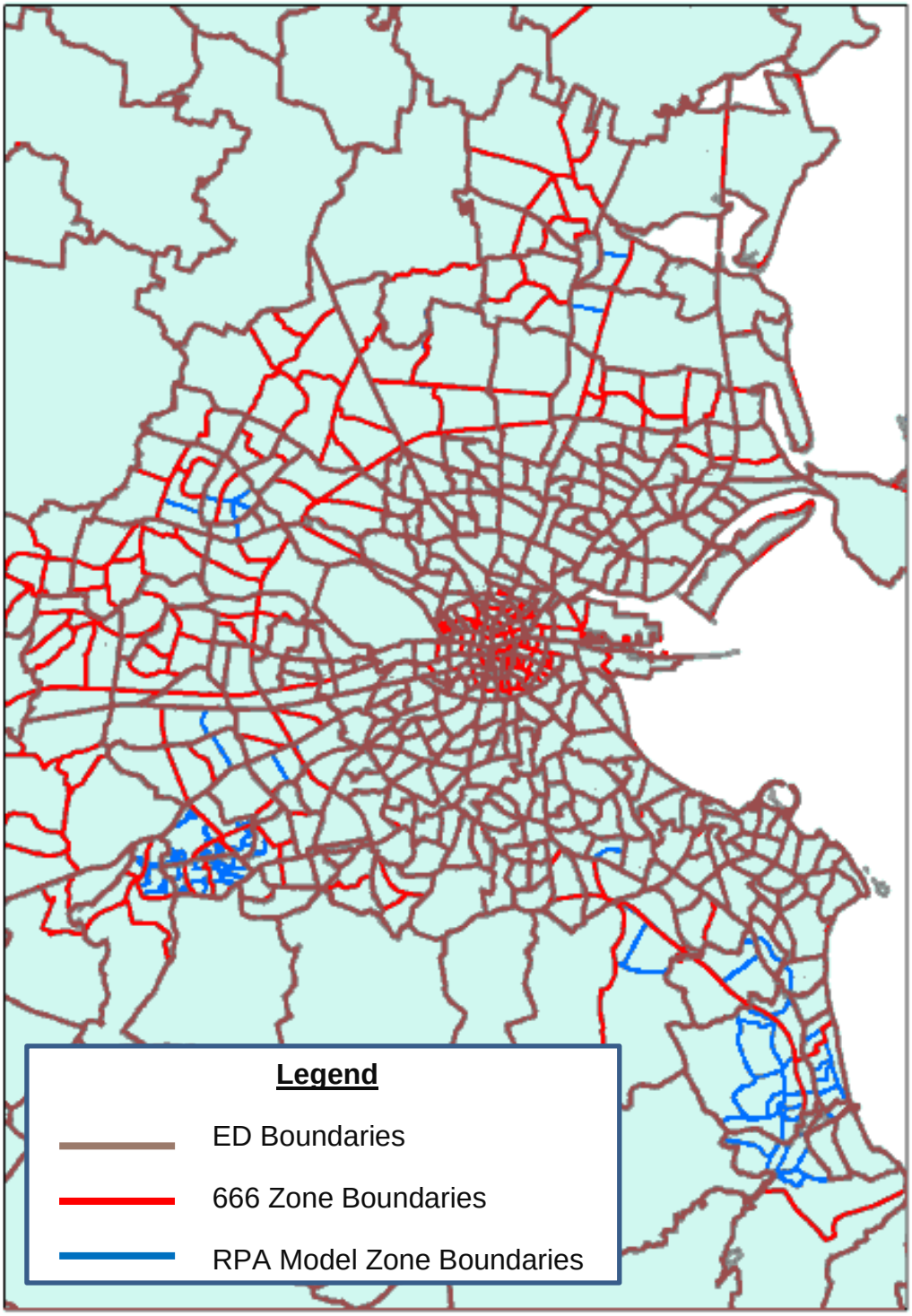

Figure 2.3 GDA Model Showing RPA Zone Boundaries

Figure 2.3 shows the GDA Model zone system with the RPA model zone system overlaid. This shows that additional detail was required in the RPA model relative to the GDA Model to be able to represent sufficient detail along the possible alignment of future LUAS schemes. This indicates that improved detail would be likely in these areas in the ERM system.

Further examination of the alignment and consistency of the GDA Model zone system was performed as part of the review. Figure 2.4 shows CSA boundaries overlaid on the GDA Model zone system. There are two main issues to note:

- The GDA Model zone boundaries do not consistently conform to the CSA boundaries; and
- CSAs do not always group neatly into an existing model zone.

It should be noted that the GDA Model zone boundaries do not align with ED boundaries because for the previous model it was decided to try to include both sides of a road within a zone (for assignment), therefore, where an ED boundary is on the centre of the road, there will be a mismatch.

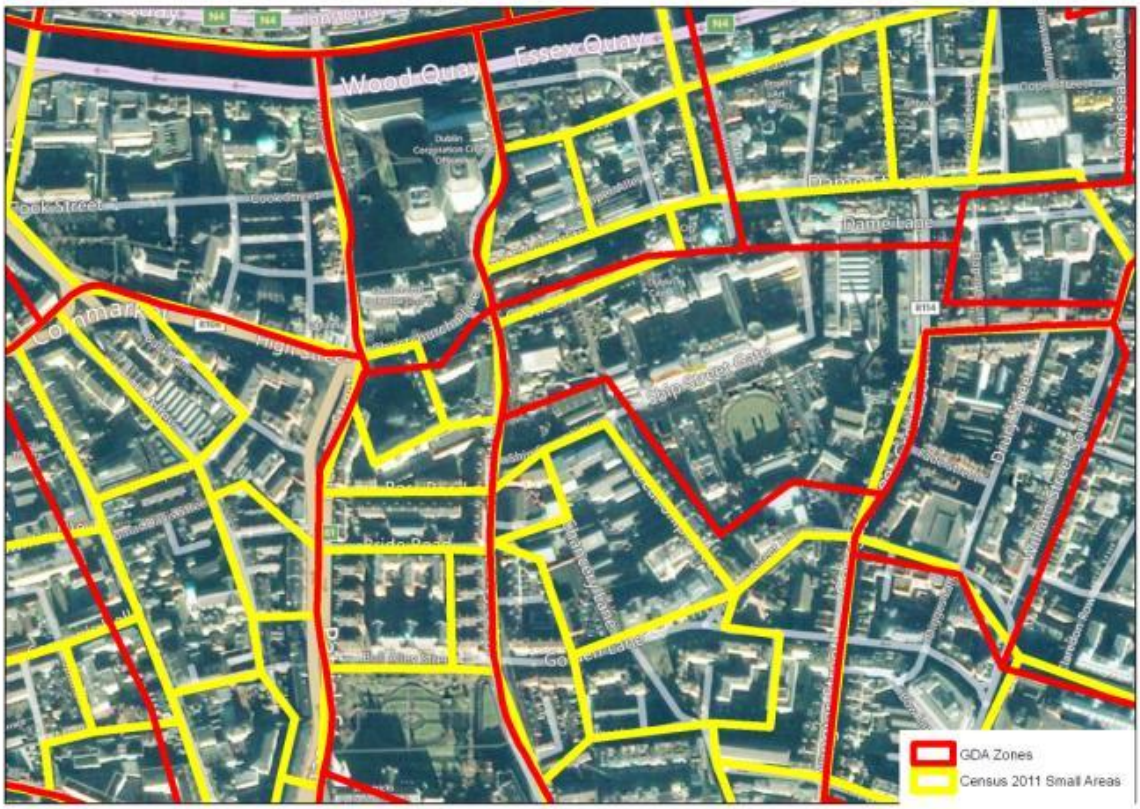

Figure 2.4 GDA Model Zone System and Small Areas Central Dublin Misalignment

Figure 2.5 shows possible boundaries of the new zone system that align to the CSA boundaries and only enclose whole CSAs.

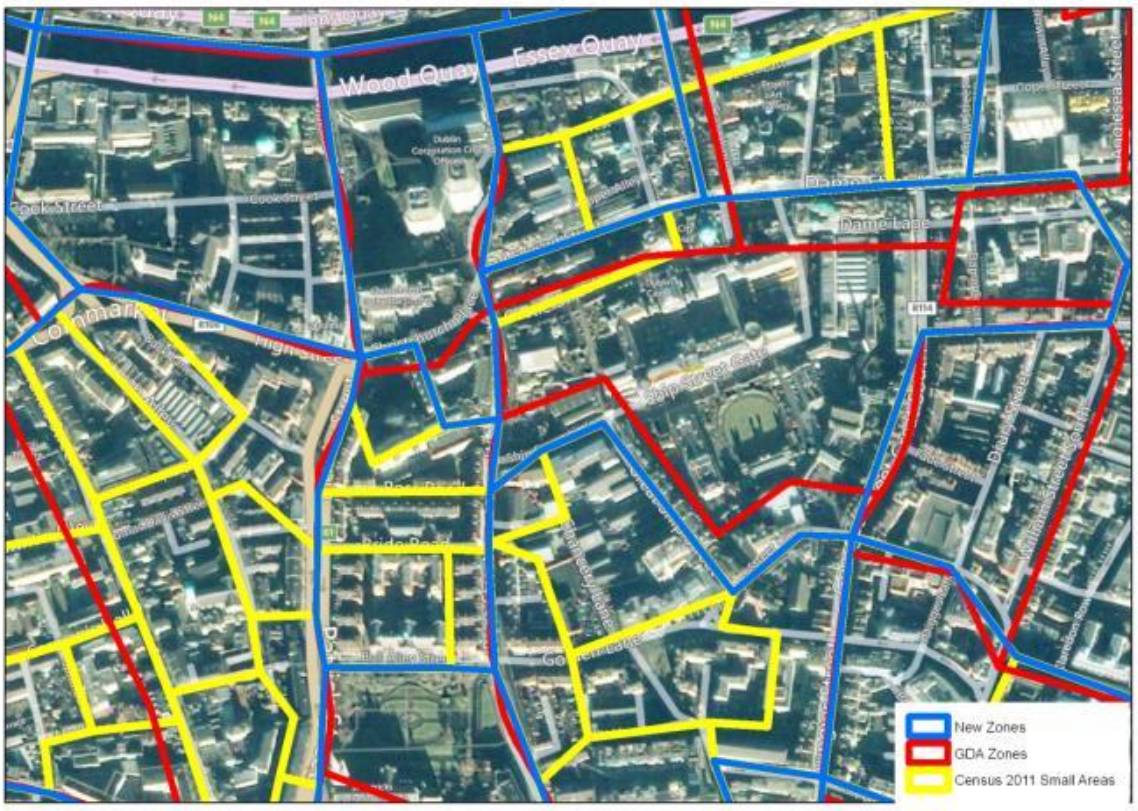

Figure 2.5 Improved alignment with CSA blue (new zones) shown over yellow (CSA), red representing GDA Model)

2.4.4 Review of Significant Growth Zones

Figure 2.6 below demonstrates a review of significant growth zones within the GDA Model zone system. Zones of significant growth are shown in red. Significant growth zones are those which fulfil one or more of the following criteria:

- 2006 population in zone >3000;
- 2026 population in zone >3000;
- Growth in population in zone between 2006 and 2026 >1500;
- 2006 employment in zone >4000;
- 2026 employment in zone >4000; and/or
- Growth in employment in zone between 2006 and 2026 >2000.

These criteria values were chosen as zonal population or employment levels above about 3,000 or 4,000 respectively would suggest a possible need for more detailed zoning. Employment growth was sufficient to provide a 'feel' for the likely level of additional detail likely to be required in the zoning, and hence education growth was not examined at this stage.

Figure 2.6 2006 vs 2026 Growth and 'Large' Absolute Values Considered (from planning data spreadsheet provided)

Figure 2.7 shows the same colour scheme for a central city area. This also provides another example of how the CSA boundaries (in yellow) do not match the GDA Model zones (in red). Figure 2.8 shows how the zones could be re-aligned and reconfigured based on CSA to produce new model zones (in blue), whilst also increasing the zonal detail where activity levels are above the significance levels outlined above.

Benefits of the new zone definition include improved centroid connection and therefore distribution of trips loading to/from the network. Furthermore, the improved detail available for each CSA makes it easier (although not strictly) to isolate homogenous development type and consequent travel behaviour.

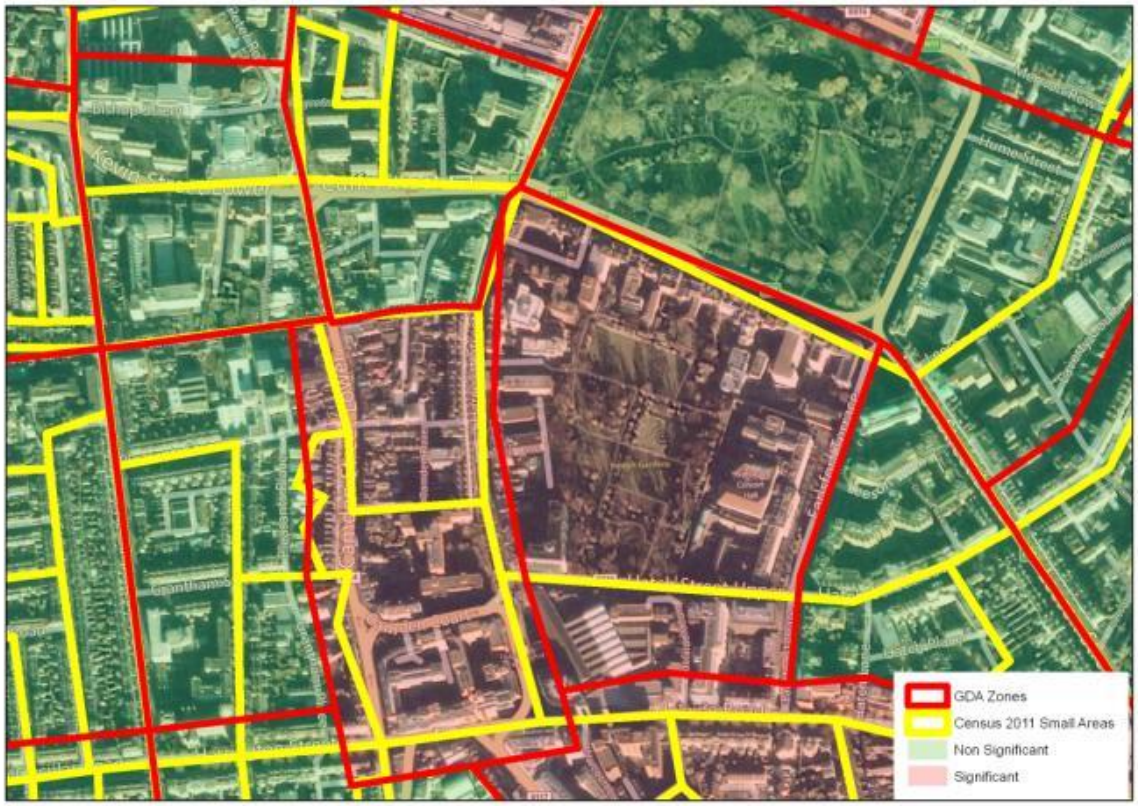

Figure 2.7 Population and Employment – Example, Existing Zones and CSA

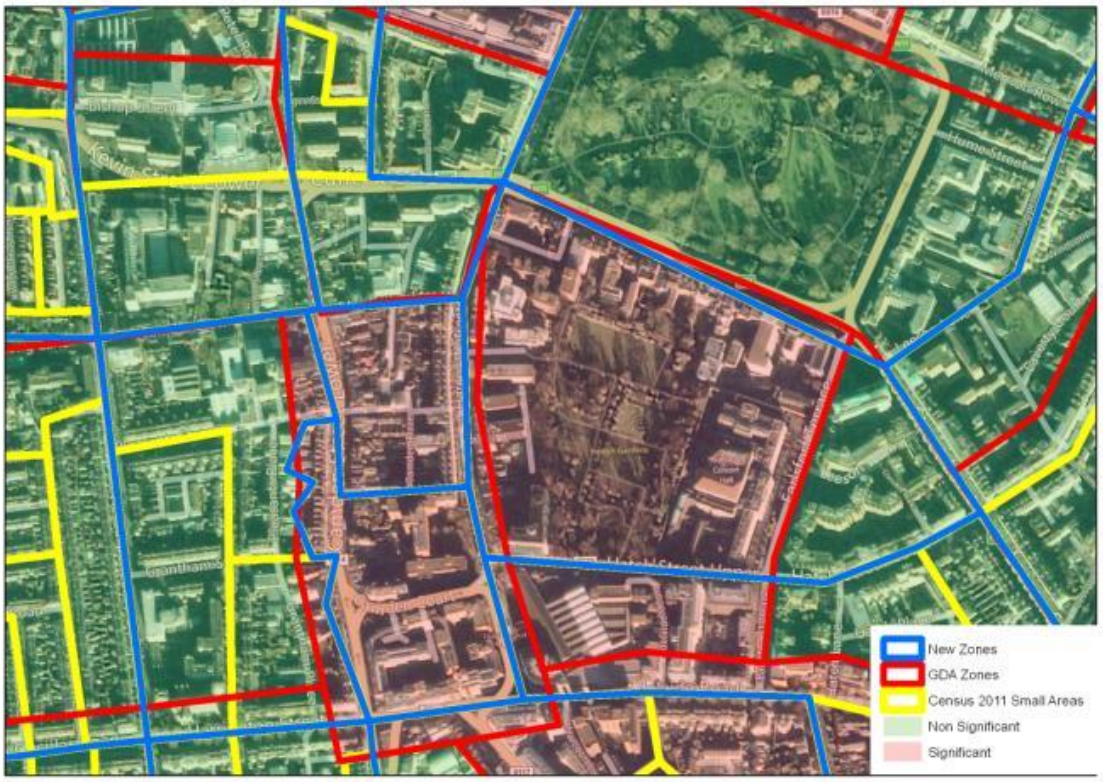

Figure 2.8 Population and Employment – Example, Proposed Zones

Figure 2.9 shows a continuation of the above review process, with GDA Model zones shown in red, with new zones (about 70) shown in blue.

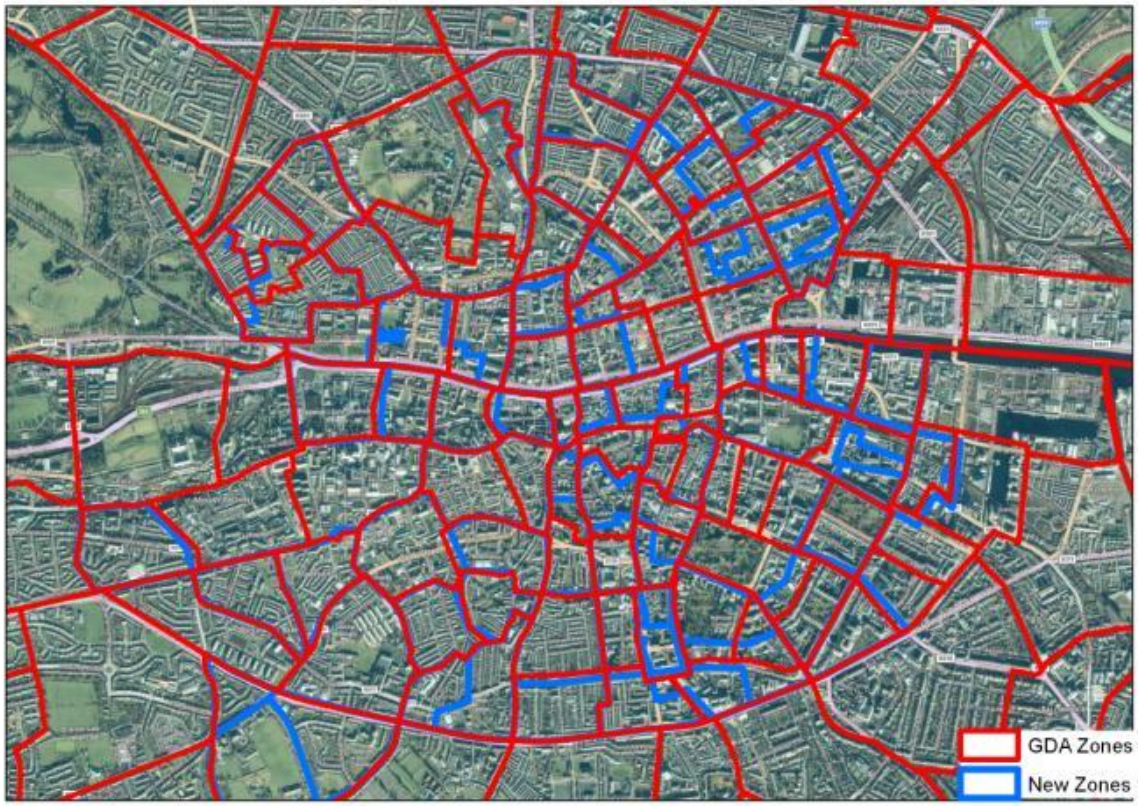

Figure 2.9 Central Dublin (partial completion)

2.4.5 Preliminary Development Stage Conclusions

The preliminary review / development stage in the Model Scoping task provided an understanding of the likely level of detail required in the ERM zone system and some of the useful data sources for its development. Figure 2.9 shows some preliminary development work that was undertaken to create new zones within the city centre area. This was done to provide a feel for the level of new zonal detail that would be required given this type of land use and network density.

The preliminary Model Scoping review suggested the following:

- the level of detail outside the M50 in the 666 GDA Zone System is low and would have to be refined to be able to model hinterland towns more accurately;
- the level of zonal detail in the RPA model zone system demonstrated that the zone system could be more detailed where specific schemes are being considered;

- the examination of zonal growth based on the provided planning forecasts suggested that there could be excessive trip loading from some zones in the network models (e.g. road and/or PT); and
- the CSAs also presented some inconsistent boundary alignments with the 666 GDA Zones system.

Based on these issues it was decided to create a new zone system that would improve zone representation across a range of criteria and ensure full consistency with CSA boundaries and therefore with Census data.

The Model Scoping stage also recommended that for the subsequent zone system and model development tasks:

- zone size should be related to activity levels (planned and existing);
- guidance on the number of trips per zone should be developed by considering the maximum number of zones that is desirable to achieve acceptable run times and the total level of trip making in the various regions being modelled;
- it is beneficial for model zones to be either subdivisions or collections of CSAs;
- zone boundaries should respect barriers to travel (including variations in access to public transport), so that trips from each zone can be accurately loaded to the modelled network; and
- it is essential to use the same zone system in the demand model, road network and PT network assignments, to achieve the greatest precision in assignments and demand responses.

2.5 ERM First Pass Zone Development Overview

An initial ‘First Pass’ zone system was developed for the full ERM area based on an agreed set of principles: e.g., not to lose any detail relative to existing NTA or RPA zones; use of CSA boundaries and employment densities to guide process; and use of NTA planning forecasts and future scheme alignments to highlight growth areas.

It is important to highlight that this stage of the zone system was developed without quantitative consideration of land use. Rather Google Maps was used to highlight areas with contrasting land uses, but only in a qualitative and interpretive way.

At this stage there was also the intent to minimise the creation of zones which required a sub-division of a particular CSA. Dividing CSAs makes it more difficult to attach Census related data to the model zone system, and hence an objective within the first pass was to maintain whole CSAs until the requirements for zonal detail became clearer.

Regular communication was maintained with the NTA during development to highlight various aspects of zone creation and ensure the level of detail was

appropriate. When the full model area was completed the zone system was provided to the NTA for a more detailed review.

This Chapter described the development of this 'First Pass' zone system.

2.5.1 Initial Zoning Principles

Developing the First Pass zone system involved setting out a set of principles that would be used to guide the development process.

To develop the first pass zone system, new zones were defined:

- in areas of high forecast growth;
- where future transport infrastructure will need to be modelled; and
- where natural features or infrastructure create a barrier to free movement.

The new zones were defined using a combination of spatial data, e.g., CSA boundaries, the GDA Model 666 zones system and the RPA model zone system.

New zones were also defined based on land use (using background mapping), according to the following principles:

- where possible no two rail stations or Luas termini should be in the same zone;
- ensure appropriate station walk-in access (particularly relevant to rural areas where larger zones will be an issue);
- where possible isolate school demand (i.e. schools contained in a single zone, recognising there can often be many schools in an area which would make this impossible in those cases);
- where possible separate land uses; and
- no new zone should cross an ED boundary.

The process was also guided by spatial analysis of employment densities, which highlighted the distribution of jobs and therefore the requirement to allocate specific zones to those areas. Special generators/attractors comprising large generators/attractors of traffic such as Airports, Hospitals, shopping centres etc. should be allocated to separate zones.

2.5.2 Use of Census Small Areas

As previously discussed, Census Smalls Areas are the fundamental geographic unit used to develop the zone system. CSAs are typically smaller than would be appropriate or necessary in a strategic transport model, so when developing the zone system, the consideration is often how they should be aggregated.

CSAs are designed by the CSO based on fixed population targets per CSA. As such, they can be large where population density is low (for example in rural or industrial areas), even though activity levels could be high in those areas. When this is the case the consideration is how to disaggregate the relevant CSA to form appropriately sized model zones.

2.5.3 First Pass Zone System

The first version of the zone system was provided to the NTA in April 2013. The supplied files were entitled New_Zone_System_Draft_2_Dissolved.

An information note entitled "*20130408 Information Note v1.0*" was also supplied that describes the initial development (this file is included as Appendix B).

Figure 2.10 shows the model zone system extent following completion of the First Pass. Three separate tiers can be identified within the zone system:

- **Tier 1:** encompasses the Greater Dublin area, the Mid-East Regional Authority, and Louth County. This area represents the core modelled area with the most detail. Zones in this area are numbered 1-1302 and 3000-3008;
- **Tier 2:** includes the Midland and South East Regional Authorities and the remainder of the Border Regional Authority, representing external zones with some detail. Settlements within tier two with a population greater than 3000 and a train station are modelled at a finer scale (zone numbers 1303-1342). The remainder of the tier is modelled at an aggregate level (zone numbers 2001-2031); Within Tier 2:
    - zones covering the settlements have been amalgamated – these zones fall outside of the main modelled area and their primary purpose is to represent trips to and from the settlements\stations; and
    - zones surrounding the settlements have been divided into smaller areas - zones surrounding the settlements in the Midland and South-East Regional Authorities have been divided into smaller areas to more accurately represent trips to the settlement zones.
- **Tier 3:** encompasses the West, Mid-West and South-West Regional Authorities each of which is modelled as one 'large' external zone (numbered 4001, 4002 and 4003 respectively).

The First Pass Zone System thus contained 1,311 Tier 1 Zones; 71 Tier 2 Zones; and 3 Tier 3 Zones–a total of 1,385 zones. Figure 2.10 shows the full extent of the zone system.

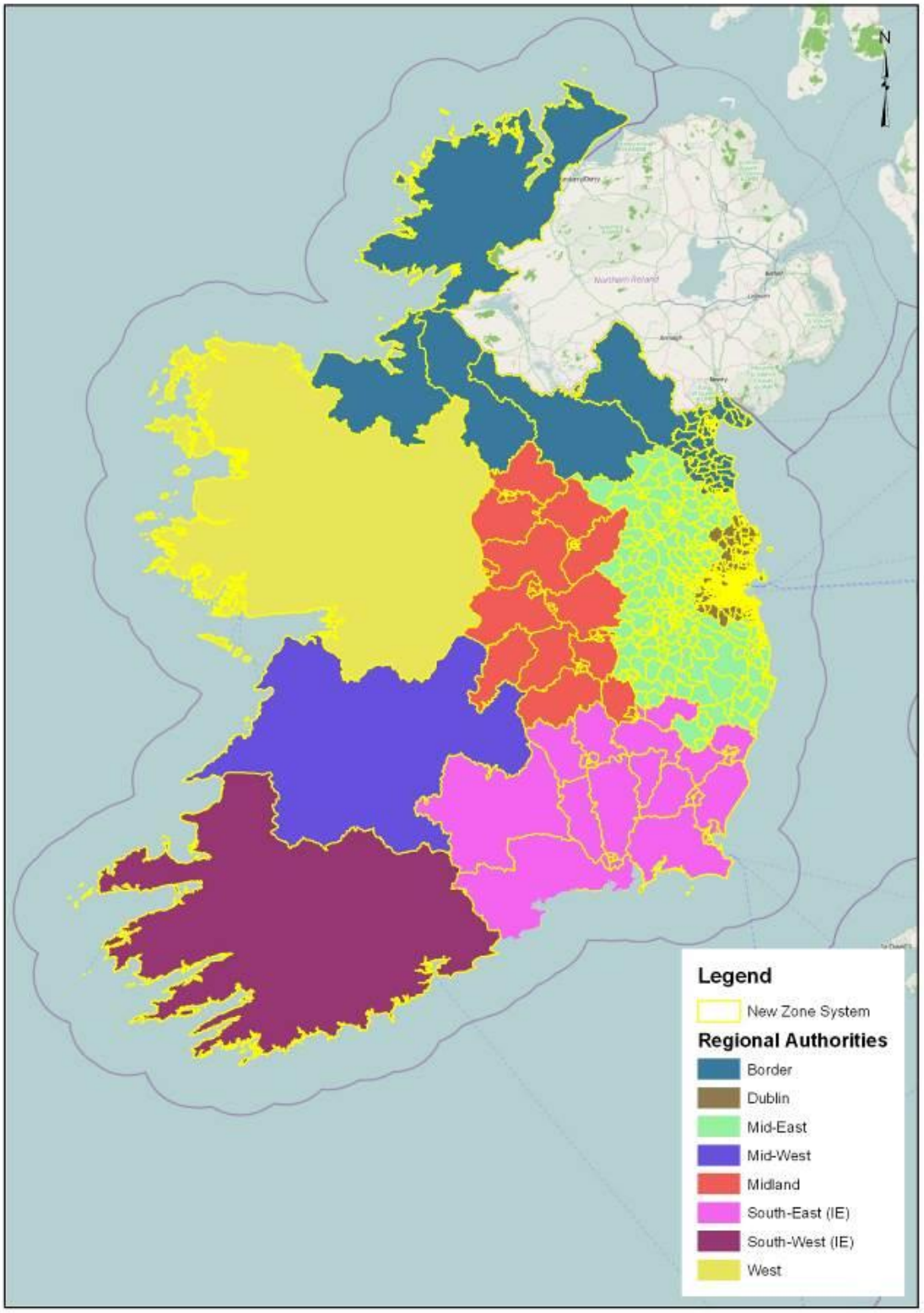

Figure 2.10 First Pass Model Zone System Overview

3 ERM Zone Development Review Process

3.1 Overview

Following the completion of the process outlined in Chapter 2, the First Pass Zone System was reviewed by the NTA. The purpose of the review is to improve the initial zone system with respect to network and land use configuration whilst taking into account each of the previously discussed zone criteria.

3.2 NTA Review

The NTA reviewed this system with respect to:

- zonal population and employment levels within each zone (see Appendix C); and
- how the new zones aggregate up to the DED level (see Appendix D1).

The NTA also provided a summary of the technical paper "*Approach to Delineating Traffic Analysis Zones*" (Appendix F1) accompanying the first review. This paper was based on the Cambridge Systematics Paper *"A Recommended Approach to Delineating Traffic Analysis Zones in Florida"* (Appendix F2).

The above documents were reviewed and considered by the zone development team. As an initial response, an information note entitled "20130304 Zone System Information Note v3.2" (Appendix E1) was provided to the NTA which sought to provide further information on population and employment levels within each zone in response to NTA queries. A further note "20132706 Zone System Information Note v4.6" (Appendix E2) expands on the information provided in note 3.2.

A summary of the key points raised and discussed in these notes is provided below.

3.2.1 Zonal Population and Employment Levels

The NTA queried the number of zones with a population in excess of 2,000 (see Appendix C). The objective of having fewer zones above this threshold was noted in the technical note *Traffic Assignment Zones_Guidelines* (Appendix F1), e.g. "the majority of zones should have a population of about 2,000 falling away sharply above 3,000 and below 1,000".

In response, discussion was provided on the frequency of zones with population in excess of 2,000 and the associated AM peak trip productions of those zones. For example, of the 332 zones identified as having a resident population of greater than 2000, travelling to work or school exceeds 2000 in the case of only 46 zones and there are zero zones where the number of people travelling to work/school by car in the morning peak is in excess of 2000.

The discussion notes that the level of demand associated with populations of this size would not be inappropriate in a strategic model. However, further disaggregation of larger zones (to reduce zonal activity levels) was not ruled out at this stage.

3.2.2 ED Consistency

The feedback received also highlighted a number of instances where there were inconsistencies in terms of CSO ED and zone boundaries and/or problems with zone numbering (see Appendix D1).

The first pass version of the zone system was fully consistent with the CSO ED layer; however, it was noted when undertaking the ED consistency checks that there are some issues in the ED layer itself. More specifically, there are several instances where CSO EDs are divided into non-contiguous parts. An example of this is provided in Figure 3.1.

The list of CSO EDs where this occurred is: Numbers 11079, 11035, 09051, 12087, 04023, 06087, 15036, 06064, and 10027.

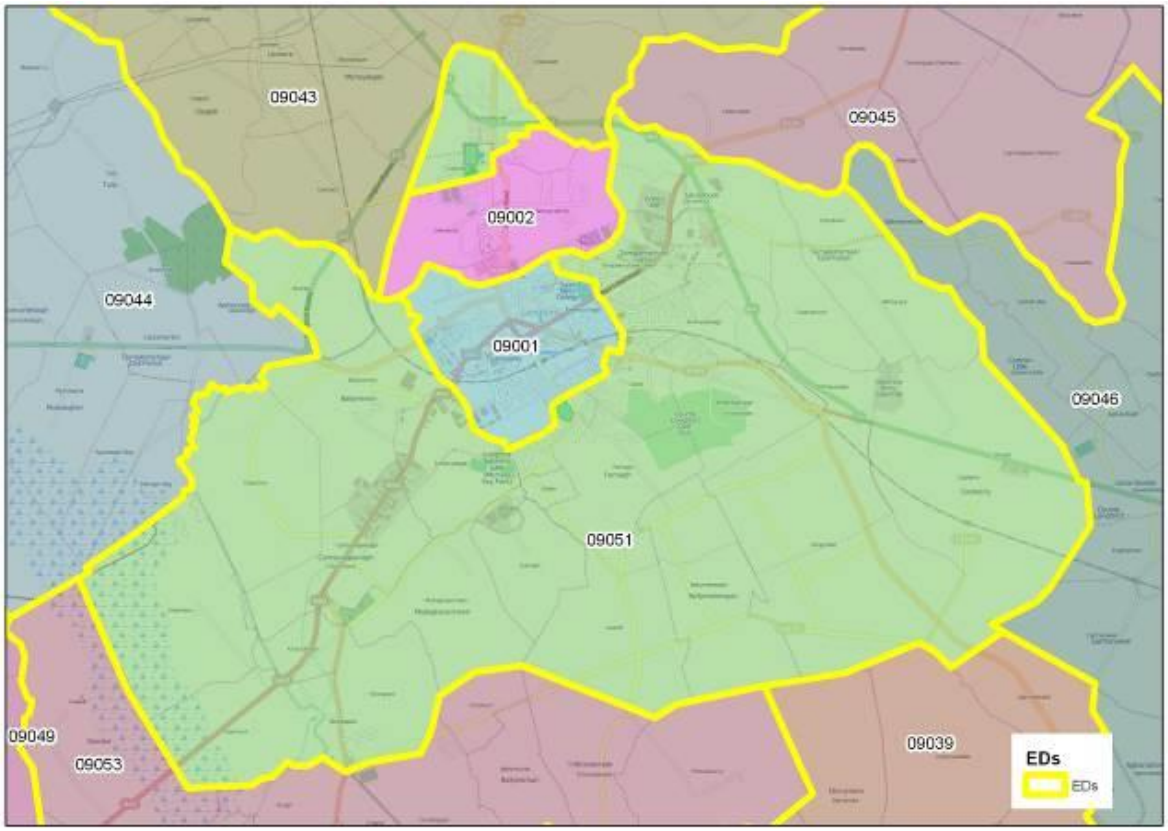

Figure 3.1 Example of CSO ED Division - ED 09051 (shown in green) divided into two non – contiguous parts

3.2.3 Comparison of Proposed Model Zones in relation to MyPlan

During the review of the first draft of the zone system the NTA made use of the MyPlan map layer called “MyPlan” (see Appendix D1 Section 2 - *Comparison of*

Proposed Model Zones in relation to MyPlan). This dataset includes land use information for the entire modelled area, including land parcels with the potential for future development.

Although land use was considered in the first pass zone system, MyPlan provides far more detailed information which had not previously been available. MyPlan is also useful in identifying areas of proposed future development, for example areas where it is proposed that large new residential or commercial areas be developed which are likely to create a high number of trips different to that of the surrounding areas. In these cases these areas could be isolated and divided into separate zones.

In the feedback received, a number of issues were raised regarding the extent to which the draft model zone system corresponds with the MyPlan land use categories, particularly where the first draft of the model zone system was deemed to not be in accordance with the MyPlan layer. The issues raised are discussed in Appendix D2 by way of a series of examples.

3.3 Concluding the First Pass

The NTA also proposed a methodology allowing assessment against the existing land use zoning, and 2011 employment data from POWSCAR. This methodology is included in Appendix D1 and helped to form the basis of the approach adopted for the next pass of the zone system.

The NTA's review highlighted the need to improve the consistency of the zoning with respect to land use, using appropriate GIS compatible spatial data. It was noted that the MyPlan could be used to improve the consistency of the model zone system with respect to land use and hence it was incorporated in to the zone boundary definition process. Therefore, a revised process for defining model zones was developed using a combination of:

- MyPlan land use data for the Greater Dublin Area;
- rules and approaches set out in the Cambridge Systematics Paper *"A Recommended Approach to Delineating Traffic Analysis Zones in Florida"*;
- continued close liaison with the NTA land use planning team; and
- refinement through analysis of population/activity levels at zonal level.

Furthermore, it was agreed that the next pass of the zone system should not attempt to restrain the number of split CSAs if required, based on the above criteria, and hence a standard methodology for apportioning data below the CSA unit was defined.

3.4 Overview of the Second Pass Zone System Development

The rules and approaches set out in the document "Approach to Delineating Traffic Analysis Zones" can be summarised as:

- **Population, Employment and Education** – the number of zones with values of population, number of jobs and persons in education above a certain threshold should be minimised;
- **Activity Levels** – the number of zones with activity levels that have very low or very high levels of trips should be minimised;
- **Intra-zonal Trips** – threshold values should be applied to the proportion of intra-zonal trips within each zone, to avoid an underestimation of flow, congestion and delay on the network;
- **Land Use** – zones should be created with homogeneous land use and socio-economic characteristics where possible;
- **Zone Size/Shape** – zone size and the regularity of zone shape should be considered in order to avoid issues with inaccurate representation of route choice;
- **Political Geography** – it will be possible to aggregate all zones to ED level i.e. zone boundaries do not intersect ED boundaries; and
- **Special Generators/Attractors** – large generators/attractors of traffic such as Airports, Hospitals, shopping centres etc. will be allocated to separate zones.

While the first pass zone system took the above criteria into consideration, the second pass attempted to formulate a more objective and procedural way of applying them. The benefit of this approach is that the method could be applied consistently to any area—not just the ERM.

This Chapter describes the development of a methodology to refine the first pass zone system.

3.5 ERM Zone System Methodology Development

A workshop was held with the NTA on the 12 July 2013 to agree an approach to finalising the zone system. The material presented at the workshop is included in Appendix G1. The purpose of the presentation was to outline how the above criteria could be applied to the zone system in a hierarchical manner that provides for possible conflict between criteria and parameters.

The sequence of criteria and applied parameters is outlined below. In each case the thresholds outlined in Appendix F1 were adopted.

3.5.1 Zone Population

A target population range of between 1,000 and 3,000 was examined. The following table shows the distribution of zones against this criterion.

Table 3.1 First Pass Zone Population Distribution

	ALL ZONES COUNTS	%
< 1000	449	32%
> 3000	138	10%

The proposed action based on this examination was to try to amalgamate zones below 1,000 and disaggregate zones above 3,000, noting that neither of these actions would always be feasible e.g. for generators or attractors given special zones or for zones created to follow physical boundaries (water, motorways, or rail).

3.5.2 Zone Activity

A target activity level (productions and attractions) of less than 2,000 trips in the AM peak was examined.

Table 3.2 First Pass Zone Activity Level Distribution

	COUNTS	%
< 500	302	23%
> 2000	127	9%

The proposed action was to disaggregate the 127 zones above the threshold activity level, subject to the constraints mentioned above.

3.5.3 Intrazonal Trips

The guidance suggests a target intrazonal trip level of less than 5% of the total productions and attractions of the zone. As shown in Table 3.3, 86% of zones had an intrazonal trip level of less than 5%. This distribution is based on POWSCAR 2011 using a combination of both work and school journey purposes.

The proposed action was to attempt disaggregation of zones over 10% first (only 7.5% of the zones), subject to the constraint that the population level should not drop below 1,000.

Table 3.3 First Pass Zone Intrazonal Trip Proportions

	COUNTS	%
< 5%	1,159	86.4%
< 10%	1,241	92.5%

3.5.4 Land Use

The MyPlan dataset allowed a much more comprehensive analysis of land use during zone system development in the second pass. The presentation noted the objective of having homogenous land use characteristics within all zones but that many zones in the first pass zone system did not respect this objective when assessed using MyPlan. The NTA's views were sought at this point to determine the best approach to achieving land use consistency based on use of the MyPlan land use data.

3.5.5 Size of Zone

A target of 80% of activity made by zones that are less than 5 km² was examined. In the first pass system 64% of activity was made by zones under this size. The proposed action on these zones was to disaggregate zones above the target size, respecting the minimum 1,000 population constraint. All zones were assessed on a case-by-case basis, so large zones such as Dublin Airport, the Phoenix Park, or zones which include islands (e.g. Bull Island), were not subjected to disaggregation due to their large sizes.

The figure below shows the zones which are over 5 km² in the first pass system.

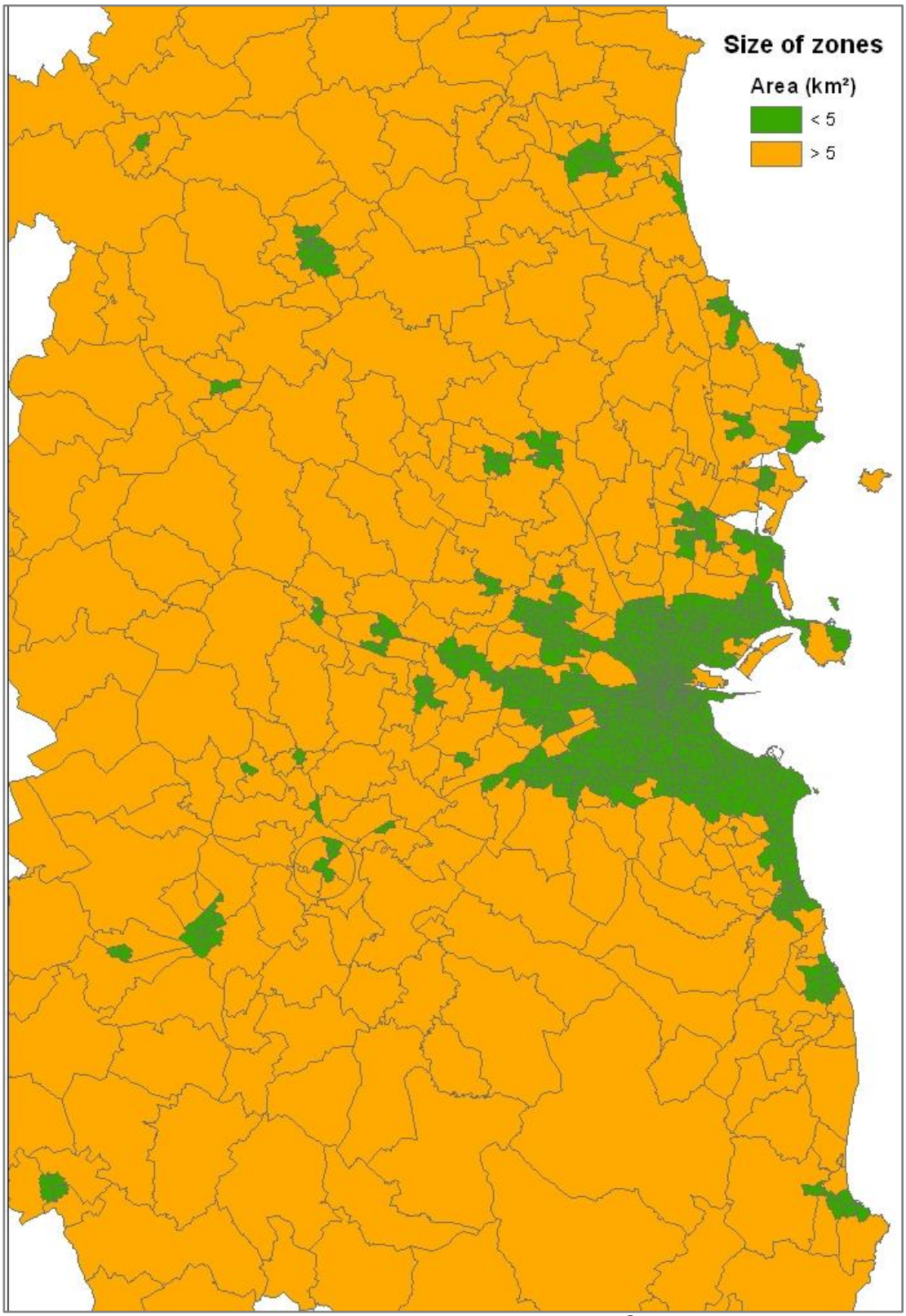

Figure 3.2 Zones Above and Below 5km^2

3.6 Other Criteria Discussed

A number of other criteria were discussed such as:

- **Political Geography:** for example to respect DED boundaries (already implemented in the first pass system); and
- **Zone Shape**: Zones should be convex where possible, i.e., they should bulge outwards and have a smooth shape. In this respect internal angles should be consistent. This objective is constrained by the need to conform to the shape of existing CSA boundaries which tend to be very irregular.

A meeting was held on the 17 July 2013 to clarify some aspects of the approach (the presentation is included in Appendix G2 and the meeting minutes are included in Appendix G2.1). A summary of the material and key outcomes of the follow up meeting are described below.

3.6.1 Clarification of Generator / Attractor Zones Approach

Based on further discussion with the NTA, the following was agreed:

- a list of key generators, e.g., hospitals, commercial centres and shopping centres was to be identified (please see Appendix G3 for the list). Where possible data on relevant scale (e.g. number of patients for hospitals) was made available by the NTA;
- each identified generator would be isolated in a zone, where possible;
- it was agreed that Trinity College and generally other mono-use generators could be represented by a single zone even if the estimated activity levels were above the target thresholds, particularly if the car mode-share is low, or if the network is permeable around the zone with sufficient numbers of loading points;
- the agreed types of generator to be identified were:
  - hospitals;
  - key transport stations;
  - education;
  - shopping centres; and
- the agreed activity levels for each type of generator are shown below in Table 3.4.

Table 3.4 Proposed Activity Thresholds for Generators

	NAME	DESCRIPTION	THRESHOLD
1	Hospital		>50,000 attendances a year
2	Transport	Airports, Ports, large Railway stations	>5,000 pass/day
3	Commercial centre		>10,000 m²

4	Education	Universities, Institutes of Technology	>2,000 students
5	Company site	large employers	>1,000 employees

3.6.2 Clarification of Boundary Criteria (motorways, water, railway)

Based on further discussion with the NTA, the following was agreed:

- it was decided that zones should be split along significant physical boundaries in all cases.

3.6.3 Clarification of Land Use Criteria

Based on further discussion with the NTA, the following was agreed:

- MyPlan includes a comprehensive set of categories to describe a wide variety of land uses. However, many of these categories are similar with respect to travel behaviour and / or trip rates. It was therefore agreed that similar land uses should be grouped into single representative categories (termed ‘macro’ categories).
  -
  -
  -

- Figure 3.3 comprises a map of the zoning by the number of different (macro) land use categories;
- Table 3.5 shows the distribution of zones by the number of land use categories; and
- as well as grouping the many types of category into macro categories, it was necessary to set a threshold to identify only ‘significant’ macro land uses within a zone. Otherwise

zones would be identified as having very diverse land uses when for the purposes of a strategic model they should be simplified. Hence, if a particular macro land use composed less than 5% of the zone area, it was not considered in the count of different categories.

- the NTA subsequently advised on how these macro land use categories should be developed from the full set of MyPlan categories;
- for each macro-category, a list of data sources would be compiled to indicate the scale / intensity of land uses;
- zones with acceptable levels of land use mix would be flagged for further review (e.g. residential and open space); and
- a CSA disaggregation methodology would have to be developed. The NTA would provide detail of a former methodology that used GeoDirectory points to split CSAs.

Table 3.5 Frequency Distribution of Land Use Categories per Zone

NUMBER OF LAND USE CATEGORIES	ALL	ONLY CATEGORIES OVER 5% OF THE ZONE AREA	ONLY CATEGORIES OVER 20% OF THE ZONE AREA
1	2.1%	7.4%	45.9%
2	9.2%	31.6%	47.0%
3	18.1%	28.8%	6.8%
4	19.9%	17.4%	0.1%
5	16.4%	9.1%	0.0%
>5	34.3%	5.8%	0.0%

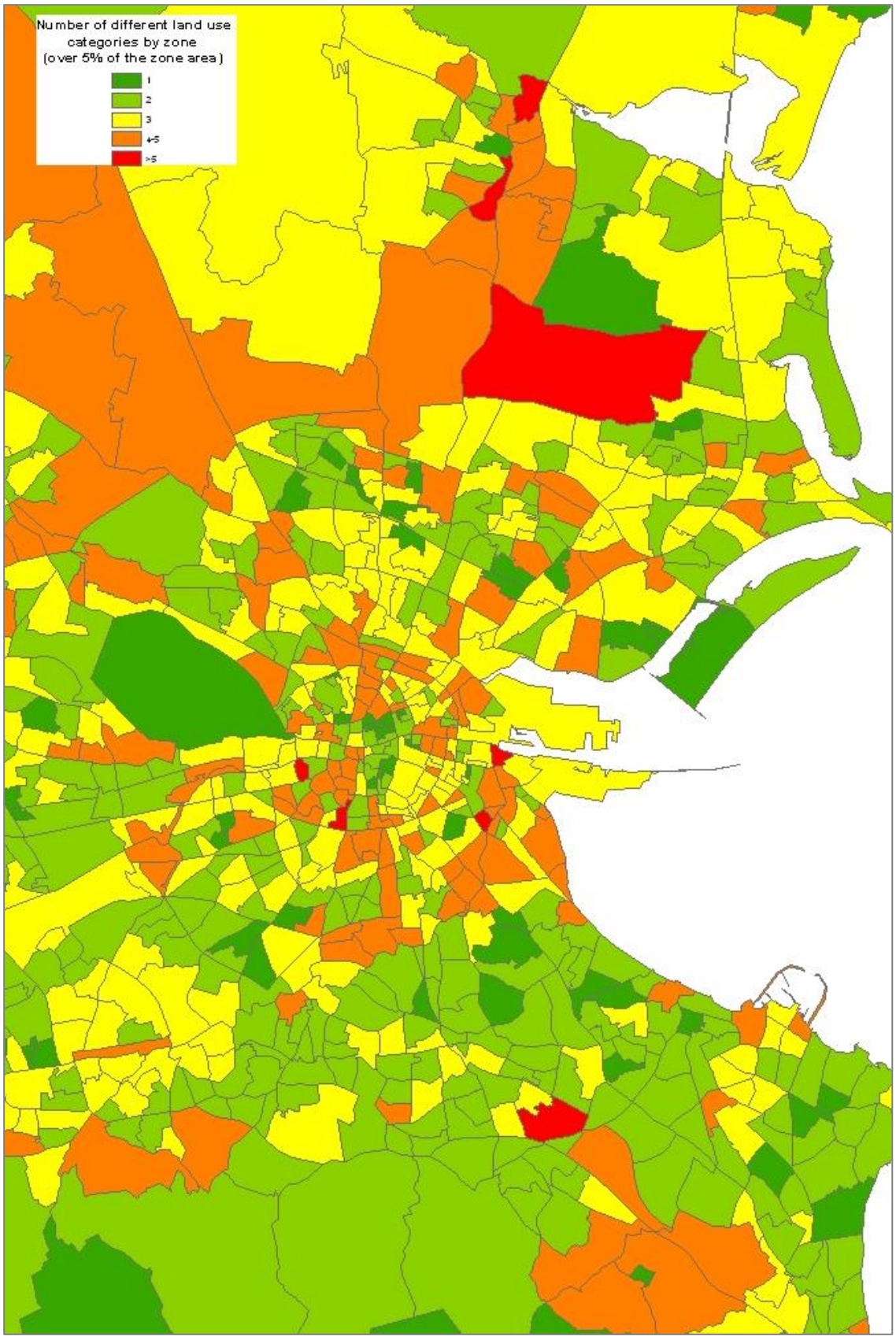

Figure 3.3 Map of the Zoning by Number of Different Land Use Categories

3.7 Development of CSA Disaggregation Approach

At the 17 July 2013 follow up meeting it was agreed that an approach should be developed to enable CSA data to be apportioned to sub-CSA disaggregated zones. An information note was hence produced to detail the proposed methodology. This is provided in Appendix H.

In summary, the tests and analysis detailed in this note led to three disaggregating processes for CSAs: one for population and two for destination trips. The proposed methods to apportion data among sub-SA are described as follows:

Population Disaggregation

Four different methods for allocating population to sub-CSA areas are available:

- GeoDirectory residential addresses can be used to share population among sub-CSAs on a pro rata basis;
- My Plan residential features can be used to share population among sub-CSAs on a pro rata basis;
- GeoDirectory: all addresses can be used to share population among sub-CSAs on a pro rata basis; and
- Surface area: Population can be shared based on an area ratio.

Destination Disaggregation

The approach to both work and school trips (the only journey purposes for which destinations to all CSAs are known) is the same. The three processes presented below are applied to the sub-CSAs. Where the results differ significantly, the sub-CSAs are flagged for manual apportionment.

Work Trips

- Geo Directory - Commercial addresses: The sharing is based on the pro rata of commercial addresses among sub SA;
- My Plan – Offices, Commercial, Education, Industry, Airport weighted land use: The sharing is based on the pro rata of employment area among sub SA, weighted by employment densities (see Appendix H Section 4.2 for more details); and
- POWSCAR Grid – work trips: The sharing is based on the pro rata of POWSCAR grid points working trips within sub SA.

School Trips

- Geo Directory – School addresses: The sharing is based on the pro rata of school addresses among sub CSAs;
- My Plan – Education: The sharing is based on the pro rata of education area among sub CSAs; and
- POWSCAR Grid – school trips: The sharing is based on the pro rata of POWSCAR grid point school trips within sub CSAs.

More detail is provided in the note in Appendix H.

3.8 Application of Agreed Criteria

A period of approximately 2 weeks was spent working through the criteria and approach outlined above. Examples of the type of modifications to the first pass zone system are presented in Appendix I1. These are briefly discussed below.

3.8.1 Physical Boundaries

Figure 3.4 shows an example of the disaggregation done throughout the model area. The dotted red line shows where the zone was divided in order to respect the boundary formed by the railway line.

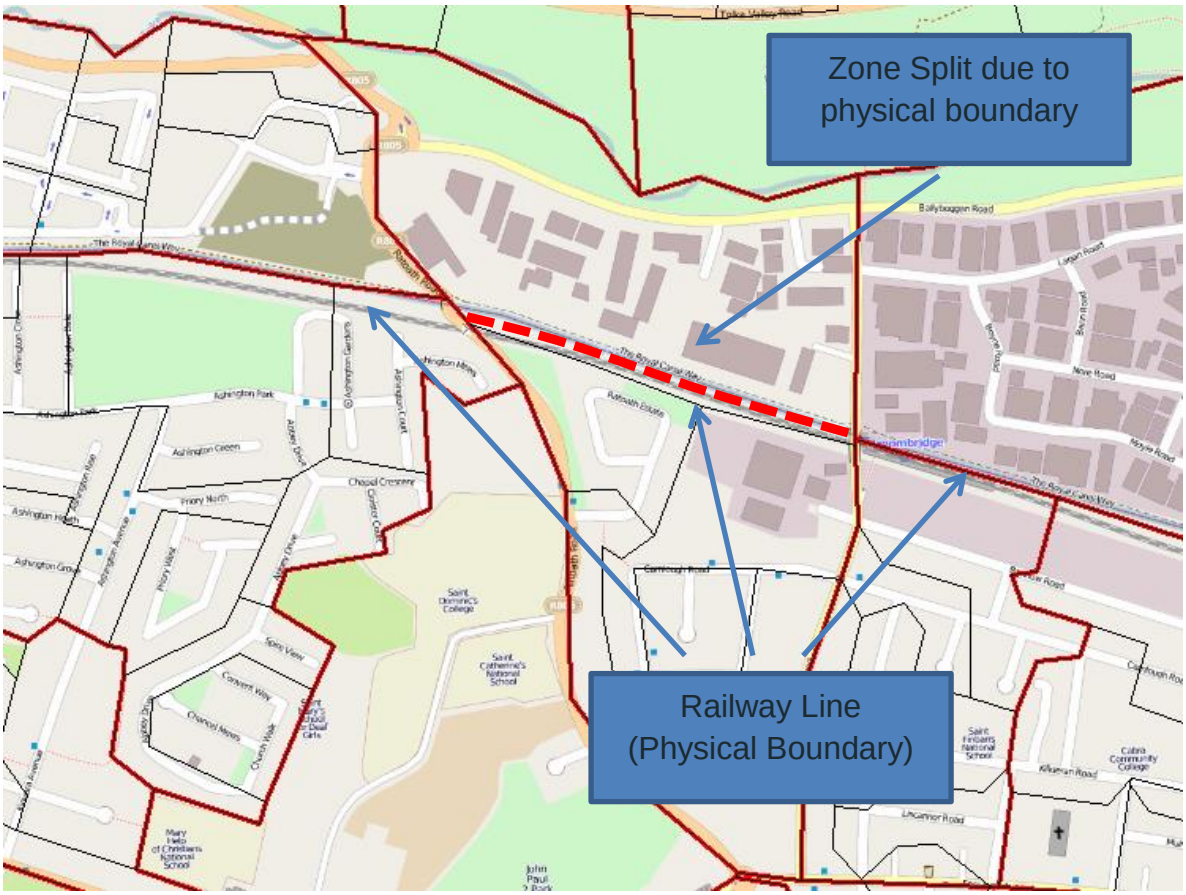

Figure 3.4 Example of Zone Split due to Physical Boundary

3.8.2 Land Use

The following sections present the agreed generators for the following types of land use:

- Hospitals;
- Transport (e.g. stations);
- Education; and
- Shopping.

Hospitals

Data based on hospitals general attendance in 2009 was used to identify the following list of special hospital generators (for which only public hospitals with an attendance over 50,000 were considered). spitals that meet the criteria.

Table 3.6 provides a list of the identified hospitals that meet the criteria.

Table 3.6 List of Hospital Generators

NAME	TOTAL ATTENDANCE
St. James Hospital	178,107
Adelaide & Meath Hospital Inc NCH	160,969
Beaumont Hospital	158,993
Mater Misericordiae Hospital	152,471
St. Vincents Hospital Elm Park	126,945
Coombe Women and Infants University Hospital	97,952
Our Ladys Children's Hospital Crumlin	84,761
National Maternity Hospital	82,405
Rotunda Hospital	67,945
St. Lukes Hospital - Dublin	61,473
Connolly Hospital - Blanchardstown	59,048
Temple Street Childrens Hospital	55,712

Transport

The following set of key transport attractor / generators was identified based on local knowledge, rather than a particular measure of activity.

Table 3.7 Key Transport Attractor / Generators

NAME	GENERATOR
Dublin Airport[2]	Transport
Dublin North Dock	Transport
Heuston station	Transport
Connolly station	Transport

[2] Dublin Airport may require special treatment within the demand model

Busáras	Transport

Education

Third level education institutions with more than 2,000 places were identified.

Table 3.8 provides a list of the identified institutions that meet the criteria.

Table 3.8 Key Education Generators

NAME	COMMENTS
DCU	
St Patrick's college	
Trinity college	Large zone
UCD Belfield	Large zone
Maynooth South Campus	
Maynooth North Campus	
Dublin Institute of Technology	Multiple Sites
Institute of Technology, Carlow	
Dundalk Institute of Technology	
Institute of Technology, Tallaght	Not isolated in the zone (electoral boundaries)
Dun Laoghaire Institute of Art, Design and Technology	
Institute of Technology, Blanchardstown	
National College of Ireland	

Shopping Centres

As with transport generators, local knowledge and common sense review of the larger shopping centres in Dublin was used to develop the following list:

- Blanchardstown Centre;
- Dundrum Town Centre;
- The Square, Tallaght;
- Swords Pavilions Shopping Centre;
- Jervis;
- ILAC shopping centre;
- Stephen's Green shopping centre;
- Liffey valley shopping centre;
- Nutgrove shopping centre;

- Blackrock shopping centre;
- Santry omni centre;
- Northside shopping centre;
- Donaghmeade shopping centre; and
- Charlestown shopping centre.

A map of these locations is provided below in Figure 3.5.

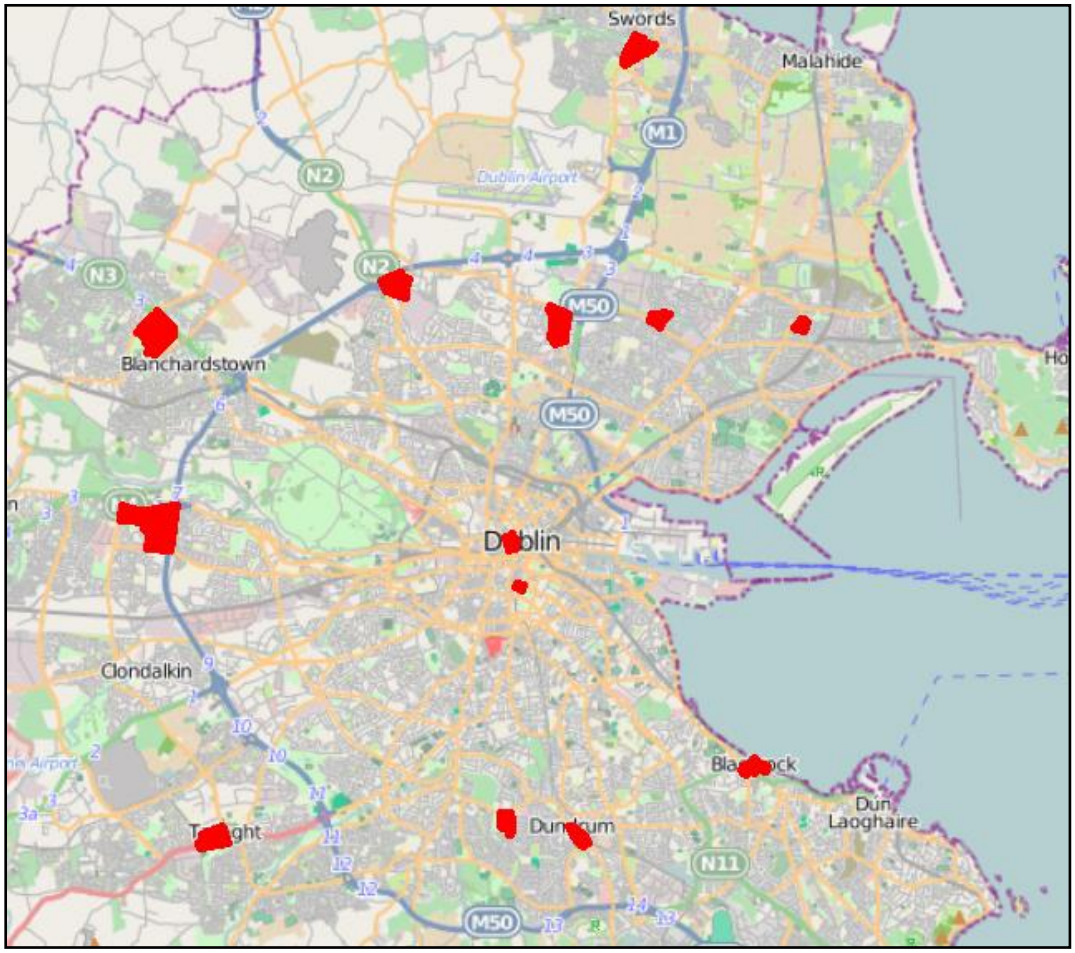

Figure 3.5 Locations of Identified Shopping Centre Generators

POWSCAR

The POWSCAR database was used to identify CSAs which had over 2,500 destination trips (all modes, all time periods). This resulted in 85 small areas being identified, of which:

- 59 were in the Tier 1 modelled area, of these:
  - 28 had already been identified as a generator; and
  - 31 would have to be split if they could not be defined as an isolated generator.
- 26 were outside the Tier 1 modelled area. It would not be beneficial to disaggregate zones in Tiers 2 and 3 of the zone system as the

level of network detail would not be commensurate with smaller zone sizes and/or activity levels.

3.9 ERM Output Zoning System

The output zoning system, after any necessary disaggregation was applied to the identified zones, contained 1,490 zones, an increase of 110. This version of the zone system was named Zoning v1.3.

ERM Zoning System Versions 1.3 and 1.4

Further refinement was performed on an on-going basis. The next version supplied to the NTA was v1.4 which reflected continued disaggregation to v1.3. The next version, v1.4, was the first version on which the NTA performed a detailed zone by zone review. This review is provided in the Appendix I2 spreadsheet. Having addressed the comments included in this spread sheet, v1.5 was provided to the NTA.

ERM Zoning System v1.5 Review

This version had 1,510 zones. A total of 1,362 zones in the main model area were reviewed by the NTA. The coverage of the review is shown below in Figure 3.6.

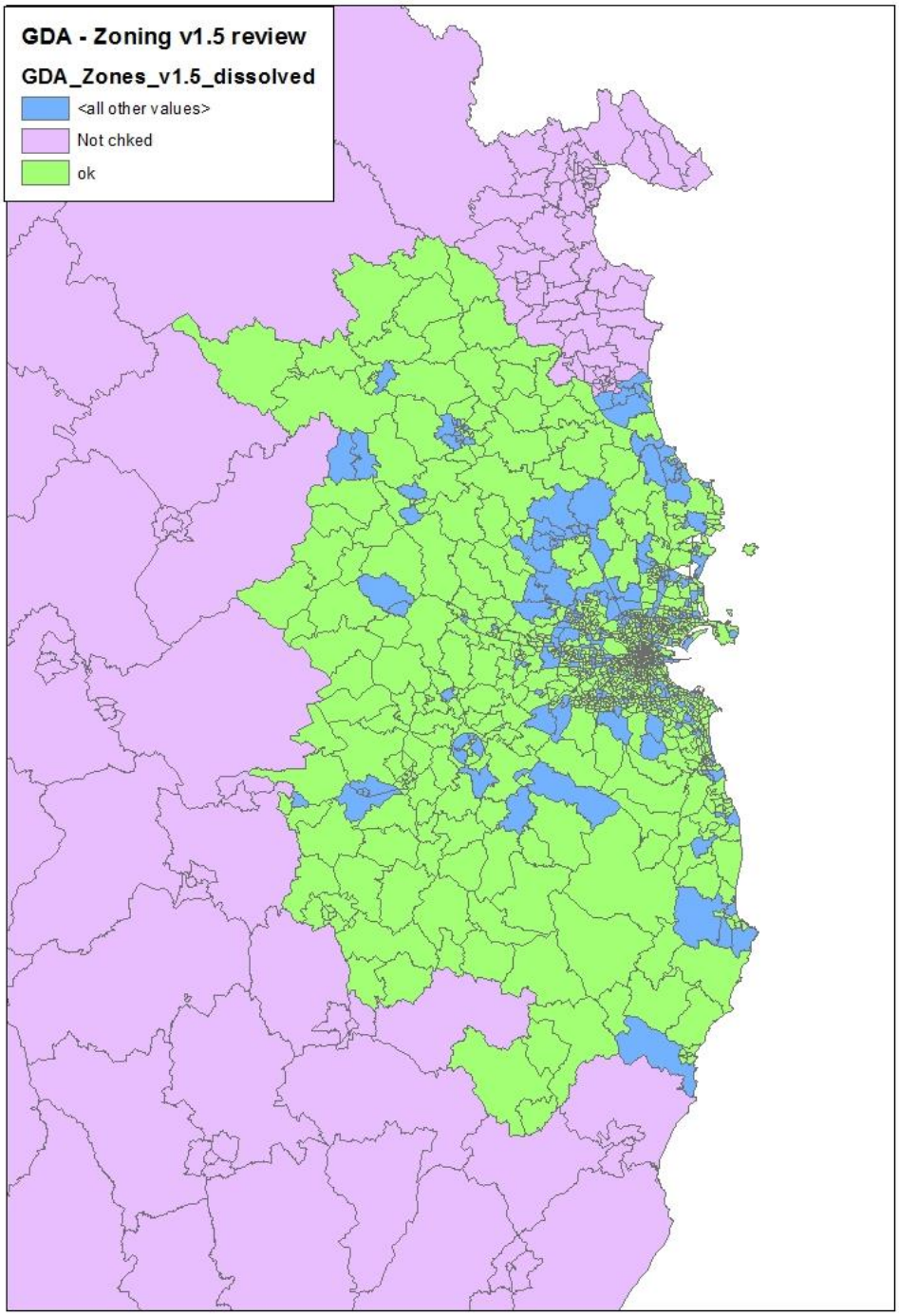

Figure 3.6 Coverage of the NTA review of Zoning v1.5

The key aspects of the NTA review of v1.5 are:

- it was suggested that all schools be reviewed to check if the school can be isolated in a zone;
- Town Centres in hinterland towns should be reviewed to attempt to achieve a more 'doughnut' shape with a small zone for the town centre surrounded by similar sized zone representing the town catchment; and
- the NTA review of zoning in Louth was incorporated after v1.5.

The review included miscellaneous comments for zones which seem to contradict the agreed criteria and thresholds. These comments and the consultant team's response are provided in Appendix J1. Modifications were required to about 15% of the zones based on this review.

The presentation included in Appendix J2 summaries the other key aspects of the NTA review and final round of iteration, e.g. examples of school and town centre issues and corresponding zoning modification proposals. Appendices J3 and J4 demonstrate some of the actions performed on the zone system as a result of the v1.5 review. The examples relate to specific NTA comments in Appendix J2.

The version of the zone system produced as a result was termed v2.0. Table 3.9 provides some high level statistics on how conformance to the key criteria for zonal population and activity level improved from version 1.5 to version 2.0.

For each new version of the zoning that introduces new sub-CSA zones, the data allocation process defined in the note in Appendix H has to be applied so that the final activity level distribution can be calculated.

Table 3.9 Population / Activity Comparison Zoning v1.5 – v2.0

	ZONING V1.5		ZONING V2.0	
	Number	**Ratio**	**Number**	**Ratio**
Population				
<3,000	1372	91%	1550	93%
>3,000	138	9%	111	7%
Total	1510	100%	1661	100%
Total Activity				
<500	141	9%	200	12%
500-2,500	1097	73%	1238	75%
>2,500	272	18%	223	13%
Total	1510	100%	1661	100%

It should be noted that activity levels have been defined based on the sum of POWSCAR total work and education productions and attractions.

3.10 ERM V2.0 Final Review

The NTA review of v1.5 highlighted 227 zones to be checked (further details provided in Appendix K1 under the field 'ISP_Chk2').

The Consultant team reviewed each of the 227 zones and redefined zone boundaries where appropriate. In some cases the decision was to leave the zone unchanged. In either case the reason is given under the column 'Systra_C_1'. An additional review of the SYSTRA response was performed by the NTA. The vast majority (217 of 227) of SYSTRA's responses were agreed. The remainder included some clarification of the response – for example, if the SYSTRA response was 'ok – zone to be split' the NTA specified in a small number of instances the preferred new boundary.

Having performed the necessary actions on theses 227 zones, a new version of the zoning was provided to the NTA termed ERM Zoning v2.1.

The NTA responded with a small number of comments. These are provided in Appendix K2. The majority of these comments related to small zones sizes and/or low activity levels. However, in all of these cases, the zoning was driven by the objective of having as few as possible land uses in a zone, which inevitably will produce smaller zone sizes.

A similar comparison as provided above in Table 3.9 is shown below in Figure 3.7. The chart compares the number of zones with activity levels inside interval ranges of 250.

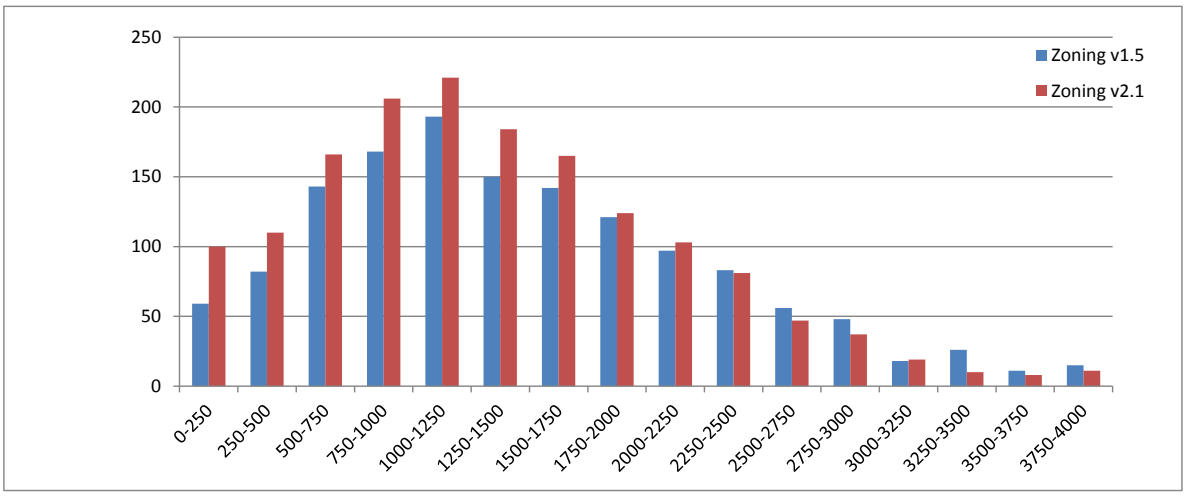

Figure 3.7 Activity Level Distribution Comparison Zoning v1.5 – v2.1

It is apparent that more zones have been created with low activity levels as a result of the high level of disaggregation entailed by the land use review. However, there

are fewer zones with high activity levels and more within the desirable 500-2000 range.

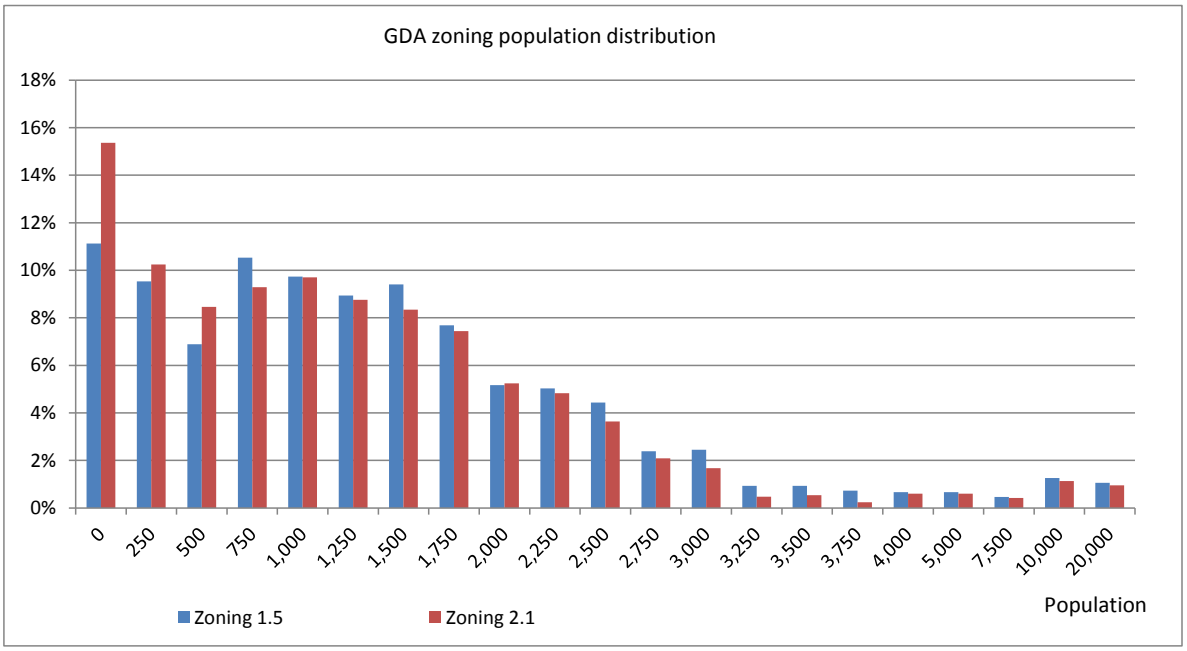

Figure 3.8 Population Distribution Comparison Zoning v1.5 – v2.1

Figure 3.8 shows the population distribution for ERM Zoning versions 1.5 and 2.1. A similar trend is exhibited as for the activity level distribution above. A large number of zones with no or very low population (e.g. 250 or less) were created for various reasons, e.g., creating zones for sparsely populated areas to separate residential land uses from other types. While CSAs exhibit a more bunched distribution in the 200 to 500 range (see item (1), Appendix F1), a similar distribution is not possible in the model zone system as many zones will contain no population for the reasons noted.

3.11 Analysis of ERM Zone Size

Further analysis may be undertaken with respect to zone size. The Zones Guidelines in Appendix F1 note that zone size should be relative to the amount of activity that is being represented by the zone in the base and future years. A simple estimation measure is to plot base and future year activity compared to zone size on a cumulative frequency distribution. The overall zone size distribution for Zones v2.6 is shown below in Figure 3.9.

The notes on zone size in Appendix F1 suggest that 80% of activity should be represented by zones under 5km². For the ERM Zoning system, about 65% of zones are under this size.

While the suggested target of 80% has not been met, it is important to note that the zones that are above this size have been reviewed on a case by case basis, and following these checks, have been deemed to be appropriate for the areas they

represent. Each model zone was created by considering activity level, relationship to the transport network, mix of land uses, as well as the wider contexts of overall number of zones, and the level of demand data available for model creation. Therefore, zone sizes greater than the threshold were often created, as long as the criteria were satisfied in a balanced way.

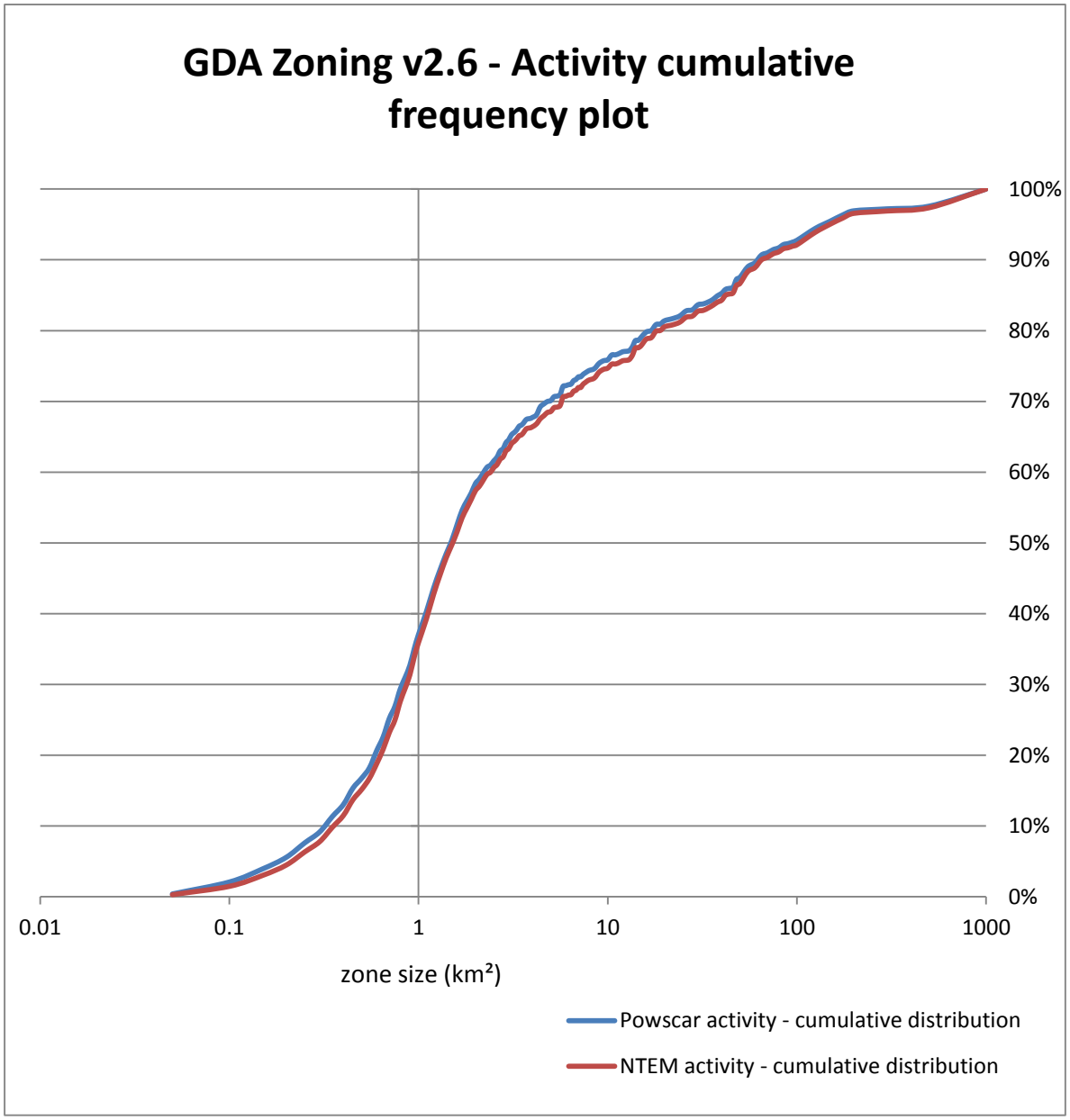

Figure 3.9 Cumulative % of Activity by Zone Size – ERM Zones

3.12 Third Pass Zone System

Zoning v3.2 has been introduced following the first tests carried out on the model, and zone aggregation/disaggregation was required locally. Very few modifications were made, as more than 99% of the zones haven't changed between v2.6 and v3.2. The three special zones have also been included at that stage. Zoning v3.2 was completed in November 2014 and used for the calibration of ERM v1 as for testing the GDA Strategy in June 2015.

A typical set of transport model zones can be separated into three types of zone:

- the internal zones (where the demand model derives travel demand for all person trips excluding goods);
- the external zones, outside the area included in the demand model, which have their demand created by a bespoke process; and
- special zones within the internal modelled area, particularly ports and airports, which are not assigned to geographical zones, but are considered as zones within the model structure to enable assignment to/from representative points in the networks.

A set of larger internal zones were identified as adversely skewing the calibration of mode and destination choice due to the large number of total productions and attractions assigned to them. The geographic area covered by the internal zones could be seen to be represented by two levels of detail; an inner detailed area and an outer belt consisting of the large zones skewing the calibration.

There were 1,635 zones within the internal modelled area (1,680 zones within the full zone system, of which 42 are external zones and 3 are special zones). However, the set of 'big' outer zones only included 24 zones (approximately 1.5% of the total), and these represented 16.5% of the total trip ends.

Figure 3.10 shows the v3.2 zoning system coloured by the total number of trip productions per zone, and clearly demonstrates that the different level of detail prevalent among zones breaks into 2 distinct regions within the modelled area.

These zones lead to problems in the modelling as there was too much weight in the trip ends and they have large intra-zonal movements. It was not possible to calibrate a mode choice model that accurately reflected travel demand for both of these different levels of geography.

The solution to the calibration related problem was to exclude the 'big' zones from the calibration process, and therefore enable the modelling of appropriate trip lengths and modal shares across the other zones.

Although this resolved issues related to the large producing/attraction numbers skewing the resulting models, the results were poor when the models were applied to the 'big' zones excluded from the calibration. Hence, it was decided that the only course of action was to disaggregate the big zones to avoid these issues in progressive versions of the model.

Therefore the area in question was reviewed with zones being disaggregated to create a system with the majority of zones aiming for the following target attributes where possible:

- zone activity target of 2,000;
- zone population max target of 5,000; and
- zone size below 70km^2.

The application of the targets was on a case-by-case basis, so that some zones' attributes remain above the thresholds, but the overall system is much more disaggregate.

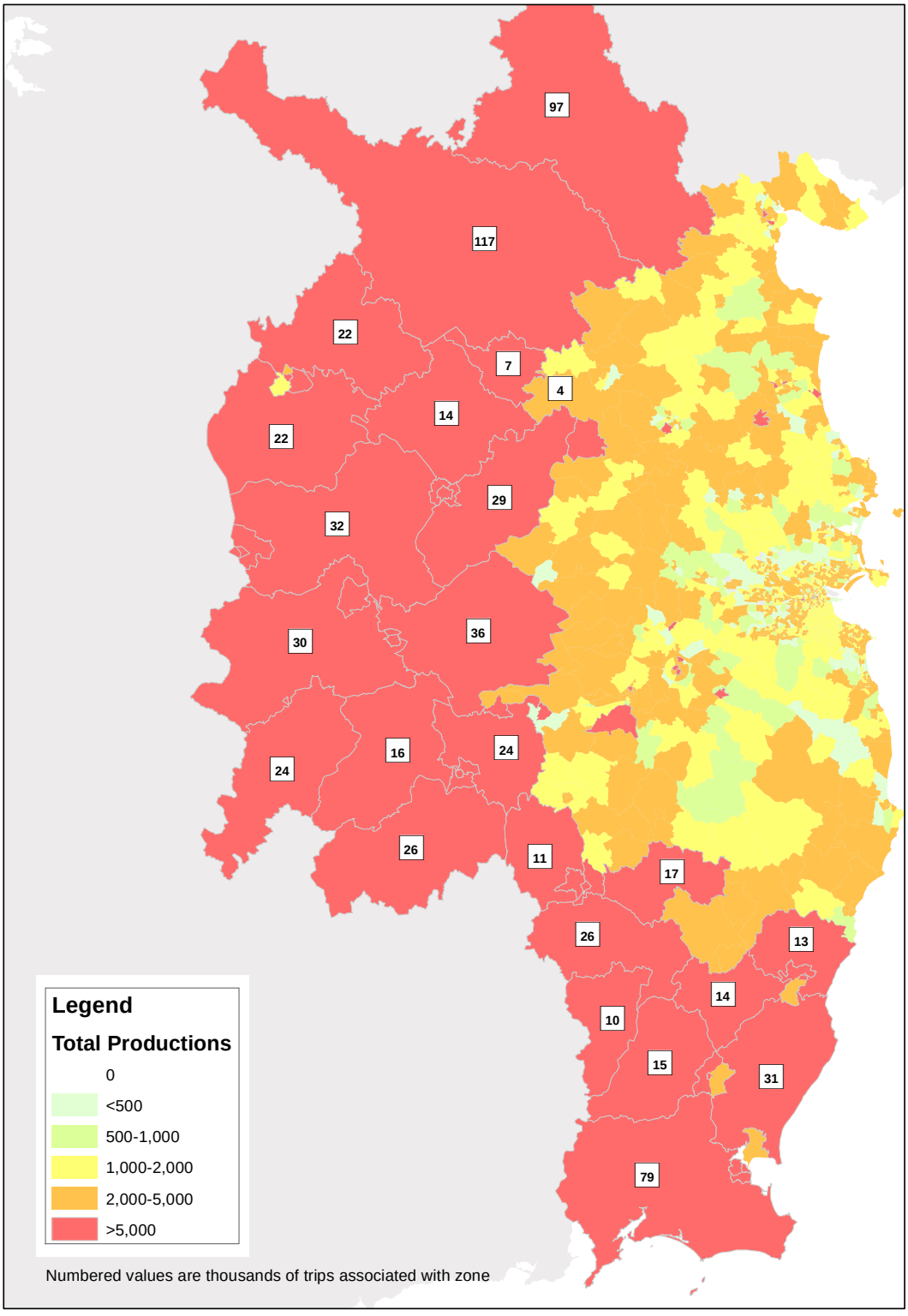

Figure 3.10 Total Production Levels of ERM Internal Zones v3.2

3.13 Fourth Pass Zone System

The main requirement of the final zone system update was to create consistent zone sizes across the model area to improve the model calibration. This was achieved by disaggregating the large zones indicated in the figure above. It was estimated at the beginning of the process that 300 to 500 additional zones would be required in this area.

Tests carried out on the SWRM identified an issue relating to the area of some of the zones and the representation of active modes in the Regional Models. Application of the aggregation criteria outlined in Section 3.8 resulted in some large zones in rural areas (where there were low levels of activity).

In the initial PT assignment, the length of the public transport walk connector was taken to be proportional to the area of the zone (it was taken to be 2/3 of the radius of the zone, with the assumption that each zone was a perfect circle). This resulted in long walk connectors, and hence a high PT access cost, for some zones, which impacted on the calibration of the FDM. It also led to the over estimation of intra-zonal walking and cycling trips, with the error in the proportion of these trips proportional to the length of the centroid connector.

Cavan and Monaghan counties, in particular, required disaggregation, as they were not included in the initial versions of zoning for the Greater Dublin Area. As such, they were represented by single zone for each county.

An example is shown in Figure 3.11, where Cavan is assigned to a single county. The available Census Small Areas to use in zone creation are also shown for comparison. A similar revision of the zoning was required for County Monaghan.

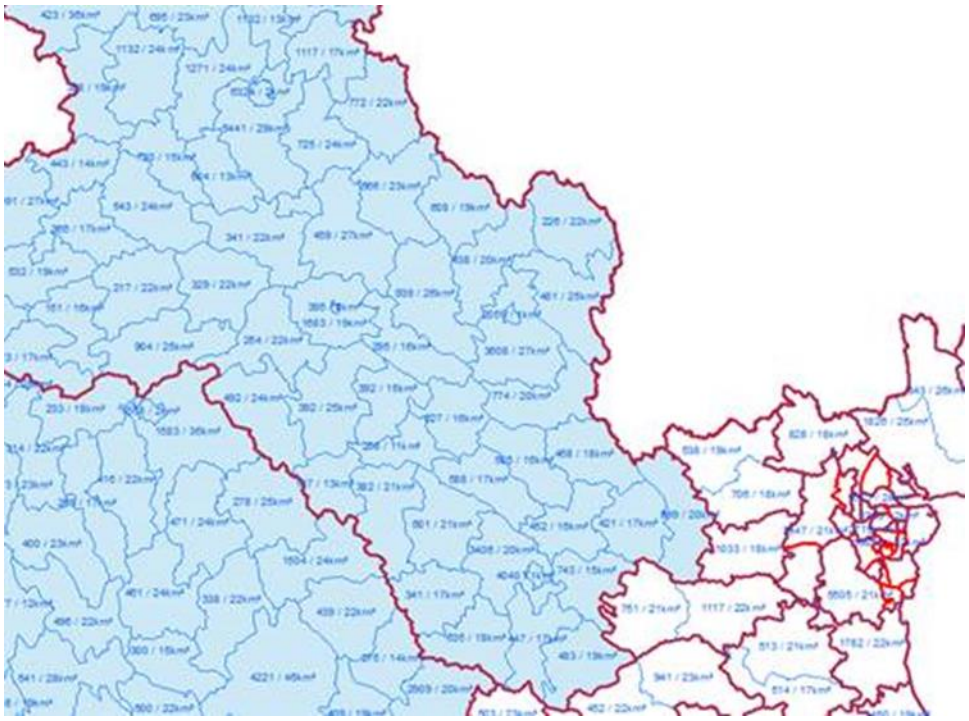

Figure 3.11 Cavan Zoning v3.2/v4.2 Version Comparison

In the above figure the red boundary indicates the v3.2 zones (i.e. the whole of Cavan was allocated to only one zone), and the lighter boundaries indicate the more detailed v4.2 zoning system.

4 ERM Sectoring and Numbering System

4.1 ERM Guidance

As set out in the ERM Guidance (ZN TN07 GDA Sectoring System Information Note), a sector system has been developed for the ERM. This sector system is presented below, and is used to define a hierarchical zone and node numbering system.

4.2 Sectoring System

A number of resources have been used in the development of the sectoring system, including:

- the finalised zone boundaries of the ERM;
- key geographical features, notably motorways (M50), canals and the River Liffey;
- county boundaries; and
- a 19-settlement type classification system provided by the NTA.

In total, 33 sectors have been developed for the ERM. These are listed in the table below.

Table 4.1 ERM Sectors

SECTOR	NAME
100	North East
101	North West
102	Dublin Port
103	Poolbeg
104	South East
105	South West
200	Kimmage
201	Templogue
202	Glasnevin
203	Balsbridge
204	Phoenix Park
205	North East Suburbs
206	Inchicore / Ballyfermot

300	Castleknock
301	Ballymount ind est. etc.
302	North East Suburbs
303	Ballymun
304	Southside
305	Dun Laoighaire
306	Knocklyon
307	Palmerstown Lower
400	Stepaside
401	Belgard
402	Clondalkin
403	Firhouse
404	Airport
405	Blanchardstown
500	Hinterland / Metropolitan Towns
600	Towns (>50km & <100km, Population<20,000) ex: Arklow
700	Towns (>100km, Population>20,000) ex: Waterford
800	Towns (>50km & <100km, Population>20,000) ex: Dundalk
900	Towns (>100km, Population<20,000) ex: Tullamore
1000	Rest of the zoning

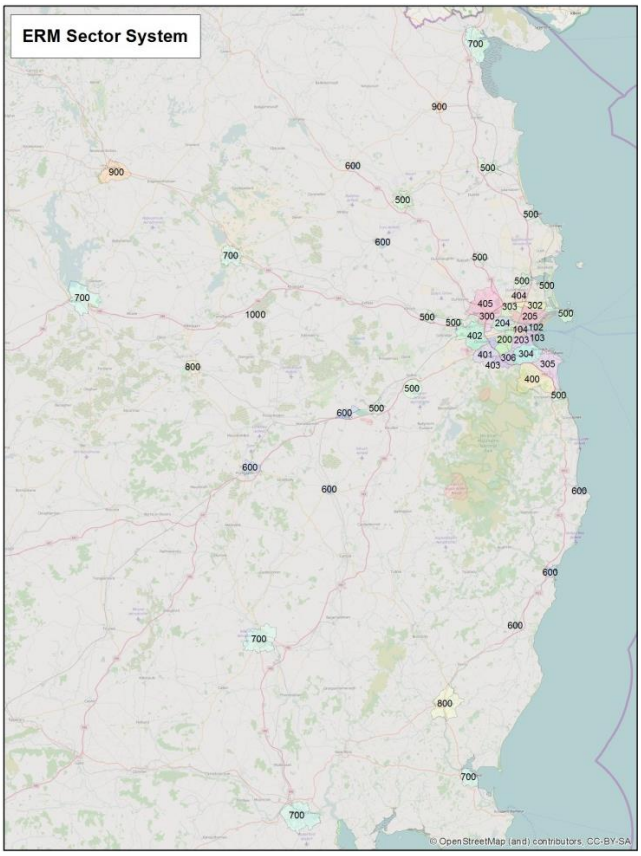

Figure 4.1 ERM Sectoring – General view

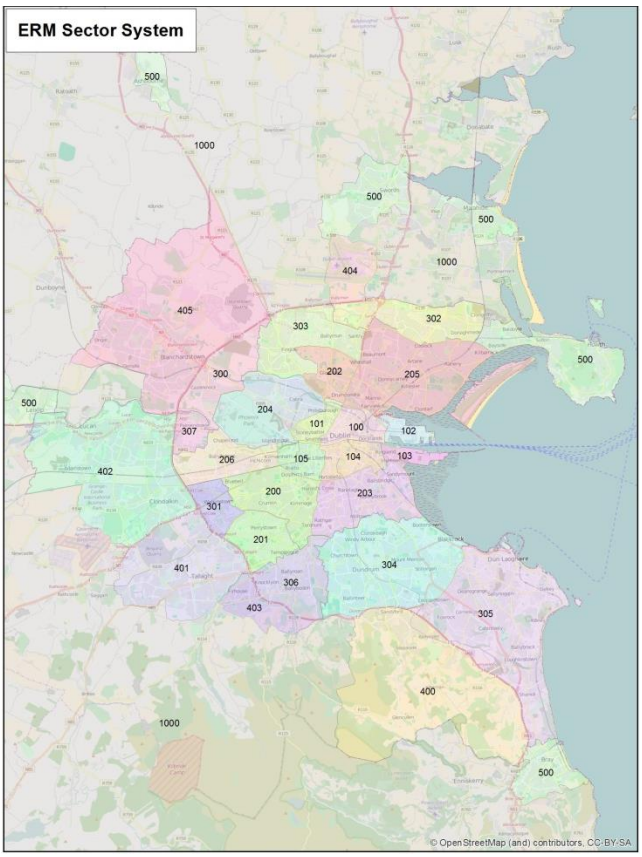

Figure 4.2 ERM Sectoring – Dublin view

4.3 Zone and Node Numbering

It is important to note that the numbering system in the first versions of the zone system was not maintained in later versions.

The SA TN07 Regional Model Hierarchical Numbering System contains guidance on zone numbering for the regional models. A hierarchical system will be adopted, with zones in the ERM renumbered based on the sector in which they are contained. This numbering system will be consistent across the suite of regional models, ensuring that independent sector, zone and node numbers are available for each of the models whilst remaining within the 5-digit (99,999) number limit within the SATURN software.

ERM has been given an allocation of 100 zone and 900 node numbers per sector, with the exception of Sector 500 (Commuter Satellite Towns) and 1000 (Undefined area), which has been allocated 250 (Sector 500) and 500 (Sector 1000) zone and node numbers. The first 100 numbers of each sector have been reserved for zone numbering, and the remaining numbers reserved for node numbering. Table 4.2 below details the zone and node numbering for the ERM.

Table 4.2 Sector, Zone and Node Numbering

SECTOR	ZONES	NODES
100	2000 - 2099	2100 - 2999
101	3000 - 3099	3100 - 3999
102	4000 - 4099	4100 - 4999
103	5000 - 5099	5100 - 5999
104	6000 - 6099	6100 - 6999
105	7000 - 7099	7100 - 7999
200	8000 - 8099	8100 - 8999
201	9000 - 9099	9100 - 9999
202	10000 - 10099	10100 - 10999
203	11000 - 11099	11100 - 11999
204	12000 - 12099	12100 - 12999
205	13000 - 13099	13100 - 13999
206	14000 - 14099	14100 - 14999
300	15000 - 15099	15100 - 15999
301	16000 - 16099	16100 - 16999
302	17000 - 17099	17100 - 17999
303	18000 - 18099	18100 - 18999
304	19000 - 19099	19100 - 19999
305	20000 - 20099	20100 - 20999
306	21000 - 21099	21100 - 21999
307	22000 - 22099	22100 - 22999
400	23000 - 23099	23100 - 23999
401	24000 - 24099	24100 - 24999
402	25000 - 25099	25100 - 25999
403	26000 - 26099	26100 - 26999
404	27000 - 27099	27100 - 27999
405	28000 - 28099	28100 - 28999
500	29000 - 29249	29250 - 30999

600	31000 - 31099	31100 - 31999
700	32000 - 32099	32100 - 32999
800	33000 - 33099	33100 - 33999
900	34000 - 34099	34100 - 34999
1000	35000 - 35499	35500 - 40999

4.4 Special zones

Transport infrastructures where passengers travel from/to foreign destinations (such as airports or ports) can generate and attract a large number of trips. People that are working at these places are considered in the "regular" demand model as both origins and destinations are within the model area. Trips made by the travellers have a part of their journey outside the model area and a part made within the model area. These trips have then to be considered separately in the model and transport demand for these hubs is modelled differently from the rest of the zones.

In the ERM, three special zones are considered:

- Dublin airport;
- Dublin Port; and
- Dun Laoghaire Port.

5 Comparison Zoning v3.2 and v4.2

This Chapter presents a comparison between the versions 3.2 and 4.2 of the zone systems, based on distributions of population, activity levels (i.e. trips generated), and zone size.

5.1 Zoning Analysis - Population

The important differences between the versions are in the ranges above 7,500 population. In v3.2, there are 40 such zones, whereas in v4.2 the number is reduced to 8.

Table 5.1 and Figure 5.1

show the more complete coverage of zones with smaller populations extending throughout the full model area.

Table 5.1 ERM Zoning Population distribution v3.2/v4.2

MIN	MAX	LABEL	ZONING v4.2	PROPORTION	ZONING v3.2	PROPORTION
0	500	0-500	340	18%	436	26%
500	1,000	500-1000	369	20%	295	18%
1,000	1,500	1000-1500	372	20%	310	18%
1,500	2,000	1500-2000	322	17%	262	16%
2,000	2,500	2000-2500	223	12%	170	10%
2,500	3,000	2500-3000	127	7%	95	6%
3,000	3,500	3000-3500	54	3%	36	2%

3,500	4,000	3500-4000	16	1%	14	1%
4,000	5,000	4000-5000	14	1%	9	1%
5,000	7,500	5000-7500	6	0%	10	1%
7,500	10,000	7500-10000	0	0%	7	0%
10,000	20,000	10000-20000	2	0%	17	1%
20,000		>20,000	6	0%	16	1%
Total			**1851**		**1677**	

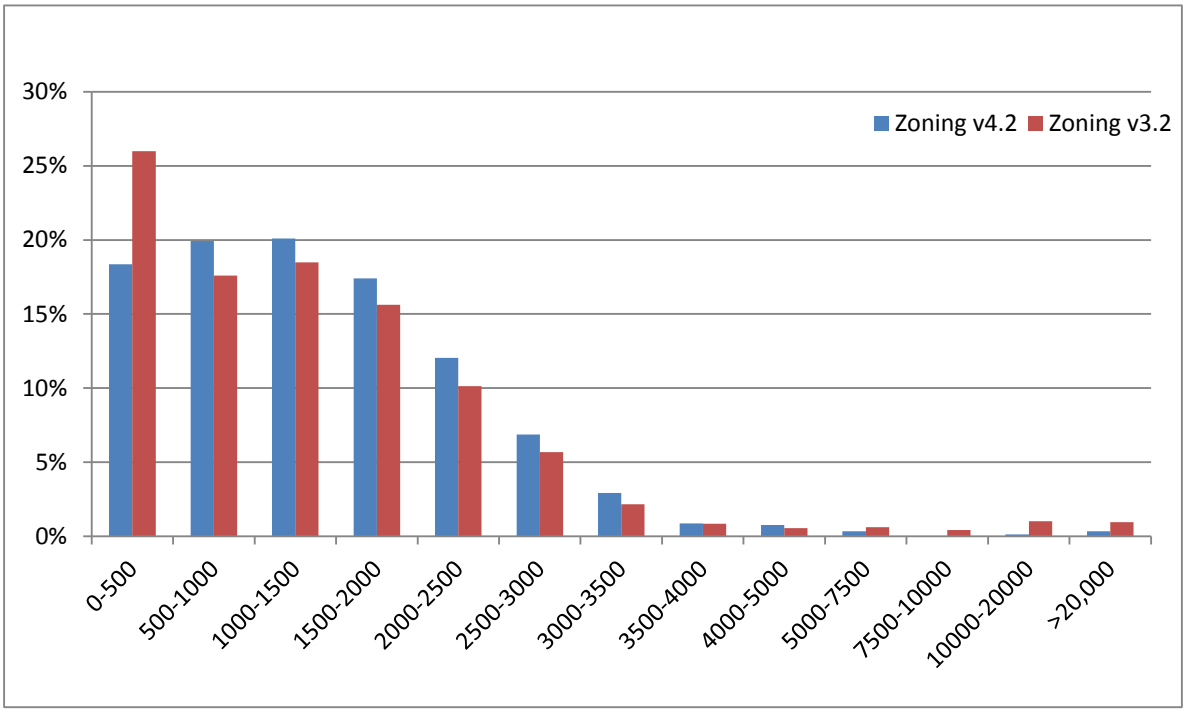

Figure 5.1 ERM Zoning Population distribution v3.2/v4.2

5.2 Zoning Analysis - Activity

The important differences between the activity levels of zones in either version are at the bottom and top ends of the scales. There are far fewer zones below the level of 500 in v4.2, and also less above the value of 20,000. This is because single zones representing whole counties have been fully disaggregated. It is notable that in v4.2, there are many more 'mid-size' zones—e.g. with activity levels between 2,000 and 10,000. They number 578, compared with 362 previously. The areas that are now disaggregated in v4.2 have a predominance of low density development. Hence, the available CSAs to construct zones from are of a larger

typical size than nearer the urban areas. The effect on the frequency distribution is evident in the table and figures below.

Table 5.2 and Figure 5.2 show the improvement of mid-range activity zonal coverage throughout the modelled area.

Table 5.2 ERM Zoning Activity distribution v3.2/v4.2

MIN	MAX	LABEL	ZONING v4.2	PROPORTION	ZONING v3.2	PROPORTION
0	500	0-500	124	7%	213	13%
500	1,000	500-1000	371	20%	372	22%
1,000	1,500	1000-1500	418	23%	405	24%
1,500	2,000	1500-2000	331	18%	289	17%
2,000	2,500	2000-2500	221	12%	183	11%
2,500	3,000	2500-3000	117	6%	84	5%
3,000	3,500	3000-3500	62	3%	30	2%
3,500	4,000	3500-4000	43	2%	19	1%
4,000	5,000	4000-5000	56	3%	18	1%
5,000	7,500	5000-7500	54	3%	17	1%
7,500	10,000	7500-10000	25	1%	11	1%
10,000	20,000	10000-20000	22	1%	21	1%
20,000		>20,000	7	0%	15	1%
Total			**1851**		**1677**	

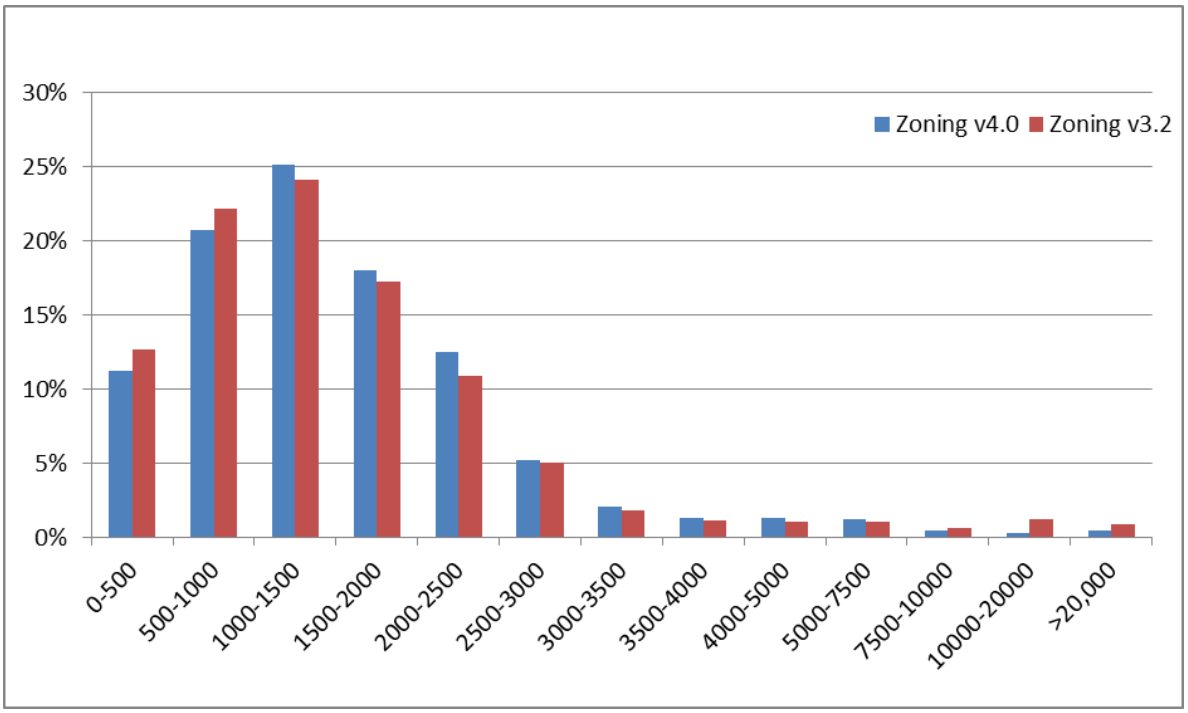

Figure 5.2 ERM Zoning Activity distribution v3.2/v4.0

5.3 Zoning Analysis - Area

The plot of zone size distribution below (note that this does not show the <1km^2 range because that represents 70% of zones and skews the plot area) shows that there are significantly more zones between 50 and 75 km^2 in v4.2. The explanation for this is the same as for the increases within certain ranges of activity level, as explained above. Figure 5.3 explains this visually. It can be seen that most of the new zones are within this size range.

It is worth noting the number of very large zones is has been decreased from 35 to 7. The remaining 5 zones are listed in the table below.

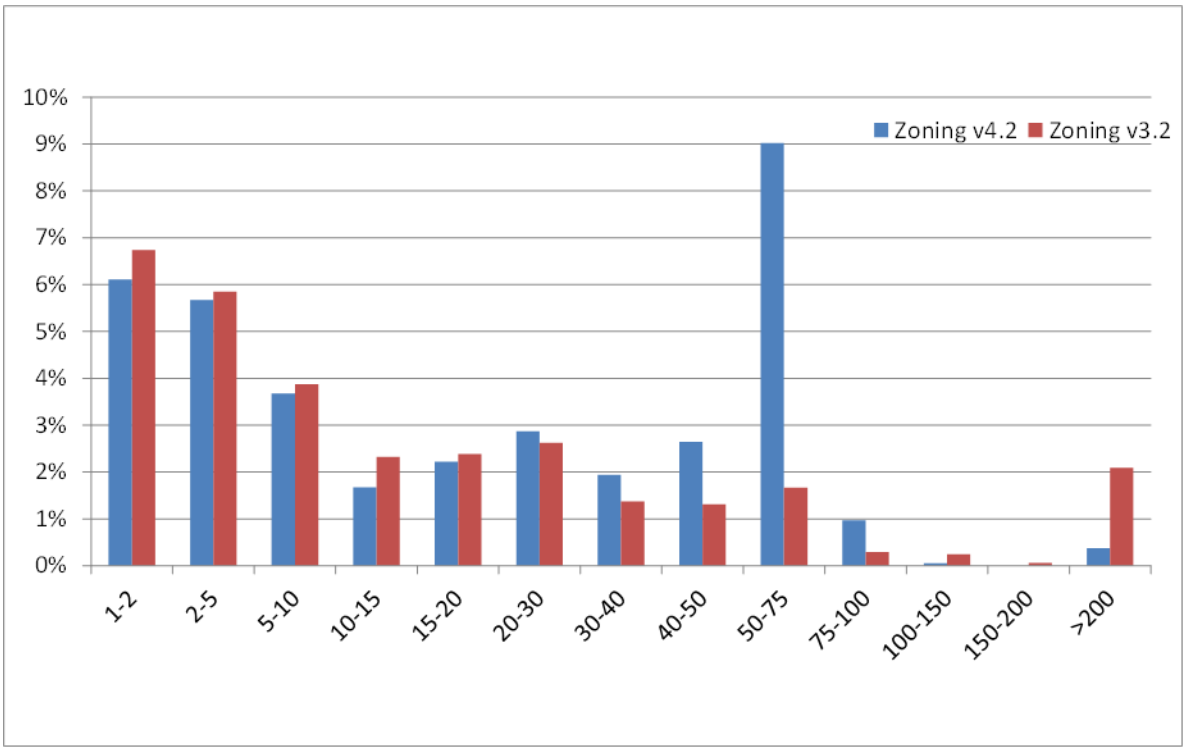

Figure 5.3 ERM Zoning Area distribution v3.2/v4.2

Table 5.3 ERM Large Zones

ZONE	COVERAGE
39501	County Mayo, County Roscommon, County Leitrim, County Donegal, County Sligo
39502	County Galway, Galway City
39503	County Clare, County Limerick, Limerick City, North Tipperary
39504	County Cork, Cork City, County Kerry
39505	County Kilkenny, County Waterford, Waterford City, South Tipperary, County Wexford

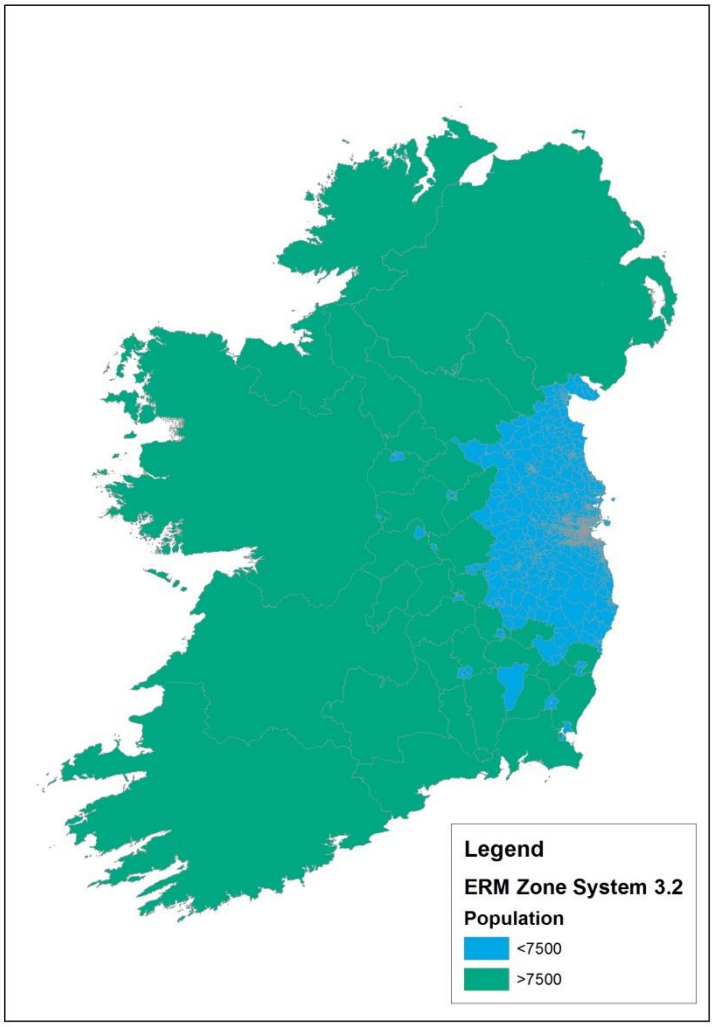

Figure 5.4 ERM Zoning v3.2
Populuation <7500 plot

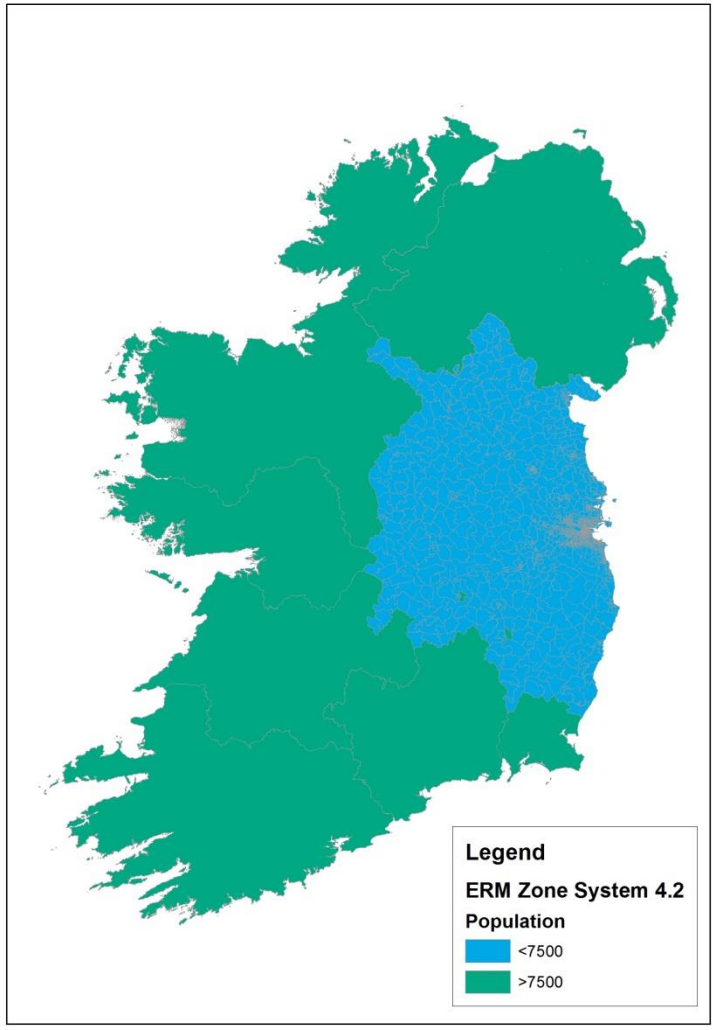

Figure 5.5 ERM Zoning v4.2
Populuation <7500 plot

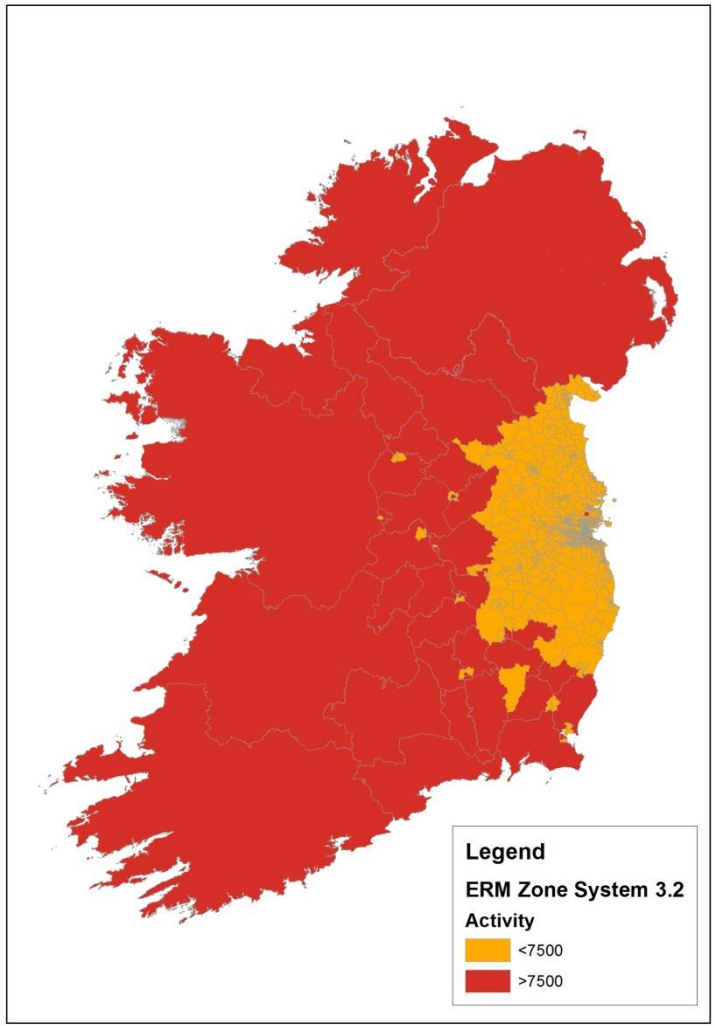

Figure 5.6 ERM Zoning v3.2 Activity <7500 plot

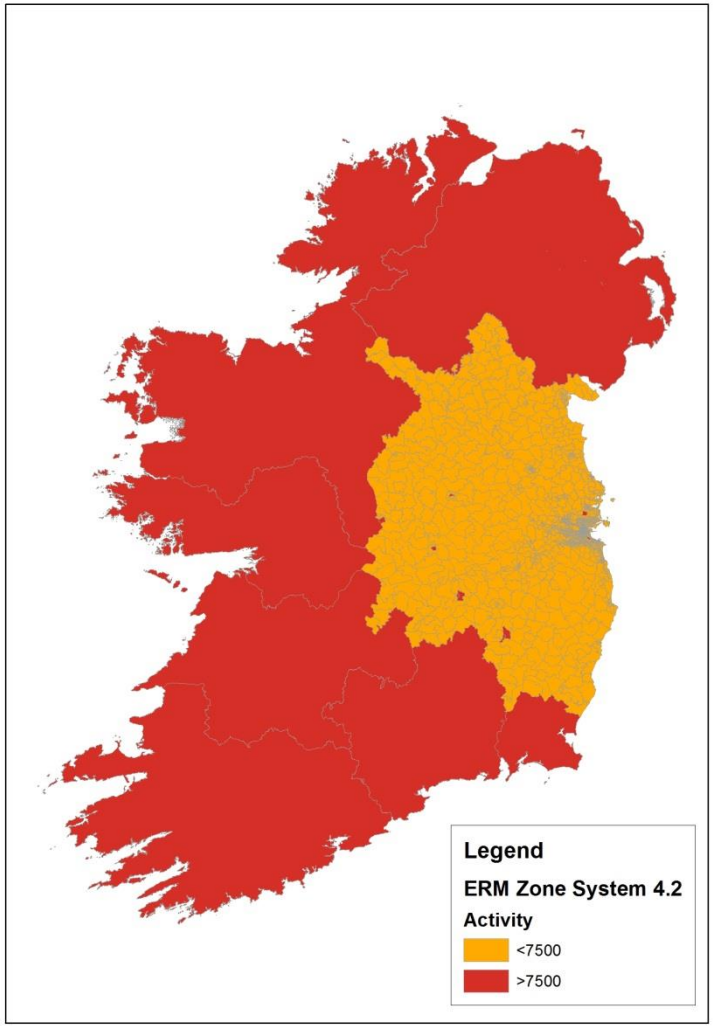

Figure 5.7 ERM Zoning v4.2 Activity <7500 plot

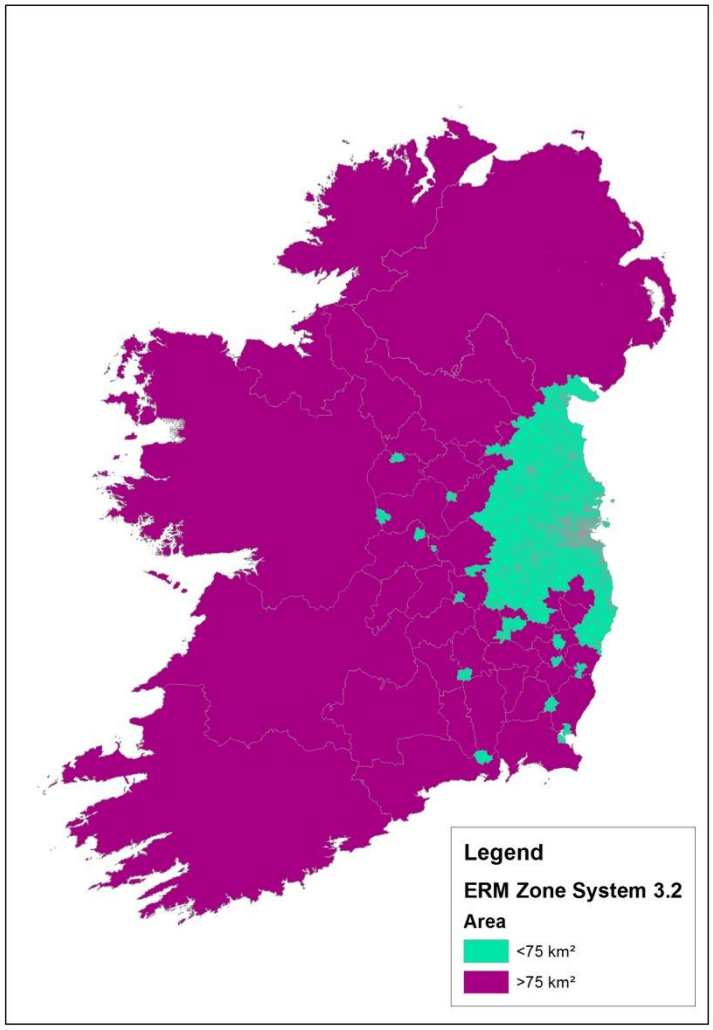

Figure 5.8 ERM Zoning v3.2 Area <75km2 plot

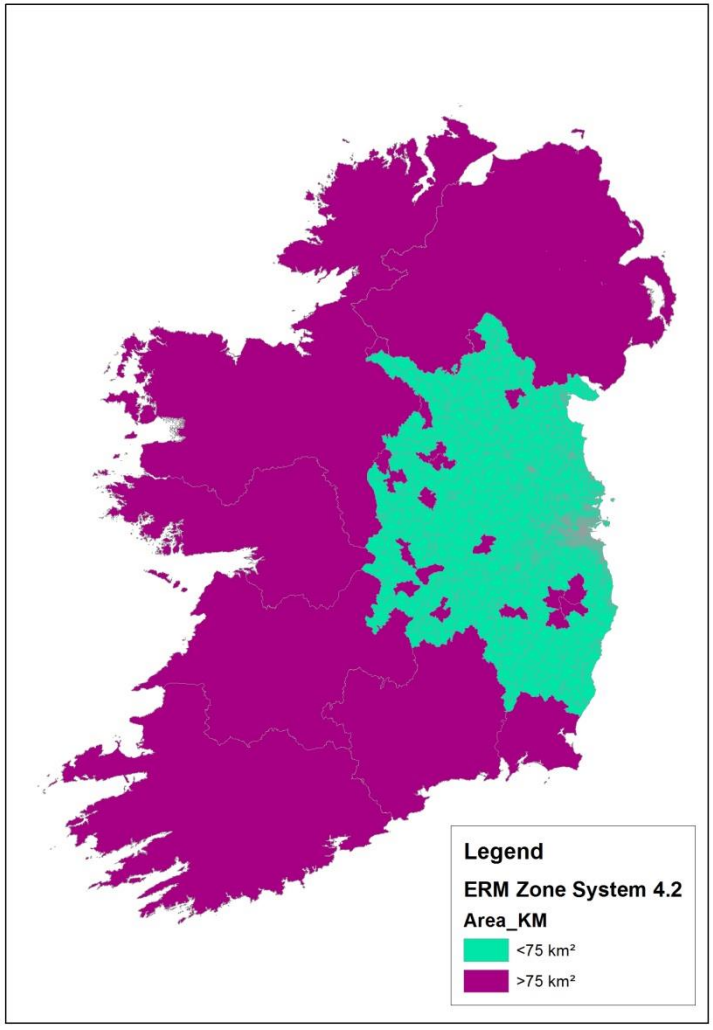

Figure 5.9 ERM Zoning v4.2 Area <75km2plot

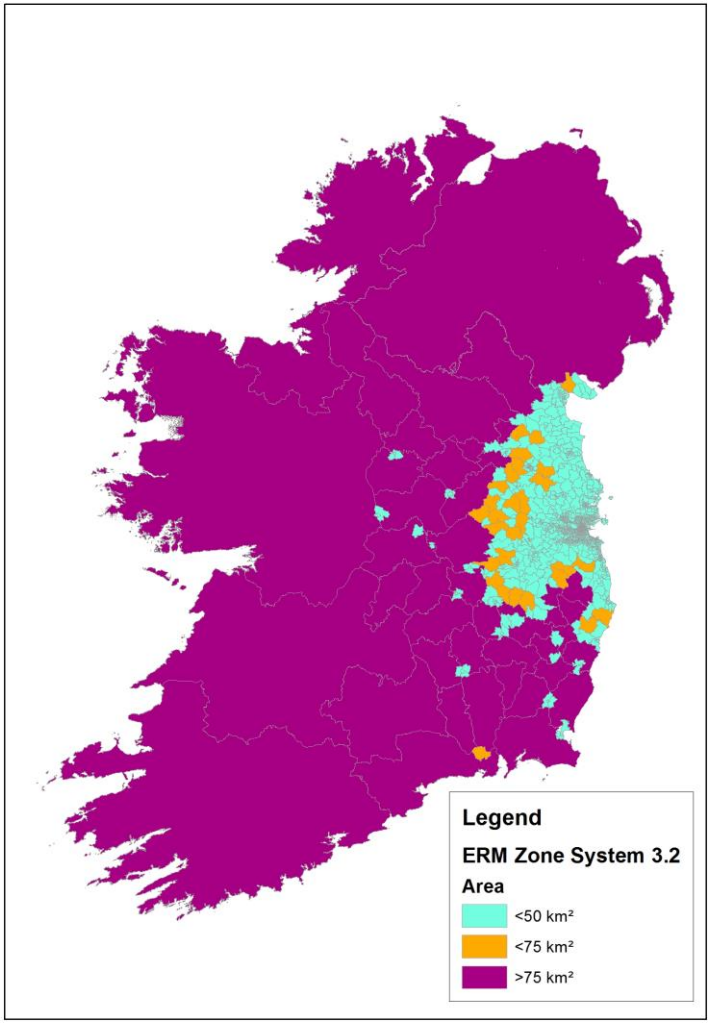

Figure 5.11 ERM Zoning v3.2 Area 50-75 km² plot

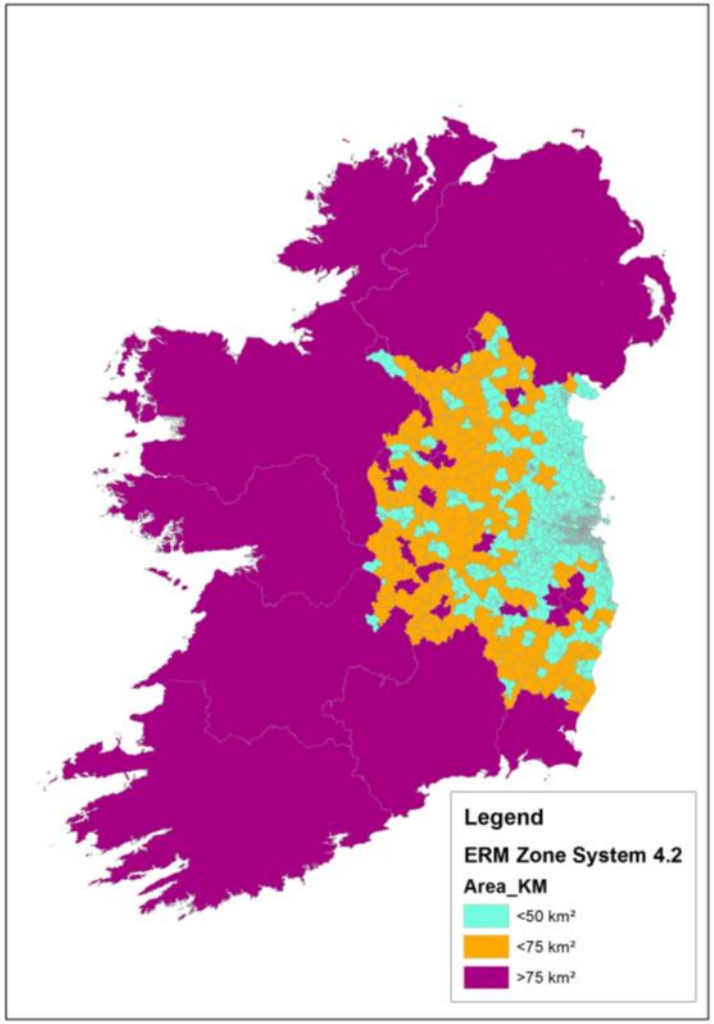

Figure 5.10 Zoning v4.2 Area 50-75 km² plot

6 ERM Final Zone System

6.1 Overall Figures

The final ERM zone system (v4.2) is shown in Figure 6.1. It has 1,854 zones as follows:

- County Dublin zones: 1,140;
- County Kildare zones: 142;
- County Wicklow zones: 107;
- County Meath zones: 141;
- County Louth zones: 82;
- County Laois zones: 34;
- County Offaly zones: 36;
- County Monaghan zones: 29;
- County Cavan zones: 36;
- County Longford zones: 20;
- County Westmeath zones: 40;
- County Carlow zones: 19;
- County Wexford zones: 18;
- External zones: 7; and
- Special zones: 3.

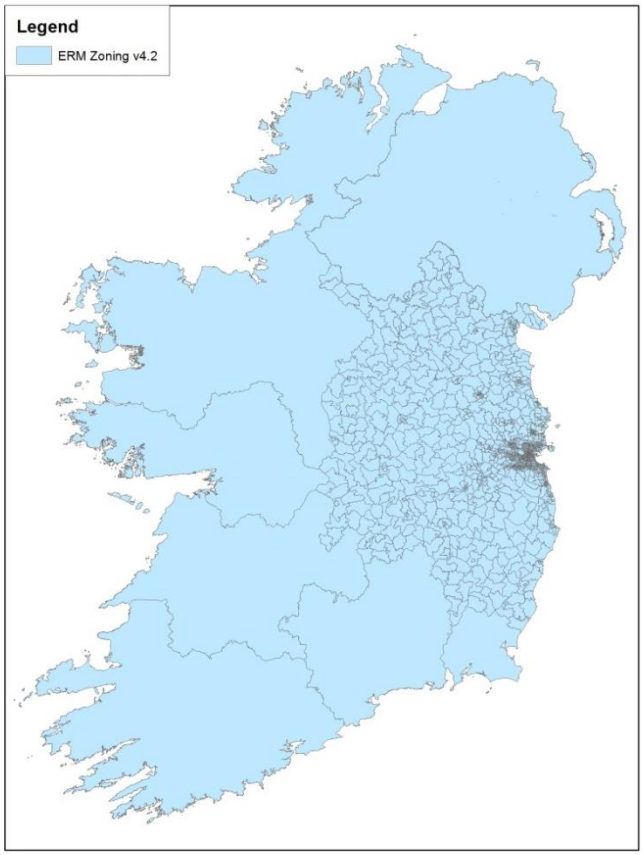

Figure 6.1 Final ERM Zone System

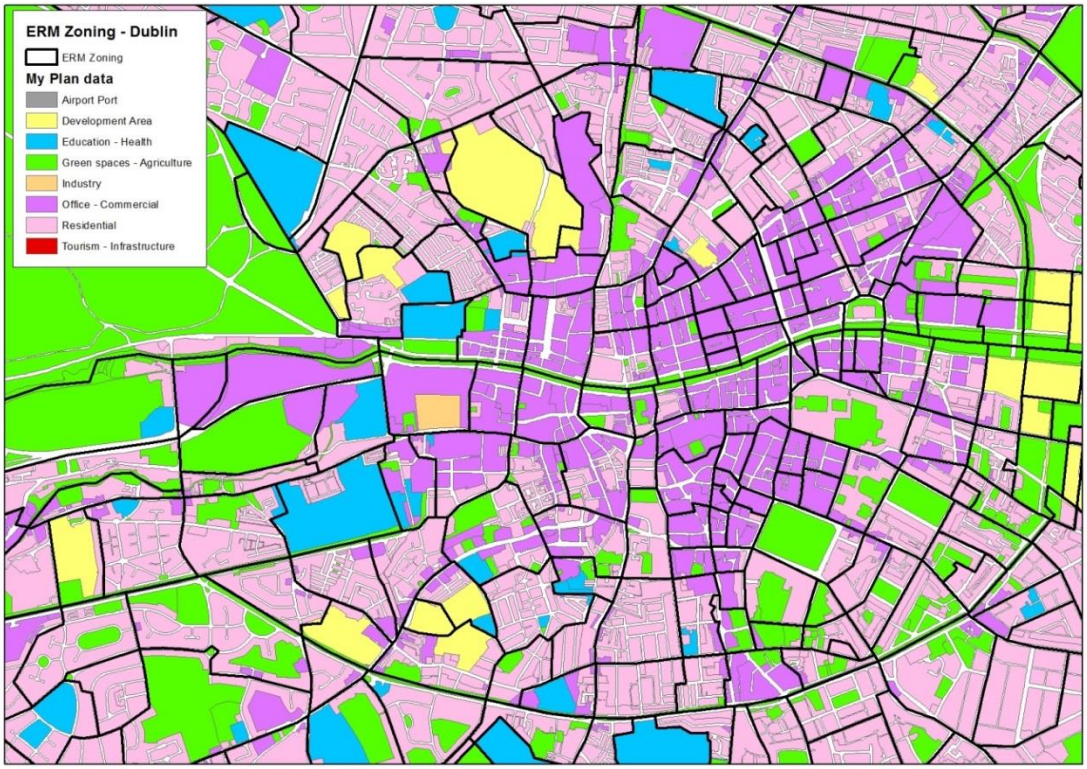

Figure 6.2 Final ERM Zone System & My Plan data – Dublin City Centre

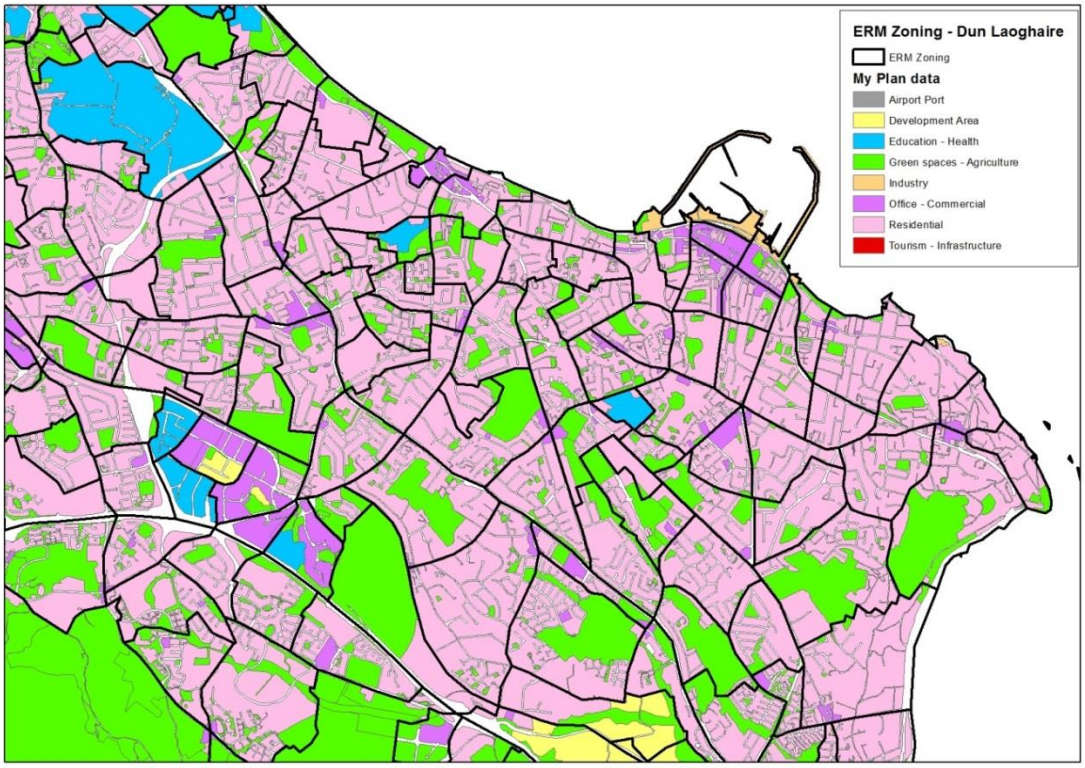

Figure 6.3 Final ERM Zone System & My Plan data – Dun Laoghaire

6.2 Zoning Analysis

Along with the GIS shapefiles of the zone system, an analysis spreadsheet is produced to check that the zoning is acceptable and meets the criteria defined in the repeatable method process.

The following criteria have been applied across the final zone system to appraise its quality, and to compare it with the other Regional Model zone systems:

- **Population** below 3,000;
- **Activity** between 500 and 2,000 trips;
- Less than 2 different **land use categories**; and
- **Intrazonal trip ratio** below 5%.

6.2.1 Population

The population distribution for the ERM zone system is illustrated in Figure 6.4, and is calculated using the Census Small Area data. In the ERM, there are 5% of the zones which have a population that exceed the 3,000 threshold criteria. Considering the large number of zones of the ERM, compared to the other regional models, further disaggregation would have big impacts on other components of the model (e.g. running time, file sizes) and has not been judged worthwhile.

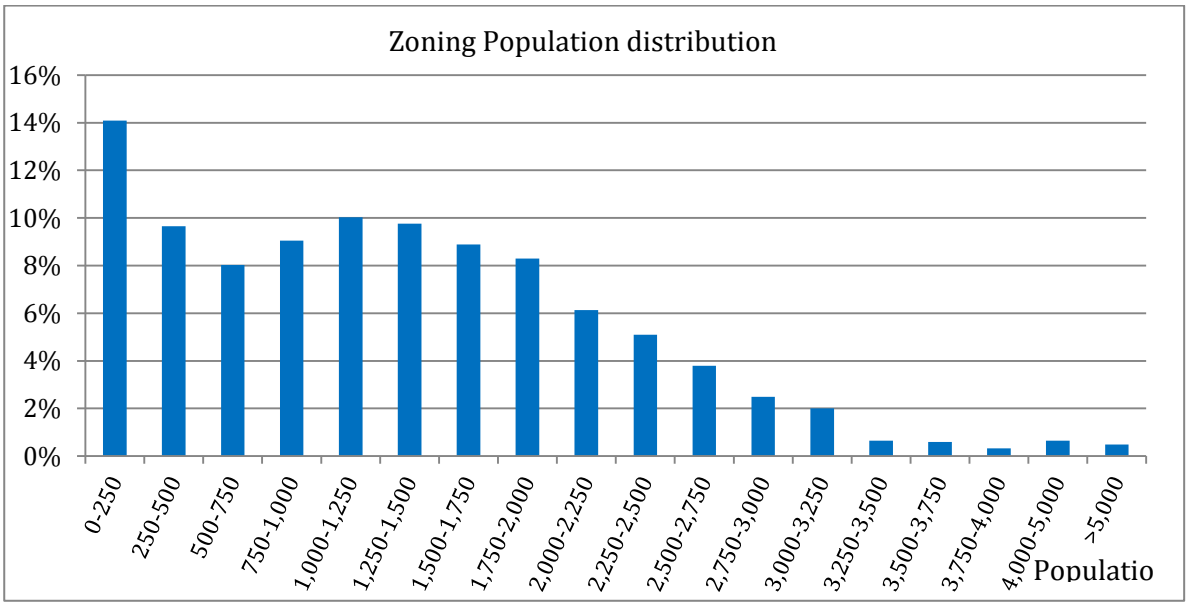

Figure 6.4 Final ERM Zoning – Population distribution

6.2.2 Activity

Activity is defined at the zonal level as the sum of trip productions and attractions. It is calculated at the zoning development stage and is derived from the POWSCAR 2011 database, for all modes and all time periods. This indicator provides a useful mechanism to compare zones of different types, i.e. residential zones (which are mostly trip producers in the POWSCAR database) and employment zones (which are mostly trip attractors).

The target activity range, defined by the repeatable method process, is 500 to 2,000 trips. The activity distribution for the final ERM zone system is shown in Figure 6.5. Approximately 12% of the zones within the ERM have an activity level below the specified minimum threshold of 500 trips. This is acceptable due to the fact that these zones are mostly located in rural areas, and aggregating them to meet this criterion would have led to very large zones.

23% of the ERM zones have an activity level above the maximum threshold of 2,000 trips (and 6% above 3,000 trips), and these represent large attractors (e.g. industrial estates, education and commercial areas).

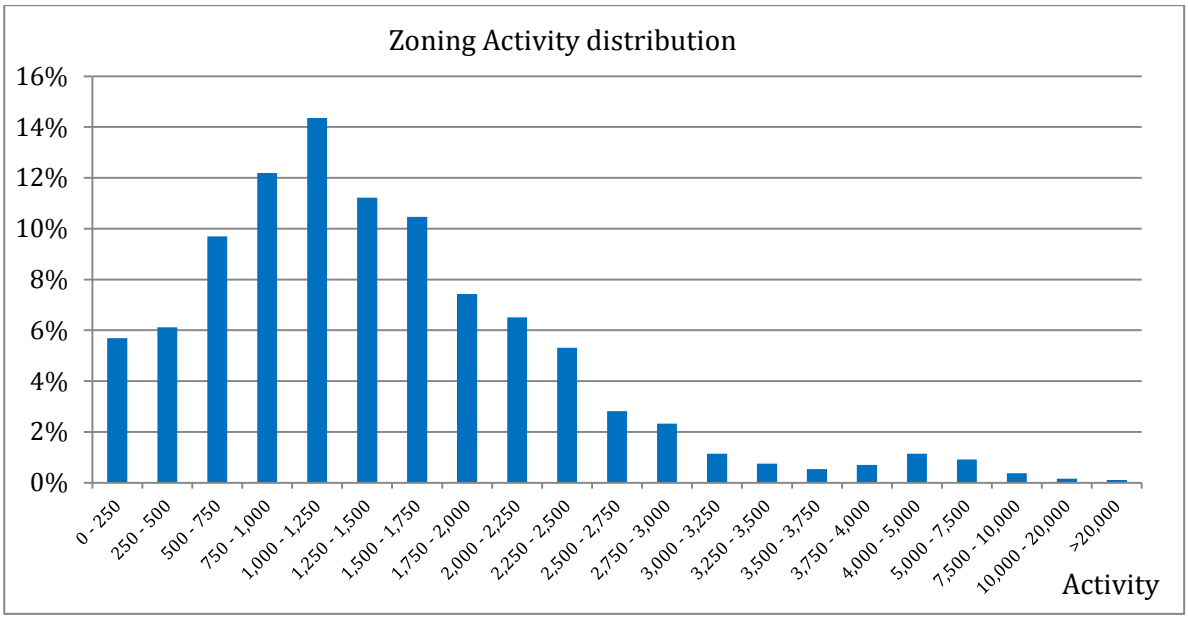

Figure 6.5 Final ERM Zoning – Activity distribution

6.2.3 Land Use Categories

Having homogeneous zones from a land use point of view is important as these areas will then exhibit similar travel purposes. As detailed earlier in this report, MyPlan data has been used to separate (where possible) areas with different land use. Figure 6.6 provides an overview of the number of different land use categories within zones in the ERM. It should be noted that MyPlan data was unavailable for approximately 20% of the zones within the ERM. The results in Figure 6.6 indicate that only 18% of ERM zones contain more than a single land use category.

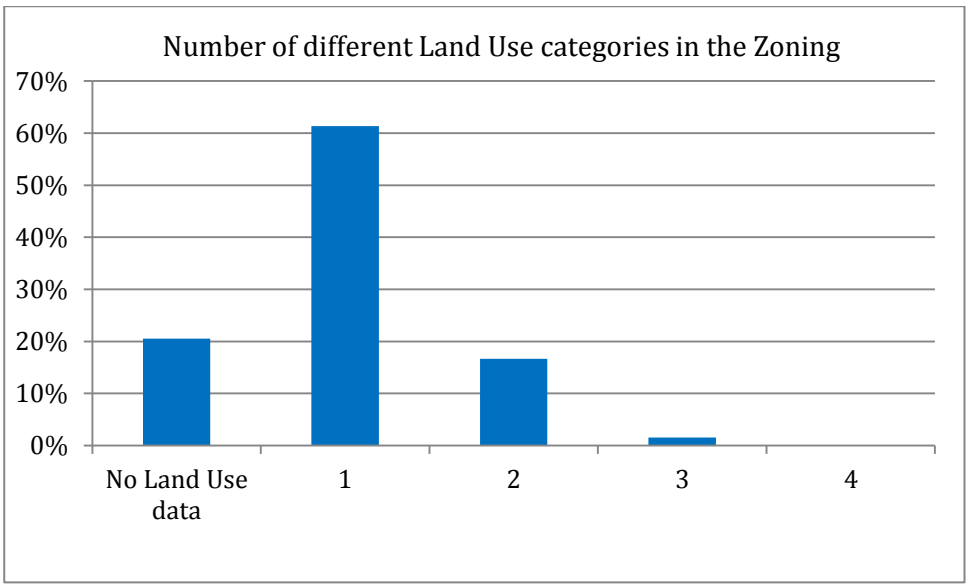

Figure 6.6 Final ERM Zoning – Different Land Use categories

6.2.4 Intrazonal Trip Ratio

The Intrazonal Trip Ratio is calculated as the ratio of trips that remain within a zone (intrazonal trips) over the sum of trips arriving and leaving the zone. This has been calculated for all zones within the ERM and measures the level of detail of the zone system. A high intrazonal trip ratio means that a large number of trips are not loaded on to the modelled network as they are made within the zone.

In the ERM zone system, 73% of zones have an intrazonal trip ratio below the threshold criteria of 5%. Zones with higher intrazonal trip ratios are mostly large in size with low activity levels. Further disaggregation of these zones to meet the intrazonal trip ratio criteria would have a negative impact on the minimum activity threshold of 500 trips outlined previously.

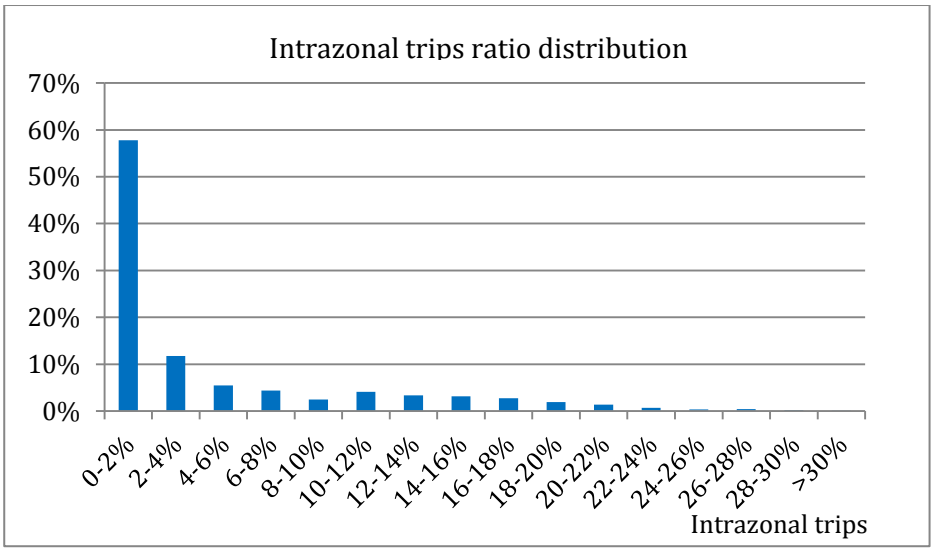

Figure 6.7 Final ERM Zoning – Intrazonal trip ratio distribution

6.2.5 Summary

The previous sections of this chapter outline the criteria utilised to appraise the quality of the ERM zone system. Figure 6.8 illustrates the proportion of ERM zones which meet each of these criteria thresholds. The analysis indicates that:

- 49% of zones meet all the criteria;
- 38% of the zones fail one criterion;
- 9% fail two criteria; and
- 4% fail three or more criteria.

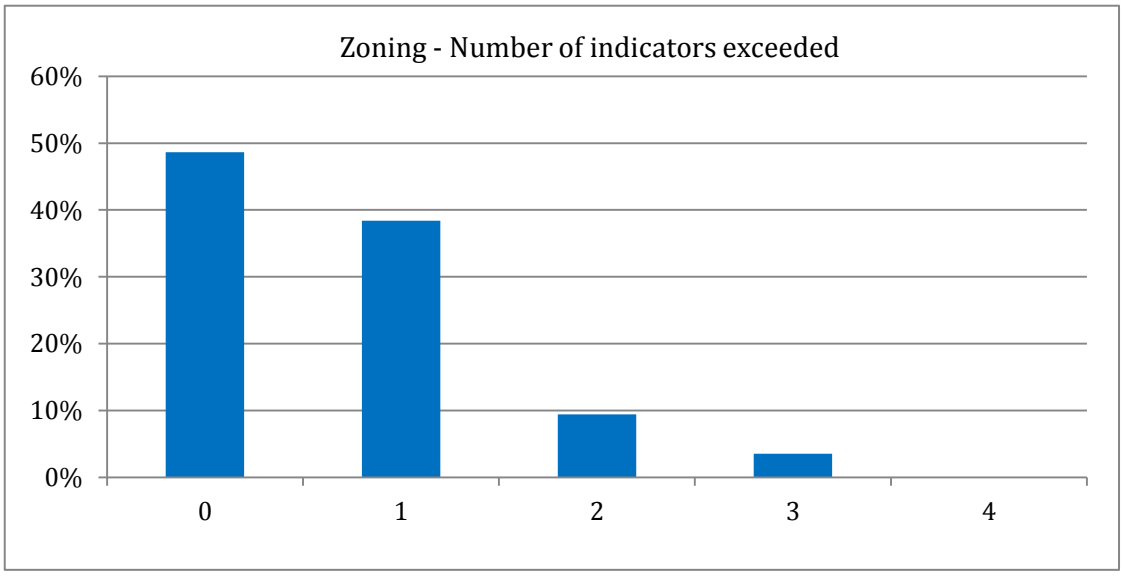

Figure 6.8 Final ERM Zoning – Number of indicators exceeded

6.3 Development of Generic Guidance

It was agreed in the concluding stages of the ERM zoning task that the methodologies developed would be generalised for all regional models. A detailed report was produced as part of the ERM Zoning task that describes a generic methodology to zoning based on the work described in this report.

“ZN TN05 Guidance for Zoning delineation process” presents a discussion on the data sources to be used in defining zones, sets out the criteria on which zones will be defined and outlines a series of repeatable methods designed to save time for future zoning development and give consistency among all NTA transport models.

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