# LAND USE AND SAFETY: AN INTRODUCTION TO UNDERSTANDING HOW LAND USE DECISIONS IMPACT SAFETY OF THE TRANSPORTATION SYSTEM

>>>

Technical Committee 3.1 *National Road Safety Policies and Programs* World Road Association



5

15

# **STATEMENTS**

The World Road Association (PIARC) is a nonprofit organisation established in 1909 to improve international co-operation and to foster progress in the field of roads and road transport.

The study that is the subject of this report was defined in the PIARC Strategic Plan 2012 - 2015 and approved by the Council of the World Road Association, whose members are representatives of the member national governments. The members of the Technical Committee responsible for this report were nominated by the member national governments for their special competences.

Any opinions, findings, conclusions and recommendations expressed in this publication are those of the authors and do not necessarily reflect the views of their parent organisations or agencies.

This report is available from the internet site of the World Road Association (PIARC): http://www.piarc.org

Copyright by the World Road Association. All rights reserved.

World Road Association (PIARC) Tour Pascal B - 19<sup>e</sup> étage 92055 La Défense CEDEX, FRANCE

International Standard Book Number: 978-2-84060-440-2 Frontcover © Technical Committee 3.1

# LAND USE AND SAFETY: AN INTRODUCTION TO UNDERSTANDING HOW LAND USE DECISIONS IMPACT SAFETY OF THE TRANSPORTATION SYSTEM

Technical Committee 3.1 *National Road Safety Policies and Programs* World Road Association

# **AUTHORS/ACKNOWLEDGMENTS**

This report has been prepared by the working group Land Use and Safety of the *Technical Committee 3.1*: National Road Safety Policies and Programs of the World Road Association PIARC.

The contributors to the preparation of this report are:

- Robert Ritter (United States of America)
- Catherine Berthod (Canada-Québec)
- Deka Deka (Mali)
- Matts Åke Belin (Sweden)
- Robert Hull (United States of America)
- Jamilah Mohd Marjan (Malaysia)
- Justin Ward (United Kingdom)

The editors of this report are:

- Robert Ritter (United States of America) for the English version,
- Catherine Berthod (Canada-Québec) for the French version.

The translation into French of the original version was produced by Nathalie Polet, ministère des Transports du Québec.

Robert Ritter (United States of America) was responsible within the Technical Committee for the quality control for the production of this report.

The Technical Committee was chaired by Matts Åke Belin (Sweden) and Annie Canel (France) and Robert Hull (United States of America) were respectively the French and English-speaking secretaries.



**EXECUTIVE SUMMARY** 

2016R32EN

## LAND USE AND SAFETY: AN INTRODUCTION TO UNDERSTANDING HOW LAND USE DECISIONS IMPACT SAFETY OF THE TRANSPORTATION SYSTEM

Unplanned communities create hazards for road users of all types generating unsafe conditions for motorists on the roadway and significant dangers for pedestrians, bicyclists and residents alongside or adjacent to the road. While the World Road Association continues to investigate options and recommendations for communities that already exist in these environments, Technical Committee 3.1 generates this report to explain the relationship between land use and transport planning and the need for determined, thoughtful planning processes to prevent unsafe road conditions from developing. This report is not a design guide, but rather an attempt to inform the reader about the impact of fundamental land use and transportation decisions on the character and safe operations of the transportation system. Information in this report comes from contributions of the Technical Committee members and a literature review of international land use and transport planning research.

Responsible planning has always been vital to the sustainability of safe, healthy, and secure urban environments. Planning not only deals with land use, but also social and community services, managing cultural and heritage resources, creating economic capacity in local communities as well as addressing transportation and infrastructure. While transportation safety is often thought of as the outcome of transportation infrastructure decisions only, land use design and development can have significant impact on the overall safety performance of the transportation system and the transportation options available.

This report provides an introduction to land use planning concepts for non-experts and reviews the impacts that fundamental land use decisions (density, use, mix) and fundamental transportation decisions (functional classification of roads, transit availability, speed, access) can have on safety outcomes.

At its core, the value of land is based on its utility, among other factors. Transportation access increases that utility. This report provides an introduction to the relationship between transportation development and land use development. As transportation options connect one land parcel to other land, users, markets, and services, the desirability of the land increases. Transportation improvements can allow for more users and more dense development as more people can access the parcel and the desirability of the parcel increases. That increased density has an impact on safety performance. While increased density tends to increase crash frequency, it can also reduce traffic speeds which reduce crash severity and per capita traffic fatalities.

The report begins with a discussion of the three main highway functional classifications - arterial, collector, and local roads – and the relationship between functional classification and land access. Arterials provide a high level of mobility and a greater degree of access control, while local facilities provide a high level of access to adjacent properties but a low level of mobility. Collector roadways provide a balance between mobility and land access.

1

Appropriate functional classification design must match the surrounding actual land use in order to protect road user safety. Certain combinations of land use are particularly effective at reducing travel and travel speed, such as incorporating schools, stores, parks and other commonly-used services within residential neighbourhoods and employment centers. These land uses should be paired with local or collector road classifications.

This report also provides examples of where and how land use and transportation decisions are made in various government structures since the decision making authority can vary in different countries. In general, both land use and transportation decisions are made to different degrees at all levels of government: National, Regional, Municipal and District. Coordination and agreement among these decisions are essential to support a safe and efficient transportation system that contributes to strong communities and healthy economic development. Decision making structures in India, Malaysia, South Africa, Sweden and Canada-Québec are examined, identifying how national decisions are communicated and used at the State and regional/local level. The report also briefly explores several tools and techniques to improve safety in transportation and land use interactions.

## CONTENTS

INTRODUCTION	3
1. LAND USE PLANNING	5
1.1. WHAT IS LAND USE PLANNING ?	6
1.2. ROADWAY FUNCTIONAL CLASSIFICATION	7
1.3. RANGE OF LAND USE TYPES	9
1.4. WHY IS LAND USE PLANNING IMPORTANT?	10
1.5. WHAT ARE THE BARRIERS TO LAND USE PLANNING?	11
2. IMPACTS OF TRANSPORTATION ON LAND USE	13
2.1. WHO IS RESPONSIBLE FOR LAND USE PLANNING?	16
2.2. DECISION MAKING STRUCTURES	17
3. CASE STUDIES OF SUCCESSFUL INTEGRATION OF LAND USE AND ROAD SAFETY	24
3.1. THE LAND USE AND DEVELOPMENT PLAN OF THE MRC CHARLEVOIX-EST	
(CANADA-QUÉBEC)	24
3.2. THE LAND USE AND DEVELOPMENT PLAN OF MRC L'ASSOMPTION	
(CANADA-QUÉBEC)	26
3.3. INTERSECTORAL PLANNING OF STOCKHOLH, SWEDEN	29
3.4. ACCESS MANAGEMENT	31
3.5 COMPLETE STREETS	33
4. CONCLUSION AND NEXT STEPS	34
5. BIBLIOGRAPHY / REFERENCES	36
6. GLOSSARY	

#### **INTRODUCTION**

According to the World Health Organization road traffic injuries are the eighth leading cause of death globally, and the leading cause of death for young people aged 15-29 (*http://www.who.int/violence\_injury\_prevention/road\_safety\_status/2013/en/index.html* Global status report on road safety 2013). Road traffic injuries are therefore, globally a major public health problem which has been addressed in the Global Plan for the Decade of Action for Road Safety 2011-2020 (*http://www.who.int/roadsafety/decade\_of\_action/plan/en/index.html*)

The World Road Association is part of the global movement to combat this epidemic. During the 2012-2015 work cycle, *Technical Committee 3.1*: National Road Safety Policy and Programs, examined the relationship between land use and urban planning and transportation system safety. Land use and urban planning can impact the three factors that influence the number of people killed or injured in road accidents: exposure, accident rate and injury severity (Göran Nilsson 2004, *http://lup.lub.lu.se/luur/download?func=downloadFile&recordOId=21612&fileOId=1693353*) According to the handbook of road safety measures (the handbook of road safety measures 2<sup>nd</sup>, 2009), the objective of land use planning used as a traffic safety measure is to:

- locate roads, residential areas, workplaces and other industries in such a way that traffic volume and travel distance are minimized,
- create a road network that separates access roads from roads from through traffic and ensure that traffic volume on access roads is as small as possible,
- design individual roads so that the accident rate on the road is low and
- make the traffic system simple and easily understandable for all road users.

One major trend across the world in terms of land-use is the significance of the mega-trend of the growth in cities (and in particular mega cities across Africa, Asia and Latin America). The implications of land use decisions on transportation system safety, how these decisions could be politically managed and how policy tools can shape safety outcomes is relevant given the shift to urbanisation across the world, with the forecast that 2/3 of people will live in cities by 2040.

Historically, a lack of understanding, control and accountability results in sprawling land developments, including hazardous linear settlements that result in road safety issues. The alternative reviewed in this report is based on more controlled and planned outcomes, where land use is developed in a more coordinated way that encourages greater centralisation of development, with appropriate zoning controls. Thoughtful and organized development patterns would also encourage the development of the public realm as opposed to privatised space and would, therefor, allow for transportation service that safely meets the needs of all travel modes.

Unconstrained development has led in many places to the problems posed by linear settlements, as outlined in the PIARC "*Road Safety Manual*" (*http://roadsafety.piarc.org/en*). The Technical Committee recognized the problem with uncontrolled and unfettered development along transportation facilities throughout the world. These unplanned communities create hazards for road users of all types generating unsafe conditions for motorists on the roadway and significant dangers for pedestrians, bicyclists and residents alongside or adjacent to the road.

While the World Road Association continues to investigate options and recommendations for communities that already exist in these environments, Technical Committee 3.1 generates this report

to explain the relationship between land use and transport planning and the need for determined, thoughtful planning processes to prevent unsafe road conditions from developing. Information in this report comes from contributions of the Technical Committee members and a literature review of international land use and transport planning research. While this report does not provide design solutions to these problems, it does begin to identify political, legal and policy measures that could be instituted to provide for safe and efficient access to important services.

High income countries will recognize the planning process and decision making structures described in this report but may find case study examples to strengthen their current practices. Low income countries will learn more about the interactions among land use and transportation planning and the resultant impact on safety performance and may identify examples how national policies can be established that help regional and local land use decisions protect the safety of the transport network.



Policy tools – a land-use taxation approach that values land to drive decisions, e.g. out of city developments would be more expensive to encourage investment into more centralised and brownfield (regeneration) developments. Zoning of land use. Other policy measures such as *congestion charging* could be used to manage demand. *Permeability of cities* to encourage walking and cycling through cities (to encourage private developers not to close off/gate communities) and therefore allow people to walk/cycle on quieter roads. Land use and road space: consider *reallocation of road space* to segregated cycling routes and implementation of access management, complete streets, traffic calming and road safety audits

The Canadian Institute of Planners defines planning as "the scientific, aesthetic, and orderly disposition of land, resources, facilities and services with a view to securing the physical, economic and social efficiency, health and well-being of urban and rural communities."<sup>1</sup>

Responsible planning has always been vital to the sustainability of safe, healthy, and secure urban environments. Population is growing and, with more people migrating from rural to urban areas, the planning profession must increasingly deal with urbanization issues, such as: conversion of land from natural habitats to urban built areas, maintenance and use of natural resources and habitats, development of transportation related infrastructure, ensuring environmental protection.

Planners do not only deal with land use, but also social and community services, managing cultural and heritage resources, creating economic capacity in local communities as well as addressing transportation and infrastructure. While transportation safety is often thought of only in the context of transportation infrastructure, land use design and development can have significant impact on the transportation options available and the overall safety performance of the transportation system.

#### **1.1. WHAT IS LAND USE PLANNING ?**

Transportation planners need to work with city planners, local and regional elected officials, and other appropriate officials to ensure that good principles of mixed land use are incorporated into local and regional short- and long-range plans. The perfect connection of planning to safety is appropriate mixed land use and smart growth planning.

Land use planning addresses the types of use permitted in different areas: residential, commercial, industrial, agricultural, recreational, etc. Historically, land uses were mixed – agriculture, residential and manufacturing were all located adjacent to each other. With the growth of the automobile, often, each type of use (residential, commercial, retail, and industrial) is separated from the others.

The term "*land use*" refers to the function and form of human development and land management activities (physical characteristics as well as how it is used). This includes buildings, transportation facilities, associated sites, agriculture, forestry, etc. In other words, any development or management activity that changes the land and vegetation cover from its natural state.

Note that while land "*use*" implies human development or management, it can also be used to describe the natural land cover (forests, wetlands, grasslands). Planners, ecologists and others use the term "*land cover*" or "*land classification*" to describe a range of both developed and undeveloped states.

Choices about how to "*use*" land are made by those who own or control the land, considering both natural constraints (climate, soils, geography) and institutional constraints (land use planning and zoning laws).

Single use developments result in more extreme peaks and peak hour travel patterns as everyone in the development needs to travel to access other land uses, often at the same time. Single-use, or segregated, development force automobile trips, and often lengthy ones, and is also less conducive to non-automobile transportation, as different uses are spread further apart.

However, land use planners can array land uses differently, to allow shorter trips, more opportunities for walking or biking, and to connect the grid so that trips don't have to be forced onto a larger or higher functional classification roadway.

Land use planners also define the intensity (or density) of the use of the land: how many housing units per acre, floor area of retail use, industrial uses, etc. As densities increase, there is a greater market for a wider variety of goods and services. The higher densities and mix of uses are conducive to using transit, biking, and walking, as a variety of goods and services is available within a short distance of residential development. The mix of uses helps to spread out the peaks.

TABLE 1 - LAND USE FACTORS		
Factor	Definition	Travel Impacts
Regional accessibility	Location of development relative to regional urban center.	Reduces per capita vehicle mileage. More central area residents typically drive 10-40% less than at the urban fringe
Density	People or jobs per unit of land area (acre or hectare).	Reduces vehicle ownership and travel, and increases use of alternative modes. A 10% increase typically reduces VMT 0.5-1% as an isolated factor, and 1-4% including associated factors (regional accessibility, mix, etc.).
Mix	Proximity between different land uses (housing, commercial, institutional)	Tends to reduce vehicle travel and increase use of alternative modes, particularly walking. Mixed-use areas typically have 5-15% less vehicle travel.
Centeredness (centricity)	Portion of jobs and other activities in central activity centers (e.g., downtowns)	Increases use of alternative modes. Typically 30-60% of commuters to major commercial centers use alternative modes compared with 5-15% at dispersed locations
Network Connectivity	Degree that walkways and roads are connected	Increased roadway connectivity can reduce vehicle travel and improved walkway connectivity increases non-motorized travel
Roadway design	Scale, design and management of streets	Multi-modal streets increase use of alternative modes. Traffic calming reduces VMT and increases non-motorized travel
Active transport (walking and cycling) conditions	Quantity, quality and security of sidewalks, crosswalks, paths, and bike lanes.	Improved walking and cycling conditions tends to increase nonmotorized travel and reduce automobile travel. Residents of more walkable communities typically walk 2-4 times more and drive 5-15% less than in more automobile-dependent areas.
Transit quality and accessibility	Quality of transit service and access from transit to destinations	Increases ridership and reduces automobile trips. Residents of transit oriented neighborhoods tend to own 10-30% fewer vehicles, drive 10-30% fewer miles, and use alternative modes 2-10 times more than in automobile-oriented areas.
Parking supply and management	Number of parking spaces per building unit or acre, and how parking is managed and priced	Tends to reduce vehicle ownership and use, and increase use of alternative modes. Cost-recovery pricing (users finance parking facilities) typically reduces automobile trips 10-30%.
Site design	Whether oriented for auto or multi-modal accessibility	More multi-modal site design can reduce automobile trips, particularly if implemented with improvements to other modes.
Mobility management	Strategies that encourage more efficient travel activity	Tends to reduce vehicle ownership and use, and increase use of alternative modes. Impacts vary depending on specific factors.

This table describes various land use factors that can affect travel behavior and population health<sup>2</sup>.

#### **1.2. ROADWAY FUNCTIONAL CLASSIFICATION<sup>3</sup>**

**Functional classification** is the process by which streets and highways are grouped into classes, or systems, according to the character of traffic service that they are intended to provide. There are three main highway functional classifications: arterial, collector, and local roads. All streets and highways can be grouped into one of these classes, depending on the character of the traffic (i.e., local or long distance) and the degree of land access that they allow.

<sup>&</sup>lt;sup>2</sup> LITTMAN, T. and STEELE, R., Land Use Impacts on Transport: How Land Use FactorsAffect Travel Behavior, Victoria Transport Policy Institute, 2015

<sup>&</sup>lt;sup>3</sup> http://www.fhwa.dot.gov/environment/publications/flexibility/ch03.cfm Flexibility in Highway Design, published by FHWA.

8

#### The Functional Classes:

- 1. Arterial
- 2. Collector
- 3. Local

EACH TYPE OF ROAD HAS A SPECIFIC PURPOSE OR FUNCTION.		
<b>Functional System</b>	Services Provided	
Arterial	Provides the highest level of service at the greatest speed for the longest uninterrupted distance, with some degree of access control.	
Collector	Provides a less highly developed level of service at a lower speed for shorter distances by collecting traffic from local roads and connecting them with arterials.	
Local	Consists of all roads not defined as arterials or collectors; primarily provides access to land with little or no through movement.	

Typically, travelers will use a combination of arterial, collector, and local roads for their trips. Each type of road has a specific purpose or function. Some provide land access to serve each end of the trip. Others provide travel mobility at varying levels, which is needed en route.

There is a basic relationship between functionally classified highway systems in serving traffic mobility and land access, as illustrated in the illustration below. Arterials provide a high level of mobility and a greater degree of access control, while local facilities provide a high level of access to adjacent properties but a low level of mobility. Collector roadways provide a balance between mobility and land access.



Illustration 1. Relationship of functionally classified highway systems in serving traffic mobility and land access. Source: Safety Effectiveness of Highway Design Features, Volume I, Access Control, FHWA, 1992

#### Arterials

- higher mobility
- low degree of access

#### Collectors

balance between mobility and access

#### Locals

- lower mobility
- high degree of access

### **1.3. RANGE OF LAND USE TYPES**

Increased land use mix tends to reduce the distances that residents must travel for errands and allows more use of walking and cycling for such trips. It can reduce commute distances (some residents may obtain jobs in nearby businesses), and employees who work in a mixed-use commercial area are more likely to commute by alternative modes (Modarres, 1993; Kuzmyak and Pratt, 2003). Certain combinations of land use are particularly effective at reducing travel, such as incorporating schools, stores, parks and other commonly-used services within residential neighborhoods and employment centers. This creates *urban villages*, which are walkable centers and small neighborhoods that contain the services and activities people most often need<sup>4</sup>, but the terms zoning could apply to such land-use planning that allows for a greater mix of uses in residential zones.<sup>5</sup>

Land use types are often characterized in the following categories:

**Residential** - This type of development is dominated by single-family or multi-family homes that are located along local roads with connection to the arterial roadway network. Home offices for certain professional services may be allowed as well. Depending upon the density, most people will travel by automobile and the residential streets will be busiest during peak commuting hours. Local bus service may be present.

**Commercial** – This type of development includes offices, shops, restaurants, and professional services which are usually located along collector or arterial roads that carry heavier traffic loads than local residential streets. While most people often access the commercial businesses by auto, local bus service or light rail transit and pedestrian traffic can play a key role depending upon the density of the area.

**Institutional** – This type of development can include hospitals, universities, and schools. Institutions can have a high rate of trip attractions and are usually located on arterial roadways to handle the high volume of traffic. Transit service can include shuttles, bus, and rail. Institutions tend to be high trip generators especially at peak periods, which can produce large numbers of trips during work shift changes, and school hours. Institutions tend to operate long hours each day with many, such as hospitals, operating 24-hours a day.

**Industrial** – This type of development includes manufacturing and processing plants, warehouses and storage. Access to transportation infrastructure is critical as industries depend on being able to accept and deliver goods efficiently. Industrial land uses are typically located separate from residential and commercial businesses. Depending on the nature of the facility, highway; railroad; or port access may be required.

**Agricultural** – This type of development is generally a low traffic generator and therefore has low access needs. More than most other uses, major transportation investments adjacent to agricultural land can lead to development pressures to convert the land from its current use to a higher use - such as residential, commercial, or institutional.

Open space – Typically open space (unbuilt space) is preserved as parks or conservation areas which

<sup>&</sup>lt;sup>4</sup> Online TDM Encyclopedia, Victoria Transport Policy Institute, Land Use Impacts on Transportation

<sup>&</sup>lt;sup>5</sup> http://www.citylab.com/commute/2014/02/9-reasons-us-ended-so-much-more-car-dependent-europe/8226/

may or may not be open to the public For those that are open to the public, there may be significant parking demand for special events, but the peak periods of travel will usually be outside of the normal peak hour periods for other parts of the transportation system. Heavy use is on weekends, holidays, and after work. While most people may access the site by auto, there may be a demand for the investment in non-motorized facilities (bike paths, walking trails, etc.) both within the open space as well as to the area.

The growth of suburbs resulted in less mixing and more segregation of land use. When comparing the roadway systems of the mixed land-use and later development patterns, several distinctions are noticeable. Mixed land use generally has a grid pattern of streets with more total street length, more blocks, more intersections, and more access points. Conventional land-use patterns result in more of a *«hub and spoke»* or *«human circulatory system»* roadway pattern.

In a mixed land-use pattern, more streets mean more choices in route and convenience. Multiple routes and intersections provide more connections and avoid loading traffic on one particular street. Travel distances and times may be lessened, as well as dependency on the automobile. A mixed land-use pattern can ease congestion on main streets by offering acceptable alternative routes, but it will also add through traffic on some residential streets, which makes the need to use appropriate functional roadway design more critical.

Public market squares, streets and pedestrian areas could be used as an opportunity to mediate against the risks posed by liner settlements. In many low and middle income countries traders and vendors occupy the road reserve to set up goods and stalls. In urban areas, traders and vendors take over footpaths, and this can force pedestrians onto roads. The unauthorised use of space poses a number of road safety risks. How land use is allocated can help address this (alongside enforcement) ; for instance, certain streets, public market squares or pedestrians areas could be designated for street vendors<sup>6</sup>.

#### **1.4. WHY IS LAND USE PLANNING IMPORTANT?**

According to the United Nations Food and Agricultural Organization, "There is bound to be conflict over land use. The demands for arable land, grazing, forestry, wildlife, tourism and urban development are greater than the land resources available. In the developing countries, these demands become more pressing every year. The population dependent on the land for food, fuel and employment will double within the next 25 to 50 years. Even where land is still plentiful, many people may have inadequate access to land or to the benefits from its use. In the face of scarcity, the degradation of farmland, forest or water resources may be clear for all to see but individual land users lack the incentive or resources to stop it."<sup>7</sup>

Urban space serves a variety of needs: housing, work, social interaction, nature/leisure (trees, parks, recreation, functioning ecosystems). Urban space must also serve the mobility needs of the people. Michael Gilat and Joseph M. Sussman discuss the importance and challenges of land use and transportation planning in their paper, *Coordinated Transportation and Land Use Planning in the Developing World – The Case of Mexico City*<sup>8</sup>

10

<sup>&</sup>lt;sup>6</sup> http://roadsafety.piarc.org/en/planning-design-operation-responsibilities-and-policy/safe-system-impacts

<sup>&</sup>lt;sup>7</sup> Guidelines for land-use planning, FAO Development Series 1, Food and Agriculture Organization of the United Nations, 1993, ISSN 1020-0819

<sup>&</sup>lt;sup>8</sup> Gilat, M, Sussman, J.M.; Coordinated Transportation and Land Use Planning in the Developing World: Case Study of Mexico City; Transportation Research Record No. 1859, Sustainability and Environmental Concerns in Transportation, 2003

11

In the developing world many people are poor and do not own automobiles. The cities are growing rapidly, and many of the poorest people live on the outskirts, where they depend on expensive informal low-capacity transit, and usually spend a greater percentage of their income on transportation than people with high income. This diminishes their economic opportunities. Mixed land uses still prevail in the centers of the cities, including apartments, commerce (both formal and informal), and in some places light industry.

These conditions also present opportunities for (Transit Oriented Development) TOD and other methods of coordinated transportation and land use planning. With proper planning and investment, the urban form of rapidly growing cities can be designed to be transit-oriented. This can slow down the onset of motorization and sprawl, and mitigate their effects when they do occur, so that transit and non-motorized transportation maintain relatively high mode shares even after per capita income has risen to near-Western levels. TOD can also have beneficial socioeconomic and environmental effects, by concentrating the population along corridors served by high-capacity transit, which has lower operating costs and emissions per seat, and can charge lower fares...

Although the opportunities are great, there are some serious barriers to TOD in the developing world, most of them institutional. Planning institutions are less developed and have fewer resources than their counterparts in the developed world, and often cannot afford to collect much of the data required to inform the planning process. Interdisciplinary planning and metropolitan planning are often poorly developed. Corruption and cronyism are often a problem. Where zoning codes exist, enforcement is sometimes lax or nonexistent.

#### **1.5. WHAT ARE THE BARRIERS TO LAND USE PLANNING?**

With all the benefits of land use planning to carefully consider how and where development should occur and how it should interact with other land uses and the transportation network, well considered planning does not always happen nor are land use planning decisions always followed when actual development occurs. Why? Many factors get in the way of even the best intentions and plans.

Some countries and cultures are reluctant to even engage in planning in the first place. Planning considers the collective good while also taking into account individual rights. In many countries and cultures those individual rights are primary, so governments are reluctant to infringe on individual rights even for a collective good as important as improving safety performance. In other cases, communities and individuals distrust or fear government control. Hence, the government does not bother to engage in land use planning that is doomed to be ignored.

Reluctance towards land use planning, or bad land use planning decisions can result from<sup>9</sup>:

- Land use laws that separates uses requiring more long distance travel to access employment and retail
- An automobile-oriented culture that does not adequately consider the needs of all transportation system users
- Concerns about schools and public safety that obstruct certain types of development or transportation infrastructure

1.

2016R32EN

- Racism and racial tension where land use decisions are seen to benefit some, rather than all, in the society
- Inadequate ecological awareness so that environmental protections are not included in the plans
- Global economic change in an information age causing changes to development patterns and transportation needs faster than the planning system can adapt
- National policies and spending programs that do not emphasize the goals of the land use and transportation planning process
- Owners' concerns over property values which prevent the implementation of the land use plan or the acquisition of appropriate rights of way for transportation needs
- History of misuse/abuse of government powers, including the planning system, to serve the more powerful and influential. In these cases, land use planning is viewed as a tool to further the pursuits of the rich or powerful, not conducted for the collective good

## 2. IMPACTS OF TRANSPORTATION ON LAND USE

The relationship between land use and transportation can be a circular one. New investment in transportation can open the possibilities for more intensive and varied uses of land. This increase in use in turn creates a demand for additional investments in transportation. On the other hand, not investing in transportation can result in inadequate access or connectivity that stymies full economic development potential.

Transportation investments can improve the accessibility of land. They can increase the through-put or capacity of existing transportation systems to allow more people to use the system at the same time. Improved transportation can reduce the time it takes to get from one land parcel to another. All of these improvements can have a profound impact on land use.

The value of land is based on its utility, among other factors. Transportation access increases the utility of land. By connecting a land parcel to other land, users, markets, and services, the desirability of the land increases as well. Transportation improvements can also allow for more dense development as more people can access the parcel as well as access various destinations from the parcel.

Transportation investments can have negative impacts as well. Negative impacts include:

- The fragmentation of neighborhoods or areas as a road, transit line or railroad bisects a community,
- The placement of physical barriers that prevent easy movement from one side of the highway to the other
- Noise and vibration generated by the vehicles as they travel
- Incompatible uses- such as when an infrastructure investment results in increased truck traffic through a mostly residential area
- Adverse impacts on minority and economically challenged areas.

Transportation decisions makers can have profound impacts on land use. By locating transportation infrastructure, transportation decisions determine the accessibility of land parcels. Transportation decision makers can also determine access from the land to the transportation system – by physical construction (walls, curb cuts/driveways, sidewalks) as well as be regulation or permit. The size and type of transportation investment could also impact the size and density of land use that could be accommodated.

Accessibility can be defined for personal travel as the ability to reach desired destinations such as jobs, shopping, or recreational opportunities. For goods movement it can be defined as the ability to reach suppliers or buyers of products. Finding the right balance between access and mobility can be a challenge, especially when different agencies control the road and the surrounding land.

- Land Use patterns and characteristics affect travel demand. With increased development, more trips and the characteristics of the development affect those trips (how many, what mode).
- As the supply and demand characteristics of transportation change (new highway, added lanes, operational improvements, new light rail transit, bus rapid transit, reduced headways), land use is affected through changes in accessibility. More opportunities are made readily available which can lead to changes in land use the land in that corridor or area is more easily accessed. This can raise safety concerns.

- 14
- Accessibility is a function of both land use and transportation
- Accessibility can be maintained either through transportation investments or compact land use patterns



*Illustration 2. Urban density and motor vehicle travel* From: Land Use Impacts on transportation: Victoria Transport Policy Institute

Increase density is a function of land use decisions and has an impact on safety performance. Increased density increases crash frequency but reduces severity. Increased density reduces per capita traffic fatalities. Increased density tends to increase traffic friction (interactions among road users) which reduces traffic speeds. Slowing traffic improves safety for people walking and for drivers<sup>10</sup>.

The higher the speed of a vehicle, the shorter the time a driver has to stop and avoid a crash. In normal conditions, a car travelling at 50 km/h will require 13 meters in which to stop, while a car travelling at 40 km/h will stop in less than 8.5 meters. For car occupants in a crash with an impact speed of 80 km/h, the likelihood of death is 20 times what it would have been at an impact speed of 30 km/h.<sup>11</sup> An adult pedestrian has approximately a 20% risk of dying if struck by a car at 40 km/h and impacts above 40 km/h will likely result in severe injury or death.<sup>12</sup> Pedestrians have almost no chance of surviving an impact at 60 km/hr.

<sup>&</sup>lt;sup>10</sup> Stopping Distance for Cars, Road Safety Authority

<sup>&</sup>lt;sup>11</sup> Road Safety Speed, World Health Organization, 2004.

<sup>&</sup>lt;sup>12</sup> Pedestrian Safety : A Road Safety Manual for Decision-Makers and Practitioner, World Health Organization, 2013



Illustration 3. Pedestrian fatality risk as a function of the impact speed of a car

*Illustration 4* below is based on casualties to seat belt wearing drivers in car to car crashes in the USA between 1982 and 1991 (*Evans, 1993*). The probability of serious injury or death is plotted for a range of impact. Notice that the fatal curve rises steeply beyond 60km/h.



Illustration 4. probability of fataL/severe injury to belted driver

TABLE 1 - PROBABILITY OF BELTED DRIVER BEING KILLED OR SEVERELY INJURED IN TWO CAR COLLISIONS			
Delta V (km/h)	Prob. of fatality	Prob. of sev. inj. or fatality	
40	0.02	0.08	
50	0.05	0.16	
60	0.11	0.27	
70	0.21	0.40	
80	0.31	0.54	
90	0.41	0.65	
100	0.50	0.75	

16



Illustration 5. Distribution of delta v for fatalities to belted drivers

*Illustration 5* shows the frequency distribution of impact speeds for the same data as the previous illustration. Notice that half of all fatalities to seat-belted drivers occurred at less than 45km/h. Although the risk of a fatality is low at these speeds the total number of reported crashes (including non-injury crashes) in this impact speed range is much greater than at the higher impact speeds. This suggests that measures which address impact speeds in the range 30 to 50km/h are just as important as those which address higher speeds. These data are for seat belted drivers.<sup>13</sup>

#### 2.1. WHO IS RESPONSIBLE FOR LAND USE PLANNING?

Responsibility for land-use planning lies with different organizations and offices at different levels of government. It could occur at the national, State, city or local level. It has generally been considered planning for economic development. For that reason, transportation planners tend to see their role in land use planning as advisory rather than decision-making, and they focus on transportation planning to support economic development or capacity enhancements.

Transportation planners need to work with local officials to inform how land-use decisions could improve the overall transportation system and help achieve community goals. At the same time, transportation planners need to be aware of local economic development, environment and safety goals so the transportation system will support these. For example, mixed land-use zoning can have a positive effect on security and economic development. Compact, sustainable, and efficient use of land can reduce air pollution, vehicular speeds, and the number and severity of crashes. This can lead to a safer and more secure environment for those who walk or ride bicycles<sup>14</sup>.

<sup>14</sup> http://www.citylab.com/commute/2014/02/9-reasons-us-ended-so-much-more-car-dependent-europe/8226/

<sup>&</sup>lt;sup>13</sup> http://users.tpg.com.au/users/mpaine/speed.html Developments in Safer Motor Vehicles

Conference organised by SAE Australasia and NSW Parliament Staysafe Committee ,16-17 March 1998 Parliament House, New South Wales

#### **2.2. DECISION MAKING STRUCTURES**

With the inter-relationship between land use planning, transportation design and safety, it is important to examine and understand where and how these decisions are made in various government structures. The decision making authority can vary in different countries, but in general, land use decisions are made at all levels of government: National, Regional, Municipal and District. Transportation decisions are also made at these levels: National, State/Region, Municipal. Coordination and agreement among these decisions are essential to support a safe and efficient transportation system that contributes to strong communities and healthy economic development.

#### 2.2.1. Victoria, australia

while land use planning is conducted at the national and state level, deisions regarding development on a particular land parcel are governed by land use permits in Victoria, Australia. According to the Victoria Department of Planning and Community Development:

A planning permit is a legal document that allows a certain use or development to proceed on a specified parcel of land. The benefit of the permit generally attaches to the land for which it has been granted although a permit is sometimes made specific to a nominated owner or operator. A permit is always subject to a time limit and will expire under specified circumstances. The responsible authority is entitled to impose conditions when granting a permit.15

The responsible planning authority will check to ensure that the requested land use is consistent with the relevant planning scheme. In fact, in many cases, certain development that is already envisioned by the plan will not even require a permit. The Victoria transportation authority, VicRoads, is a refereal authority to the planning permit process with the responsibility for reviewing permit applications to determine if the proposed land use meets the apporpriate transportation requirements. While the referral authority cannot direc that a permit be issues, it can object to the granting of the permit on specific grounds, including transportation safety.

The local government makes the final decision whether or not to approve a land use permit. With an approved permit, some development activities can begin on the parcel, although permits for specific construction, such as buildings may still be required.

<sup>&</sup>lt;sup>15</sup> Using Victoria's Planning System, Victoria Department of Planning and Community Development, http:// www.dtpli.vic.gov.au/planning/about-planning/a-guide-to-the-planning-system

2016R32EN



Illustration 6. Using victoria's planning system

2.2.2. India



Illustration 7. decision making relationship among levels of government Wuppertal Institute From: Land Use Planning and Urban Transport Deutsche Gesellschaft fur Technische Zusammernarbeit (GTZ) GmbH

LEVEL	ACTIONS
Central Government	National Policies: Plan funds, bilateral and multilateral targeted programs aid, coordination, etc.
State Government	State Strategies: Industrial policy, population distribution, urban land policy, regional networks, social services, environmental conservation, etc.
District (Regional) Planning Committee	District or Structure Plan: Regional networks, regional social services, regional environmental conservation, allocation of funds, identification of regional projects, intra and inter district coordination, etc.
Metropolitan Planning Committee	Metropolitan Structure Plan: Metropolitan networks and social infrastructure plans, metropolitan fringe coordination plan, local economic perspective plan, identification of metropolitan projects, formulation of public private partnerships, etc.
Local Govt. Municipal Corporations Mun. Councils	Detailed Development Plans: Project formulation, implementation and monitoring, coordination between ward levels (Ward Level Committees are recommended)
Town Panchayats	For municipal corporations generally with population of 0.3 million and above, consolidation of ward level and other plans and projects, prioritising projects, project investment plan, project outlay, project implementation and monitoring, etc.
Ward and Local Level Committees	Local Specific Action Plans: Local project formulation, implementation and monitoring; coordination with local government; input to the development plan.

Illustration 8. organization of planned growth in india: planning responsibilities<sup>16</sup>

While land use planning in India is defined in the country 's consitution, several attempts have been made in the past decades to improve its operation and impact. Land use planning falls under the responsibility of the state governments. Within each state, a District Planning Committee is required for each district to "to consolidate the plans prepared by the Panchayats and the Municipalities in the district and to prepare a draft development plan for the district as a whole"<sup>17</sup>. The national/federal government focuses on policies, guidelines and model laws for adoption by the states, providing assistance and grants to states in their land use planning efforts and providing adequate funds for research and training. Various sectors (urban, rural, industrial, transport, mining, agricultural, etc.) within India have developed their own approaches to land use policies resulting in a lack of comprehensive and integrated land use planning in the country.<sup>18</sup>

Within and, when appropriate, among states, regional and municipal plans are developed to guide local land use decisions. Almost all states have an Urban and Regional Planning Act that requires a State Planning Board and provides the authority for development planning in designated areas (e.g. city, region, resource area, new town) and the requirements for the preparation, content and enforcement of various types of plans.

<sup>&</sup>lt;sup>16</sup> Land Use Planning and Urban Transport, ISOCARP, modified by Wuppertal Institute

<sup>&</sup>lt;sup>17</sup> Article 243ZD(1) of the India Constitution (74<sup>th</sup> Constitutional Amendment Act).

<sup>&</sup>lt;sup>18</sup> National Land Utilisation Policy. Framework for land use planning & Management, Draft : Version 2, Department of Land Resources, Ministry of Rural Development, Government of India, Septmeber 2013.

20

The Ministry of Urban Affairs and Employment published Urban Development Plans Formulation and Implementation Guidelines<sup>19</sup> in 1996. These guidelines call for four inter-related plans, ranging from a long term (20-25 year) policy plan to an Annual Plan within the framework of a medium-term Development Plan. In addition, specific project plans are recommended to detail specific layouts for execution by a public or private agency.<sup>20</sup>

*Illustrations 7 and 8* identify the relationship and responsibility for land use planning at different governmental levels within India.

#### 2.2.3. Malaysia

National Development Framework in Malaysia



Illustration 9. National development planning framework

## Figure: National Development Planning

<sup>19</sup> Urban Development Plans Formulation and Implementation (UDPFI) Guidelines; Volume 1; Ministry of Urban Affairs and Employment, August 1996.

<sup>&</sup>lt;sup>20</sup> National Land Utilisation Policy. Framework for land use planning & Management, Draft : Version 2, Department of Land Resources, Ministry of Rural Development, Government of India, Septmeber 2013.



Illustration 10. Malaysia land use planning authorities

At the first level, the National Physical Planning Council develops policies to improve the physical environment towards sustainable development in the country within the framework of the National Policy. Consistent with those decisions, the Regional/State Planning Committees establish regional planning that may involve area in more than 2 states or more. This regional planning promotes conservation, use and development of all lands in the State within the framework of the National Policy.

The Regional/State Planning Committees are also responsible to regulate, control, plan and coordinate all development activities in the State. Finally, more detailed land use decisions are made by local planning authorities. Malaysia requires every local Authority to act as the local planning Authority. As the local planning authority, they regulate, control and plan the development and use of all lands and buildings within its area.



Illustration 11. Malaysia land use plans

A range of plans govern the decisions made at the various levels of government. The General Planning Policy is established by the State Authority and sets general policy with respect to planning and development and use of all lands & buildings within the area of every local authority in the State; while the National Physical Plan provides the strategic policies for determining the general directions and trends of the physical development of the nation. Transport Planning is integrated in the National Physical Plan. The implementation of transport planning is mostly at National level not in the State or Local Authorities.

2016R32EN

The State Director is responsible in instituting a survey of the State and for planning the development of the State. The State Director shall institute a fresh survey if directed by the National Council or Committee. The Development plans cover principal physical, economic, environmental and social characteristics including principal land use of the State, as well as communications, the transport system and traffic. The State Director also proposed a draft structure plan to be approved by the Council. The Structure Plan formulates the policy and general proposals of State Authority in respect of the development and use of land plan, including improvement of the physical living environment. After a Structure Plan for the State has come into effect, the local authority prepares a draft local plan consisting of a map and a written statement regarding the development of:

- 1. the use of land in;
- 2. the protection and improvement of the physical environment of;
- 3. the preservation of the natural topography of; (iv) the improvement of the landscape of;
- 4. the preservation and planting of trees in;
- 5. the making up of open spaces in;
- 6. the preservation and enhancement of character and appearance of buildings in;
- 7. the improvement of communications in; and
- 8. the management of traffic in,

the area of the local plan. The local plan also prohibits development of land contrary to planning permission.

#### 2.2.4. Canada-Québec

In the province of Québec, there are more than 1100 local municipalities that, at a supralocal level, are included in 87 regional county municipalities (RCM) and two Metropolitan Communities (MC), Montréal and Québec.

The Act respecting land use planning and development establishes the legal framework for the preparation of rules governing land use planning and development in Québec. It recognizes that land use planning is a shared responsibility between various levels of decision makers. The Government thus adopts policy directions that regional authorities must consider when they prepare planning documents.

A MC must adopt a metropolitan land use and development plan that defines policy directions, objectives and criteria to ensure the competitiveness and attractiveness of the territory, in keeping with sustainable development. The plan shall focus on land transportation planning, the identification of any part of the territory that must be the subject of integrated land use and transportation planning, and the definition of territories reserved for optimal urbanization.

A RCM must prepare a regional land use and development plan. This document establishes guidelines governing the physical organization of the territory. It specifically includes the urban growth boundaries (urbanization perimeters) and priority development zones, a land transportation plan and infrastructure and facilities planning.

Finally, a local municipality is required to adopt a planning program and land use by-laws (zoning, construction, subdivision, conditions under which construction permits may be issued, etc.). They must comply with the rules and requirements of the "*complementary document*," which is a part of the RCM plan.

In order to ensure coherence between the development objectives and projects of the various bodies, the Act introduces the "*rules of conformity*." This mechanism ensures conformity:

- of the regional and metropolitan land use plan with the Government's policy directions;
- of the regional land use plan with the metropolitan land use plan in the MC's territories;
- of the planning program and land use by-laws with the regional land use plan;
- of land use by-laws with the planning program.

These planning tools are important regarding road safety because the choices adopted by the RCM, the MC or the municipality, such as urbanization perimeters, general policies on land use, and occupation density levels, have an impact on transportation demand, and on the efficiency and safety of the road network. They allow for the integration of land use and transportation planning, as well as the coordination of the decisions of all stakeholders involved.



Illustration 12. Land use planning in Quebec

# **3. CASE STUDIES OF SUCCESSFUL INTEGRATION OF LAND USE AND ROAD SAFETY**

# **3.1. THE LAND USE AND DEVELOPMENT PLAN OF THE MRC CHARLEVOIX-EST (CANADA-QUÉBEC)**



The MRC Charlevoix-Est is a rural and tourist area east of the city of Québec on the North Shore of the St. Lawrence River. It encompasses seven municipalities and 16000 residents, of whom 9000 live in the city of La Malbaie. Three main roads pass through this region covering an area of 2,300 km<sup>2</sup>: the national highways, routes 138 and 170, and the regional highway, route 362. These roads are under the jurisdiction of the ministère des Transports du Québec. They allow for interregional transit, particularly for merchandise.

Over time, urban development along these roads has led to a multiplication of direct accesses, presenting an ever-growing safety risk. Some sectors are particularly problematic. Seeing that there were still a significant number of vacant lots along these roads, starting in 1995, the MRC has imposed robust measures to limit development and manage road accesses.

2016R32EN

#### Objectives

In order to ensure the safety of the national and regional road network, the MRC adopted the following objectives, which are contained in its land use and development plan:

- Improve road conditions in the sectors that the MRC has identified as priorities, and increase the number of passing lanes.
- Along main roads:
  - Limit intersections and access outside of the urbanization perimeters.
  - Limit linear development.
  - Preserve agricultural zoning in order to limit construction and private accesses, and promote highway safety, and preserve landscape.
  - Reduce the pressure for development of commercial activities outside of urbanization perimeters, and stimulate the village cores.
- Preserve the quality of the landscapes in the tourist corridors, as well as in the visual environments of areas of interest.

#### Provisions of the land use and development plan for improved highway safety

The land use and development plan identifies four types of sectors along main roads: sectors with the greatest urban development, two types of sectors outside of urbanization perimeters, and ten priority sectors. The priority sectors are where the geometry, topography and visibility present significant limitations to the addition of accesses and the development of residential, commercial, public or institutional buildings. More restrictive provisions apply to this type of sector.

The provisions of the land use and development plan that have a stronger impact on highway safety concern highway access management along main roads (see section Access management).

#### Authorised use

On lots adjacent to priority sectors, commercial and industrial use, as well as institutions and public services are prohibited, with a few exceptions, such as recreation and tourism businesses. Municipalities can permit residential use under certain conditions.

#### Minimum lots dimensions

The minimum lot width is 117 m, measured along the front line on priority sectors, and 75 m or 50 m in sectors outside of urbanization perimeters.

#### Number of accesses per lot

One single access is permitted per lot, except for commercial, public and institutional uses that generate a high volume of traffic, such as service stations, shopping centres and retail stores having a floor space of more than 300 m<sup>2</sup>. However, two accesses could be permitted if the ministère des Transports du Québec authorizes it.

#### New access

In situations where a lot is adjacent to a main road and also to a local road, the new access must be made to the local road. The ministère des Transports du Québec may approve exceptions.

#### New intersections

No new thoroughfare making an intersection with main roads can be created without a written notice from the ministère des Transports du Québec stating that the planned thoroughfare will

not increase the risk of crashes and will not have a significant impact on the level of service of the road (fluidity, safety, speed, etc.).

#### Access management

In the priority sectors, the front setback for the main residential, commercial or industrial building must be at least 30 m from the highway right-of-way.

What's more, loading and unloading areas, as well as turning areas must be situated entirely on the lot in question and in such a way that all vehicles can enter the lot moving forward and change direction without using the highway.

Access to lots adjacent to main roads must be in compliance with the ministère des Transports du Québec standards for property access.

# **3.2. THE LAND USE AND DEVELOPMENT PLAN OF MRC L'ASSOMPTION** (CANADA-QUÉBEC)



Situated north east of the Montréal metropolitan community, the MRC of L'Assomption is made up of six municipalities and has a population of 120 000. The region covers 265 km<sup>2</sup>, and is largely in an agricultural zone. While the economic and demographic growth that the MRC has seen over recent decades will likely continue, it must also deal with densely developed urban areas where vacant lots are rare.

26

2016R32EN

This growth corresponds with a significant increase in the demand for transportation, which has been almost entirely based on the use of cars. In spite of major highway infrastructures such as freeway 40, which links the cities of Québec and Montréal, traffic congestion problems are becoming increasingly frequent.

#### **Objectives**

The land use and development plan adopted by the MRC in 2012 defines clear objectives in response to the economic and demographic growth, and encourages the use of public transport over cars:

- Combine access to public transport with major structural projects and projects with demographic characteristics;
- Promote density and diversity near services and public transit zones;
- Promote integrated development of transportation infrastructures;
- Optimize the use of urban space through development and redevelopment;
- Maintain the density and limit urban spread by managing the development of new zones on the periphery of urban areas and in sectors served by the public services and infrastructures.

#### Provisions of the land use and development plan for improved highway safety

The land use and development plan contains several provisions concerning urban development that aim to improve road safety.

Managing projects that generate movement of people

Any new development or redevelopment project that creates a significant volume of person trips must, before approval, be supported by an assessment of the accessibility and an assessment of the impact on traffic and road safety and of the road network capacity to manage increased traffic.

The following projects are considered to be "projects generating significant movement":

- 1. a commercial establishment on a distinct lot covering more than 8000 m<sup>2</sup>;
- a commercial area covering more than 42 000 m<sup>2</sup> or a complex of businesses on a distinct lot with a total commercial area covering more than 12000 m<sup>2</sup>;
- a complex of office buildings or businesses offering personal services for which the total floor area on a distinct lot is more than 10 000 m<sup>2</sup>;
- 4. a residential complex with more than 50 housing units on a distinct lot adjacent to a local road network;
- 5. a seniors' residence with more than 100 bedroom units on a distinct lot adjacent to a local road network.

This assessment must, prior to receiving the authorisation by the municipality, have received notice from the regional public transit network (RTCR).

#### Managing projects that generate movement of merchandise

Any new project for implementing a logistics centre must ensure the efficiency and capacity of the transportation infrastructures that allow intermodality (rail and road). "*A logistics centre*" is considered a multi-purpose site, related to the distribution, storage and treatment of goods, which generates a significant volume of trips and covers at least 15 000 m2.

#### Planning the road network and public transit

When planning the road network for any new urban sector to be developed, the municipalities must promote mixed use of the public right-of-way for all collector streets and arterials in order to accommodate a public transportation circuit. The municipalities must specifically give priority to the safety and comfort of pedestrians and cyclists when planning public spaces and the road network.

#### Opening new streets

No new streets will be accepted in the following areas outside of urbanization perimeters: low-density residential areas; agricultural areas; agro-forestry areas; conservation areas; rural areas; recreation and tourism areas, except in the case of joining existing roads that finish in a dead end.

Any newly created street must not be more than 100 metres long. The joining of existing streets that finish in dead ends is intended to increase safety for children and the streets' residents (delivery trucks and snow-removal vehicles that must back up, collision preventing residents from leaving through the only exit, etc.) and ensure improved efficiency in the delivery of services to the residents (school buses, garbage removal, etc.).

#### Managing access to highways

In order to ensure the best possible efficiency of the national, regional and collector highways, and improve the safety of the road users as well as the residents living along or near these highways, the municipalities must regulate the subdivision (surface area and lots dimensions) and zoning (use, setbacks, etc.) in order to limit the number of intersections and accesses in respect to the following principles, and thus, both within and outside of urbanization perimeters:

- Within already built-up areas, municipalities must promote the reduction of the number of accesses to roads by way of agreements between property owners (use of shared or common entries) or by the elimination of direct accesses to the street for businesses located on corner lots.
- 2. In areas that have not been built up, accesses to properties adjacent to major traffic lanes should primarily be created using secondary roads in order to eliminate direct access to the major traffic lanes. On these lanes, intersections must be limited, as much as possible, to one every 500 m.

28

### **3.3. INTERSECTORAL PLANNING OF STOCKHOLH, SWEDEN**

In addition to integrated planning discussed above, there are actions/activities that transportation planners, engineers and safety professionals can undertake to improve safety performance of the transportation system, regardless of the land use decisions that are made.



Illustration 13. Stockholm Necklace of Pearls From: Planning and Design for Sustainable Urban Mobility: Policy Directions Global Report on Human Settlements 2013 IN HABITAT for a better urban future

While Sweden does not have a national level transportation or land use plan, there are some controlling national laws and various policy statements that direct the actions at other levels of government. Much of the planning is guided by two laws: the Planning and Building Act and the Environmental Act.The Planning and Building Act establishes the decentralization for municipalities. The cities are given independence, which allows for more effective resource management and better plan implementation.There is also sectoral infrastructure planning at the national level.

The Stockholm Region is a special case in Sweden with more than 50 years of regional planning and production of a number of regional plans. The latest regional plan is from 2001 and is the first attempt to make a regional development or spatial plan which covers more than the traditional physical issues in the region. The operational organ within the Stockholm County Council is the Office of Regional Planning and Urban Transportation governed by its political Committee. This organization is part of the County Council for Stockholm.

The Regional plan's purpose is to co-ordinate issues affecting more than one municipality. The regional plan can, where it is of importance to the region as a whole or for parts of it, suggest

principles for the use of land and water areas as well as guidelines for the location of development and civil engineering works. The regional plan has a long term and strategic focus.

The comprehensive plan aims to deal with long-term, strategic questions regarding land use and development. The comprehensive plan gives the main points concerning use of land and water areas and the municipality's views concerning how the built environment is to be developed and preserved.

The comprehensive plan presents the background, current trends, and maintenance of the built environment. It includes descriptive text, setting out the planning assumptions, rationale for its formulation, and the measures that the municipalities intend to take to implement the plan. The text is supplemented with supporting material and maps.

A development plan, adopted by the municipality, is required before urban development may take place The development plan includes an examination of a site's suitability for development and the control of the design of the built environment for that site. The plan provides regulation concerning the size and height of buildings, the purpose for which they may be used, the land intended for parks, roads, water and sewerage mains, etc.<sup>21</sup>

Today's Stockholm is very much a result of planning efforts and development strategies during the last century. From the 20's the city took active part in providing people with affordable and decent housing. An important part of the strategy was to buy land for development and also to preserve areas for recreation purposes. The strategy and the planning goals were inspired by modernistic ideals with clear physical separation between dwelling, work and business areas, following the principles of zoning.

In the beginning of the 50's a city-wide comprehensive plan was made that lined out a strategy for the growth of the city. New suburbs were planned along metro lines like pearls on a string. Each suburb was designed as a neighbourhood unit with a social and commercial core, high density housing close to the station, and in the periphery lower density housing together with self-built one-family homes. A green structure was established with green areas and parks dividing the neighbourhoods.

Major investments were also made in establishing an efficient public transport system, based on a network of metro lines and commuting trains. The idea was to make it possible for people to live pleasantly in the suburbs and take the metro to work in the city centre or in designated work areas.<sup>22</sup>

Some overall concepts that guide greater Stockholm planning include<sup>23</sup>:

- Nature conservation is an important piece of sustainability, and should benefit both humans and the environment,
- Adapt the urban structure to the geographical constraints-urban development occurred in

<sup>22</sup> Pemer, Mats; Developing a sustainable compact city in Stockholm, Sweden. By Mats Pemer Director, Strategic Department, Stockholm City Planning Administration

<sup>&</sup>lt;sup>21</sup> http://www.eurometrex.org/Docs/eATLAS/STOCKHOLM\_eAtlas.pdf

<sup>&</sup>lt;sup>23</sup> Nelson, Alyse; Stockholm, Sweden; http://depts.washington.edu/open2100/Resources/1\_OpenSpaceSystems/Open\_ Space\_Systems/Stockholm\_Case\_Study.pdf, accessed 22 Sept 2014

natural depressions of the land, with a radial metro system running through each neighborhood and suburban town,

- This radial development pattern leaves green "wedges" in between the urban areas—which form a system of parks and open spaces that make a regionwide system linked by paths and green arterials
- The nodes of urban development along the public transportation system need to be dense, mixed-use, and walkable,
- Planning for nature requires knowledge of the availability of green areas, and their recreational, natural, and cultural value,
- Open space planning requires cooperation between involved municipalities, regional entities, and the national government.



Illustration 14. Relationship of decision making in stockholm planning

## **3.4. ACCESS MANAGEMENT**

According to the U.S. Transportation Research Board's Access Management Manual, Access Management is the systematic control of the location, spacing, design and operation of driveways, median openings, interchanges, and street connections. It is a set of techniques that state and local governments can use to control access to highways, major arterials, and other roadways for improving traffic flow without the need for new or expanded facilities. Access management encompasses roadway design treatments such as medians and auxiliary lanes, and the appropriate spacing of traffic signals. It includes several techniques that are designed to increase the capacity of these roads, manage congestion, and reduce crashes.

Access Management is an opportunity to retro-fit existing transportation corridors to reduce the number of conflict points as traffic enters and exist the corridor. Access Management is appropriate for transportation corridors with some barrier (as minimal as curbs) to road access.<sup>24</sup>

- 1. Provide a Specialized Roadway System
- 2. Limit Direct Access to Major Roadways

<sup>24</sup> Principles of Access Management (TRB Access Management Website)

- 3. Promote Intersection Hierarchy
- 4. Locate Signals to Favor Through Movements
- 5. Preserve the Functional Area of Intersections and Interchanges
- 6. Limit the Number of Conflict Points
- 7. Separate Conflict Areas
- 8. Remove Turning Vehicles from Through Traffic Lanes
- 9. Use Nontraversable Medians to Manage Left-Turn Movements
- 10. Provide a Supporting Street and Circulation System

Options for making changes:

- Increasing spacing between signals and interchanges;
- Driveway location, spacing, and design;
- Use of exclusive turning lanes;
- Median treatments, including two-way left turn lanes (TWLTL) that allow turn movements in multiple directions from a center lane and raised medians that prevent movements across a roadway;
- Use of service and frontage roads; and
- Land use policies that limit right-of-way access to highways.

State, regional, and local governments across the United States use access management policies to preserve the functionality of their roadway systems. This is often done by designating an appropriate level of access control for each of a variety of facilities. Local residential roads are allowed full access, while major highways and freeways allow very little. In between are a series of road types that require standards to help ensure the free flow of traffic and minimize crashes, while still allowing access to major businesses and other land uses along a road.<sup>25</sup>

Access management can be achieved not only by actions on the road infrastructures, the intersections and the driveways, but also by land use planning and techniques. Land use measures define the use of a lot and consequently the type and intensity of the generated traffic, and the way it enters from and exits to the adjacent road; all these aspects are key factors for road safety conditions. Such land use measures are mainly:

- Road network planning: road classification, connectivity for all modes,
- General policies: location of growth areas and major trip generators, urban design for new neighborhoods and other developments,
- Subdivision regulations for lots along the roads: minimum width for the lots to be created, number of accesses,
- Zoning regulations: restrictions in residential and commercial use on lots adjacent to main roads in rural areas
- Construction regulations: building setback requirements, location of accesses on the lot, corner clearance,
- Conditions required for the emission of the land development and access permits, especially when the municipality which is responsible for the land use planning, is not responsible for the road.

These elements can be used to implement the main access management strategies, like spacing, location and design of driveways and intersections. Land use measures are an efficient way to manage accesses because they can be taken when lots are still not developed or before the construction of a new road, when it is still possible to prevent road safety and traffic problems.

#### **3.5. COMPLETE STREETS**

Complete Streets is a movement developed in the United States to ensure that the entire right-of-way is planned, designed, constructed, operated, and maintained to provide safe access for all users. Complete Streets policies ensure that transportation systems are safe and accessible for everyone. Characteristics of Complete Streets include:

- Roadways that serve all users-vehicle drivers, pedestrians, bicyclists, transit riders and freight
- Interconnected, multimodal networks
- Safe for all ages and abilities
- Vary by context (e.g., urban/rural)
- Based on community desires
- Outcome of good planning and design

Design elements on Complete Streets may include:

- Wider sidewalks
- Narrower travel lanes, traffic calming features
- Crosswalks, curb ramps, accessible pedestrian signals
- Median islands
- Universal design features
- Bike lanes
- Wide paved shoulder
- Bus stops, shelters, bus pull outs
- Curb extensions



#### 4. CONCLUSION AND NEXT STEPS

Thoughtful, coordinated land use planning and implementation is important, not only for economic development and environmental protection but also for the efficiency and safety of the transportation network. Land use decisions impact how the transportation network is used and how it should develop, which in turns affects the type of transportation users, mode choice, traffic speed, congestion and various factors that can reduce fatalities and serious injuries. Many countries have established procedures to coordinate decisions at all levels of government. Implementing and enforcing local, as well as national, land use and transportation decisions are essential to support a safe and efficient transportation system that contributes to strong communities and healthy economic development.

This report was prepared by Technical Committe 3.1 National Road Safety Policies and Programmes of the World Road Association. The Technical Committee recognized the problem with unplanned communities creating hazards for road users of all types, generating unsafe conditions for motorists on the roadway and significant dangers for pedestrians, bicyclists and residents alongside or adjacent to the road. Technical Committee 3.1 generates this report to explain the relationship between land use and transport planning and the need for determined, thoughtful planning processes to prevent unsafe road conditions from developing. Information in this report comes from contributions of the Technical Committee members and a literature review of international land use and transport planning research

More research is necessary in this area. This report details the relationship between land use and transportation decisions and documents the institutional structures in several countries that govern land use decisions. The focus of the report is to explain how better consideration of transportation safety during the land use policy and planning phases would result in development that generates safer options for all users of the transportation network, particularly non-motorized users.

The World Road Association continues to strive for understanding of existing conditions and to investigate options for communities where significant development has already occurred in such a way that safe transport options are not readily available. Redeveloping and redesigning existing housing, industrial and transportation infrastructure is prohibitively expensive and disruptive to existing communities.

In addition, more research is necessary to quantify the safety impacts of different land use planning insitutional structures and developmental patterns. Transportation safety is the result of a wide range of factors – engineering, behavioral, enforcement, education, emergency medical services, etc. Land use patterns, types of development and transport options impact each of these factors, some to greater extent than others. The land use planning, transportation planning and safety communities strive to develop tools and procedures to quantify the impact of these various decisions. The World Road Association will continue to reach out to member countries to identify and share best practices and to find examples to contrast safety performance in communities based on good land use planning with those where development occured without the benefit of strong planning decisions to emphasize the benefits of effective land use planning.

At the same time, there is also a need for greater understanding of the institutional structures for comprehensive decisionmaking that prioritizes safety for all users. While this report details how land use and transportation planning decisions are made and communicated across different levels of government, more can be done to assess the efficacy of those structures and to highlight noteworthy practices.

## **5. BIBLIOGRAPHY / REFERENCES**

Canadian Institute of Planning http://www.cip-icu.ca

Ministère des Affaires municipales, des régions and de l'occupation du territoire. Guide La prise de décision en urbanisme. Troisième édition, 2010.

http://www.mamrot.gouv.qc.ca/amenagement-du-territoire/guide-la-prise-de-decision-enurbanisme/avant-propos/

Ministère des Affaires municipales, des régions and de l'occupation du territoire. Planning and Development powers in Québec. Summary. 2010.

http://www.mamrot.gouv.qc.ca/pub/amenagement\_territoire/urbanisme/plan\_development\_ powers\_angl.pdf

Municipalité régionale de comté de Charlevoix-Est. Schéma d'aménagement et de développement révisé.

http://www.mrccharlevoixest.ca/amenagement-du-territoire/schema-amenagement-and-dedeveloppement.aspx

Municipalité régionale de comté de l'Assomption. Schéma d'aménagement et de développement révisé.

http://www.mrclassomption.qc.ca/amenagement-territoire

Table de concertation sur les paysages. Côte de Beaupré. Charlevoix. Charlevoix-Est. Plan paysage de la route 138. Rapport final. 2013.

http://www.notrepanorama.com/uploads/LTR\_12441\_plan-paysage\_client.pdf

AVELAR, R E.; DIXON, K K.; BROWN, L S.; MECHAM, M E.; VAN SCHALKWYK, I. *"Influence of Land Use and Driveway Placement on Safety Performance of Arterial Highways.* " Transportation Research Record of the Transportation Research Board, No.23998, Pp.101-109. Transportation Research Board of the National Academies, Washington, DC 2013.

Saving Lives with Sustainable Transport. World Resources Institute, EMBARQ.

The Economic Benefits of Sustainable Streets., New York City Department of Transportation.

Planning and Design for Sustaining Urban Mobility: Policy Directions. Global Report on Human Settlements 2013, United Nations Human Settlements Programme

www.smartgrowthamerica.org/complete-streets/

Land Use Planning and Urban Transport, Sustainable Transport: A Sourcebook for Policy-makers in Developing Cities, Module 2a, September, 2004, Deutsche Gesellschaft fur Technische Zusammernarbeit (GTZ) GmbH

MCCANN, B and RYNNE, S., Editors, Complete Streets: Best Policy and Implementation Practices, American Planning Association, 2010

LITTMAN, T. and STEELE, R., Land Use Impacts on Transport: How Land Use FactorsAffect Travel Behavior, Victoria Transport Policy Institute, 2015

http://web.worldbank.org/WBSITE/EXTERNAL/TOPICS/EXTTRANSPORT/EXTURBANTR ANSPORT/0,,contentMDK:23215585~menuPK:8717821~pagePK:210058~piPK:210062~theSi tePK:341449,00.html

EWING, R and CERVERO, R; Travel and the Built Environment: A Meta-Analysis, Journal of the American Planning Association, May 2010

EL-GENEIDY, A. M., LEVINSON, D. M.; Access to Destinations: Development of Accessibility Measures, Report # 1 in the series Access to Destinations Study, 2006 http://www.lrrb.org/ media/reports/200616.pdf

Workshop for Building Inspectors, Post-Georges Disaster Mitigation Project in Antigua & Barbuda and St. Kitts & Nevis, April 2001; *www.oas.org/pgdm/document/BITC/papers/dthomas.htm* 

Safety Effectiveness of Highway Design Features, Volume I, Access Control, FHWA, 1992

LEAF, W.A. and PREUSSER, D.F., "Literature Review on Vehicle Travel Speeds and Pedestrian Injuries Among Selected Racial/Ethnic Groups," US Department of Transportation, National Highway Traffic Safety Administration, 1999.

PEMER, M., Developing a sustainable compact city in Stockholm, Sweden, Stockholm City Planning Administration, 2001, *www.un.org/ga/Istanbul+5/7-Sweden.doc* NELSON, A; Stockholm, Sweden : City of Water; *http://depts.washington.edu/open2100/ Resources/1\_OpenSpaceSystems/Open\_Space\_Systems/Stockholm\_Case\_Study.pdf*, accessed 22 Sept 2014

Project for Public Spaces, accessed July 2014, http://www.pps.org/

Planning and Design for Sustainable Urban Mobility: Policy Directions, Global Report on Human Settlements, 2013, IN HABITAT for a better urban future

MTANTATO, S, Chapter 11: Impact of current Land-Use Patterns On Public Transport And Human Settlements, Submission for the 2012/13 Division of Revenue Technical Report, Financial and Fiscal Commission, South Africa, 2011

Malaysia National Physical Plan, 2005, www.kpkt.gov.my/kpkt\_2013/fileupload/dasar/NPP.pdf

Paine, M., Devices to help drivers control their speed - Intelligent Speed Assist\* (ISA), accessed September 2014 *http://users.tpg.com.au/users/mpaine/speed.html* 

Developments in Safer Motor Vehicles, Conference organised by SAE Australasia and *NSW Parliament Staysafe Committee*, 1998 Parliament House, New South Wales Road Safety Speed, World Health Organization, 2004, http://www.who.int/violence\_injury\_ prevention/publications/road\_traffic/world\_report/speed\_en.pdf

Online TDM Encyclopedia, Victoria Transport Policy Institute, Land Use Impacts on Transportation, *www.vtpi.org/tdm/* 

Safety Effectiveness of Highway Design Features, Volume I, Access Control, FHWA, 1992

*http://www.fhwa.dot.gov/environment/publications/flexibility/ch03.cfm* Flexibility in Highway Design, FHWA, 1997.

EPA Office of Sustainable Communities, http://www.epa.gov/smartgrowth/

Access Management Manual, Transportation Research Board, Washington, DC.

Road Safety Audits, FHWA Office of Safety, http://safety.fhwa.dot.gov/rsa/

Road safety audit guidelines for safety checks of new road projects, World Road Association, 2011

Using Victoria's Planning System, Victoria Department of Planning and Community Development,

http://www.dtpli.vic.gov.au/planning/about-planning/a-guide-to-the-planning-system Guidelines for land-use planning, FAO Development Series 1, Food and Agriculture Organization of the United Nations, 1993, ISSN 1020-0819

GILAT, M. S, Coordinated Transportation and Land Use Planning in the Developing World: Case Study of Mexico City; Transportation Research Record No. 1859, Sustainability and Environmental Concerns in Transportation, 2003

Pedestrian Safety : A Road Safety Manual for Decision-Makers and Practitioner, World Health Organization, 2013

Stopping Distance for Cars, Road Safety Authority http://www.rulesoftheroad.ie/ rules-for-driving/speed-limits/speed-limits\_stopping-distances-cars.html

National Land Utilisation Policy. Framework for land use planning & Management, Draft : Version 2, Department of Land Resources, Ministry of Rural Development, Government of India, Septmeber 2013.

Urban Development Plans Formulation and Implementation (UDPFI) Guidelines; Volume 1; Ministry of Urban Affairs and Employment, August 1996.

Land Use Planning and Urban Transport, Deutsche Gesellschaft fur Technische Zusammernarbeit (GTZ) GmbH, ISOCARP, modified by Wuppertal Institute retreieved from *http://www.unchs.org/unchs/english/urbanpl/asian/asian.htm#4* 

#### 6. GLOSSARY

TERM	DEFINITION
Roadway Functional Classification	the process by which streets and highways are grouped into classes, or systems, according to the character of traffic service that they are intended to provide
Planning	the scientific, aesthetic, and orderly disposition of land, resources, facilities and services with a view to securing the physical, economic and social efficiency, health and well-being of urban and rural communities
Land use	the function and form of human development and land management activities (physical characteristics as well as how it is used)
Density	how many housing units per acre, floor area of retail use, industrial uses, etc.
Arterial	Provides the highest level of service at the greatest speed for the longest uninterrupted distance, with some degree of access control.
Collector	Provides a less highly developed level of service at a lower speed for shorter distances by collecting traffic from local roads and connecting them with arterials.
Local	Consists of all roads not defined as arterials or collectors; primarily provides access to land with little or no through movement.
Residential	Ttype of development dominated by single-family or multi-family homes that are located along local roads with connection to the arterial roadway network. Home offices for certain professional services may be allowed as well.
Commercial	Type of development that includes offices, shops, restaurants, and professional services which are usually located along collector or arterial roads that carry heavier traffic loads than local residential streets.
Institutional	Type of development that can include hospitals, universities, and schools.
Industrial	Type of development that includes manufacturing and processing plants, warehouses and storage.
Agricultural	Type of development that includes farms, raising crops and livestock.
Open space	Unbuilt space. Land use that is typically preserved as parks or conservation areas which may or may not be open to the public.
Transit Oriented Development	Land use that includes a mixture of residential and commercial and amenities integrated into a walkable neighborhood located near quality public transportation.
Accessibility	the ability to reach desired destinations such as jobs, shopping, or recreational opportunities
Metropolitan Communities	the systematic control of the location, spacing, design and operation of driveways, median openings, interchanges, and street connections.
Access Management	the systematic control of the location, spacing, design and operation of driveways, median openings, interchanges, and street connections.
Complete Streets	a movement in the United States to ensure that the entire right-of-way is planned, designed, constructed, operated, and maintained to provide safe access for all users



Copyright by the World Road Association. All rights reserved.

World Road Association (PIARC) Tour Pascal - 19<sup>e</sup> étage 92055 La Défense CEDEX, FRANCE

International Standard Book Number: 978-2-84060-440-2 Frontcover © Technical Committee 3.1