CHAPTER 3: STREET NETWORKS

Street Networks should be designed to maximise connectivity between destinations to promote higher levels of permeability and legibility for all users, in particular more sustainable forms of transport. This will allow people to move from place to place in a direct manner with greater route choice.

3.0 STREET NETWORKS

3.1 Integrated Street Networks

Sustainable neighbourhoods are areas where an efficient use of land, high quality urban design and effective integration in the provision of physical and social infrastructure such as public transport, schools, amenities and other facilities combine to create places people want to live in.

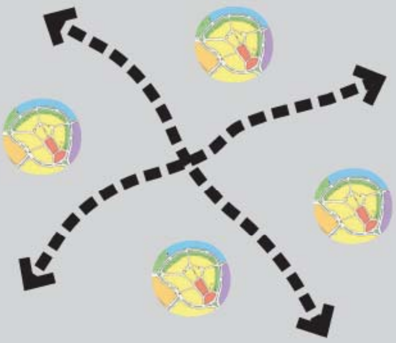
Additional features of sustainable neighbourhoods include:

- Compact and energy efficient development;
- Prioritising sustainable modes of transport;
- Provision of a good range of amenities and services within easy and safe walking distance of homes.

The implementation of the *Guidelines for Sustainable Residential Development in Urban Areas* (2009) and *Smarter Travel* (2009) strategy support an integrated urban structure where land uses are spatially organised around strategic connections and nodes. Strategic connections are the primary routes that connect places. Nodes form where these routes converge and intersect. Within Ireland there is a long established pattern of development evolving at nodes (such as cross roads and river crossings) as these tend to be the most connected places. It is this connectivity that allows the cities, towns and villages to grow and thrive (see Figure 3.1).

The integration of land use and transportation encourage the consolidation of development along strategic connections and around nodes (including city, town and village centres). The strategic connections are also the major routes for public transport, and the nodes their primary destination or interchange hub. This maximises accessibility to services and promotes the use of more sustainable forms of transportation, thus reducing car dependency.

Centres form the 'hub' of sustainable urban development through the formation of connected compact communities.



Positioning centres away from strategic routes deprives them of life and passing trade.

The answer is to create pedestrian and public transport orientated centres at the convergence of strategic links.

Figure 3.1: The creation of connected centres forms the backbone of integrated land use and transportation development. Base images from the UK Urban Design Compendium (2000) and UK Urban Design Taskforce.

Figure 3.2 illustrates an abstract model of an integrated land use and transportation settlement structure at a metropolitan scale, with an indicative street hierarchy. This settlement pattern has universal application and can be adapted according to the scale of a settlement. It may also be adapted according to accessibility by public transport. For example, as vehicular traffic (and in particular through traffic) converges on city, town and village centres, it may be diverted around the core area, allowing more efficient service by public transport routes.

This structure should be supported by a permeable and legible street network that offers route choice and flexibility for managing movement within it. These approaches are discussed in the ensuing sections with regard to the design and management of street networks.

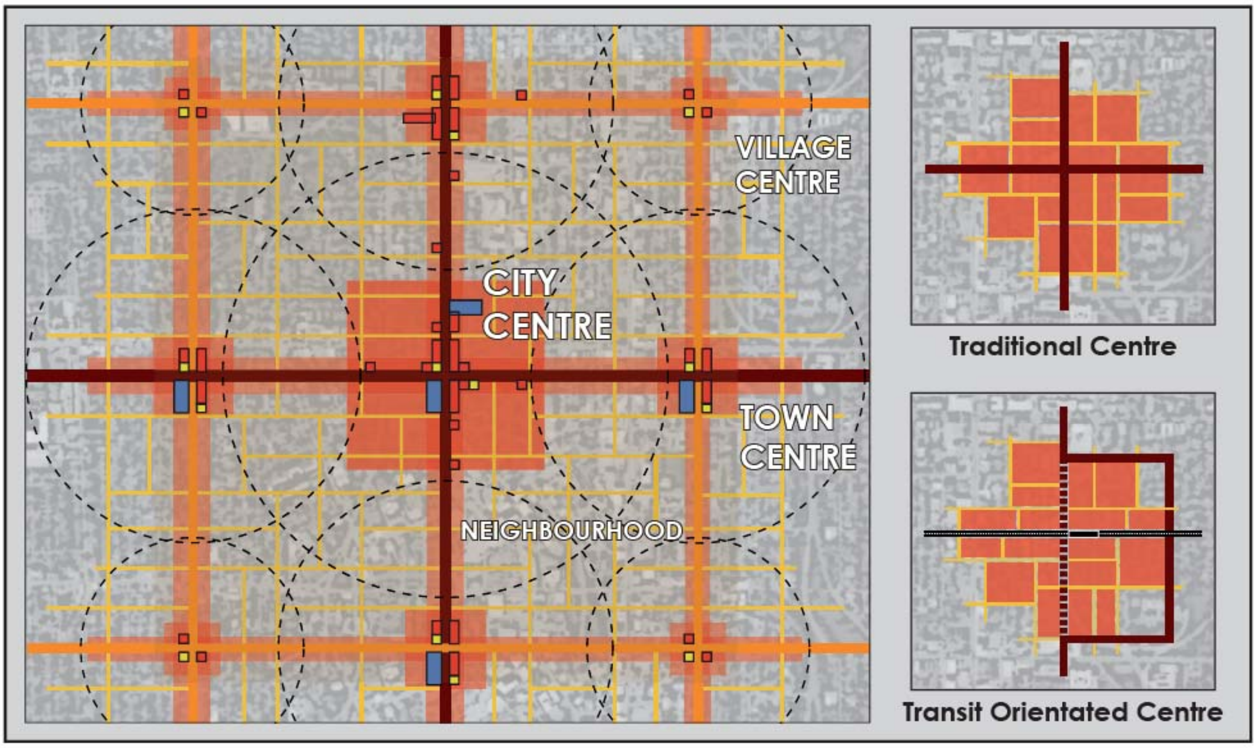


Figure 3.2: At a larger scale land use and transport integration occurs where more intensively developed areas are spatially organised around strategic links and centres/nodes.

3.2 Movement and Place

3.2.1 Movement Function

The movement function of a street is generally described using a classification system, such as a street hierarchy. This guide refers to street hierarchy as follows (see Figure 3.3):

- *Arterial Streets*
- *Link Streets*
- *Local Streets*

Table 3.1 illustrates how street/road hierarchies contained within other relevant documents are cross-referenced with the above.

The nature of this street hierarchy is well understood. In general, greater levels of connectivity are required between significant destinations, particularly those generating or attracting large volumes of traffic.

Designers must consider the *Function* of a street/street network. In general, as the movement function increases the street, designers:

- Should optimise the movement of public transport.
- Should cater for greater numbers of pedestrians and cyclists.
- May need to cater for higher volumes of traffic.

This approach should have regard to settlement size. For example an *Arterial Street* through a city may have to cater for much larger volumes of traffic than that in a village.

DMURS Description	Roads Act/NRA DMRB	Traffic Management Guidelines	National Cycle Manual
Arterial	National	Primary Distributor Roads	Distributor
Link	Regional (see note 1)	District Distributor Local Collector (see Notes 1 and 2)	Local Collector
Local	Local	Access	Access

Notes

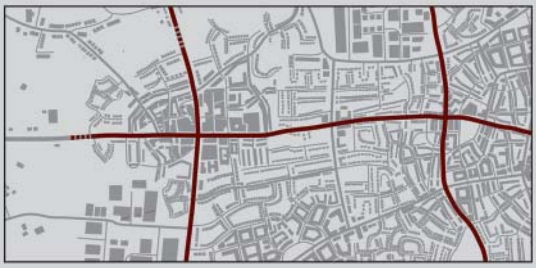
Note 1: Larger Regional/District Distributors may fall into the category of *Arterial* where they are the main links between major centres (i.e. towns) or have an orbital function.

Note 2: Local Distributors may fall into the category of *Local* street where they are relatively short in length and simply link a neighbourhood to the broader street network.

Table 3.1: Terminology used within this Manual compared with other key publications.

Figure 3.3: FUNCTION AND THE IMPORTANCE OF MOVEMENT

HIGHER



ARTERIAL STREETS

These are the major routes via which major centres/nodes are connected. They may also include orbital or cross metropolitan routes within cites and larger towns.

LINK STREETS

These provide the links to *Arterial* streets, or between *Centres*, *Neighbourhoods*, and/or *Suburbs*.

LOCAL STREETS

These are the streets that provide access within communities and to *Arterial* and *Link* streets.

LOWER

3.2.2 Place Context

One of the criticisms of the classification led approach is that the same set of standards are applied along the entire route, regardless of *Context*. Urban roads and streets can traverse many areas with very different characteristics, such as industrial areas, residential areas, mixed use neighbourhoods and city, town and village centres (see Figure 3.4). This clearly requires different design solutions within each of these different contexts.

The Irish urban landscape contains an array of places that have their own unique set of characteristics. Where there are collective similarities between the characteristics of place they can be defined as a particular *Context*. For the purposes of this guide, *Context* is classified as:

- Centre;
- Neighbourhood;
- Suburb; and
- Business Park/Industrial Estate;

In general, place status will be elevated where densities and land use intensity is greater, resulting in higher activity levels (in particular pedestrian activity).

Designers must consider the *Context* of a street/street network. In general, as the place value of a street increases:

- Greater levels of connectivity will be required as accessibility demands will be higher.
- Higher quality design solutions should be implemented that highlight and promote the importance of place.
- Higher levels of pedestrian movement should be catered for and promoted to support vibrant and sustainable places.
- Higher levels of integration between users will be required to calm traffic and increase ease of movement for more vulnerable users.

Figure 3.5 summarises the relationship between place status and context.

In most circumstances the characteristics of a place enable the classification of its *Context* to be readily identifiable. There are places where context will be more ambiguous. In such cases designers should undertake a process of analysis which identifies the characteristics of a place.[1]

1 Further guidance to assist designers in identifying context will be published as downloadable content to accompany this Manual.

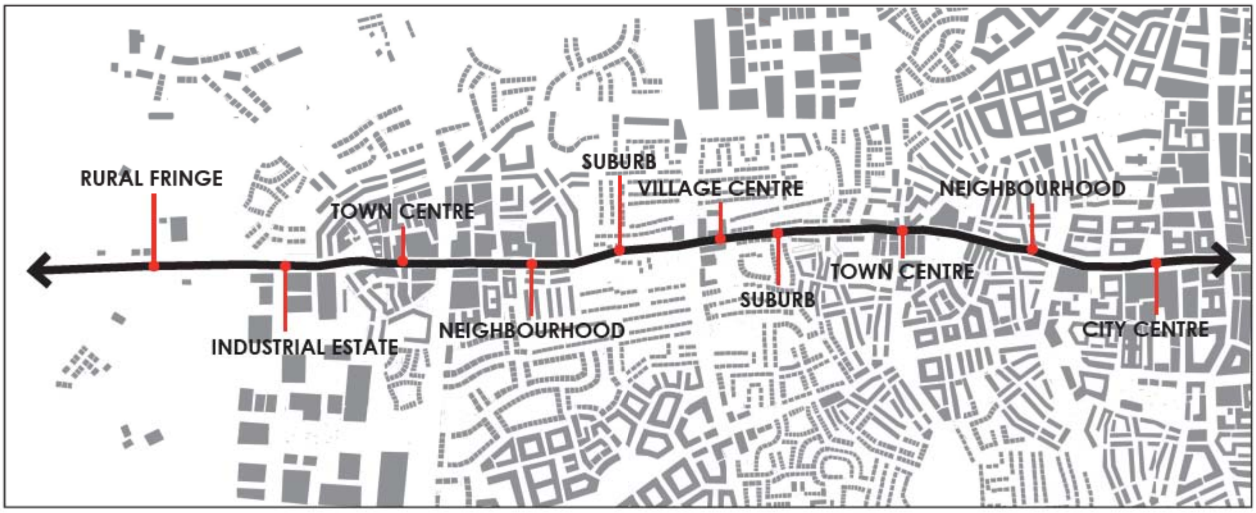
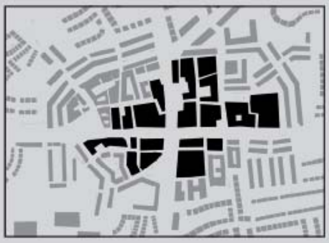


Figure 3.4: A street or road may pass through a number of different contexts along its route. As context changes, the design of streets and roads will need to change accordingly.

Figure 3.5: CONTEXT AND THE PLACE VALUE OF STREETS

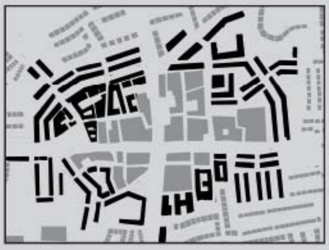
HIGHER

LOWER



CENTRES

Centres include areas that are the focus of economic and cultural activity. Many cities, towns and villages are defined by the image of streets within their *Centres*. Place status is at its highest. Larger City and Town centres may occupy a number of blocks whilst smaller Village centres may only occupy a single street. Pedestrian activity is high as this is where most people are travelling to and once there, will most likely travel on foot. Pedestrian activity is highest in *Centre* streets that contain a concentration of retail and commercial frontages that directly open onto the street.

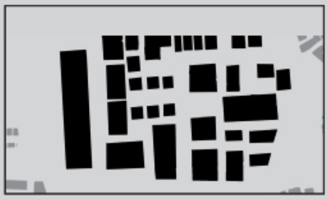


NEIGHBOURHOODS

Neighbourhoods include new and existing areas which are intensively developed with medium to higher density housing and/or contain a broad mix of uses. These areas generally include older areas that represent the first stages of urban expansions and more recently developed compact communities located towards the peripheries of cities and towns (i.e. those in excess of 35 dwellings per ha). Pedestrian activity ranges from higher to more moderate levels. The highest levels of pedestrian activity occur along major streets which connect destinations, where public transport services run. Such streets may also contain dispersed retail and commercial frontages.

SUBURBS

Suburbs predominantly consist of existing lower density housing developed over expansive areas. The place status of streets is harder to define within Suburbs. Many of these areas are attractive living places which are highly valued by residents for their green qualities and sense of tranquillity. However, many areas are criticised for their 'placelessness', due to a lack of connectivity and a high frequency of streets and 'distributor roads' that are devoid of development. Many of these characteristics contribute to lower levels of pedestrian activity.



BUSINESS PARKS/ INDUSTRIAL ESTATES

Business Parks/Industrial Estates are areas that are primarily focused on (and often purpose built for) providing areas of commercial and industrial activity outside of *Centres*. Streets within these areas generally have a low place status as buildings have little street presence and they are largely devoid of pedestrian activity. Many of these areas are in a state of transition toward more intensive commercial and residential uses replacing older industrial ones. As this transition occurs, the status of these places will rise. Place status in existing campus style *Business Parks* also tends to be higher and pedestrians can be highly active in these areas during business hours.

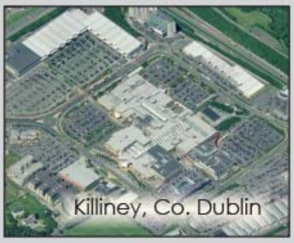
NOTE: 1. This refers to existing *Shopping Centres* developed to service lower density areas. These generally do not display the characteristics associated with highly valued places due to their inward looking nature and focus on vehicle movement (including extensive areas of surface parking). Their importance as destinations gives them a high place value that needs to be better responded to should these centres undergo significant redevelopment.

birds eye images from www.bing.com/maps/

CITY CENTRE

TOWN CENTRE

VILLAGE CENTRE



SHOPPING CENTRE [1]

MIXED USE CORE

EARLY RESIDENTIAL [2]

MEDIUM/HIGHER DENSITY

LOW DENSITY RESIDENTIAL [3]

INDUSTRIAL ESTATE

BUSINESS PARK [3]

NOTE: 2. Some areas may have densities below 35 dwellings per hectare where sites are long and narrow. From a street design perspective they are compact neighbourhoods due to their narrow frontages (i.e. fine grain) and proximity of dwellings to the street/continuity of the built form (i.e. strong sense of enclosure).

NOTE: 3. The examples listed above are illustrative of existing contexts. Future development or retrofit schemes in any of the contexts indicated above must be subject to national policy on sustainable development as set out in relevant policy documents and to the principles, approaches and standards contained within this Manual.

Transition Areas

There are also those *Contexts* where designers should provide a transition from those roads built to NRA DMRB led standards to those roads and streets described by this Manual. These include (and as further detailed in Section 3.3.4 Wayfinding):

- In *Business Parks/Industrial Estates* undergoing a period of transition toward more intensive forms of commercial and residential development, designers should cater for increased levels of pedestrian activity (see Figure 3.6).
- In the *Rural Fringe* when moving between rural areas and cities, towns and villages (see Figure 3.7).

Managing transitions within *Business Parks/Industrial Estates* presents a series of challenges to designers. As development within these areas intensifies, designers are encouraged to move toward standards that are better suited to densely populated urban areas (i.e. *Centres* and/or *Neighbourhoods*). However, the implementation of standards which seek to slow vehicular movement and increase pedestrian mobility (such as narrower carriageways or tighter corner radii), may be more difficult to implement due to the manoeuvrability requirements of larger vehicles. Under such circumstances designers may consider additional mitigation measures (as further detailed in Chapters 4 and 5).

Many *Rural Fringe* areas act as transitional *Gateways* between the rural and more urban/suburban forms of development. These areas may be treated as a *Transition Zone* (see Section 3.3.4 Wayfinding). In such circumstances, designers should implement a series of measures aimed at highlighting this transition and slowing drivers. Further advice in this regard is also contained throughout Chapters 4 and 5.

Figure 3.6: Sandyford Industrial Estate, Co. Dublin, is undergoing a process of significant change from an industrial estate to a mixed use area of centre/urban qualities. The new crossing in the foreground in one example of how designers are responding to its rising place value and the needs of pedestrian users.

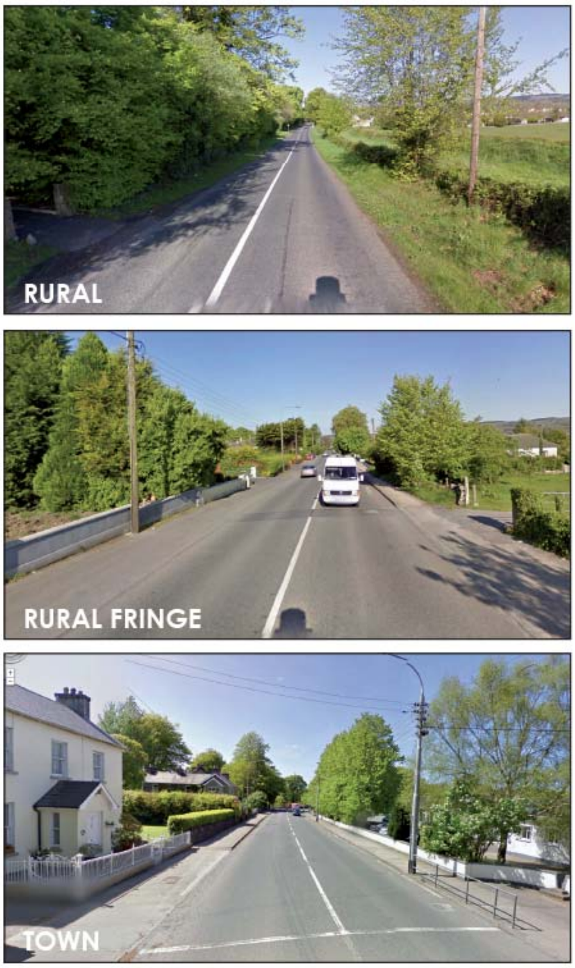


Figure 3.7: Example of a road that goes through a period of transition between a rural area (top) to that of a town/urbanised area (bottom) (image source: Google Street View).

3.3 Permeability and Legibility

3.3.1 Street Layouts

The movement towards more integrated and sustainable forms of development will result in a shift away from dendritic street layouts to highly connected networks which maximise permeability, particularly for pedestrians and cyclists. When designing new street networks designers should implement solutions that support the development of sustainable communities. In general, such networks should:

- be based on layouts where all streets lead to other streets, limiting the use of cul-de-sacs that provide no through access.
- maximise the number of walkable/ cycleable routes between destinations.

Maximising the connections within a site will allow the street network to also evolve over time to meet local accessibility needs. This will limit the use of cul-de-sacs that do not allow through accessibility for all users. These streets should be limited to areas where mid-block penetration is desirable (see Section 3.3.2 Block Sizes). Figure 3.8 illustrates three network typologies that can be adapted to the needs of place.

Street networks that are orthogonal (see Figure 3.8a) in nature are the most effective in terms of permeability (and legibility). Within the Irish context orthogonal or grid layouts are often found within the *Centres* and *Neighbourhoods* developed between the Georgian and Edwardian periods (e.g. Limerick City Centre). More recent successful examples include Dublin Docklands and Belmayne, Co. Dublin.

Street networks that are curvilinear (see Figure 3.8b) may also be highly effective. Within the Irish context, these types of grids are often found within *Suburbs* developed from the 1920s onwards (e.g. Marino and Cabra, Dublin). More recently designers have successfully used similar geometric patterns in higher density developments to draw people toward spaces, highlighting *Focal Points* (see Section 3.3.4 Wayfinding) and creating attractive curvilinear streetscapes. More recent successful examples include Clongriffin, Co. Dublin.

Figure 3.8: Permeable street layouts may be formed via a number of different configurations including examples of the more rigid orthogonal, curvilinear and/or organic.

Street networks that are organic (see Figure 3.8c) have usually developed over time in a haphazard manner, but can be highly connected. As noted in the *Urban Design Manual* (2009) the more organic layout of some small villages can be very different from orthogonal grids, but perform a similar function. These types of layouts can be found within many Medieval or Early Modern Centres (such as Lusk, Co. Dublin). Organic layouts introduce place benefits by introducing variety and intrigue. An example where designers have recreated these qualities within a recently developed area can be found in Poundbury, Dorchester, in the UK.

The creation of a permeable network is a multi-layered process. The process should begin with a site analysis that identifies any constraints to the development of a particular network (such as environmentally sensitive areas, topography, existing structure etc). The process then should move into a design phase. This should outline:

- Points of access.
- The major destinations (such as *Centres* and nodes).
- The main strategic connections between destinations.

This process will identify the basic framework for the application of a more detailed street hierarchy. Figure 3.9 outlines how this process can evolve in four simplified stages of design. This process should also be expanded to take account of:

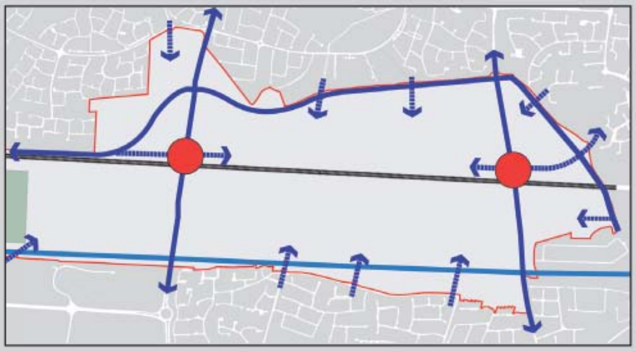
- The likely number of trips generated by each destination. This may result in additional *Link Streets* that are designed to cater for larger volumes of traffic (and in particular buses).
- Movement prioritisation measures for buses, particularly along *Arterial* and *Link* streets and within *Centres* (see Section 3.4.3 - Bus Services).
- The creation of a cycle network.[2]
- Possible restrictions on the movement of private vehicles (see Section 3.4.1 Vehicular Permeability).

Designers may refer to Appendix 1 of the *Urban Design Manual* (2009) which provides several examples of an analysis process and the subsequent design outcomes. This includes a number of extensions to existing areas. Understanding the historical context of a place will give a greater appreciation of the way it evolved and the street patterns that exist. This is particularly important for extensions to existing towns and villages and should help avoid the imposition of incongruous street layouts.

2 Chapter 3 of the *National Cycle Manual* (2011) outlines a 7 step process for Network Planning.

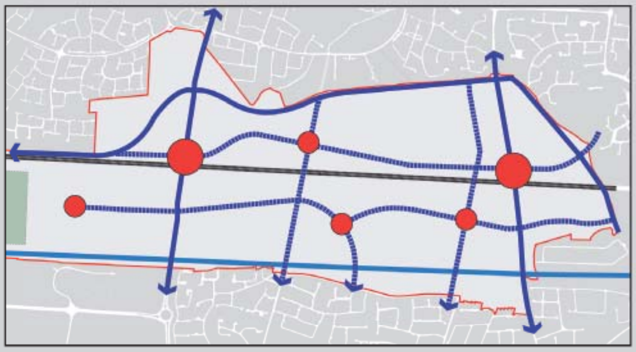
Figure 3.9: Illustrations of the creation of a structured and permeable grid network as a multi-layered process.

The site analysis should identify the connection opportunities (1) within a site including the major destinations (such as *Centres* and nodes) within it and access from the surrounding area.



1. CONNECTION OPPORTUNITIES

The connection options form the basis for the main *Strategic links* (2) into and through the site. These routes will form the principle corridors for the movement of pedestrians, cyclists, public transport and vehicles within and through the site. They should be as direct and as continuous as is possible within the constraints of any site.

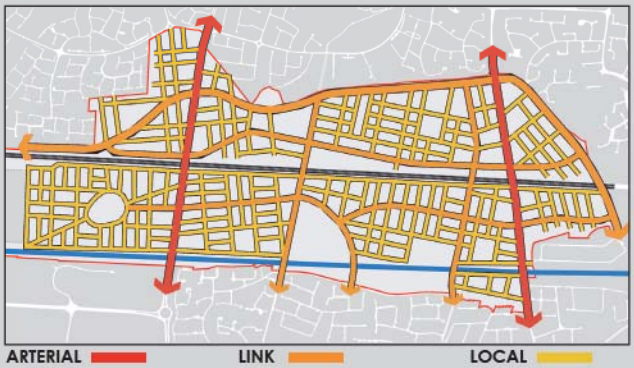


2. MAIN STRATEGIC LINKS

Further links and connections will be needed to allow for permeability within a network. The creation of routes for (3) access and circulation ensure all parts of the site are accessible from a number of different directions.

3. ACCESS AND CIRCULATION

As the process moves into (4) detailed design, designers will need to address further structural issues, including block layouts, mobility levels for different users and the street hierarchy.



4. DETAILED DESIGN

3.3.2 Block Sizes

Designers must also have regard to size of blocks within a street network and how they impact on permeability. Smaller, more compact blocks should be focused around *Centres* to optimise connectivity. Larger block sizes may occur away from *Centres*, through less intensively developed areas (see Figure 3.10). With regard to block dimensions:[3]

- A block dimension of 60-80m is optimal for pedestrian movement and will sustain a variety of building types. This range of dimensions should be considered for use within intensively developed areas, such as *Centres*, to maximise accessibility.

- Larger blocks within *Centres* and *Business Parks/Industrial Estates* may be required to cater for larger commercial or civic developments. In such cases mid-block pedestrian links should be provided.

- A block dimension of up to 100m will enable a reasonable level of permeability for pedestrians and may also be used in *Neighbourhoods* and *Suburbs*.

Within a development there may be sections of a site where accessibility requirements are low or where the site constraints may not facilitate a more permeable block pattern. Where this occurs designers may need to apply larger block dimensions. However, all efforts should be made to ensure the maximum block dimension does not exceed 120m. On larger and/or irregular blocks short cul-de-sacs may also be used for mid-block penetration to serve a small number of dwellings and to enable more compact/efficient forms of development (see Figure 3.11).

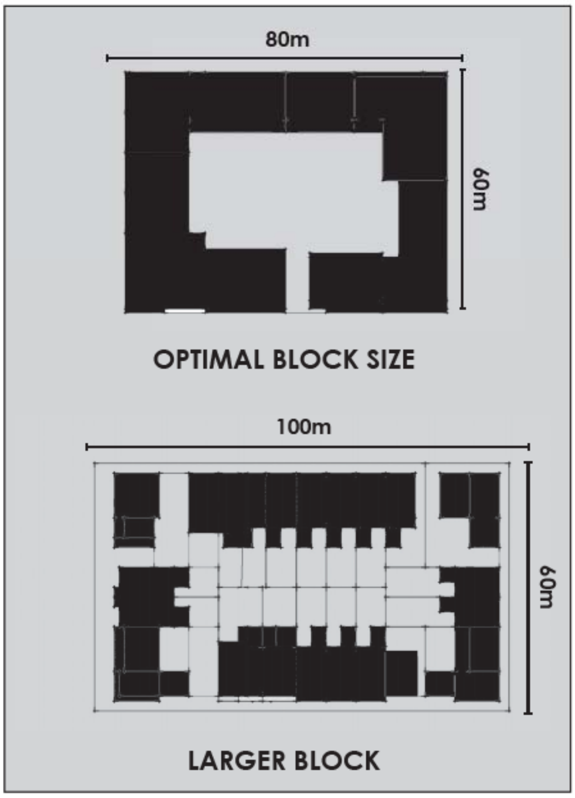


Figure 3.10: Optimal block dimensions in varying contexts that will promote a walkable neighbourhood.

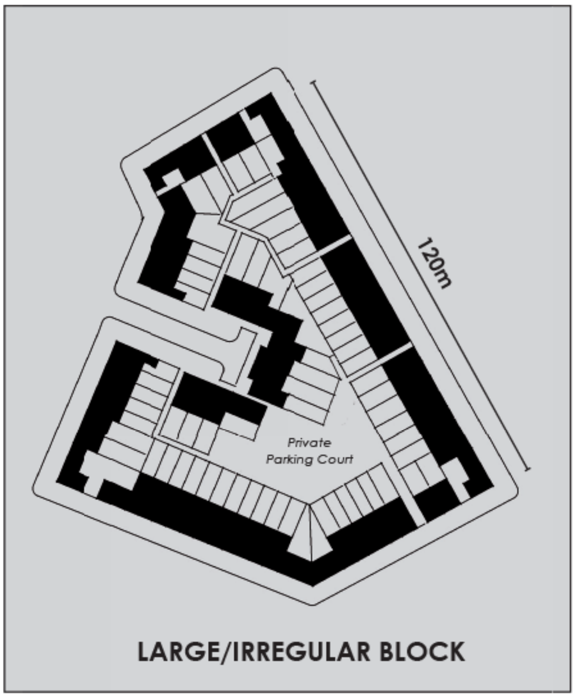


Figure 3.11: An example of a short cul-de-sac which is used to penetrate an irregular/larger block and serves a small number of dwellings.

3 Designers may also refer to Section 3.7.2 of the UK *Urban Design Compendium* (2000) for further guidance on block sizes and permeability.

3.3.3 Retrofitting

Smarter Travel (2009) recognises that sustainable travel can be supported through retrofitting and requires that local authorities prepare plans to retrofit areas in order to create more sustainable neighbourhoods.[4] The retrospective application of a permeable network to increase connectivity levels within more segregated street patterns can be problematic. The dendritic nature of some of these street patterns often means that connection opportunities are very limited.

Well placed links can lead to substantial benefits for the local community in terms of reducing walking distances to essential services. Research has found that increased local movement is also beneficial to security as it can increase levels of passive surveillance.[5] Designers should seek to engage closely with local communities to highlight such benefits.

4 Refer to Action 4 of *Smarter Travel* (2009).
5 Refer to *An Evidence Based Approach to Crime and Urban Design* (2009).

Figure 3.12 illustrates two recently constructed pedestrian and cyclist connections made in Dublin. Both examples significantly reduced walking times to public transport (top) and local shops (bottom). The bottom example included consultation sessions and a survey of residents prior to the formal planning process. This survey indicated that 86% of the local community (located within a 10 minute walking catchment) supported the link. Post construction monitoring has also found up to 500 people a day using the link.[6]

There are also a number of processes and design principles that may also assist in gaining greater community support:

- Focus on the provision of pedestrian/cyclist only links.

6 Source: South Dublin County Council.

Figure 3.12: An example of two local permeability projects in Dublin which have significantly improved local access to the LUAS (top) and local shops (bottom) for pedestrians and cyclists. These links formalised routes that were used by locals which previously involved walking across unlit fields, muddy patches and/or climbing over/through fences.

- Rather than seeking to retrofit a fully permeable network (i.e. maximising all connections), focus on key desire lines where the maximum gain can be achieved through the minimum amount of intervention.
- Ensure any plan clearly highlights reductions in journey times, walking distances etc. (see Figure 3.13).
- Identify potential reductions in private vehicle use or increases in cycling and walking.
- Ensure links are short, overlooked, have clear sight lines and are well lit to mitigate anti-social behaviour. Longer links should be limited to those which go through areas of open space.
- Implement a package of landscape improvements that will directly add to the attractiveness of an area.
- Implement parking management plans (such as pay and display/controlled parking permits) to mitigate any possible influx of vehicles seeking to 'park and ride' on neighbouring streets.
- Where possible, focus on formalising routes which are currently used by more able pedestrians but due to barriers are not suitable for use by the mobility Impaired and disabled.

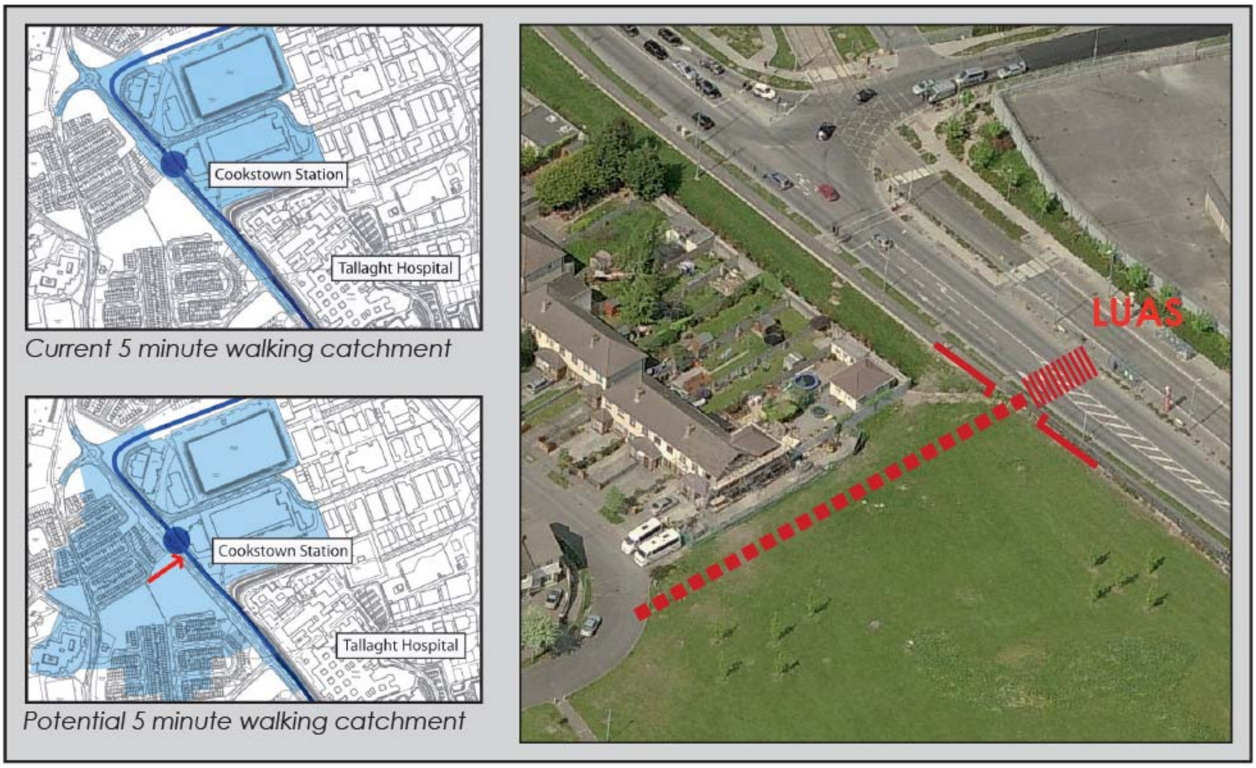


Figure 3.13: Connectivity study undertaken for the Tallaght Town Centre LAP identified how a short link intervention through an area of open space (achieved by providing a path, crossing and partial removal of a fence) could significantly increase the number of households within the 400m walking catchment to the LUAS station (base map source:www.bing.com/maps).

3.3.4 Wayfinding

Wayfinding, or legibility, relates to how people can find their way around an area. For pedestrians and cyclists this is of particular importance as they are more likely to move through an area if the route is clear. There are many tools that designers can use to provide a series of design cues by which people can orientate themselves. For example, changes in building height and form, materials and finishes and landscape features. From a broader perspective designers should ensure that journeys through the network are relatively straightforward. In general:

- The more the orthogonal street layout the more legible it will be (as well as being the most connected).
- The network should be structured to draw people towards *Focal Points* such as *Landmarks*, *Gateways* and other civic buildings and spaces.

Figures 3.14 and 3.15 illustrate how legibility can be achieved with street networks by drawing people toward key destinations or *Focal Points*.

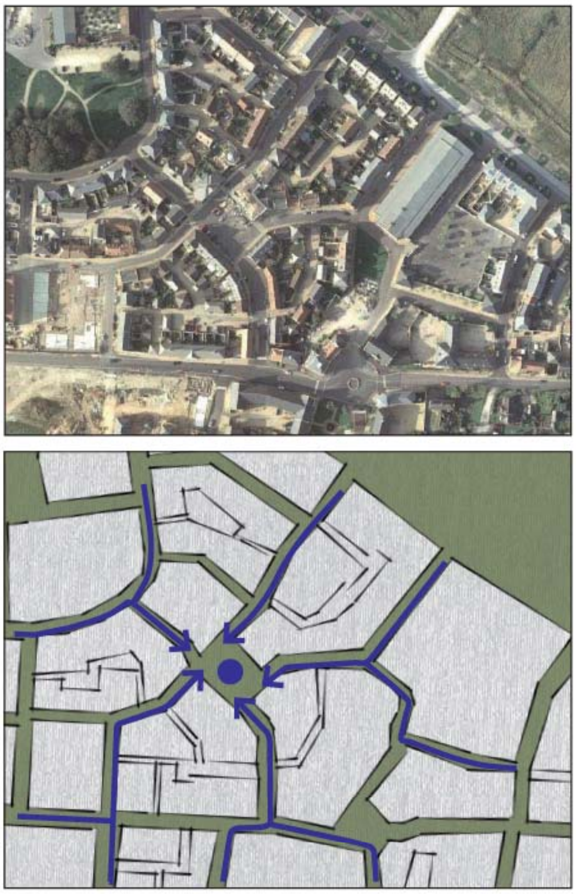


Figure 3.14: Poundbury, Dorchester, UK. The network of interconnecting streets directs people toward a central location, whilst also allowing for route choice (base map source: Google Earth).

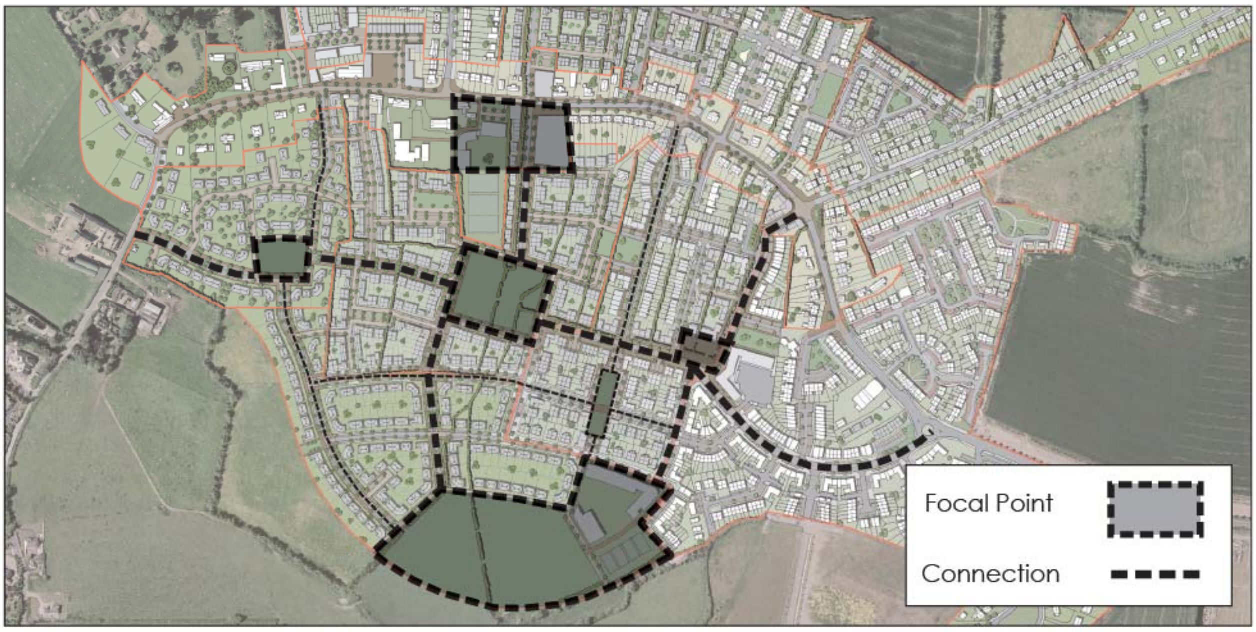


Figure 3.15: The Newcastle LAP (South Dublin County Council) illustrates how movement within the village is structured by connecting major Focal Points, which are also used to slow/discourage through traffic.

To Increase effectiveness the streets around *Focal Points* require a more individualised design response that highlights their high place value. These are further discussed below in relation to their implications for street design.

Landmarks and civic buildings and spaces

Landmarks are features that stand out from their surrounds and are valued by the broader community for their aesthetic and/or historic qualities. Examples include a tall or historic building, archaeological site or landscape feature. Civic buildings and spaces generally include local facilities such as areas of open space and buildings of civic importance. Areas of open space include parks, squares or plazas. Buildings of civic importance include a wide range of places such as schools, churches, hospitals and other institutions.

Designers should highlight these *Focal Points* by (see Figure 3.16):

- Ensuring that pedestrian facilities are adequate to cater for large number of visitors.
- Traffic is calmed using surface treatments and other elements that further highlight the importance of the place.

Gateways

Gateways are used to demarcate a point of arrival from one place to another. They are important placemaking tools as they form the 'first impression' of a place. *Gateways* are also an important traffic-calming tool as they can be used to inform drivers of a change in driving conditions ahead. Common forms of gateways in Ireland occur at the entrances to residential estates and on National Roads at approaches to villages.

To create an effective gateway that adds value to place designers should:

- Use elements of place such as landscape and built form to create a strong sense of enclosure (see Figure 3.17).
- Use material changes and street furniture as supplementary measures (see Figure 3.18).

Figure 3.16: Illustration of surface treatments in Dundalk, Co. Louth. These treatments enhance the sense of place by expanding the square into the adjacent streets and are an effective way of improving pedestrian mobility and calming traffic.

Figure 3.17: Example of a Gateway from Adamstown, Co. Dublin, where changes to the built form and landscaping treatments add to the sense of enclosure and create a formal entry point.

Transition Zones

A *Transition Zone* refers to an area that may be needed for slowing vehicles when entering an urban area from a faster moving road, such as from a rural road into a city, town or village or from a motorway into an integrated street network (see Figure 3.19). Designers should emphasise *Transitions Zones* by:

- Introducing measures that provide enclosure, such as large trees.
- Applying transitional geometric measures, such as the narrowing of carriageways.
- Applying changes to carriageway surfacing materials.

The length of a *Transition Zone* will largely be influenced by the required reduction in speed. Designers should also take into account how visible/prominent any subsequent *Gateway* is. If a *Gateway* is highly visible from a distance, a *Transition Zone* may not be necessary as drivers will instinctively be inclined to slow.

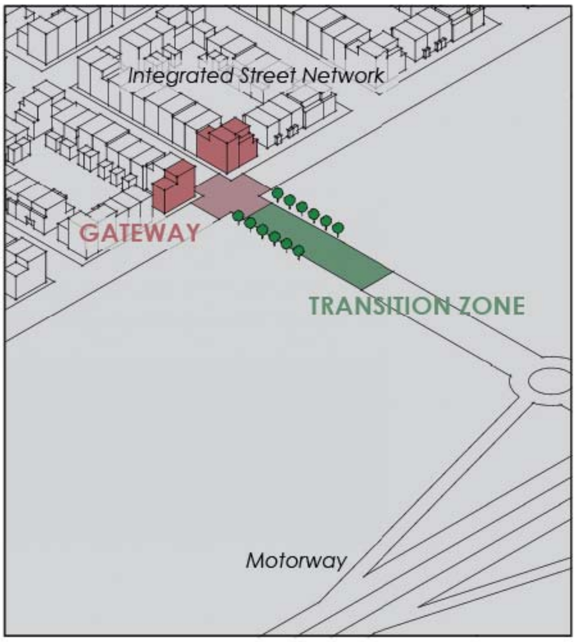


Figure 3.19: Illustration of a Gateway and Transition Zone that reinforces a large speed reduction when entering an integrated street network.

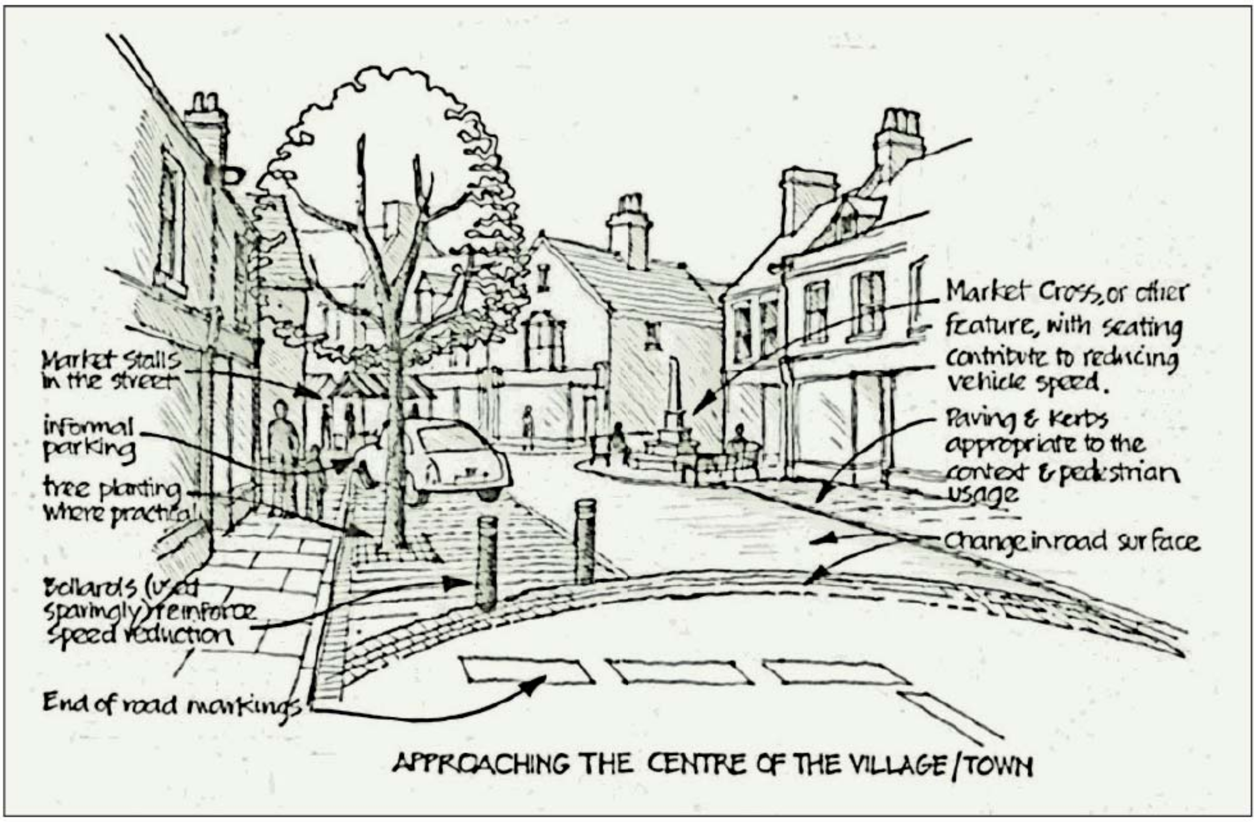


Figure 3.18: Image from Traffic in Villages (2011) showing a various number of gateway treatments designed to enhance the character of the village and calm traffic.

3.4 Management

3.4.1 Vehicle Permeability

Integrated networks do not require the same degree of restrictions to be placed on the movement of vehicles as is applied to more conventional/segregated networks. A network of integrated/self-regulating streets provides the framework for higher levels of accessibility for slow modes (including motor vehicles at slow speed) and strategic continuity for cross-network modes at more moderate speeds (such as public transport) as (see Figure 3.20):

- The slower nature of *Local* streets (i.e. 10-30 km/h) will result in them being less attractive to through traffic. Although trips through *Local* streets may be more direct (and therefore legible), the traffic-calmed nature of these streets may not necessarily result in significant advantages in overall journey times.
- Through traffic will be attracted to *Arterial/ Link* streets where trips are more direct and are designed to cater for more moderate speeds (i.e. up to 50km/h).
- Public transport along *Arterial/Link* streets can be prioritised by measures such as *Quality Bus Corridors* and *Bus Lanes* (see Section 3.4.3 Bus Services).

There are a number of advantages to more permeable networks in regard to the management of traffic and vehicle speeds such as:

- Drivers are more likely to maintain lower speeds over shorter distances than over longer ones. As drivers are able to access individual properties more directly from *Access/Link* streets (where speeds are more moderate) they are more likely to comply with lower speed limits on *Local* streets (see Figure 3.21).
- Permeable layouts provide more frequent junctions which have a traffic-calming effect as drivers slow and show greater levels of caution.[7]

Figure 3.20: Examples from Adamstown, Co. Dublin. Through routes (top) are designed to cater for more moderate speeds and to prioritise public transport movement. Local streets (bottom) are slower moving, thus discouraging use by through traffic.

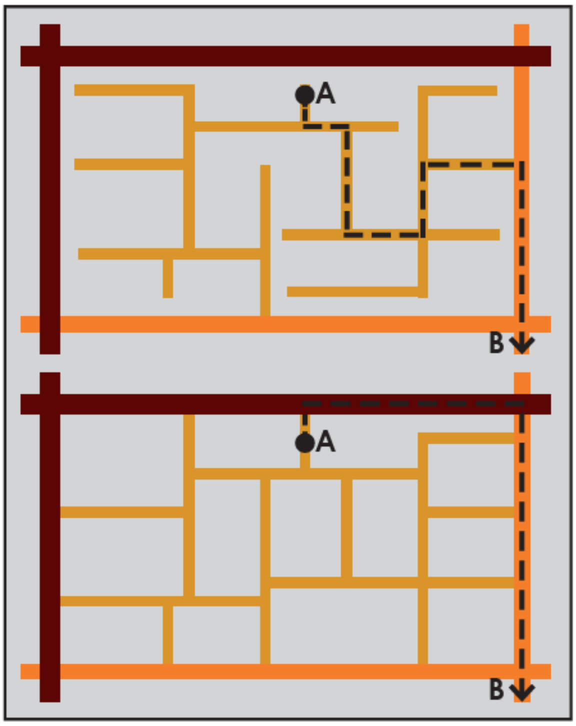


Figure 3.21: Drivers are more likely to comply with posted speed limits where less time is spent on streets with a low design speed (as per the bottom example)

7 Refer to *Whose Street is it Anyway? Redefining Residential Street Design* (2006).

- Increasing access to neighbourhood cells can result in the more equitable distribution of traffic and the impacts of congestion as it is no longer concentrated on a few select junctions or local access streets (see Section 3.4.2 Traffic Congestion) and noise and air pollution (see Section 3.4.5 Noise and Air Pollution).

- The value of place can also be improved as slower moving traffic has less impact on the surrounding environment (see Section 3.4.5 Noise and Air Pollution).

- Frequent entrances to a neighbourhood cell can reduce the size of individual junctions and streets. This will reduce the potential for severance between communities and increase pedestrian/ cyclist mobility as streets/junctions are more compact and easier to navigate.

Designers may be concerned that more permeable street layouts will result in a higher rate of collisions. However, research has shown that there is no significant difference in the collision risk attributable to more permeable street layouts in urban areas and that more frequent and less busy junctions need not lead to higher numbers of accidents.[8]

The degree to which permeability is provided for different transport modes can be categorised into four types (see Figure 3.22):

- *Dendritic Networks* which place significant restrictions on movement for all users.

- *Open Networks* which allow full permeability for all users.

- *3 way Off-Set Networks* which contain a large proportion of 3 way junctions.

- *Filtered Permeability* networks which allow full permeability to some users whilst placing greater restrictions on others.

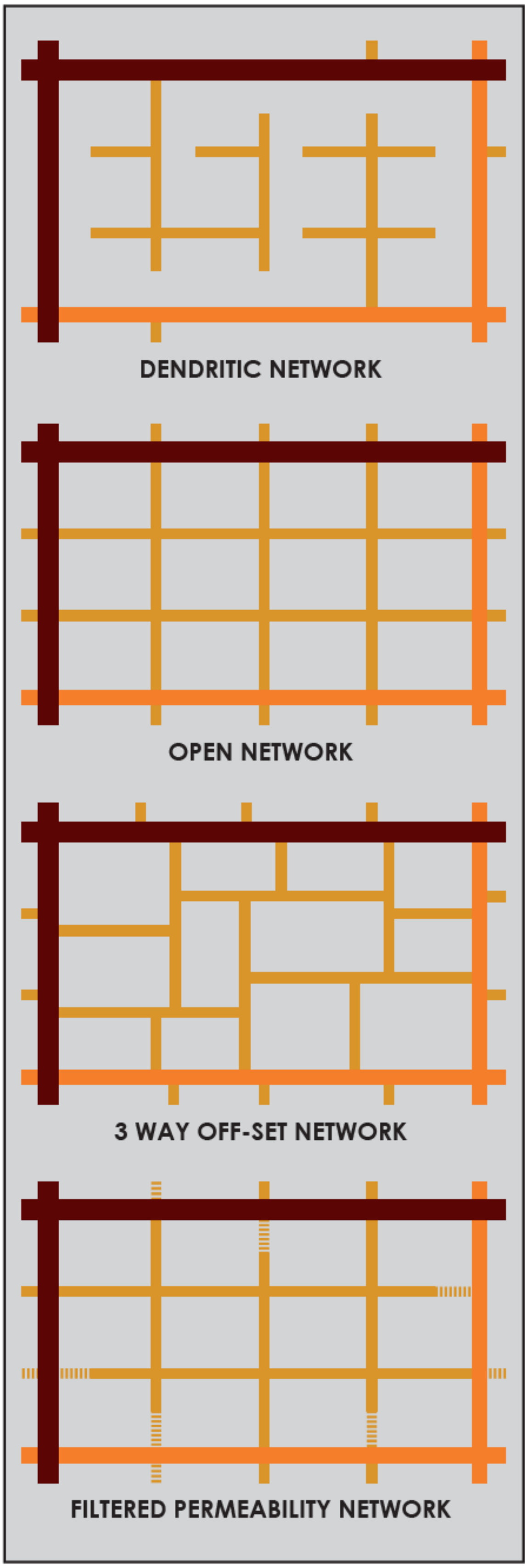


Figure 3.22: Types of Street Network identified within Road Safety Planning: New tools for Sustainable Road Safety and Community Development (2007).

8 Refer to *Whose Street is it Anyway? Redefining Residential Street Design* (2006) and 'Safenet' analysis *Manual for Streets: Evidence and research* (2007).

Designers should avoid the creation of *Dendritic* networks which place heavy restrictions on movement. The use of cul-de-sacs that do not allow through access for users should be restricted throughout any network (see Section 3.3.2 Block Sizes).

Open Networks place few restrictions on the permeability of users. They are best suited to contexts where maximum accessibility is desirable for all users such as within *Centres*. *Open Networks* may also be desirable in *Business Parks/Industrial Areas* to allow more efficient access for commercial vehicles.

3 Way Off-Set Networks allow through movement for all modes, however, they discourage faster modes by requiring vehicles to slow, stop and/or change direction repeatedly when travelling along *Local* streets. Such networks are suitable to all contexts, but there are limitations to their overall effectiveness. The use of multiple junctions off-sets can reduce legibility. This can discourage walking/cycling as the network is difficult to navigate and the route unclear (as well as increasing journey times). It can also result in driver frustration, as noted above.

Filtered Permeability Networks, which restrict universal permeability, may be applied where designers are seeking to prioritise the movement of more sustainable modes (i.e. pedestrians, cyclists and public transport) over private vehicles. For example bus gates and other measures, may also be used to prioritise bus movements, particularly in *Centres* (see Section 3.4.3 Bus Services). The limited use of vehicular cul-de-sacs may be considered in *Neighbourhoods* and *Suburbs* where there is a particular concern regarding through traffic.

The use of vehicular cul-de-sacs to enforce *Filtered Permeability* networks should be approached with caution. Their overuse can result in many of the negatives associated with Dendritic networks being replicated. Additional design measures should be applied to ensure that pedestrian and cycle links are not perceived as 'anti social spaces'. Links should maintain clear sight lines and be overlooked by development (see Figure 3.23).

Figure 3.23: Examples of vehicular cul-de-sacs in Adamstown, Co. Dublin, which allows for through pedestrian and cyclist access only and has incorporated design measures to ensure that it is safe (i.e. clear sightlines and passive surveillance).

Within existing networks, pressure is often applied from local communities to create vehicular cul-de-sacs. Designers should approach such requests with caution, as street closures will often simply shift the problem elsewhere.

One-way streets have also been widely implemented, retrospectively, in order to filter vehicle permeability and relieve traffic congestion. The use of one-way systems for traffic management should also be approached with caution by designers as they:

- Promote faster speeds as drivers are likely to drive faster when no risk is perceived from oncoming traffic.
- Will result in longer vehicular journeys, including those for cyclists and public transport.
- Can be confusing for users when they deflect people away from destinations.
- Require additional signage.

Conversion to one-way systems may be beneficial on narrow carriageways where the street reserve is limited in order to provide additional space for pedestrians, cyclists and other public realm improvements. Counter flow cycle lanes should also be considered in order to maintain permeability for cyclists Examples include Centres where the implementation of a one-way system has direct placemaking benefits as it allows for additional footpath width and/or on-street parking (see Figure 3.24).

The key to network design is balance. An optimal approach to network design is to start from the position of an *Open Network*. This will provide for the development of a robust network that can evolve over time to meet the changing needs of a place. Parts of the network may then be refined by incorporating elements of *Filtered Permeability Networks* and *3 Way-Off Set Networks* according to local conditions and where there are clear benefits in terms of prioritising more sustainable modes of transport, improving safety and reducing energy consumption.

Figure 3.24: Example from Drogheda, Co. Louth, of narrow street that was converted from a two-way system to a one way system to facilitate a series of improvements within the town centre that calm traffic, expand the pedestrian domain and strengthen the sense of place.

3.4.2 Traffic Congestion

A primary function of all transport policies has been to reduce the waste of resources caused by congestion. National and regional transport policies and plans have recognised that it is not feasible or sustainable to accommodate continued demand for car use. In contrast, sustainable modes (walking, cycling and public transport) can cater for very high volumes of movement in a far more efficient manner (see Figure 3.25). Policies and plans, therefore, promote sustainable modes of travel and acknowledge that, in the absence of demand management, a certain level of car congestion is inevitable.

One of the outcomes of a more connected, traffic-calmed network will be reduced car dependency and increased use of more sustainable modes of transport. This is the most balanced way of addressing traffic congestion. Higher levels of connectivity for all users will also enable greater vehicular permeability, albeit at slower speeds. The benefits of this approach include:

- Slower vehicle speeds are often perceived to be a cause of congestion but can lead to increased traffic capacity (see Figure 3.26).
- More frequent minor junctions with fewer vehicle movements calm traffic and are easier for pedestrians and cyclists to navigate.

Within urban networks, delay and congestion overwhelmingly occur at junctions. Segregated networks channel traffic towards fewer junctions and this can locally concentrate the negative impacts of traffic, resulting in large junctions where bottlenecks occur (see Figure 3.27). The design of junctions has traditionally prioritised the minimisation of vehicular queuing and delay. As a result pedestrians can face significant delays. This is also evident in the various computer programs used to analyse junction design, which have the calculation and minimisation of vehicular queuing and delay as their primary outputs. Designers will often seek to provide junctions that operate below 90% capacity as measured by the ratio of flow to capacity (RFC).

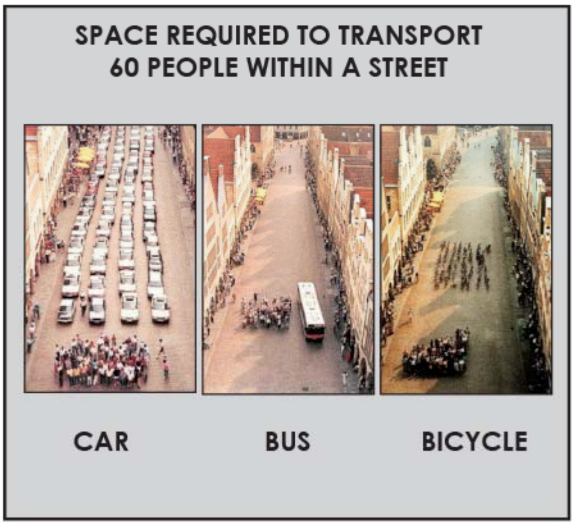


Figure 3.25: Illustration of the amount of space required to transport the same number of people via different modes of transport (image source: Munster Planning Office, Germany)

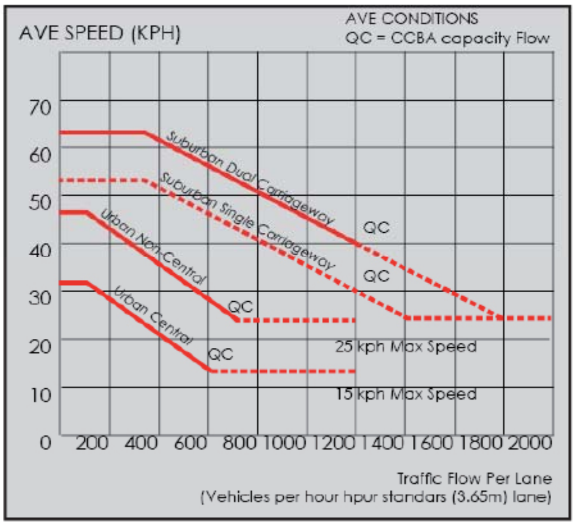


Figure 3.26: Extract from the Traffic Management Guidelines (2003) showing Traffic flow capacity increasing as speed reduces.

Smarter Travel (2009) requires greater priority to be given to the movement of pedestrians in order to facilitate more sustainable travel patterns. This includes the reprioritisation of traffic signal timings (both new and existing) to favour pedestrians and cyclist instead of vehicles and to reduce pedestrian crossing distances[9] (see Section 4.3.2 Pedestrian Crossings and 4.4.3 Junction Design).

The creation of more compact junctions that minimise pedestrian and cyclist waiting times, will place additional pressures on junction performance. In areas where pedestrian activity is high (such as in *Neighbourhoods* and *Centres*) junctions may have to operate at saturation levels for short periods (i.e. above 93% during peak periods). Where junctions operate at or near saturation levels and they are frequented by bus services, priority measures should ensure services are not unduly delayed (see Section 3.4.3 Bus Services). Where longer periods of saturation occur, pedestrian cycle times may be extended. This should be done in preference to the implementation of staged/staggered crossings (see Section 4.3.2 Pedestrian Crossings).

Figure 3.27: Highly segregated 'cell and distributor' networks channel faster moving traffic to large junctions where bottlenecks may occur (left). More permeable networks result in more frequent minor junctions with fewer vehicle movements (right) which calm traffic and are easier for pedestrians and cyclists to navigate.

9 *Refer to Action 16 of Smarter Travel (2009).*

3.4.3 Bus Services

Street networks underpin the efficiency and sustainability of public-transport and, consequently, the ability to facilitate higher development densities along public transport corridors in accordance with the objectives of *Smarter Travel* (2009). This includes an objective that all houses within urban areas are located within 800m of a bus route/stop.[10] Permeable networks which maximise connectivity will assist in achieving this objective. *Smarter Travel* (2009) also requires the implementation of bus priority measures,[11] such as *Quality Bus Corridors* and *Bus Lanes*. These ensure that buses can move through congested networks with minimal delays.

Designers must have regard to the location of bus services as a strategic network issue. In general:

- Bus services should primarily be directed along *Arterial* and *Link* streets as these will be the most direct routes with between destinations with the greatest number of connections.

- QBCs or *Green Routes* should be provided on streets which cater for higher frequency services[12] over longer distances (see Figure 3.28).

- On lower frequency routes, or in less congested networks, bus lanes that allow buses to move towards the front of queuing traffic at junctions may suffice. This approach may also be preferred on existing streets where the street reserve is constrained.

- The provision of public transport services on *Local* streets should be limited. The constrained nature of these streets will limit the delivery of efficient services. Conversely, designing *Local* streets to cater for buses would require wider streets, which will serve to increase vehicle speeds, undermining their place function.

Designers should consult with bus operators regarding the need for dedicated lanes. Under-used or unnecessary lanes can serve only to increase the width of carriageways (encouraging greater vehicle speeds) and consume space that could otherwise be dedicated to placemaking/traffic-calming measures such as planted verges, wider footpaths, cycle tracks or lanes and on-street parking.

Designers should also consider the use of bus gates (see Figure 3.29) and selective bus detection technology that prioritise buses to improve journey times by restricting other motorised vehicles. These should be strategically placed throughout a network, and in particular within *Centres*, to filter permeability and ensure more rapid movement for buses.

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10 Refer also to Action 13 of *Smarter Travel* (2009).
11 Refer to Action 12 of *Smarter Travel* (2009).
12 Refer to Section 10.2.2 of the *Greater Dublin Area Draft Transport Strategy 2011-2030* for further information on service frequency.

Figure 3.28: QBCs and Bus lanes should be considered on all Strategic Routes where the high frequency services occur or where their future need has been established.

Figure 3.29: Example of a 'bus gate' in Tallaght, Co. Dublin, which filters permeability to allow for the free passage of buses whilst excluding other vehicles.

3.4.4 Relief Roads

The focus of this Manual is the creation of place-based/sustainable street networks, which balance pedestrian and vehicle movement. However, it is recognised that there are some roads which are required to cater for the efficient movement of larger volumes of motorised traffic at faster speeds over longer distances. These are generally referred as *Inner Relief Roads* and *Urban Relief Roads*.[13]

Inner Relief Roads are generally used to divert traffic within an urban area, away from a *Centre* or *Node*. The design of these routes needs careful consideration. Chapter 2 highlights the issues associated with the provision of higher speed/highly segregated routes though cities, towns and villages. Authorities in many urban areas have attempted to overcome issues of severance by vertically separating these routes into a series of tunnels, cuttings or elevated carriageways. Such solutions, however, tend to be reserved for major national projects and can have significant negative impacts on place (see Figure 3.30).

It is more likely that *Inner Relief Roads* through urban areas will need to occur at moderate speeds (50 km/h). The route should be integrated within the urban fabric so that a sense of place is maintained and to prevent severance between adjoining areas. There are many examples in Ireland of streets that carry significant volumes of through traffic at moderate speeds and retain a high place value/levels of connectivity (see Figure 3.31). Successful solutions tend to be designed as boulevards with well planted medians and verges that provide a buffer between the heavily-trafficked carriageway and the surrounding pedestrian environment. Boulevards may also be designed as a 'multiway' boulevard with a central carriageway for through traffic and access carriageways at the side (see Section 3.4.5 Noise and Air Pollution).

Figure 3.30: Examples of major urban roads that move large volumes of traffic via vertical segregation. These require significant investment in infrastructure. As illustrated in the middle and bottom examples they can have negative impacts in terms of place and/or connectivity (image sources: Google Street View).

Figure 3.31: Dorset Street, Dublin, an example of a street that carries large volumes of traffic and where recent improvements have ensured it maintains an important place function.

13 Urban Relief Roads are defined by TD 9/12: Road Link Design, part of the NRA DMRB.

Urban Relief Roads are generally routed around urban areas and are commonly referred to as *By-Passes* or *Outer Ring Roads*. Designers may use these routes to direct longer distance traffic, and in particular Heavy Goods Vehicles (HGVs), away from cities, towns and villages provided they are clearly separated from the urban fabric (see Figure 3.32). Urban development should not extend to the edge of these routes without full integration into the surrounding street network. This is a strategic issue that should be resolved via a County Development Plan/Local Area Plan (see Figure 3.33) and may also require close consultation with the NRA, where the road is part of the national road network.[14] In the case of a motorway or national grade separated dual carriageway the future integration of the road would not be an option.

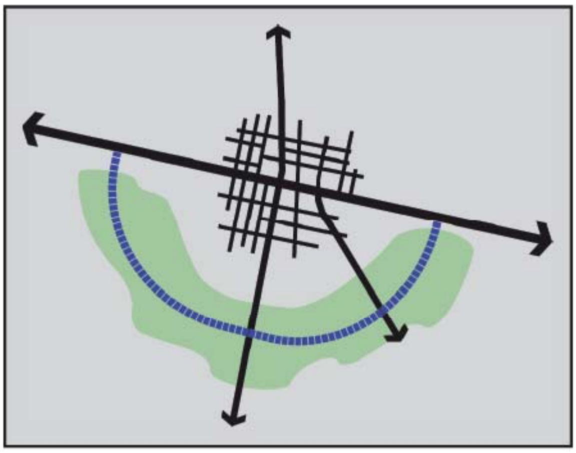

Figure 3.32 Outer Relief Roads can be used to direct long distance traffic away from cities, towns and villages

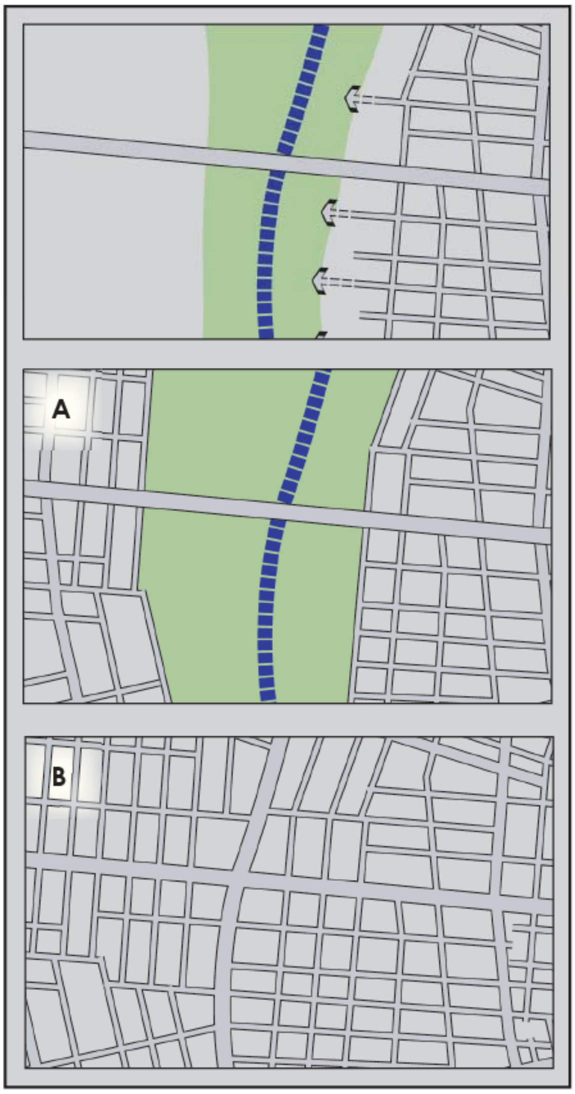

Figure 3.33: As urban expands toward an *Urban Relief Road (top) a strategic decision will need to be made as to either maintain segregation and 'leapfrog' leaving a green belt (middle), or moderate speed, retrofit and integrate route (bottom).*

14 Refer to *Spatial Planning and National Roads: Guidelines for Planning Authorities* (2012).

3.4.5 Noise and Air Pollution

The primary source of widespread environmental noise in Ireland is road traffic. Traffic is also the main source of air pollutants in cities, towns and villages. Whilst air pollutants generally have declined in recent years, those pollutants associated with traffic have not, principally because of an increase in traffic volumes and congestion.[15] Busy or congested roads can create pollution 'hot-spots' and can have a significant negative impact on adjacent street activities. Pollution can also seriously affect the attractiveness of walking and cycling along affected routes.

The main factors which determine the level of road noise and air pollution are traffic volume, speed, levels of congestion and the proportion of HGVs. Many of these issues may be substantially addressed by directing large volumes of traffic (and in particular HGVs) away from cities, towns and villages via *Urban Relief Routes* (see Section 3.4.4 Relief Roads) and by reducing speeds (see Table 3.2). The creation of a permeable street network which promotes walking, cycling and public transport will also lead to reductions in vehicular traffic and less concentration of traffic and consequently of noise and air pollution.

It is inevitable that some heavily-trafficked routes (such as *Arterial* streets) will pass through urban areas. Whilst traffic volume and noise have a significant impact on the value of place, there are many examples in Ireland of streets that carry significant volumes of through traffic at moderate speeds which retain a high place value (as per Figure 3.31 - Dorset Street). Whilst some mitigation measures can be provided through construction materials used on carriageway surfaces and within adjoining buildings, most integrated or place-based solutions should involve (see Figure 3.34):

- Apply boulevard typologies with well planted medians and verges that reduce pollution[16] and provide a buffer between the heavily-trafficked carriageway and the surrounding pedestrian environment.
- Consider the use of multiple carriageways that separate through traffic from access traffic and parking.

15 Refer to *Air Quality In Ireland* (2009).

16 Refer also to *Effectiveness of Green Infrastructure for Improvement of Air Quality in Urban Street Canyons* (2012).

SPEED AND NOISE REDUCTION

Speed Reduction	dB (A) Reduction
from 70-60 km/h	1.8
from 60-50km/h	2.1
from 50-40km/h	1.4

TRAFFIC AND NOISE REDUCTION

Traffic Volume Reduction	dB (A) Reduction
30%	1.6
40%	2.2
50%	3.0
75%	6.0

Table 3.2: Noise reduction effects of lowering traffic speeds and volumes

At a broader level, land uses should be distributed in a manner that takes into account sensitivity to traffic noise:

- Commercial or retail uses should be used to shield more sensitive receptors (i.e. residential uses). Such an approach complements the principle of integrated street design as it focuses commercial/ retail uses on *Arterial* and *Link* streets where public transport services are likely to be located.
- Where residential uses are provided on the upper floors of buildings, aspects of the upper floors may be orientated so that they are perpendicular (i.e. at right angles) to the roadway. This will ensure a degree of overlooking, whilst deflecting the impacts of pollution (see Figure 3.35).

Figure 3.35: Example of a development adjacent to a busy Arterial Street where residential development is provided over a commercial podium at street level.

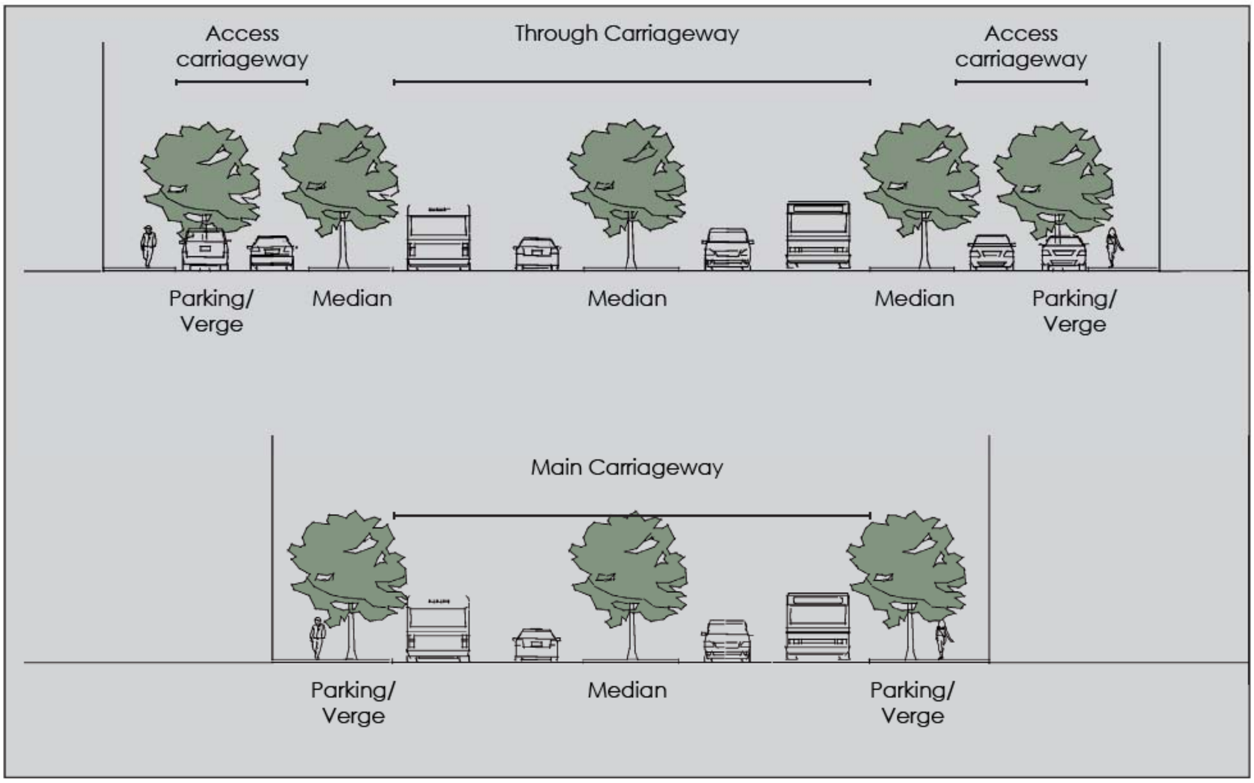

Figure 3.34: Examples of Urban Boulevard street typologies which mitigate the impacts of noise through place based design solutions.