Traffic Impact Assessment and Land Use Development and Decision Making

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This paper shows that Urbanisation is taking place at a rapid pace in many parts of the world and these expanding cities change the social structure of the cities. Land Use planning decisions creates more urban areas and thus creates changing travel patterns, which have an impact on traffic related risks to society as a whole. Land use development decision making processes and Traffic Impact Assessment (TIA) study outcomes provide guidance to decision makers to approve the land use developments. The content of each TIA differ according to the type of development and its geographical location. Land use development decisions impacts society, economy; environment, travel patterns and performance of transport networks thus create traffic congestion and accidents. Limitations to transport network often affect the performance of transport networks and creates a cascading effect on all other critical infrastructure systems that depend on the transport networks. The performance changes of transport networks are linked to land use development decision makings. This paper examines issues arising from Traffic Impact Assessment (TIA). The focus of this paper is to investigate the impact of TIA and decision making processes on transport system and society. Transport networks are one of the main critical infrastructure systems that need to be managed. This research utilises case studies to assess the components of TIA and its impact on transport infrastructure systems. Firstly, gap analysis is used to identify the gaps in TIA contents how it affects the transport infrastructure systems. Secondly, Risk analysis is used to analyse accident data, in order to identify social costs due to accidents. A set of recommendations to overcome the shortcomings of existing planning and TIA designing process is presented.

Key Words: *Traffic Impact Assessment, Transport Planning, Land Use Development, Traffic Accidents, Performance of Transport network infrastructure and social risks and costs.*

1. INTRODUCTION

Informal land use developments are seen as the main problem that is causing all these traffic congestion, road safety and environmental pollution issues. The existing land use development approval decision making strategies and policies create the present day transport issues. It is important to understand the processes and decision making to be able to improve and land use planning and transport planning integration between the two authorities. In many countries there are many authorities administering land use development components, such as land use allocation, land use strategy formations and land use conversions from rural or farmland to residential or commercial separate to transport planning. Transport planning is done by the State transport authorities. Due to this each responsible authority follows their own set of strategies and policies. Integration between authorities is not a frequent practice. This break up of coordination and planning between agencies leads to many difficulties, such as administration and implementation of required critical transport infrastructure. Therefore it's required to carry out holistic planning to ascertain the true dynamics within cities and how authorities could provide the infrastructure during land use development processes. Transport system upgrades or additional network improvements are needed to provide for urban expansion. One of the main issues that affect this is fragmental or ad-hoc residential and commercial developments

planned without giving proper consideration to strategic transport planning. Transport planning and coordination should be considered at all levels of government (national, state and local) and at international level. This way of strategic planning will improve connectivity between these levels of transport system networks. The transport system has its own complexities. Governments and countries rely on the transport systems for promoting goods and services for economic gains. For the city decision makers, to arrive at proper decisions, there tools that are used need to be reliable and accurate. It is recognised that it is important to understand the total dynamics of adjacent transport networks and connections, before any decisions are taken to approve major developments, which will change the travel patterns and have an impact on the network.

Road networks play an important role by connecting cities, townships and countries providing services for different configurations of CI systems. These networks also facilitate provision of other critical infrastructure (CI) services which are located within road reserves. Gas, water, sewerage, electricity, telecommunication and fibre optic cables are laid underground as well as above ground, which depend heavily on the transportation network to maintain their functionality.

Many local governments in Australia have their own typical road reserve layouts similar to Figure 1. Road reserve is used by utilities such as telephone, water, telecommunication, internet, electricity, gas, lighting and drainage uses road reserves for accessibility and trees planted along the shoulders to provide aesthetics and/or shade. Most of the CI services are located underground at different depths and at different offsets from the road reserve edge.

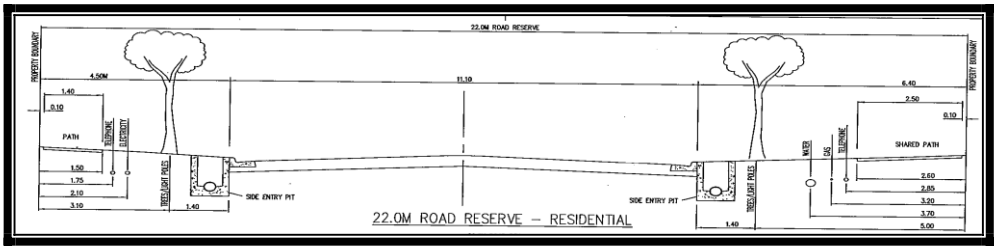


Fig.1 Service utilities within road Reserve
(Source: City of Greater Dandenong, SD 018 –Rev C, May 2005)

Modern supply chains due to concepts such as “agility”, “just in time” and “lean” are increasingly relying on efficient transport infrastructure. The reliance on the transport network is immense. Any negative impact on the transport network has an enormous impact on supply chains and CI functionalities.

(1) Importance of Transport Networks

Transport network reliability is important and defined “as the ability of the transport system to provide the expected level of service quality, upon which users have organised their activities[1)].

Transportation system is a key critical infrastructure component. In most countries the road and transport infrastructure is considered a national priority. The transport system is designed to cater to the community needs and provide accessibility to goods and services and also provide “escape routes” during disasters. The travel pattern of movement in a network may change dramatically after a disaster, due to people evacuating an area or people entering an area to render assistance[2)]. The transport system supports economic growth and helps sustain GDP in developed countries and reduces poverty in developing countries and designed to cater to community needs and provide reliability and accessibility to CI service structure. Transport networks needs to be improved as well as new networks needs to be constructed to cater to the growing urban population and to improve social status of people.

(2) Critical Infrastructure

Critical transport infrastructure protection is a research area which has raised many interesting challenges. One of the critical infrastructure systems common to all countries in the world is transport infrastructure. In Australia, the Trusted Information Sharing Network (TISN 2003)[3)] defines CI as “those physical facilities, supply chains, information technologies and communication networks which, if destroyed, degraded or rendered unavailable for an extended period, would adversely impact on the social or economic well-being

of the nation or affect Australia's ability to ensure national security". The provision of protection to CI systems is identified as Critical Infrastructure Protection (CIP). The CI would comprise a range of systems such as buildings, bridges, airports, harbours, roads, canals, reservoirs and software systems related to computers and the internet. The networks include transport systems; energy distribution systems etc. Most countries have identified a list of CI **(Table 1)** relevant to their economies and continuance of services with applicable protection mechanisms.

Table 1 Critical infrastructure types identified by selected countries

IDENTIFIED AS CRITICAL INFRASTRUCTURE				
CI	**AUSTRALIA**	**GERMANY**	**JAPAN**	**USA**
Transport	YES	YES	YES	YES
Communications	YES	YES	YES	YES
Energy	YES	YES	YES	YES
Banking & Finance	YES	YES	YES	YES
Health	YES	YES	YES	YES
Utilities	YES	NO	YES	YES
Food	YES	YES	NO	YES
Icons	YES	YES	NO	YES
Emergency Services	YES	NO	NO	YES
Defence	NO	YES	NO	YES
Administration	NO	YES	YES	NO
Industry	NO	YES	NO	YES
Stock Markets	NO	YES	NO	NO

The dependencies between critical infrastructures are very much interwoven. Many findings suggest that if one CI, it will have a flow on effect on other CI systems. Many studies have shown the detrimental effects of these cascading damages. European critical infrastructure (ECI) identifies the importance of CI systems within the European networks.

(3) Transport- Issues

Transport movements and type of vehicles combinations and available road space for vehicles plus transport infrastructure dictates all the conditions, such as environmental pollution due to air pollution or road safety or travel times and reliability. The Council of Australian Government report has estimated that economic costs due to congestion in the city of Sydney is $3.5 billion in 2005 and will rise to $7.8 billion in 2020[4].

(4) World Population (WP)

The world population increases every year and with it brings many challenges to decision and policy makers. The world population is increasing as well as moving away from rural areas to urbanised areas. This trend will continue in the future. Cities need to be better equipped to provide services for the population increases. Most of the statistical evidence shows that the world population have gone past 6 billion in 2000 and will be around 9 billion in 2050[5]. And further adds that between 2007 and 2025, the world urban population is expected to increase by 3.1 billion people[6]. Population growth rates in the world differ. In Europe, growth over the next 20 years will have an annual growth rate of 0.2%, where as in Asia it is higher and in Thailand it was found to be 0.4% per year between 2003 and 2005[7] .And it is projected that between 2000 and 2030, world population will grow at an average 1.8% (United Nations, 2005)[8] .

(5) Urbanisation

Urbanisation took place in Europe and now it is happening all over the world. The urban population increased from 270 million in 1920 to 3.3 billion in 2007[6] .It was identified that 220 million people or 13% of world population lived in urban areas in 1900 and increased to 732 million people or 29% in 1950[9] . And

as a whole living in cities rose from 29.8% (1950) to 37.9% (1975) and to 47.2% (2000), and it will probably increase to 57.2% in 2010 or 60.2% in 2030 (UN 2002:4) [10].
The urban areas have much needed basic services and goods and trade takes place at a higher rate than in rural environments. In 2007, the United Nations projected that 3.3 billion persons worldwide would be living in urban areas in 2008, constituting more than half of the world's population (UNFPA, 2007)[8] .It was stated that towns and cities constitute just 2.8 per cent of the earth's surface[11] and holds half of the world population since 2008[11]. Countries such as Australia, New Zealand and North America have gone past 80% urbanisation[6] .Urban population rate in Asia will rise to 63% or 3.3 billion people by 2050, of the projected 5.3 billion world population[11] .Most of the Asian countries is developing at a rapid space. The demand for housing has forced countries such as china, to convert rural areas into cities by building residential developments and towns. The above findings indicate that the urbanisation will continue to happen throughout the world at different rates and impose many challenges to cities and city decision makers. Urbanisation policies have to consider not only the benefits that will bring, but also the issues that are part of the urbanisation process.

(6) Mega Cities

Urbanisation forces cities to expand rapidly and join with other cities to create "Mega Cities" which hold more than 10 million people within the boundaries. It is considered that megacities are new phenomena of worldwide urbanisation processes. And further ads that this is due to globalisation and are subject to global ecological, socio-economical, and political change[10]. In 1950 only New York and Tokyo was considered as the only two megacities. In 2010, 21 cities were categorised as megacities and 15 of these are in the developing world regions[12] .It was identified that Asia has 11 mega-cities; Latin America has four; Northern America, two; and Africa and Europe both have one. Over the next 15 years an additional five would have been created in Asia, two in Africa and one in Europe[10]. It is also identified that Scientists estimate that by 2015 the world may contain as many as 60 megacities, together housing more than 600 million people[13].

(7) Reasons for urbanisation

People move into cities from rural areas to improve their social standards and to get better access to basic services. Cities provide employment opportunities and services such as water, education, sewerage and, health and other facilities compared to rural living standards. Another reason is due to people gathering in areas where it gives geographic benefits, similar to Australian main cities. All built along the coast line, away from Central areas of Australia where the climatic conditions are harsh and inhabitable due to lack of water, transport access, health facilities etc. As cities grow, they need workers to carry out the daily tasks a city creates. Cities attract businesses and good and service trading takes place.

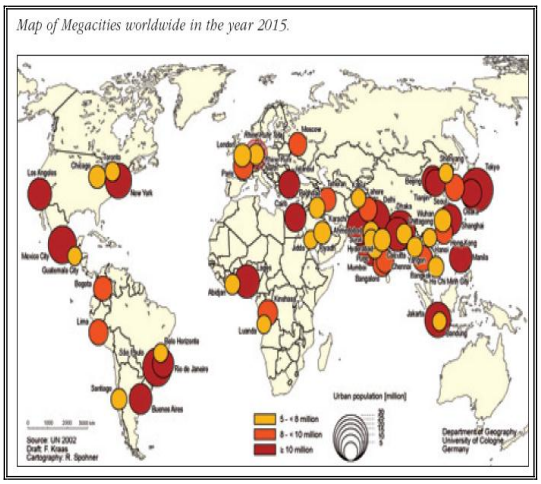


Fig.2 Megacities

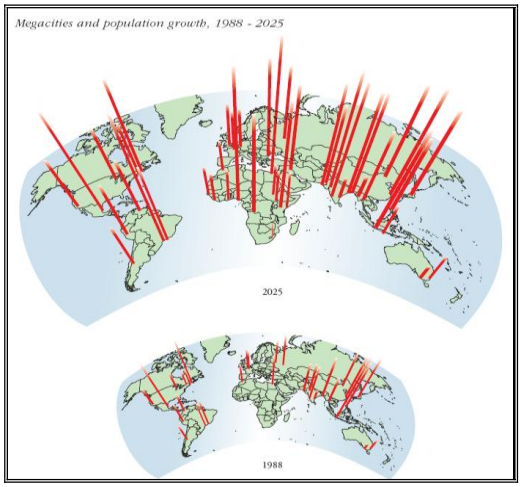


Fig.3 Megacities

(Figures 2 & 3 , Source: Megacities - our global urban future, Earth Sciences for Society Foundation, Leiden, The Netherlands, December 2005, Available at : www.yearofplanetearth.org. [14].

(8) Issues arising from Urbanisation

Megacities have estimated populations over 10 million people and cities will continue to attract people from rural areas and other cities and countries. These megacities have high population concentrations that satisfy available employment opportunities within theses cities and also create a percentage of un-employment. Increase in population, creates a demand for services and natural resources and also responsible for urban pollution. The transport networks within these cities gets congested due to heavy traffic movements that are generated due to economic productivity and people movements. This increase in population makes land space more valuable and the demand for land exceeds supply. Increase in economic activities, such as good and service trade tend to bring in increase economic benefits to the society and improve quality of life to people who are able to afford the services.

(9) Urbanisation and Pollution

The quality of life in megacities is low due to Poor air quality, water and energy shortages, erosion and soil pollution, traffic congestion, health problems, limited open spaces and the creation of slum dwellings. And the finding suggests that 70% of urban population will be exposed to unacceptable levels of pollution for humans[15]. It is also stated that the 20 largest cities consume 80% of the world's energy and urban areas generate 80% of greenhouse gas emissions worldwide[9]. Some of the transport generated pollutants are Carbon monoxide (CO), Volatile organise compounds, Sulphur dioxide, Lead (Pb), particulates and others.

(10) Urbanisation and Slums

As cities attract people, it also creates slum dwellings. In 2002, United Nations defined slums as "insecure residential status, poor structural quality of housing, overcrowding, and inadequate access to safe water, sanitation, and other infrastructure" (United Nations Human Settlements Program, 2003)[8]. Every major city houses slums. People who live in slums are faced with un-employment, poor living conditions, health issues, such as malnutrition and sicknesses and are more vulnerable to environmental disasters. It is found that the world's slum population is expected to reach 1.4 billion by 2020[9] and worldwide the slum population will grow at the rate of 27 million per year, between 2000 and 2020[8]. The worst case scenario is that if no serious action is taken to address these living conditions, that there will be over two billion slum dwellers in the next 30 years[8].

(11) Risk & Vulnerability

When cities amalgamate and make mega cities, some city areas are prioritised for development of buildings of infrastructure. The city expansions are limited by existing geographic limitations. Some areas are good for development and others are prone to environmental hazards, such as landslides or flooding or sea water rising areas. Due to the pressure for land areas, slums are built at theses geographically hazardous areas. These vulnerable slum dwellers are put at risk due to economic hardships. During a disaster of any sort, mostly poor people get affected. Most of the city planners fail to understand the dynamics that takes place within a city, when planning for the future. After any disaster, community gets back due resilient qualities within them and their communities. Therefore vulnerable communities create demand for better planning.

2. DECISION MAKING IN LAND USE PLANNING

(1) Land use development approval in Australia, Victoria

All land use planning processes and decisions have an impact on society and communities and affect peoples' livelihood and amenity and any consequences of planning decisions affect the society for a long time. In Victoria, the Planning and Environment Act 1987 (The Act) is the legislative basis of the planning system. The purpose of the Act is: "To establish a framework for planning the use, development and protection of land in Victoria in the present and long term interests of all Victorians"[24]. Council Plan and the Municipal Strategic Statement provide direction about the strategic objectives for land use planning within the municipality. Strategic planning develops strategic objectives and policies and facilitates Council to achieve Local Planning policies and objectives. Planning process decisions such as new public transport, new shopping centre, location of parks, bike paths, new road layouts have an effect on societies. These planning decisions influences Communities on how they go about their day to day things, like getting to

work, Schools, shopping and visiting and most importantly providing escape routes during disasters. Planning permit is a legal document that gives permission for a use or development on a particular piece of land. And every municipality in Victoria has its own planning scheme. It sets out the objectives, strategies, policies and controls for the use, development and protection of land in the present and long term interests of all Victorians. As shown on the two tables below, over 50,000 permits are issued in Victoria each year and 300 – 400 planning scheme amendments are approved per year (Tables 2 & 3) in Victoria.

Table 2 Planning Permit Applications

Number of Planning Permit Applications in Victoria			
	2004 - 05	**2005 - 06**	**2006 - 07**
Victoria	53260	50667	49587
Melbourne Metropolitan	33271	32117	31289
Rural / Regional	19989	18550	18298

Table 3 Planning Scheme Amendments

Number of Approvals of Planning Scheme Amendments in Victoria	
Year	**Number of Amendments**
2004 - 05	332
2005 - 06	432
2006 - 07	405

(Source: Auditor General's Report, Victoria's Planning Framework for Land Use and Development Victorian Auditor-General, May 2008, (Page 16)[16].

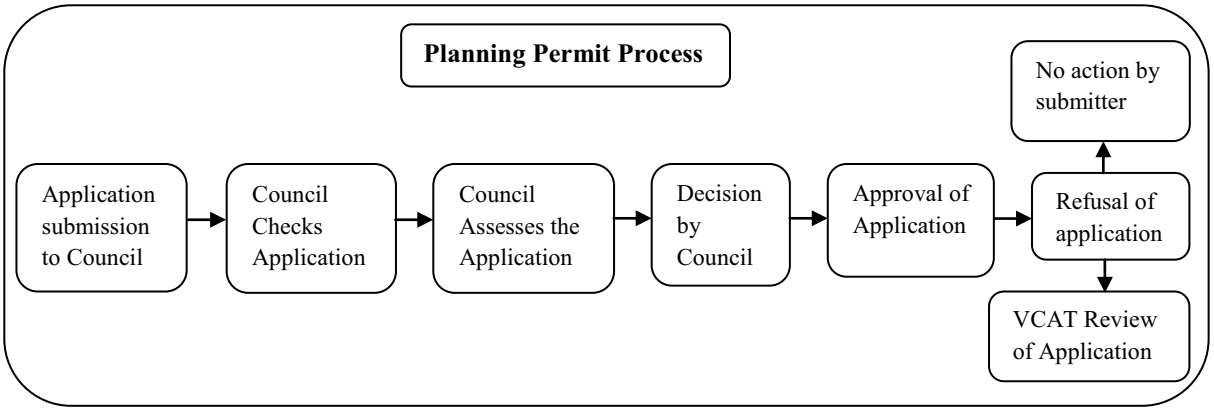


Fig.4 Planning permit flow path framework

There are two main types of planning:

a) Strategic Planning – provides the broad policy frameworks for specific land use developments.
b) Statutory Planning – includes developing and amending planning schemes, processing applications for planning permits.

(2) Components of Victorian Planning Scheme Framework

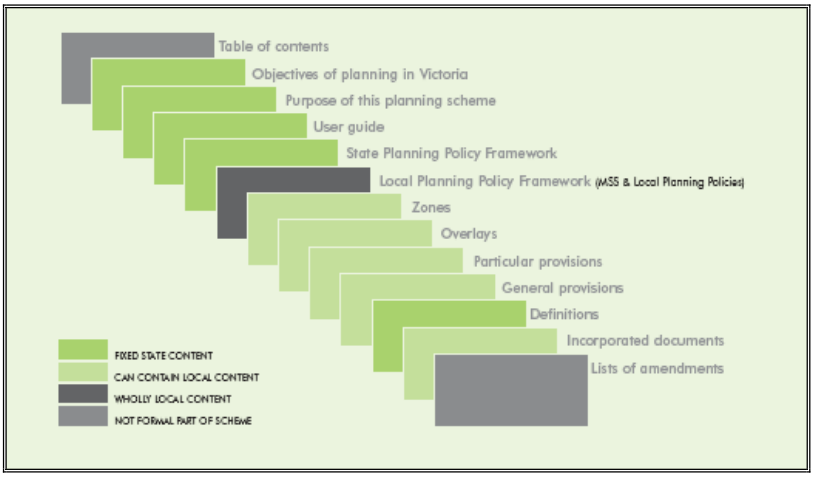


Fig.5 Planning Scheme Framework
(Source: Land Use Planning in Victoria –A Councillor's Guide, (Page 26)[17].

- **State Planning Policy Framework (SPPF)** - prepared by the State Government / Minister for Planning. This sets out State planning policies (E.g. Metropolitan development, settlement, environment, housing, economic development, infrastructure, subdivision, gaming, design and built form). Every planning scheme includes the SPPF.
- **Local Planning Policy Framework (LPPF)** - prepared by the council and approved by the Minister for Planning. The LPPF must be consistent with the SPPF and contains the Municipal Strategic Statement (MSS) and Local planning policies.
- **The Municipal Strategies Statement (MSS) -** The Municipal Strategic Statement (MSS) is the foundation of the strategic planning framework and provides the basis of planning decisions in a municipality and contains council's strategic planning, land use and development objectives and strategies for achieving these objectives.
- **VCAT (the Victorian Civil and Administrative Tribunal) -** The council's decision about a planning permit application may not be final. VCAT independently reviews decisions made by councils about planning permit applications and other planning matters. VCAT functions in accordance with the ***Victorian Civil and Administrative Tribunal Act*** **1998**. The State Government appoints VCAT members who are qualified legal practitioners, planners and other specialists. The Minister for Planning is not responsible for VCAT. The Tribunal's decision may indicate an ambiguity about the interpretation or application of a local policy in the planning scheme or a gap or uncertainty in the MSS. The Tribunal's decision is final unless there is a question of law that can be taken to the Supreme Court. Legal advice is essential before following this course of action.

(3) Auditor General's Findings-Australia - Victoria's Land Use Planning Process

DDR PEARSON, Victorian Auditor-General, stated in the "Victoria's Planning Framework for Land Use and Development Report, 2008", that "Planning decisions affect the lives of all Victorians and they can have a significant impact on local communities, the environment, key industries and the broader economy". And he further stated that proper planning processes are essential to prevent inappropriate land use and development and all decision–making process should comply with the Planning and Environmental Act 1987(Pearson 2008). The Victoria's planning system has been subject to continuous reform since the early 1990s. As part of these reforms, the Act was amended in 1996 to introduce the Victoria Planning Provisions (VPP) and establish new format planning schemes with a strategic and performance-driven focus to reduce administrative costs and increase efficiency of the planning system" [16]. The report further stated that the existing Victoria's framework for controlling land use and development is complex and unclear and the existing arrangements do not allow for comprehensive measurement and monitoring of the overall performance of the planning system, measure the effectiveness and efficiency of advisory and statutory support services primarily provided to councils [16].

3. TRAFFIC IMPACT ASSESSMENT (TIA)

All commercial and non-commercial (residential) developments generate traffic movements. This generation of traffic depends on the location and size of the development and has an impact on the surrounding areas and on the existing local and arterial transport network. Most of the time it creates traffic congestion, air pollution and safety issues to public. Therefore for the decision makers, to take decisions regarding new developments, Traffic Impact Analysis or Assessment is used as a tool to guide them to assess each development. The Traffic Impact Assessment (TIA) report should be requested by local or state authority, responsible for making the decisions and should be prepared by an industry qualified traffic or transport engineer. The report should be an impartial report, highlighting all the facts., how it will impact on the surrounding road network and also identify existing transport network improvements, funding sources, infrastructure improvements to improve safety, ways to maintain a level of safety (LOS), new road connections, impact on amenity and safety. The TIA's should be comprehensive in all ways to address the issues. If the report contains all the relevant information, then it's easier for the decision makers to agree on remedial measures than the report being interpreted differently. In Table 8, the components of a TIA are shown.

4. CASE STUDY ANALYSIS

(1) Land Use Development of a Shopping Center in West Geelong, Victoria, Australia.
Reason: This case study was chosen, because four Traffic Engineering Consultants were engaged in this one development. Two consultants prepared the reports for the developer, one consultant peer reviewed the report and the other consultant peer reviewed the previous reports for the Independent Panel report. Normal practice is one traffic consultant will prepare one report to Council. The four reports produced due to issues raised by resident groups and therefore Council decided that it should be reviewed by an Independent Panel. The proposal is to rezone land from Industrial 1 Zone (IN1Z) to Mixed Use Zone (MUZ), Residential 1 Zone (R1Z) and Business 4 Zone (B4Z).

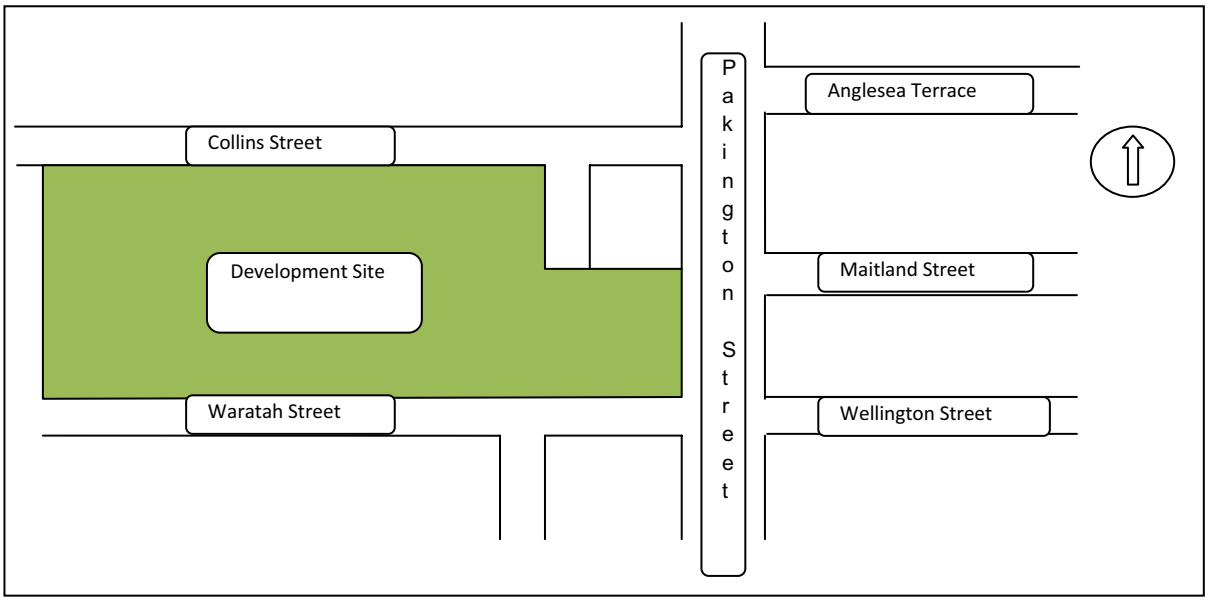


Fig.6 Proposed Shopping Center Area

The proposal requires a planning scheme amendment (Rezoning) and a planning permit application to proceed under the Planning & Environmental Act 1987.

The proposal was considered to be consistent with the SPPF &LPPF by the Developer, that it would encourage the consolidation and development of activity centres for a wide range of commercial & community users.

Table 4 Components of the development

Components of the development	
Supermarket = 3600 m^2gross leasable floor space	Car parking spaces = 320 spaces
Office = 450 m^2	Vehicle Access Points = 4
Specialty Shops = 2100 m^2	Store / Display Area = 140 m^2
4 two storey dwellings	

Accepted practice is Council should assess the application and decide one of the three options: to abandon the amendment, Change the amendment to suit the development proposal or refer to an independent panel to review the application. In this instance Council decided to give the application to an independent panel to review and prepare the report. There are existing conditions such as Design and Development Overlay 14 (DDO 14) and an Environmental audit Overlay (EAO) for the site. DDO 14 applies to building height of 7.5m. Main concerns raised by residents were – economic impact/Health Impact/ Amenity impact and heritage impact. Issues identified traffic movement and safety issues, inconsistency with the urban design guidelines, traffic impact on road network, lack of open space, and appropriateness of zone and land use. The developer is responsible for all new infrastructures, including services, signals, road works and intersection treatments.

Table 5 Traffic Accident Data Analysis (*Data 2011 up to June 30)

C96	400m radius				600m radius				1000m radius			
	Fatal=1	Serious injury =2	Other injury=3	Non-Injury=4	Fatal =1	Serious injury =2	Other injury =3	Non-Injury =4	Fatal =1	Serious injury =2	Other injury =3	Non-Injury =4
2005-2008	**0**	**8**	**4**	**4**	**0**	**10**	**9**	**5**	**0**	**16**	**31**	**12**
2009-2011*	**0**	**2**	**6**	**18**	**0**	**5**	**19**	**40**	**0**	**7**	**39**	**46**

(Full table in Appendix D.)

(2) Accident Data Analysis

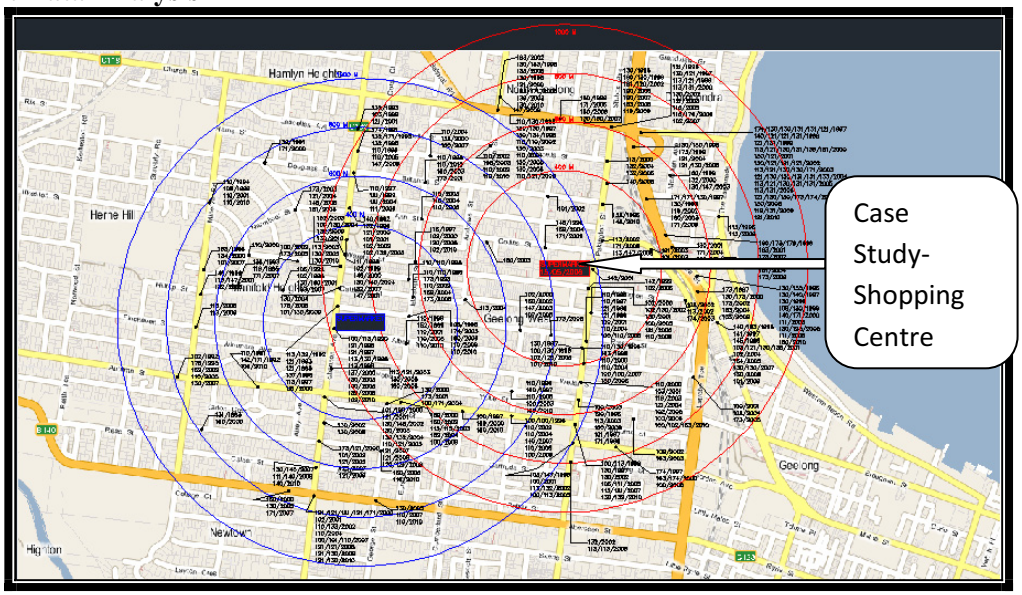


Fig.7 Accident data showing DCA's and Radius

The above data shows all the accidents that occurred between 2005 and 2011. Table 6 shows that vehicle – vehicle accidents have increased within the investigated area.

Table 6 Pedestrian related and vehicle/vehicle accident analysis

Definitions for Classifying Accidents (DCA) Analysis -Radius								
	Year	Pedestrian Related Accidents				Vehicle / Vehicle related Accidents			
		400m	600m	1000m	TOTAL	400m	600m	1000m	TOTAL
Before Development	2005	2	1	3	6	0	3	11	14
	2006	0	1	1	2	2	5	6	13
	2007	2	0	3	5	0	3	7	10
	2008	1	0	5	6	11	11	26	48
After Development	2009	1	3	6	10	7	25	38	70
	2010	2	3	4	9	8	21	27	56
	2011*	0	0	1	1	10	11	11	32

[DCA types shown in Appendix F]

Table 7 Accident Numbers – Before & After Development

Serious and other accidents -Radius									
Status of Development	Year	Serious Injury Accidents				Other and Non- Injury Accidents			
		400m	600m	1000m	TOTAL	400m	600m	1000m	TOTAL
Before Development	2005	0	0	4	4	2	4	10	16
	2006	2	4	1	7	0	2	5	7
	2007	2	3	4	9	0	0	6	6
	2008	4	3	7	14	6	8	22	36
After Development	2009	0	2	4	6	6	26	38	70
	2010	1	2	1	4	9	23	37	69
	2011*	1	1	2	4	9	10	10	29

[Total Accidents numbers according to distance from the development, *=Accident Data up to June 2011]

Table 7, shows total accidents have increased after the development year. But in the 400m radius the accidents before and after have stabilised to 10 accidents.

(3) Traffic Generation Estimates due to development

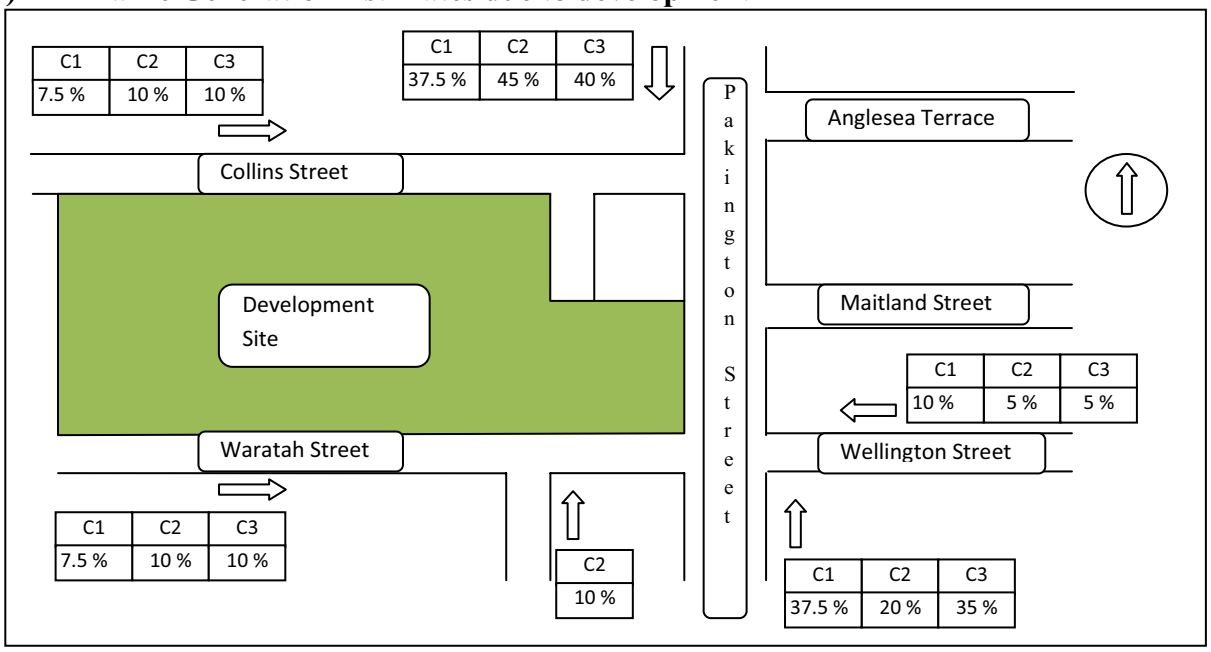


Fig.8 Traffic Generation Estimates by Consultants

[C1= Consultant for developer, C2= Consultant for developer, C3= Consultant –Peer review for Council, C4= Consultant Peer Review for Independent Panel]

Two of the four consultants discussed the traffic accidents close to the development site. C1 consultant identified two accidents (1997-2001) and C4 consultant identified four accidents (2000-2004). The following table 8 shows the main items that are in a TIA and how each consultant assessed the components.

(5) Summary of Gaps which contribute to increase in accidents

This case study highlighted that the four reports by the consultants differed in many ways. The traffic volumes considered varied and also the traffic generated by the development was not consistent. One of the main amenity issues were the safety. Only two consultants discussed the accidents in the area. But the actual accident numbers were much higher than the consultant estimates as shown in tables 6 & 7. And table.8 shows that there are gaps in the current practice of "Traffic Impact Assessment" processes. Most of the reports addressed the components, but each explanation varied from each other. And also the reports concentrated on the adjacent road network and not on the surrounding areas. It is accepted that each area is different and each development varies from one to another. The variations increase the complexity and the safety and risks to community. Whilst analysis of well known disaster events have identified gaps in the practices which led to the failure of CIs, linking these into strategic land use planning processes are still to be accomplished. Developing a process for improving the strategic transport and land use planning processes to enhance CI protection is therefore a key area which has to be addressed. The land use practices are still evolving and changing. Urbanisation is having a major impact on decision making processes. Cities expand rapidly than the policies getting updated. Therefore as shown in the case study, it is important to analyse impact to the society as a whole. During a major disaster, the failures to address the above will impact the society. And the transport network will suffer causing major losses to resident population. As the case study showed, accidents did not increase adjacent to the development, but increased further away due to traffic generation and flow towards the development. The decision makers should be able to make decisions on planning matters with accurate and relevant information and data.

Table 8 Traffic Impact Assessment Process and comparison[18)].

Traffic Impact Assessment of Consultant Reports						
Traffic Impact Assessment Main Items		**Traffic Consultants**				**Gaps identified in the process**
		C1	**C2**	**C3**	**C4**	
Main Item	**Sub Item**	**Identified in Report**				
Document proposed development	Audit development plans	Yes	Yes	Yes	Yes	Description varies
Resolve any initial problems with designers	Audit development plans	Yes	Yes	No	No	Only few issues identified
Identify area and stakeholder affected	Describe existing and design year conditions	No	No	No	Yes	Only adjacent areas identified
Determine generated traffic and modal split	Determine approach and departure directions	Yes	Yes	Yes	Yes	Partially addressed
	Assign traffic to roads	Yes	Yes	Yes	Yes	Partially addressed
	Determine where non-car traffic will go	Yes	No	No	No	Only few issues identified
Review limits of area affected		Yes	No	No	No	Only adjacent areas identified
Access traffic operation on roads	Assess traffic operation on site	Yes	Yes	Yes	Yes	
	Assess Pavement impact, Road Safety impact& Environmental Impacts	Yes	Yes	Yes	Yes	Only few issues identified
Determine required impact mitigating treatments		Yes	Yes	Yes	Yes	Only few issues identified
Obtain independent road safety engineering assessment		-	-	-	-	Done by CoGG
Document findings and recommendations		Yes	Yes	Yes	Yes	Description varies

APPENDICES

Appendix –A

Accident types before development

Year	DCA Types					
	400m radius		600m radius		1000m radius	
	DCA Type	No of accidents	DCA Type	No of accidents	DCA Type	No of accidents
2005	102	1	102	1	100	2
	107	1	110	1	106	1
			173	1	110	1
			174	1	111	1
					113	1
					121	1
					130	3
					132	1
					174	1
					175	1
					181	1

Year	DCA Types					
	400m radius		600m radius		1000m radius	
	DCA Type	No of accidents	DCA Type	No of accidents	DCA Type	No of accidents
2006	121	1	100	1	100	1
	171	1	110	3	113	3
			132	1	132	1
			160	1	160	1
2007	100	2	110	1	100	1
			140	1	102	1
			160	1	103	1
					113	1
					121	2
					130	2
					140	1
					163	1

Year	DCA Types					
	400m radius		600m radius		1000m radius	
	DCA Type	No of accidents	DCA Type	No of accidents	DCA Type	No of accidents
2008	100	1	120	1	140	2
	110	5	147	2	100	3
	130	1	132	2	130	8
	113	1	130	1	111	2
	172	2	140	1	160	2
	173	2	133	1	110	2
			171	2	121	4
			160	1	148	1
					132	1
					102	2
					163	1
					145	1

Appendix – B

Accident types after development

DCA Types						
Year	400m radius		600m radius		1000m radius	
	DCA Type	No of accidents	DCA Type	No of accidents	DCA Type	No of accidents
2009	109	1	110	4	130	4
	130	1	140	1	100	3
	152	1	130	6	103	1
	136	1	131	1	146	3
	145	1	136	1	120	2
	171	2	189	1	129	1
	160	1	121	2	110	6
			160	2	171	2
			133	2	121	4
			149	1	160	5
			101	1	113	2
			106	1	142	3
			100	1	132	1
			170	1	170	1
			150	1	181	1
			173	1	102	1
			144	1	115	1
					101	1

DCA Types						
Year	400m radius		600m radius		1000m radius	
	DCA Type	No of accidents	DCA Type	No of accidents	DCA Type	No of accidents
2010	101	1	100	2	102	2
	106	1	102	1	106	1
	110	1	110	8	107	1
	130	1	113	1	110	7
	142	1	116	2	112	1
	143	1	121	1	130	7
	144	2	130	3	132	1
	160	1	133	1	136	1
	171	1	142	1	140	2
			160	2	141	1
			173	2	149	1
					171	2
					173	1
					174	1
					179	1
					198	1

DCA Types						
Year	400m radius		600m radius		1000m radius	
	DCA Type	No of accidents	DCA Type	No of accidents	DCA Type	No of accidents
2011	160	2	130	4	198	1
	175	3	149	1	146	1
	149	1	110	1	110	1
	132	1	112	1	170	1
	146	1	174	1	130	2
	142	1	160	1	121	2
	120	1	170	2	171	1
					100	1
					111	1
					135	1

Appendix – C

Existing Traffic Volumes Surveys of Adjoining Roads –Vehicles per day (VPD)

Street Name	Location of Street and distance to site	C1=GTA Consultants Traffic Counts Jan 2003	C2=Grogan Richards Consultants Traffic Counts Apr-04	C3=Ratio Consultants Traffic Counts Aug 2006	City of Greater Geelong Traffic Counts	
					Before development 14-Nov-07	After Development 14-Feb-09
Anglesea Terrace	50m	280	250	-	309	309
Ann Street	500m	-	376	381	344	380
Britannia Street	400m	-	1319	1319	1562	1608
Bread Street	within	-	-	-	-	-
Catherine Street	550m	-	749	749	723	726
Collins Street	adjacent	1000	843	843	670	846
Donaghy Street	within	-	-	-	-	-
First Street	50m	-	-	-	216	336
John Street		-	-	-	598	605
Lawton Street	100m	-	1079	1079	907	877
Madden Street	100m	-	-	-	2766	2791
Maitland Street	Opposite side	370	90	-	313	298
McDougall Street		-	-	-	357	403
Pakington Street	Adjacent	11750	14729	14729	17612	17605
O'Connell Street	100m	-	917	917	931	888
Petrol Street		-	219	249	227	321
Raven Street		-	-	-	1329	1362
Waratah Street	Adjacent	1000	1161	1161	908	1393
Waterloo Street	75m	-	3918	3782	-	-
Wellington Street	Opposite	630	150	-	630	1038

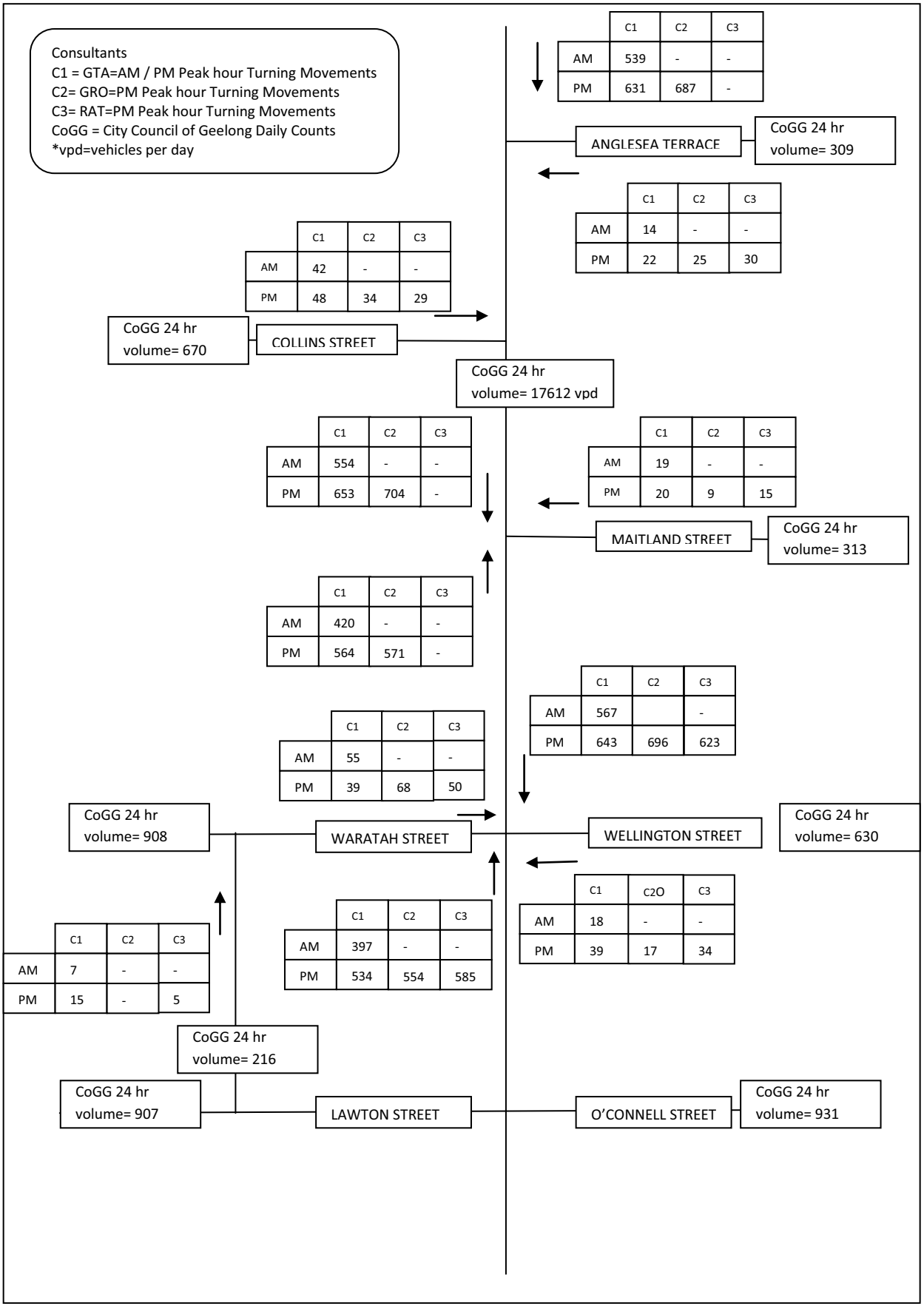
Appendix – D

Accidents numbers according to distance from the development

C96	400m radius				600m radius				1000m radius			
	Fatal=1	Serious injury =2	Other injury=3	Non-Injury=4	Fatal =1	Serious injury =2	Other injury =3	Non-Injury =4	Fatal =1	Serious injury =2	Other injury =3	Non-Injury =4
2005	0	0	2	0	0	0	4	0	0	4	10	0
2006	0	2	0	0	0	4	2	0	0	1	5	0
2007	0	2	0	0	0	3	0	0	0	4	6	0
2008	0	4	2	4	0	3	3	5	0	7	10	12
TOTAL	**0**	**8**	**4**	**4**	**0**	**10**	**9**	**5**	**0**	**16**	**31**	**12**
2009	0	0	2	4	0	2	3	23	0	4	17	21
2010	0	1	2	7	0	2	11	12	0	1	19	18
2011*	0	1	2	7	0	1	5	5	0	2	3	7
TOTAL	**0**	**2**	**6**	**18**	**0**	**5**	**19**	**40**	**0**	**7**	**39**	**46**

Appendix – E

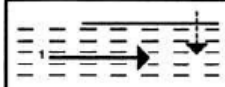
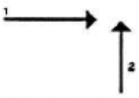
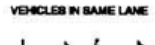
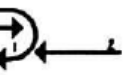
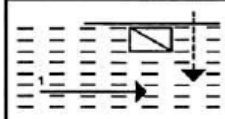
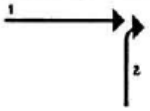
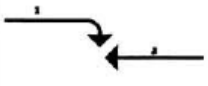
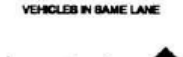
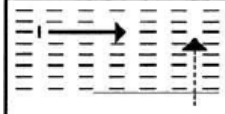
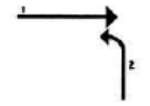
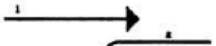
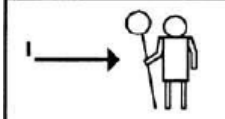
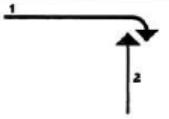
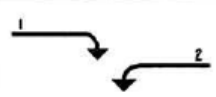
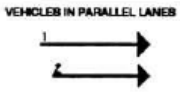
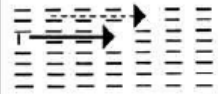
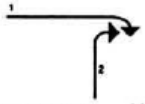
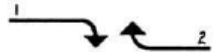
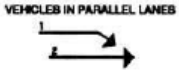
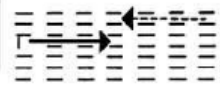
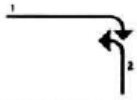
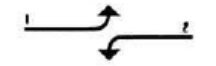
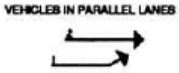
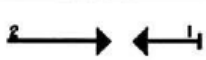
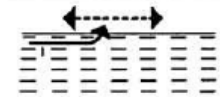
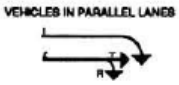
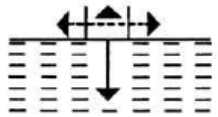
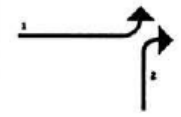
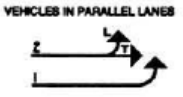
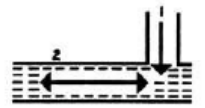
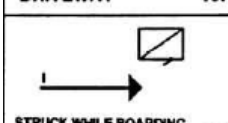
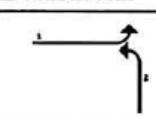
Existing AM / PM Traffic Volumes



Appendix –F

Definitions for Classifying Accidents (DCA)

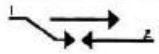
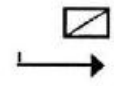
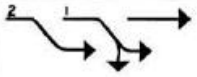
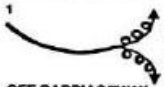
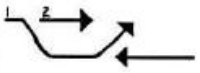
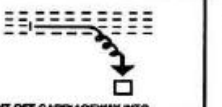
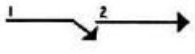
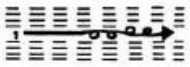
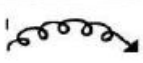
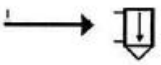
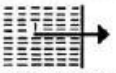
vicroads

PEDESTRIAN ON FOOT IN TOY / PRAM	VEHICLES FROM ADJACENT DIRECTIONS (INTERSECTIONS ONLY)	VEHICLES FROM OPPOSING DIRECTION	VEHICLES FROM SAME DIRECTION	MANOEUVRING
 NEAR SIDE 100	 CROSS TRAFFIC 110	 1 - WRONG SIDE 2 - OTHER HEAD ON (not overtaking) 120	 REAR END 130	 'U' TURN 140
 EMERGING 101	 RIGHT FAR 111	 RIGHT THROUGH 121	 LEFT REAR 131	 'U' TURN INTO FIXED OBJECT PARKED VEHICLE 141
 FAR SIDE 102	 LEFT FAR 112	 LEFT THROUGH 122	RIGHT REAR 132	 LEAVING PARKING 142
 PLAYING, WORKING, LYING, STANDING ON CARRIAGEWAY 103	 RIGHT NEAR 113	 RIGHT/LEFT 123	 LANE SIDE SWIPE 133	 ENTERING PARKING 143
 WALKING WITH TRAFFIC 104	 TWO TURNING RIGHT 114	 RIGHT/RIGHT 124	 LANE CHANGE RIGHT (not overtaking) 134	 PARKING VEHICLES ONLY 144
 FACING TRAFFIC 105	 RIGHT/LEFT FAR 115	 LEFT/LEFT 125	 LANE CHANGE LEFT 135	 REVERSING 145
 ON MEDIAN/FOOTPATH 106	 LEFT NEAR 116		 RIGHT TURN SIDE SWIPE 136	 REVERSING INTO FIXED OBJECT - PARKED VEHICLE 146
 DRIVEWAY 107	 LEFT/RIGHT FAR 117		 LEFT TURN SIDE SWIPE 137	 EMERGING FROM DRIVEWAY - LANE 147
 STRUCK WHILE BOARDING OR ALIGHTING VEHICLE 108	 TWO LEFT TURN 118			FROM FOOTWAY 148
OTHER PEDESTRIAN 109	OTHER ADJACENT 119	OTHER OPPOSING 129	OTHER SAME DIRECTION 139	OTHER MANOEUVRING 149

1. Definition for classifying accidents (DCA) should be determined by first selecting a column using the text above & then by diagrammatic sub-division.
2. The sub-division chosen should describe the general movement of vehicles involved in the initial event. It does not assign a cause to the accident.
3. Supplementary codes have been defined for most sub-divisions. These codes give further detail of the initial event.

Appendix –F (Cont)

DEFINITIONS FOR CLASSIFYING ACCIDENTS

OVERTAKING	ON PATH	OFF PATH ON STRAIGHT	OFF PATH ON CURVE	PASSENGER AND MISCELLANEOUS
 HEAD ON (not sideswipe) 150	 PARKED 160	 OFF CARRIAGEWAY TO LEFT 170	 OFF CARRIAGEWAY RIGHT BEND 180	 FELL IN/FROM VEHICLE 190
 OUT OF CONTROL 151	 DOUBLE PARKED 161	 LEFT OFF CARRIAGEWAY INTO OBJECT - PARKED VEHICLE 171	 OFF RIGHT BEND INTO OBJECT/PARKED VEHICLE 181	 LOAD OR MISSLE STRUCK VEHICLE 191
 PULLING OUT 152	 ACCIDENT OR BROKEN DOWN 162	 OFF CARRIAGEWAY TO RIGHT 172	 OFF CARRIAGEWAY LEFT BEND 182	 STRUCK TRAIN 192
 CUTTING IN 153	 VEHICLE DOOR 163	 RIGHT OFF CARRIAGEWAY INTO OBJECT - PARKED VEHICLE 173	 OFF LEFT BEND INTO OBJECT/PARKED VEHICLE 183	 STUCK RAILWAY CROSSING FURNITURE 193
 PULLING OUT - REAR END 154	 PERMANENT OBSTRUCTION ON CARRIAGEWAY 164	 OUT OF CONTROL ON CARRIAGEWAY 174	 OUT OF CONTROL ON CARRIAGEWAY 184	PARKED CAR RUN AWAY 194
	 TEMPORARY ROADWORKS 165	 OFF END OF ROAD 'T' INTERSECTION 175		
	 STRUCK OBJECT ON CARRIAGEWAY 166			
	 ANIMAL (not ridden) 167			
				OTHER 198
OTHER OVERTAKING 159	OTHER ON PATH 169	OTHER STRAIGHT 179	OTHER CURVE 189	? UNKNOWN 199

4. The number 1,2 identify individual vehicles involved when the DCA is linked with other vehicle/driver information.
5. These codes were used for 1987 accidents and replace the Road User Movement (RUM) code.

Produced by the Road User Behaviour Branch, Road Safety Division, VIC ROADS - DCA.pm4 & DCA2.pm4

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